BERNSTEIN

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Global ESG Research

Bernstein ESG Conference: Biodiversity Panel (Transcript)

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Biodiversity has become the topic of the day for investors. During our ESG conference, we hosted four expert speakers including Margaret Kuhlow, WWF Finance Practice Leader, Caroline Bushnell, VP of Corporate Engagement at the Good Food Institute (GFI), Erika Randolph, Director of Sustainability at Descartes Labs, and Sai Nellore, Principal Assistant Director-General, Fellowship Scheme Bureau, Blockchain & Climate Institute to discuss biodiversity loss as a systemic risk as well as emerging business model innovations and technological enablers as solutions for tackling this issue. We've summarized our key takeaways below.

Nature is valuable. Ecosystem services (e.g., biodiversity, renewable, and non-renewable resources) are valuable to the economy. However, the current level of biodiversity loss has direct impacts to the real economy that investors should factor into their risk analysis.

Agriculture and land use are the main drivers of biodiversity loss. Livestock now accounts for about 60% of the total mass of all mammals on the planet, with humans accounting for another 36%. Wildlife comprises merely 4%. The top two causes of biodiversity loss are overexploitation (including overfishing) and agricultural practices.

Alternative meat is one of the most actionable investment opportunities to tackle biodiversity loss. This includes not just plant-based meat, but also precision fermentation and cultivated meat which hold the potential to significantly reduce the land use, water use, toxic chemicals, and GHG emissions of traditional animal farming.

Another key challenge around biodiversity is the inability to track, measure, and map the loss of nature, but emerging technologies are providing solutions to do just that. Innovation such as satellite imaging data and remote censoring can provide greater visibility into overexploitation or environmental damage in a real time fashion.

Lastly, how do we trace biodiversity loss to the product and producer level? Blockchain technology could offer a solution on this front by providing greater supply chain traceability in a tamper-proof way. This increased level of traceability can also help companies promote their sustainable practices and better connect with consumers by showcasing where the product comes from and how the company has managed to reduce its environmental and biodiversity impacts along each step of the supply chain.

DETAILS

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

I am very pleased to introduce our next panel on biodiversity which has become the topic of the day. Anecdotally, biodiversity comes up in pretty much every single one of my client conversations, especially with European investors, and is becoming increasingly top of mind for US investors as well.

Joining us today are Margaret Kuhlow, WWF Finance Practice Leader, Caroline Bushnell, VP of Corporate Engagement at the Good Food Institute (GFI), Erika Randolph, Director of Sustainability at Descartes Labs, and Sai Nellore, Principal Assistant Director-General, Fellowship Scheme Bureau, Blockchain & Climate Institute.

Our four expert speakers will discuss the pressing importance of biodiversity today and how biodiversity loss impacts ecosystems, businesses, and society at large. In addition, the panel will touch upon emerging technological and business model innovation as solutions for tackling biodiversity loss.

Margaret Kuhlow, WWF Finance Practice Leader

I'm very pleased to be able to frame the panel in terms of defining biodiversity and its importance today, including the economic value of biodiversity and its relationship to pandemics. I will also briefly speak to the growing relationship between nature risk and financial risk, including from financial regulators, from efforts to improve disclosure, and finally in the context of the solution space.

EXHIBIT 1:

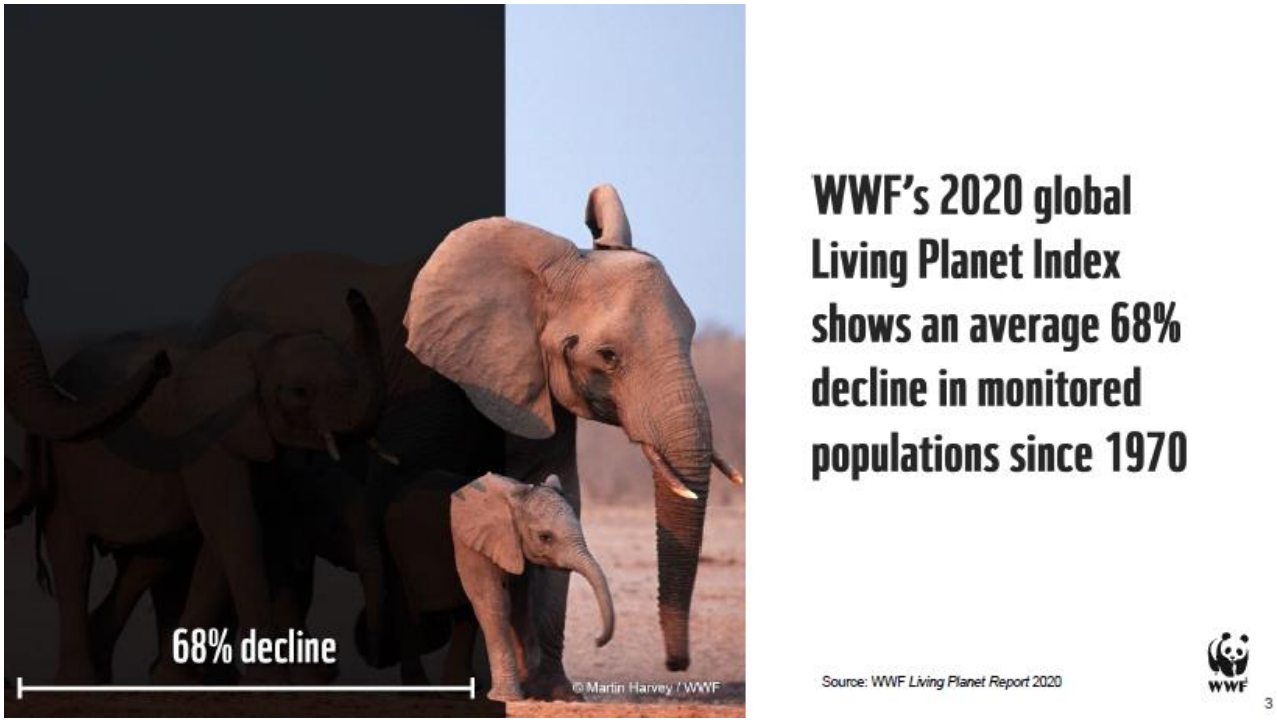
Source: WWF

I want to start with the question of 'what is biodiversity' by borrowing from a recent paper published in collaboration with scientists and other NGOs called 'A Nature Positive World'. The paper describes nature as 'stocks' and 'flows' in a way that's relatable to both investors and economists.

Nature can be thought of as a 'stock' of renewable and non-renewable resources such as plants, animals, air, water, soils and minerals, while 'flows' are the benefits to people from resources and ecosystem services. For example, ecosystem services are services such as the supply of water for agriculture, natural water filtration from forests, crop pollination, flood and storm surge protection, and carbon storage.

Generally, ecosystem services globally are worth an estimated $125-140 trillion a year, which is more than 1.5x the size of global GDP.

EXHIBIT 2:

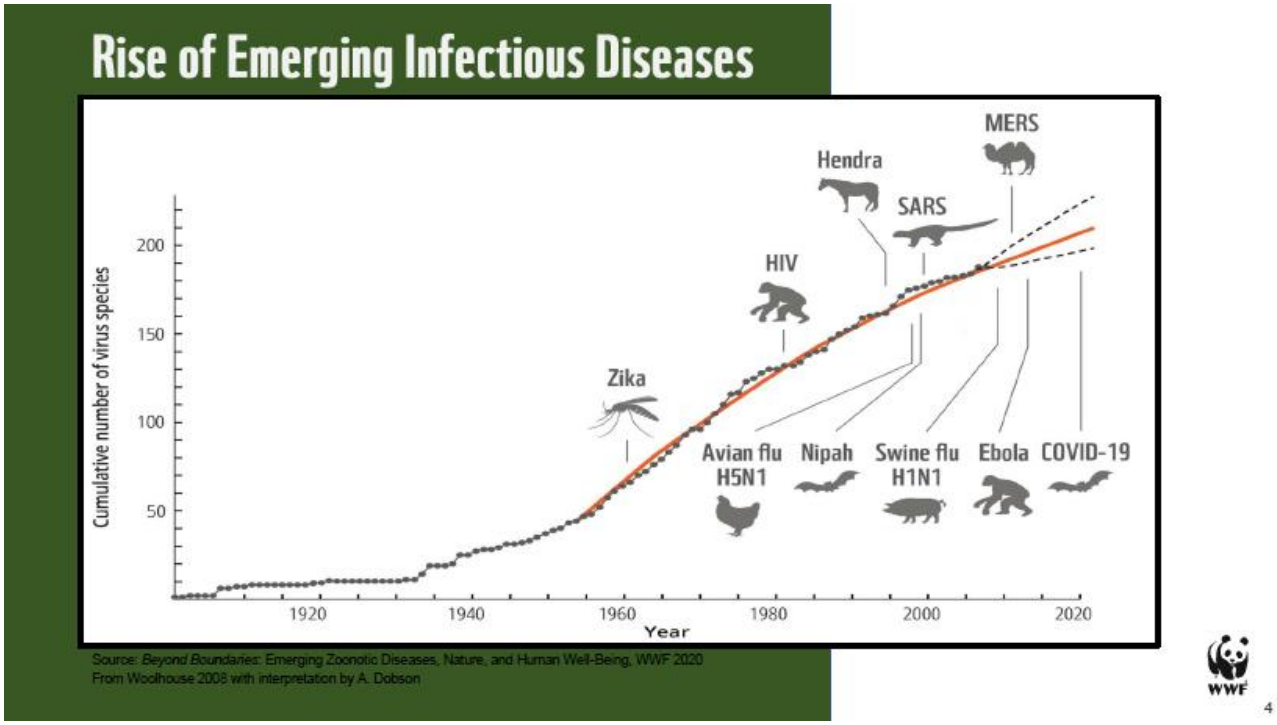


Source: WWF

While there's growing awareness of the physical impacts of rising temperature from climate change, including the melting Arctic, forest fires, dying coral reefs, flooding in cities, and droughts, we're also losing biodiversity at an alarming rate. There has been more than a 2/3 reduction of the average population size over the last 50 years and roughly 1 million species are at risk of extinction – many in our lifetime. The current level of biodiversity loss undermines the capacity of nature to limit rising temperatures and ultimately makes society less resilient in the face of physical impacts from climate change.

The current level of biodiversity loss is projected to undermine about 80% of the Sustainable Development Goals (SDGs), including targets on poverty, hunger, health, clean water, and cities. The direct impacts to the real economy are also rising into the billions – roughly $400 billion of global crop output is at risk due to the loss of bees and other pollinators. Overexploitation of fishing resources is estimated to lead to a shortfall of about $50 billion per year. Generally, biodiversity loss entails a loss of land-based ecosystem services worth about $50 billion each year.

EXHIBIT 3:

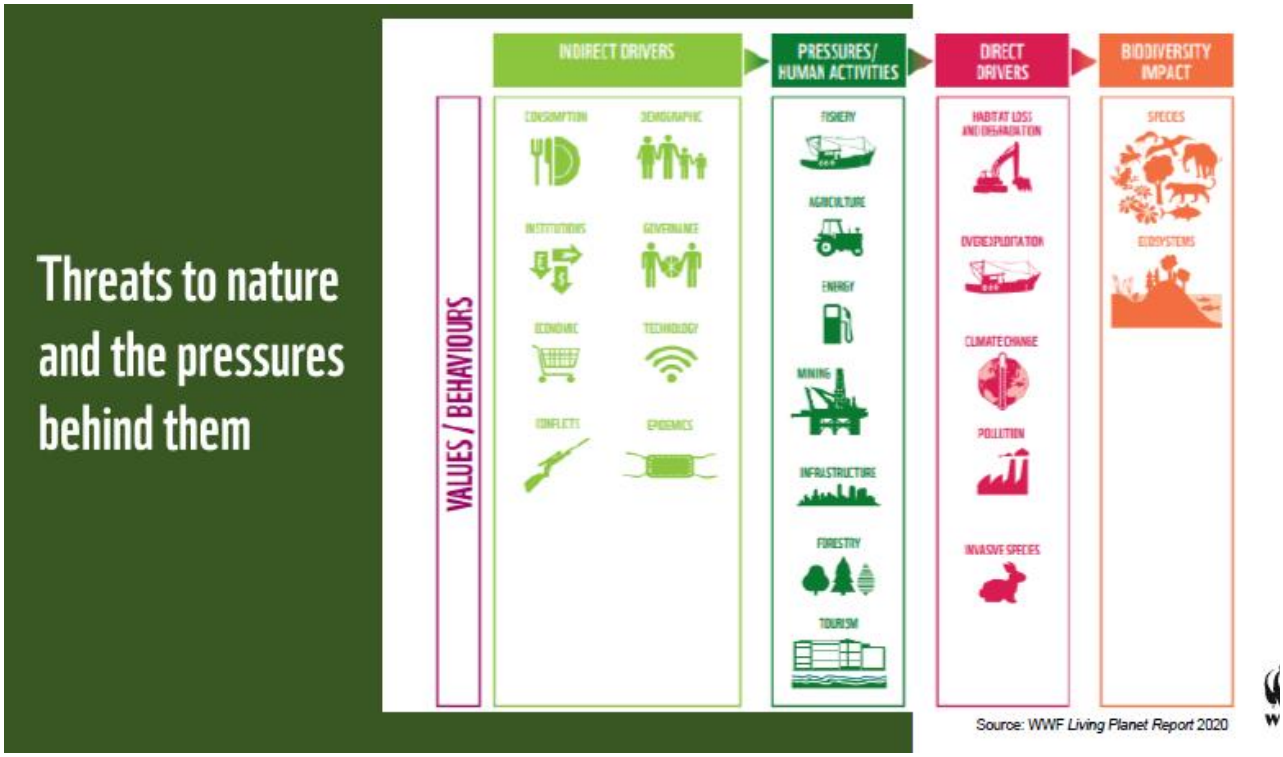


Source: WWF

We're currently living the health and economic ravages of a global pandemic against the backdrop of an increasing number of zoonotic diseases and spillover events. Exhibit 3 comes from a recently published report titled, 'Beyond the Boundaries,' which shows the cumulative number of virus species identified each year, the rise in emerging infectious diseases, and significant spillover events – from Zika around 1962 to COVID-19. A spillover event occurs when a zoonotic disease moves from animals to humans.

Over the last 60 years, we've seen an emergence of three to four new infectious diseases and a clear increase in the number of spillover events. Not all diseases have the potential to become or cause a pandemic: to classify as a pandemic a disease needs to spread from human to human once it has "spilled over" from animals to humans. We can clearly see an increase in the potential for pandemics in the future in light of historical trends.

EXHIBIT 4:



Source: WWF

The striking loss of nature mentioned previously relates to the rise of global pandemics. Land use change is a significant driver of nature loss, the rise of pandemics, and even climate change.

Exhibit 4 shows the threats to nature and the pressures behind these threats. The top direct driver is habitat loss and degradation. Land conversion for agriculture alone has caused 70% of terrestrial biodiversity loss and half of freshwater biodiversity loss, and also increases the probability of spillover of zoonotic diseases like COVID-19.

EXHIBIT 5:

Source: WWF

Many of you are aware that there is a large group of financial supervisors and central banks which have come together to form the Network for Greening the Financial System (NGFS). NGFS was originally founded with 8 members and now consists of 95 members as of a couple of weeks ago, including all of the major central banks financial regulators,15 observers, and organizations like the International Monetary Fund (IMF) and the International Organization of Security Commissions (IOSCO).

The NGFS recently launched a joint research project on biodiversity and financial stability with the INSPIRE research network. NGFS began their work in 2017, focused firmly on financial system risks of climate change, and now recognizes the need to extend that focus from climate change to address the challenges and implications of nature loss in the context of financial stability.

EXHIBIT 6:

Source: WWF

Before risk reduction can occur, we need greater risk awareness. One mechanism towards greater risk awareness is through disclosure. The Taskforce on Nature-related Financial Disclosures (TNFD) is a market lead initiative that builds on prior experience from the Taskforce on Climate-related Financial Disclosures (TCFD).

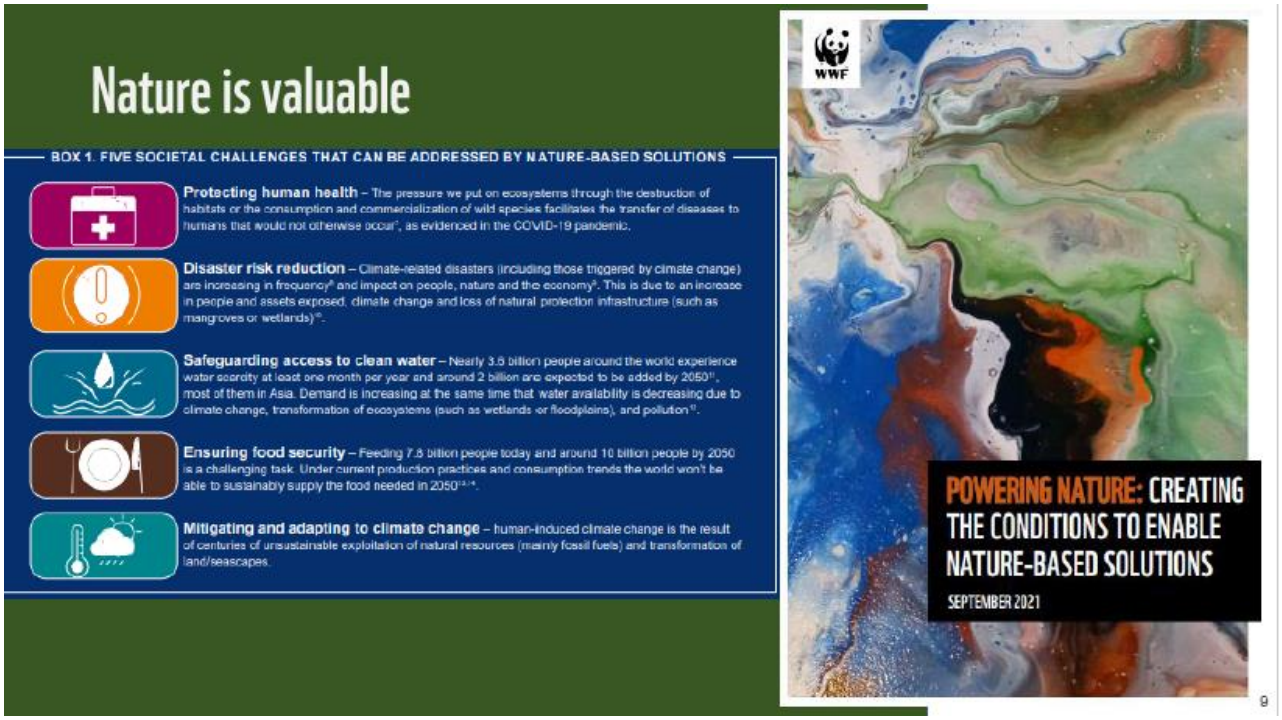
The informal working group of the TNFD included more than 70 financial institutions, corporates, and others working together to develop a draft scope of a framework to allow organizations to report and act on evolving nature-related risks. The initiative was formally launched this summer with co-chairs David Craig and Elizabeth Maruma Mrema, and the effort responds to the steady drumbeat of calls from both public and private sector investors, consumers, and now regulators for consistent, comparable, and reliable data.

EXHIBIT 7:

Source: WWF

The World Economic Forum estimates that half of global GDP is moderately or highly dependent on nature. At our current rate we could lose $10 trillion of global GDP by 2050. At the same time, there's a significant potential economic benefit to investing in nature and transitioning economies post COVID through job intensive activities like ecosystem restoration, regenerative agriculture, and circular business models, which could generate more than $10 trillion in annual business value and create as many as 395 million jobs by 2030.

EXHIBIT 8:



Source: WWF

Nature is valuable and investing in nature provides both risk reduction and an investment opportunity. As we head into the climate negotiations in Glasgow in less than 50 days, we'll hear more about nature-based solutions, which are investment opportunities that solve critical societal challenges such as protecting human health, safeguarding access to clean water, and ensuring food security. Nature-based solutions are critical but still underused tools for disaster risk reduction and mitigating and adapting to climate change.

I want to thank you for the opportunity to frame the discussion. I think we have an exciting opportunity this year in particular to do things differently and learn from the past two years. I look forward to the discussion, thank you.

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

Thank you so much Margaret. I do have one question for you in terms of nature-based solutions. What do you see as the biggest opportunity for investors when it comes to addressing biodiversity loss and what is potentially the biggest risk that investors are potentially not yet factoring into their analysis?

Margaret Kuhlow, WWF Finance Practice Leader

The most important thing to understand is that biodiversity loss and climate change are highly interconnected in a negative feedback loop. Increased temperatures and shifts in precipitation are key drivers of biodiversity loss, reducing the ability of ecosystems to withstand shocks and protect against the physical impacts of climate change, such as storm surge. A healthy ecosystem is also vital to capture and store carbon. A healthy ocean, a natural forest, and nutrient rich soil all absorb and store more carbon than their degraded alternatives and therefore looking at these risks in isolation underestimates the overall financial risk because they are highly interconnected.

Investors should look more closely at the opportunities to invest in nature and its services, not only for risk management and mitigation but also for resilience. Reefs and mangroves provide a variety of services that buffer the impacts of climate change and directly benefit over 16 million people who live in coastal regions. Reefs reduce annual expected damages from storms by more than $4 billion. Without coral reefs, we can estimate that annual damages from storms could more than double and the flooding of land around those areas could increase by almost 70%, impacting almost twice as many people annually. This example highlights both the risk and opportunity in pulling issues such as biodiversity loss and climate change together to

ensure investment portfolios are both resilient from a risk perspective and are also forward-looking in the context of new opportunities.

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

That's a great point. Thank you for setting up the overview and the framework for thinking about biodiversity. Based on my conversations with investors, a lot of us are still trying to wrap our heads around climate change and ensuring that we have a climate resilient portfolio. But to Margaret's point, our efforts may not be as effective if we fail to take into biodiversity into account given the two risks are so deeply intertwined.

Margaret's overview is a great segue to the next couple of sessions in our panel to discuss three nature-based solutions as investment opportunities and ways to leverage new technologies and business models to address biodiversity loss.

I'll now turn the conversation over to Caroline Bushnell at the Good Food Institute (GFI) to discuss how meat alternatives can help address or alleviate the impacts on climate and nature from traditional animal farming industries.

Caroline Bushnell, VP of Corporate Engagement, Good Food Institute

Great, thank you. Now we'll discuss the role that alternative proteins can play in conserving biodiversity and why we think alternative proteins are a key investment opportunity.

EXHIBIT 9:

Source: GFI

The key question we're working to address is how to feed 10 billion people by 2050 and do so sustainably, efficiently, and safely. Industrial animal agriculture is responsible for almost 15% of all greenhouse gas emissions, according to the UN FAO, and is one of the top contributors to our world's most pressing environmental issues, including pollution, water use, and biodiversity loss.

Animal agriculture is a massive user of land, but it is inefficient as it takes nine calories of feed for a chicken to produce just one calorie of meat, which is almost 90% food waste effectively. Yet chickens are far more efficient than beef, which takes about 34 calories of feed to produce just one calorie of meat.

Raising and feeding livestock uses 75% of agricultural land, yet it provides only about one third of the global protein supply. Finally, from a health and safety perspective, the industry is the number one user of medically important antibiotics, which is also the most likely cause of a next global pandemic.

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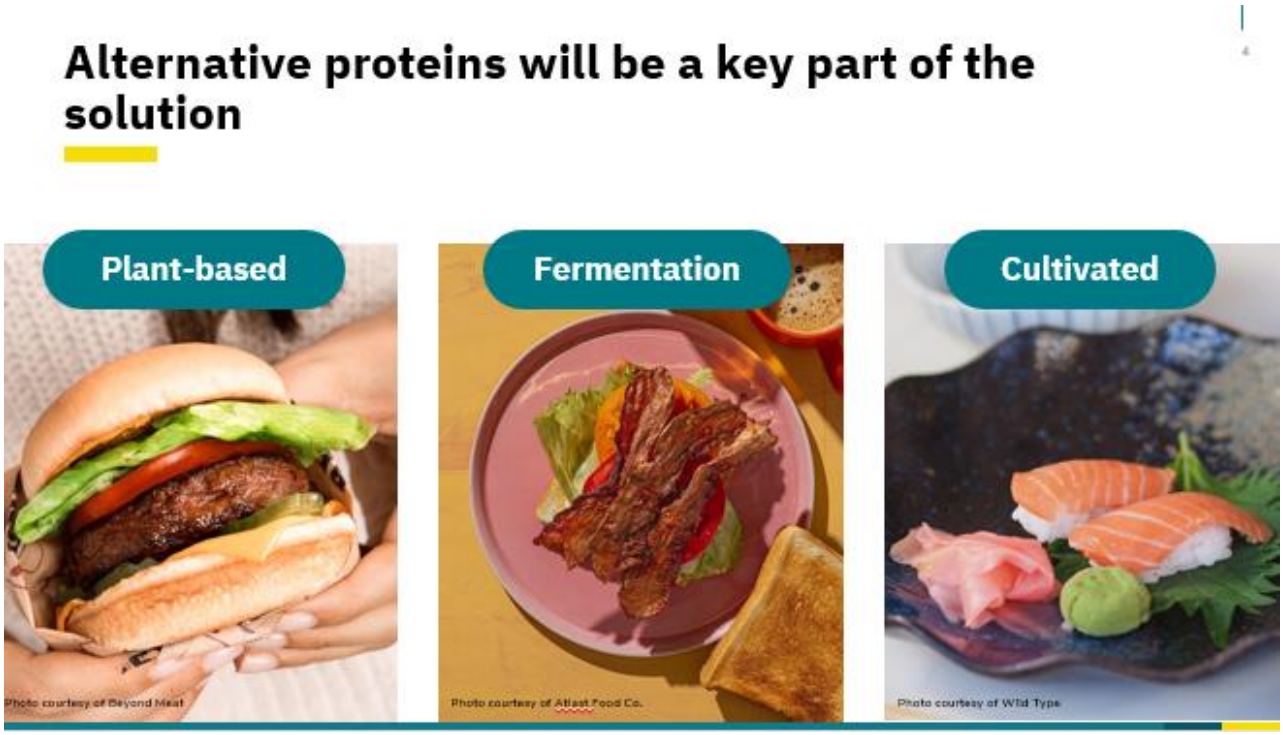
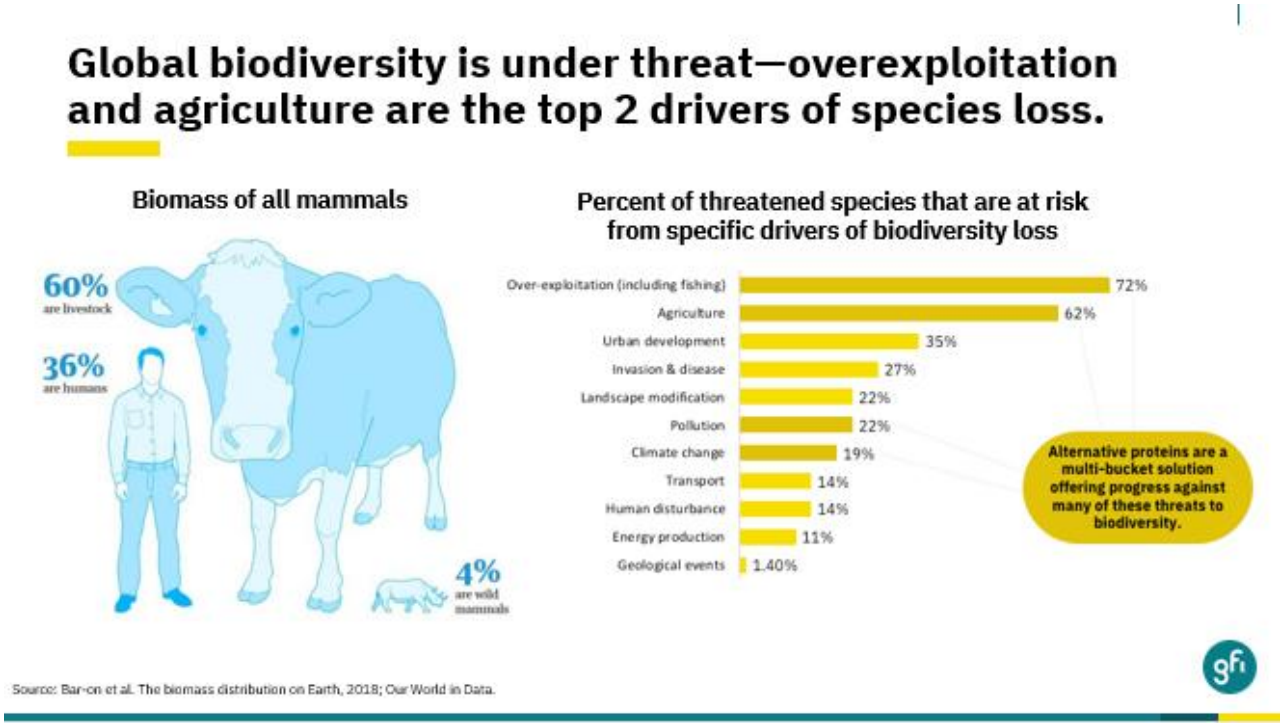


Source: GFI

We believe the answer to these issues is to make highly popular meat and dairy products in a more sustainable and efficient way by making meat directly from plants, with fermentation technology, or by using animal cell culture.

EXHIBIT 11:



Source: GFI

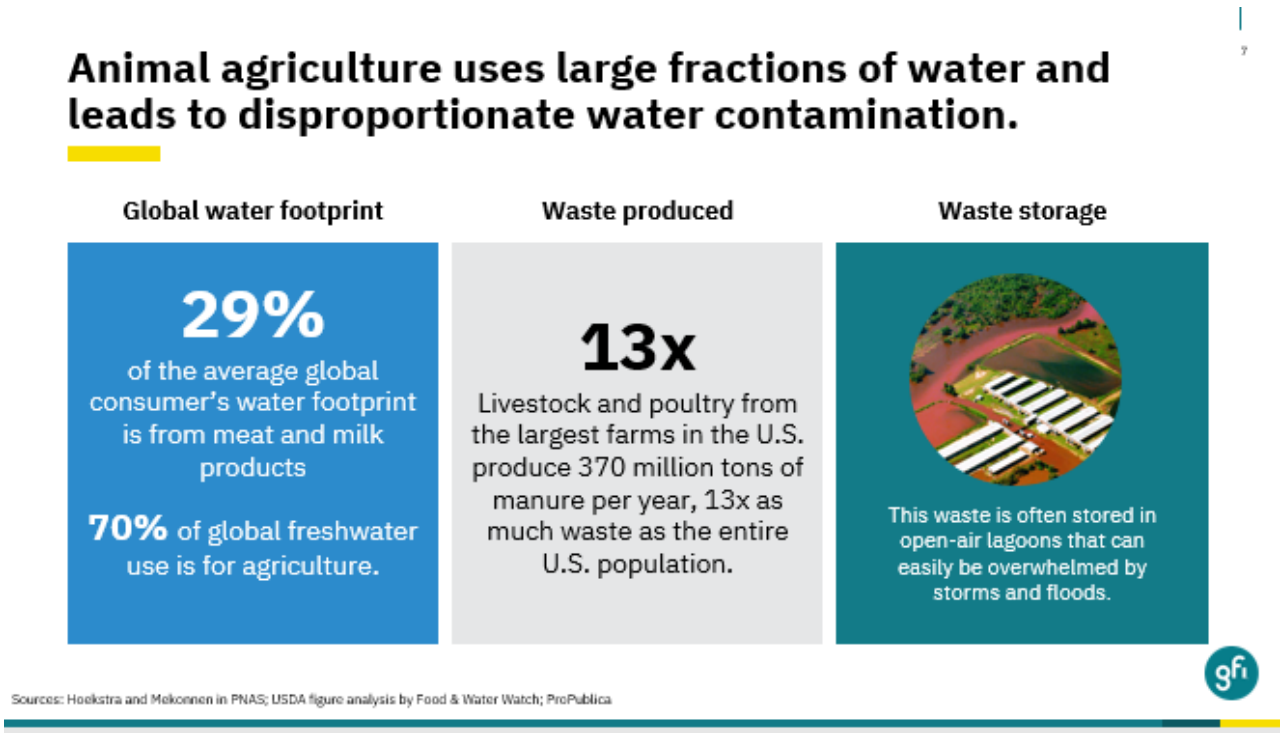
It's impossible to talk about conserving biodiversity and the healthy lands and waters required to sustain it without talking about agriculture, and specifically animal agriculture. Exhibit 11 conveys how earth's animal biomass is wildly out of balance. Livestock now accounts for about 60% of the total mass of all mammals on the planet, with humans accounting for another 36%. Together, us and our food make up about 96% of all mammals left on the earth with wildlife comprising just 4%. As you can see on the right, the top two causes of biodiversity loss are overexploitation, which includes fishing, and agriculture.

EXHIBIT 12:

Source: GFI

Agriculture is also a leading cause of deforestation and habitat loss. Agriculture is responsible for about 75% of deforestation, and animal agriculture specifically has caused up to 91% of deforestation in the Amazon to make room for raising and feeding livestock. By transitioning to alternative proteins, we can not only feed people more efficiently but also free up land from grazing and monocrops, allowing for greater ecosystem restoration and biodiversity conservation.

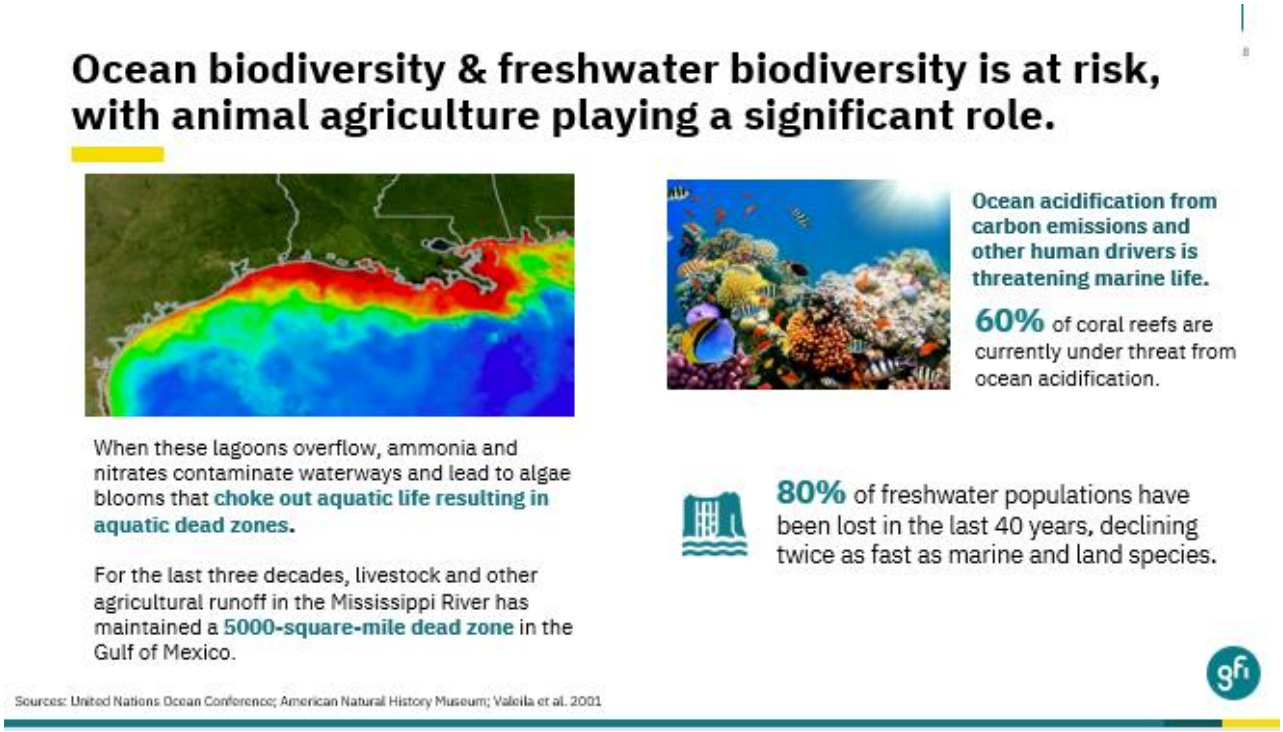
EXHIBIT 13:



Source: GFI

Animal agriculture also uses large amounts of water: agriculture uses about 70% of global fresh water and about 30% of the average global consumer's water footprint links back to consumption of meat and dairy products. Agriculture also leads to significant water contamination as US livestock farms produce 13x as much waste as the entire US population. The waste is stored in open air lagoons, which can easily be overwhelmed and contaminate waterways.

EXHIBIT 14:

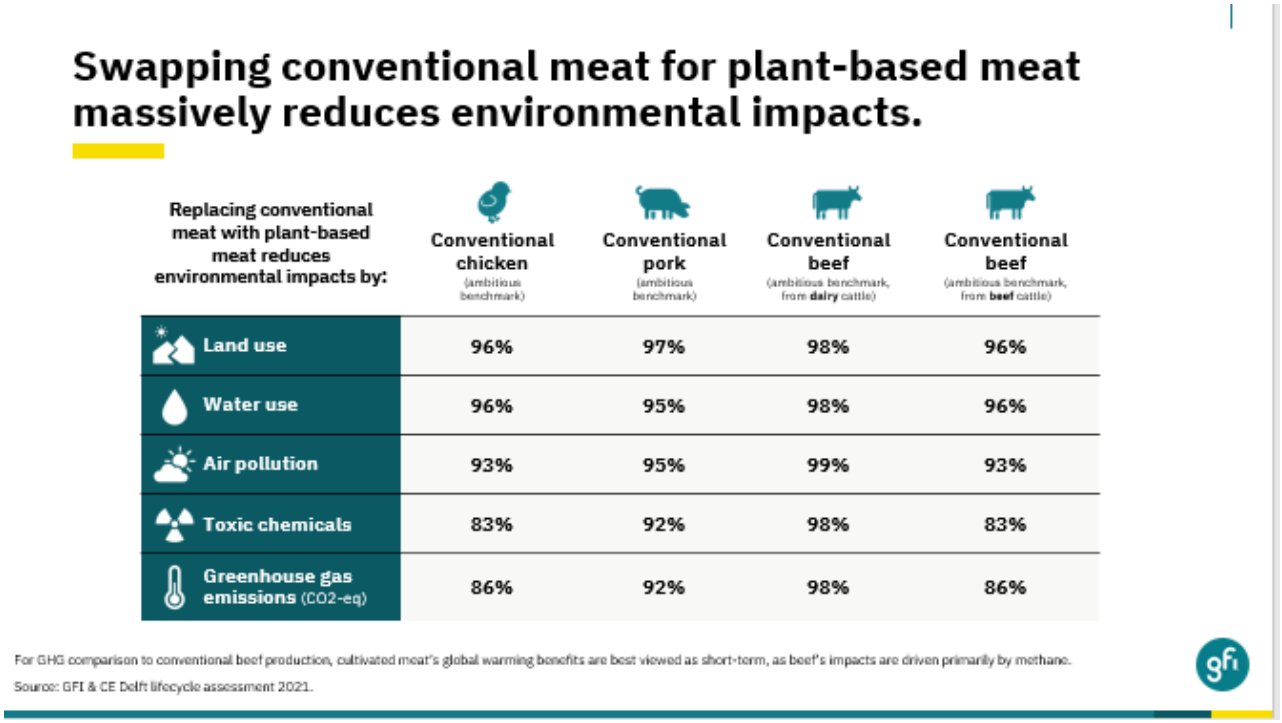


Source: GFI

This water contamination puts both ocean and freshwater biodiversity at risk. When lagoons overflow this can lead to algae blooms which result in aquatic dead zones, such as the 5,000 square foot mile dead zone in the Gulf of Mexico. Alongside climate change the increased risk of flooding increases the risk of regular water contamination.

Ocean acidification from carbon emissions also threatens marine life with 60% of coral at risk and 80% of freshwater populations have been lost in the last 40 years.

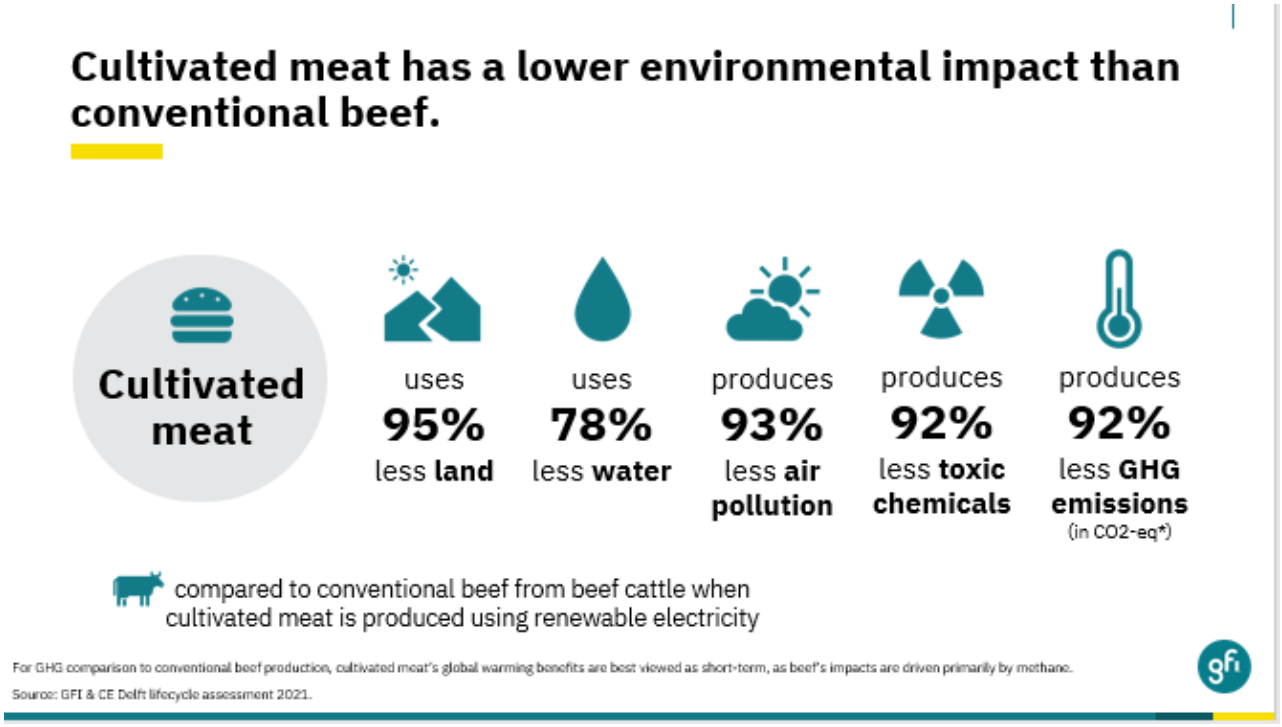
EXHIBIT 15:



Source: GFI

In terms of solutions, we know that swapping conventional meat for plant-based meat massively reduces environmental impacts, with average savings of around 96% in land use, water use, and air pollution, and results in 86% to 98% less greenhouse gas emissions.

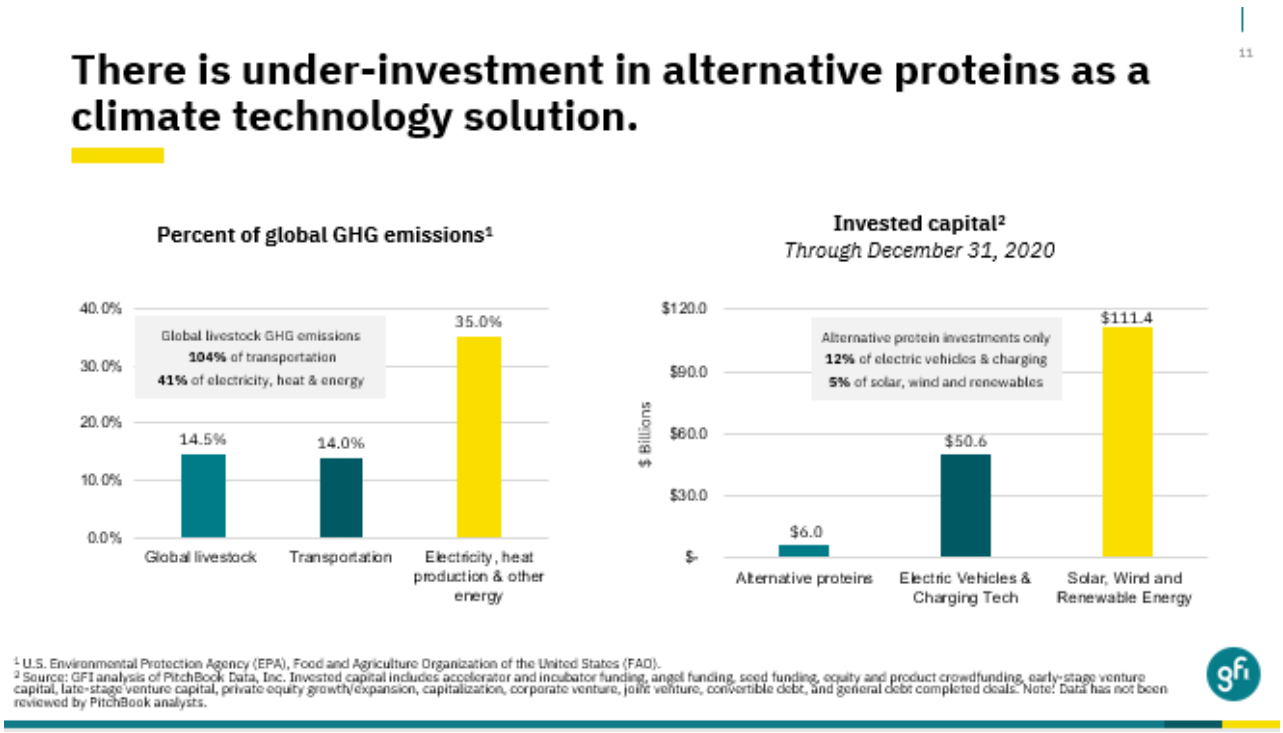
EXHIBIT 16:



Source: GFI

Similar benefits are seen for cultivated meat, which is meat grown directly from cells outside of the animal, particularly when produced using renewable energy.

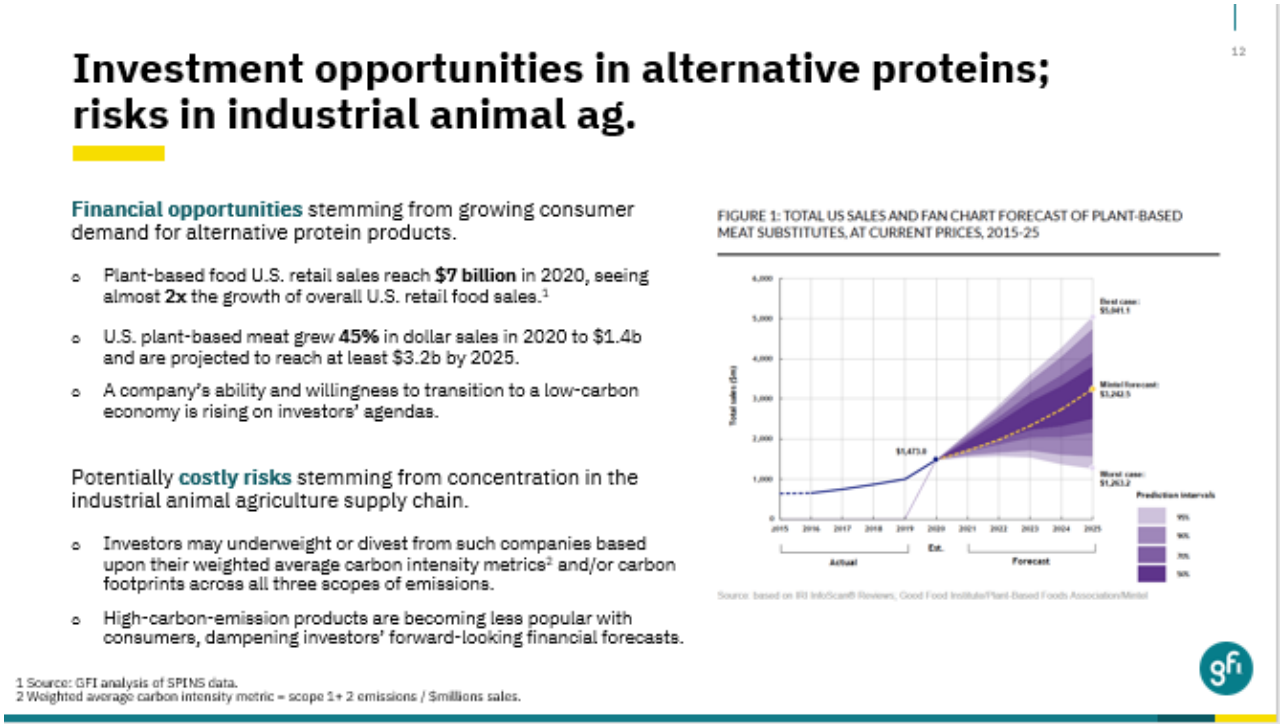
EXHIBIT 17:



Source: GFI

Despite the benefits, alternative proteins are way under-invested as a climate technology solution. While livestock is responsible for slightly more emissions than the transportation sector, alternative proteins received only 12% as much investment as electric vehicles and charging technology. And while livestock represents less than half of the emissions produced by the energy sector, alternative proteins have received only 5% of the funding seen in the renewable energy sector.

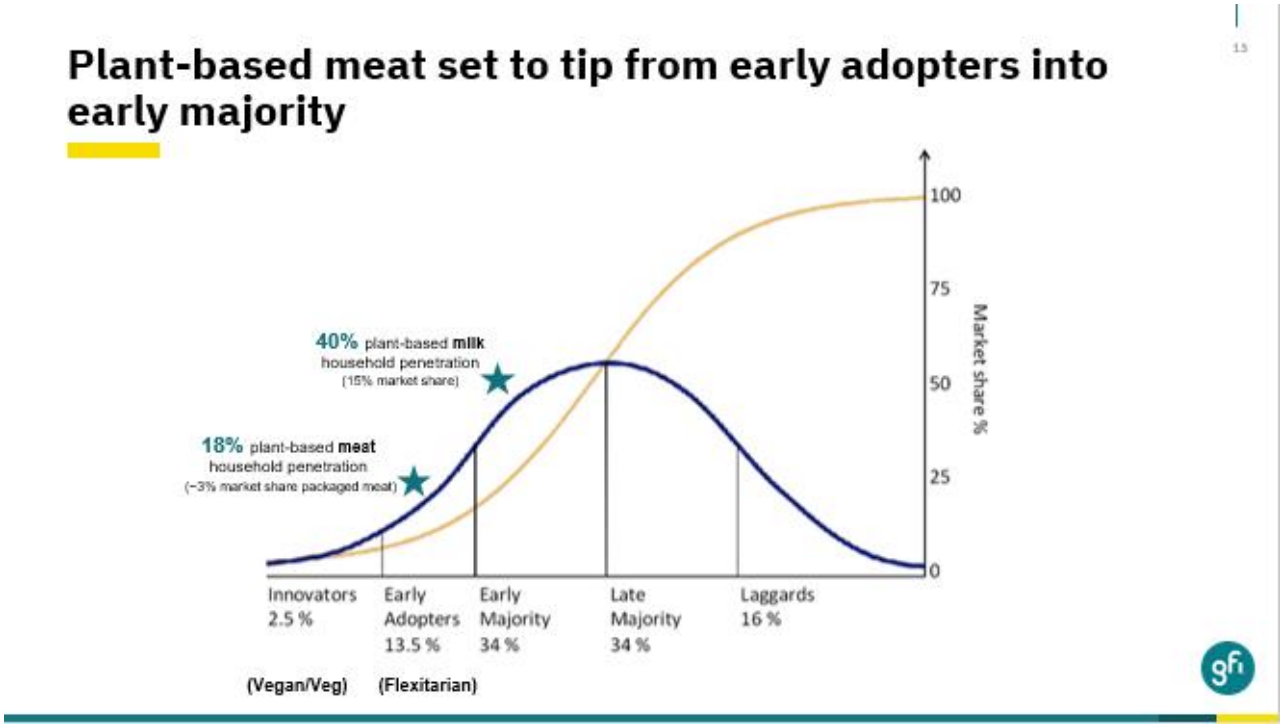
EXHIBIT 18:



Source: GFI

In evaluating food and meat companies, investors are increasingly waking up to the opportunity stemming from the growing consumer demand for alternative protein products. On the flip side, investors are also noting the potentially costly risks stemming from the concentration in industrial animal agriculture. In 2020, total plant-based food sales grew 2x as fast as total food sales in US retail, with plant-based meat growing 45% in dollar sales, highlighting the opportunity. Plant-based meat is projected to more than double to at least $3.2 billion in US retail sales by 2025 with significant upside.

EXHIBIT 19:



Source: GFI

The innovation adoption curve can be used to understand how innovations disseminate throughout society and the corresponding market share potential. When mapped to the plant-based meat and milk categories, innovators and early adopters can be thought of respectively as vegan or vegetarian consumers and flexitarian consumers. Currently, plant-based meat has an 18% household penetration in the early adopter category, but is poised to soon tip into the early majority at which pace adoption quickly spreads through the mainstream.

Plant-based milk, which is a much more developed category, is already there with 40% household penetration and 15% share of the total fluid milk market. According to Malcolm Gladwell, it only takes about 10% of the population embracing a new idea to begin reaching that tipping point.

EXHIBIT 20:

14

Global alternative protein market projected to reach $290 billion by 2035

Global alternative protein market projections				
Source	**Category**	**Projected market size**	**By year**	**Projected share of global meat market**
Stephens	Plant-based meat	$54b	2030	4%
UBS	Plant-based meat	$85b	2030	6%
J.P. Morgan	Plant-based meat	$100b	2035	7%
A.T. Kearney	Plant-based meat	$370b	2035	23%
McKinsey	Cultivated meat	$20b	2030	1.5%
Barclays	Plant-based and cultivated meat	$140b	2029	10%
Jeffries	Plant-based and cultivated meat	$240b	2040	9%
A.T. Kearney	Plant-based and cultivated meat	$1.1t	2040	60%
EY-Parthenon	Plant-based, fermentation-derived, and cultivated meat	$115b	2030	7.5%
Credit Suisse	Plant-based, fermentation-derived, and cultivated meat	$88b	2030	5%
Credit Suisse	Plant-based, fermentation-derived, and cultivated meat	$555b	2050	25%
BCG	Plant-based, fermentation-derived, and cultivated proteins	$290b	2035	n/a

Note: Global share calculations assume $1.4 trillion global total meat market, unless source materials provide their own share estimate. Base case or medium-growth projections are shown.
Source: Business Times (May 2019); J.P. Morgan (May 2019); A.T. Kearney (2019); UBS (July 2019); Barclays (August 2019); Jeffries (September 2019); A.T. Kearney (2019); Stephens (2021); BCG (2021); EY-Parthenon, median of $77-$153b range estimate (2021); Credit Suisse (2021), McKinsey & Company (2021)

Source: GFI

We've summarized a range of global forecasts published by leading banks and consultancies, and the general consensus is that globally plant-based meat sales will reach between $50 to $100 billion by 2030. Across all proteins as a whole the opportunity is much larger.

A recent report released by BCG forecasts a base case of $290 billion in global sales of alternative proteins by 2035 with significant upside if we see regulation that impacts the price of conventional meat products, which is potentially more likely in Europe.

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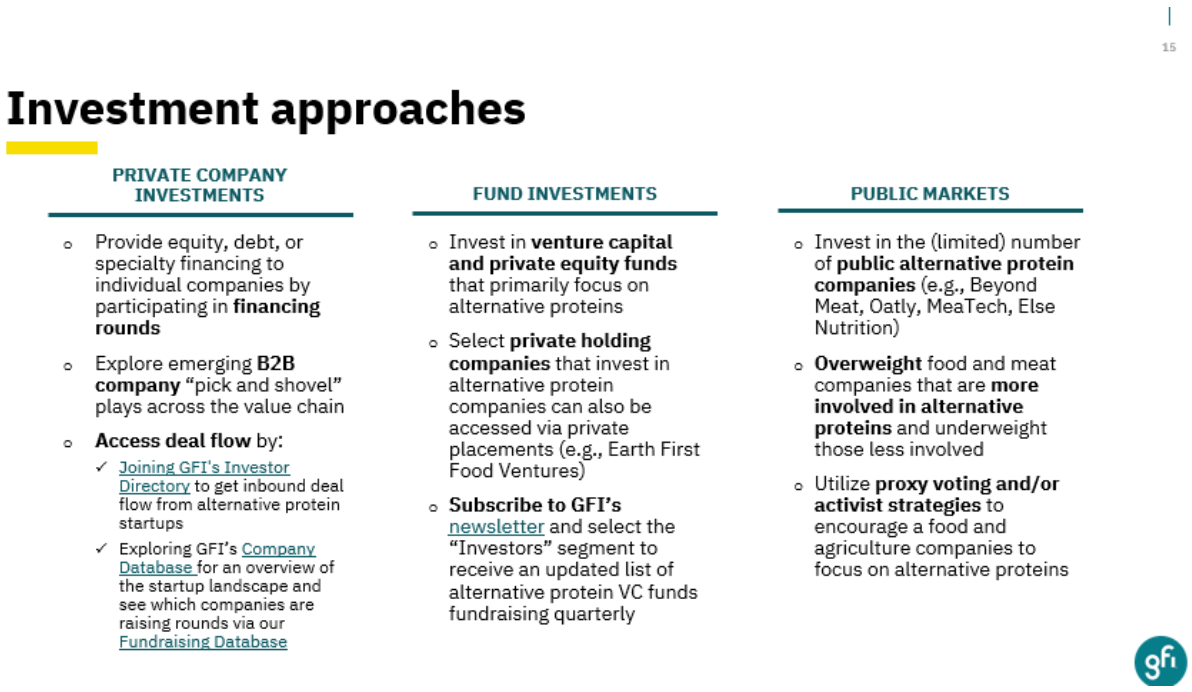


Source: GFI

I'll end with a few ways that investors might access the opportunity in alternative proteins. In the private markets, not only are there a growing number of companies creating innovative end-consumer products, but there are also increasingly new B2B companies that effectively provide pick-and-shovel plays across the value chain.

GFI maintains both a company and a fundraising database (which you can get access to by emailing me at carolineb@gfi.org) and if you're looking for inbound deal flow you can also join our investor directory. There are also an increasing number of fund investment opportunities that are focused primarily on alternative proteins and you can learn more by signing up for our investor newsletter.

There are currently limited public market opportunities for dedicated alternative protein companies, but we expect to see more. However, you could also consider overweighting conventional CPG companies that are more involved in alternative proteins or have stated commitments to grow that component of their product portfolio. You could also consider underweighting those less involved or utilize any existing positions to encourage more focus on alternative proteins as a key growth and de-risking strategy.

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

Thank you so much, Caroline. If I could expand on one point you made earlier – plant-based meat, precision fermentation, and cultivated meat are a couple of different ways to play the alternative meat theme. How do you see these couple of different segments developing over time? When will they become commercially available and do you have a view in terms of which ones will become favored by consumers over time?

Caroline Bushnell, VP of Corporate Engagement, Good Food Institute

We're really going to see them more along a spectrum, from fully plant-based all the way on one end to fully cultivated on another and a mix in between. Fermentation technology can be used in many different ways, and one example is how Impossible Foods produces their soy hemoglobin, which serves as a critical ingredient in an otherwise plant-based product. With cultivated meat companies, many of them are looking to come to market initially with blended products. We're also seeing the creation of cultivated fat or cell-based fat used as a blend in otherwise plant-based products to address key sensory characteristics that can be hard to otherwise achieve with purely plant-based fats. Ultimately, I think we will see all of them play a role in the market.

Plant-based is certainly what can be found on grocery store shelves today and still has a huge amount of runway in creating more and more analogous products. We've mostly seen plant-based products in the burger category but given that consumers eat many other forms of meat there's still opportunity for growth.

Products using mycelium is another sector of fermentation which has an incredible sustainability story as it's effectively a self-assembling protein that can be grown very quickly with very little inputs. The mycroprotein of Quorn is the original example, but there's a lot of innovation happening in the space. I also expect we'll start seeing more of these products on store shelves soon, along with products produced from precision fermentation, which allows companies to create ingredients that are typically derived from an animal, such as whey or casein protein, without the animal.

Cultivated meat also reached some major landmarks in the last year, such as receiving regulatory approval at the end of last year in Singapore. In addition, the USDA has a call out for comments on nomenclature as they prepare for it to come to market in the US. Many of the companies have reached pilot scale facilities, however, we expect several more years to reach commercial scale production.

Ultimately, I think they'll all play a key role and what's unique about cultivated meat is that no matter how good plant-based meat gets, some consumers will still demand real animal meat which cultivated meat will be able to deliver at the cellular level.

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

Very interesting, thank you, Caroline.

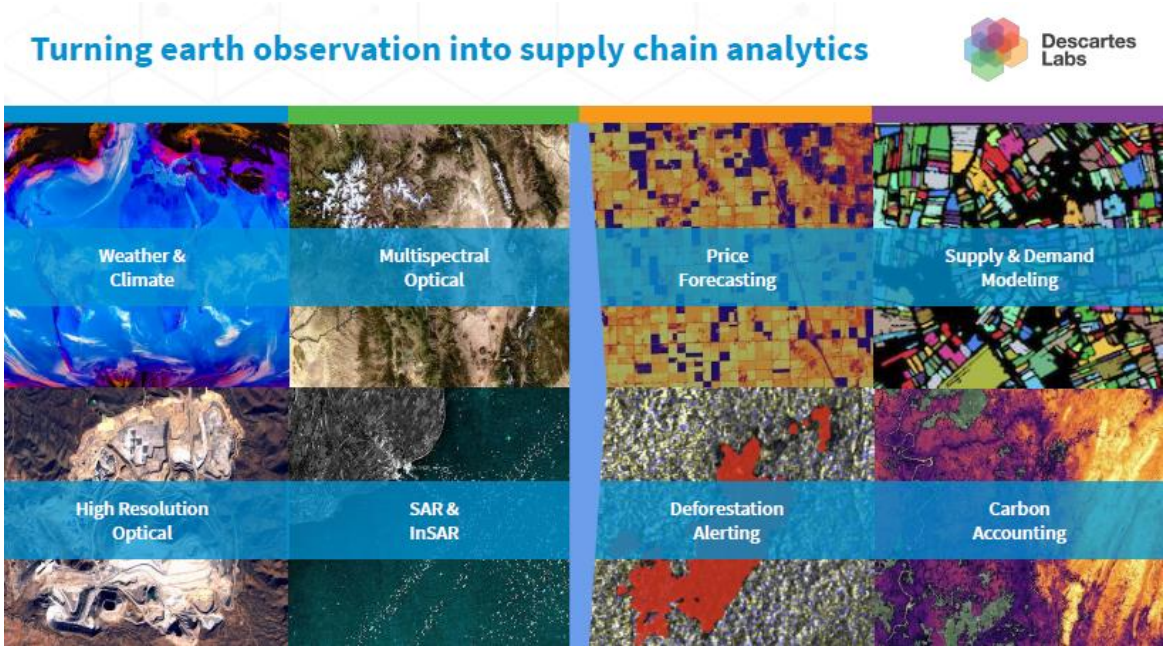
Leveraging geospatial imaging and satellite data are other potential enabling technologies to track deforestation and biodiversity loss. Such technologies not only have the potential to measure progress but also hold companies accountable for their commitments. I'll now turn it over to Erika Randolph at Descartes Labs to discuss these innovative ideas in more detail.

Erika Randolph, Director of Sustainability, Descartes Labs

We've talked about the global challenges brought about by the agricultural system thus far, and today I'll share how Descartes labs uses remote sensing, machine learning, and cloud computing to help commodity intensive companies address sustainability and biodiversity in their supply chains.

Descartes labs is a geospatial intelligence company with science and technology at our core, launched out of Los Alamos National Labs in 2014. We build models of the earth that power the analysis of the world's largest physical systems. We serve large consumer products, agriculture, mining companies, and the Department of Defense by enabling them to harness the power of geospatial analytics to better understand and reduce their impact on the physical world.

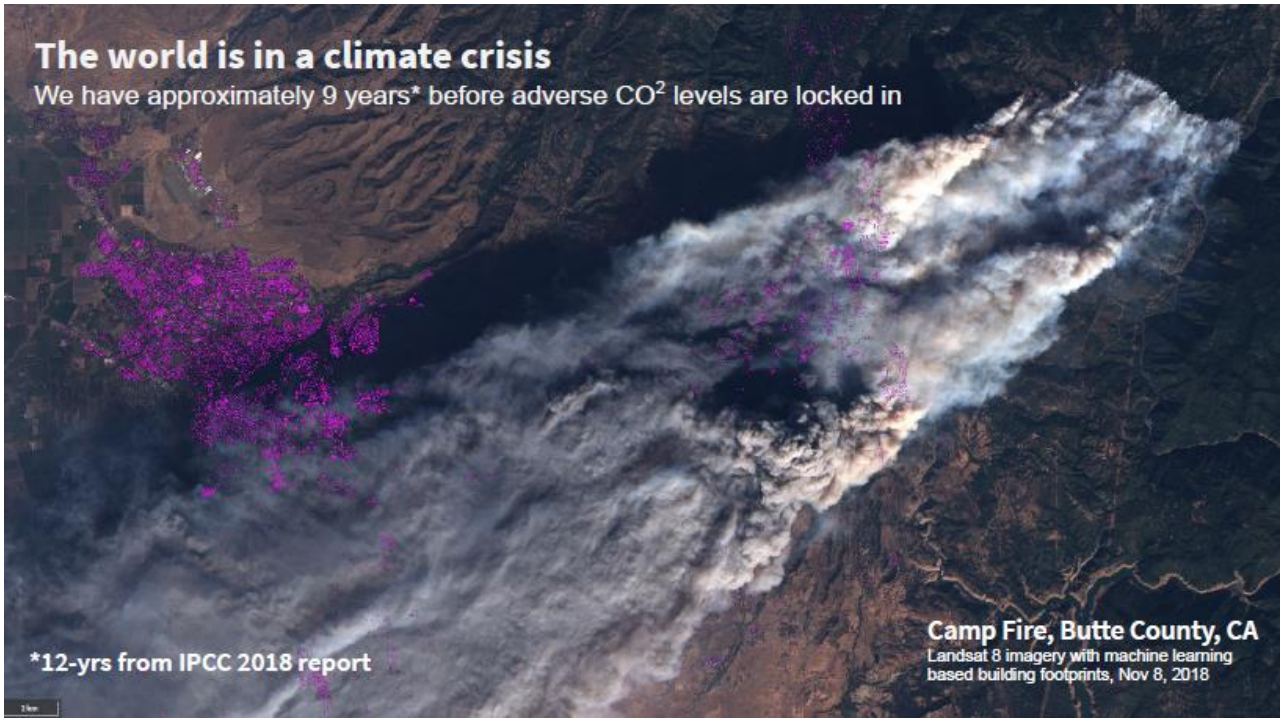
EXHIBIT 22:



Source: Descartes Labs

We believe that ESG can go hand-in-hand with enhanced operational performance by leveraging data. Our approach combines diverse datasets that are continuously updated and co-registered by location and time to fuel a variety of applications and measure critical supply chain factors that are otherwise difficult to quantify.

EXHIBIT 23:



Source: Descartes Labs

We have elected to apply our technology to some of the world's most challenging and urgent problems, namely the climate crisis. Exhibit 23 shows an image of the Camp Fire, and the purple captures the buildings in direct proximity to the burn using remote sensing and machine learning.

EXHIBIT 24:

Source: Descartes Labs

The spirit of today's focus is on biodiversity, and I will discuss how Descartes Labs leverages our technology to end deforestation in commodity supply chains.

We've heard some great facts shared by the previous speakers, and know that four commodity products (beef, palm, soy, and wood) drive the majority of deforestation globally. These products cause devastation to biodiversity and greatly reduce the carbon carrying capacity of large areas of land which help limit rising temperatures. Margaret previously mentioned an interesting fact that land conversion from agriculture accounts for 70% of biodiversity loss.

EXHIBIT 25:

Source: Descartes Labs

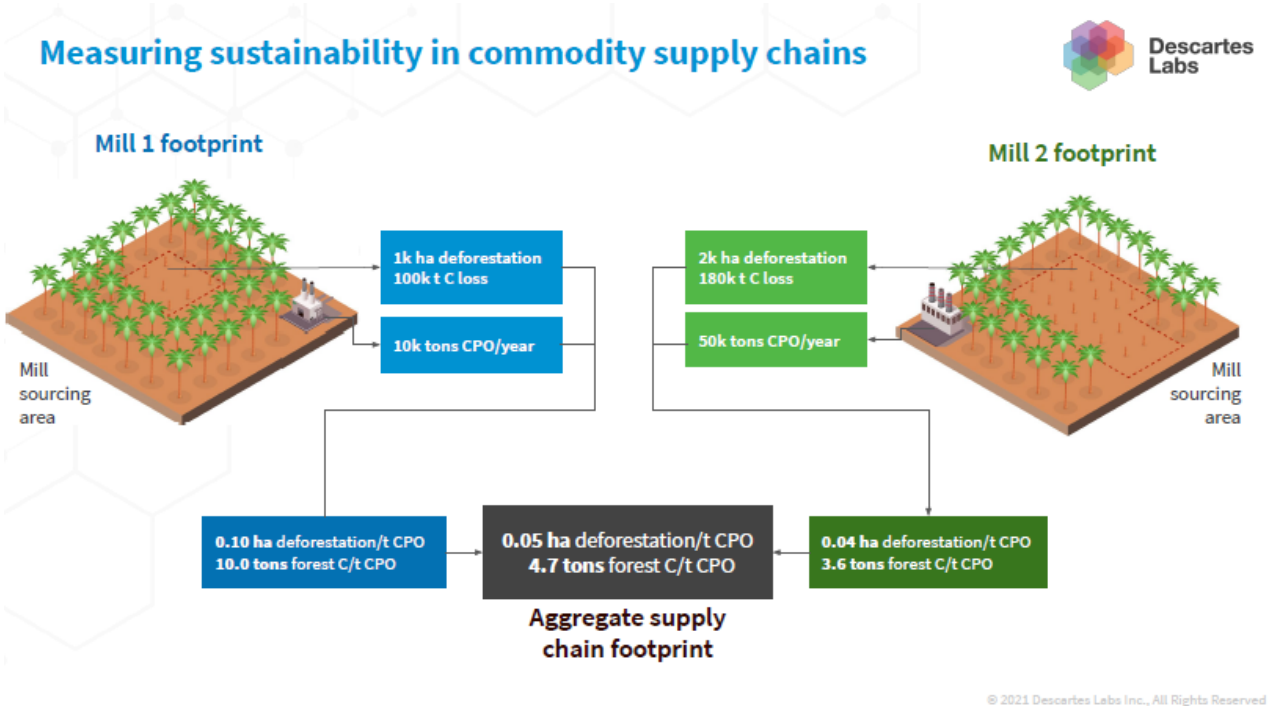
Many companies have made (and missed) their deforestation reduction commitments. There's a growing number of discussions in the voluntary standards and regulatory space around quantifying deforestation in science-based targets and emissions reporting.

Recently, we saw that Amazon, among other companies and in combination with major governments and non-profits announced the LEAF coalition, which is a global effort to end deforestation by 2030. However, the question remains in terms of what we need to measure progress against targets.

EXHIBIT 26:

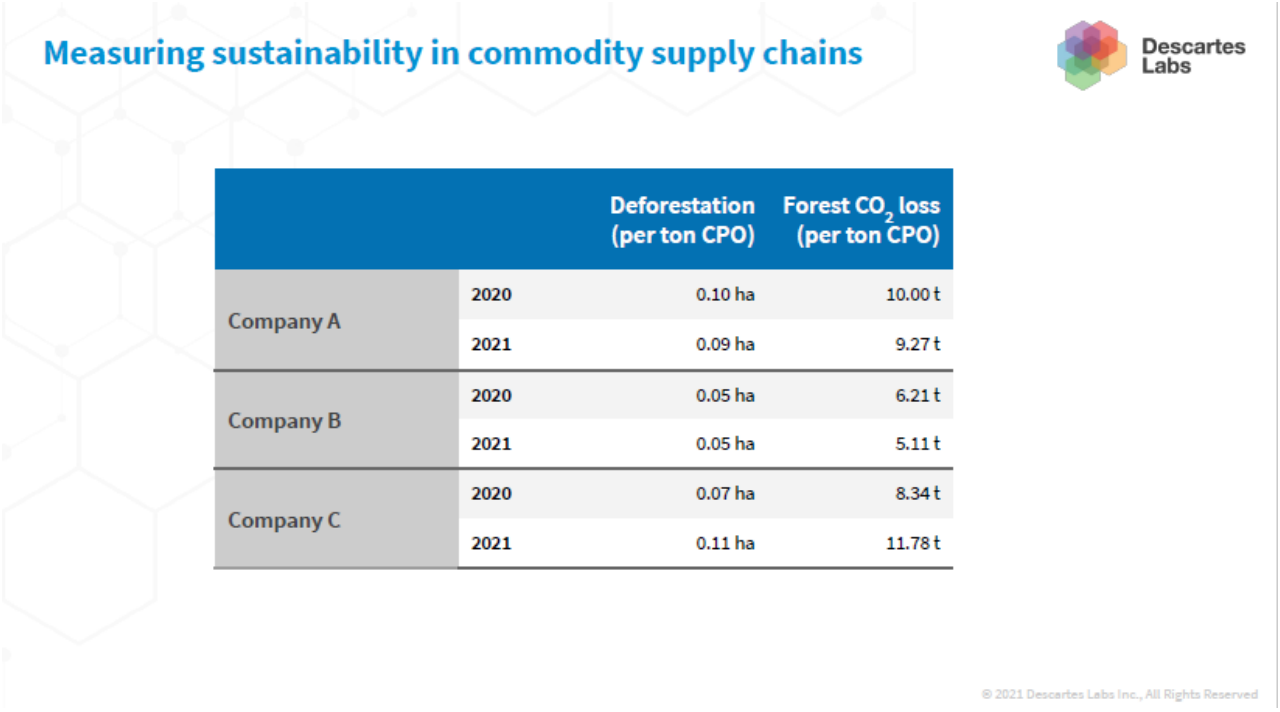
Source: Descartes Labs

EXHIBIT 27:



Source: Descartes Labs

EXHIBIT 28:



		Deforestation (per ton CPO)	Forest CO_2 loss (per ton CPO)
Company A	2020	0.10 ha	10.00 t
	2021	0.09 ha	9.27 t
Company B	2020	0.05 ha	6.21 t
	2021	0.05 ha	5.11 t
Company C	2020	0.07 ha	8.34 t
	2021	0.11 ha	11.78 t

Source: Descartes Labs

A critical component of addressing deforestation is transparent accounting of the land intensity of agricultural production. This accounting captures deforestation, as well as the carbon emissions impact of production, and attributes the data to specific companies and supply chains.

Exhibit 26 shows an example of the concept applied to the palm oil supply chain, perhaps in Southeast Asia, and potential metrics.

Exhibit 27 showcases an illustrative aggregate supply chain footprint that captures both of these factors, and when combined with a price on carbon can incentivize action throughout the supply chain.

Exhibit 28 shows how these metrics would enable comparative reporting and ESG ratings at a very granular level.

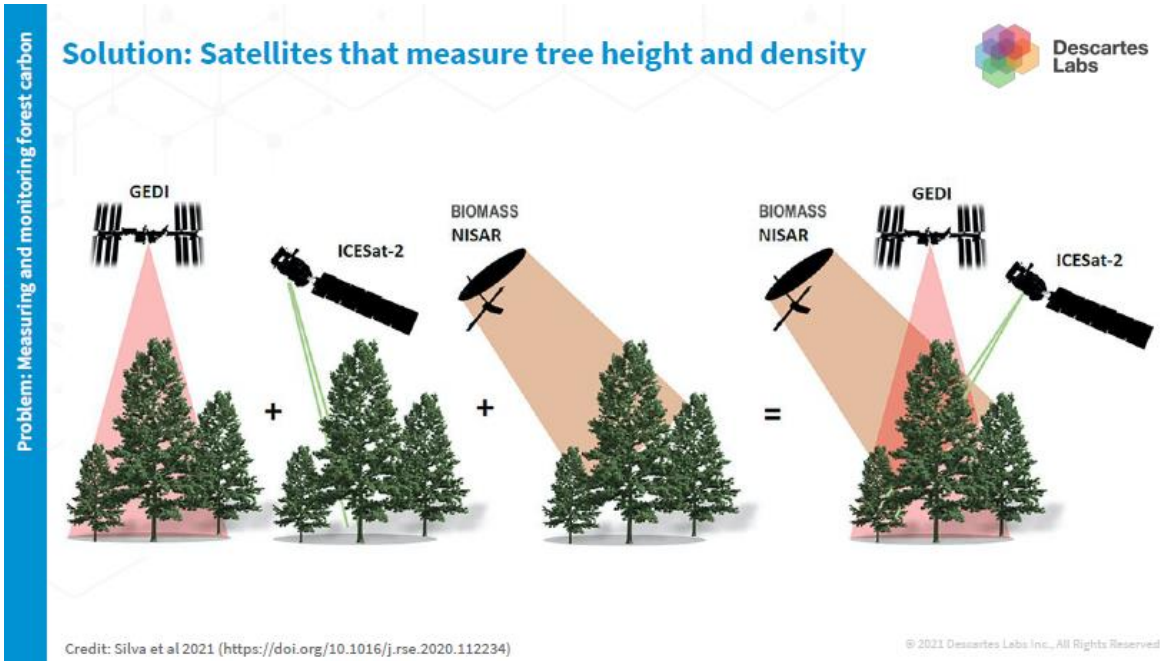
EXHIBIT 29:

Source: Descartes Labs

The question remains of how to achieve this idea as it is impossible to manage what isn't measured. There are five critical components that are necessary in implementing reporting and accounting. Four of these components are well developed and for the fifth I'm looking forward to our next speaker.

The five steps are 1) measuring forest carbon accurately, 2) measuring forest degradation, not just clearcutting, 3) measuring forest loss in real time, 4) scaling these measurements globally, and 5) mapping supply chains.

EXHIBIT 30:

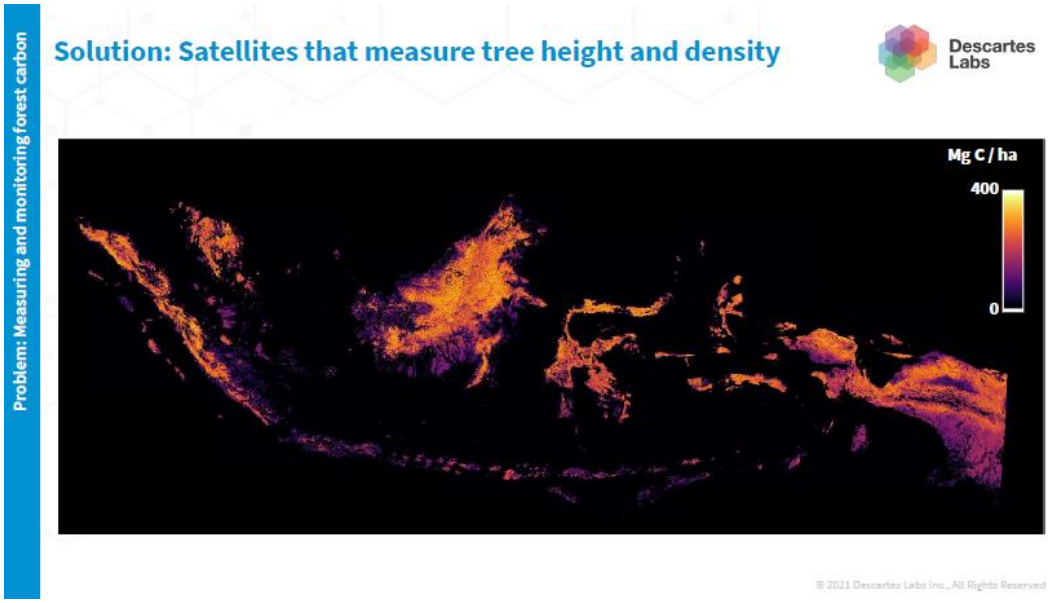


Source: Descartes Labs

The first step is measuring carbon forest accurately. We view satellites with the capability to measure tree height and density as a solution to addressing this challenge.

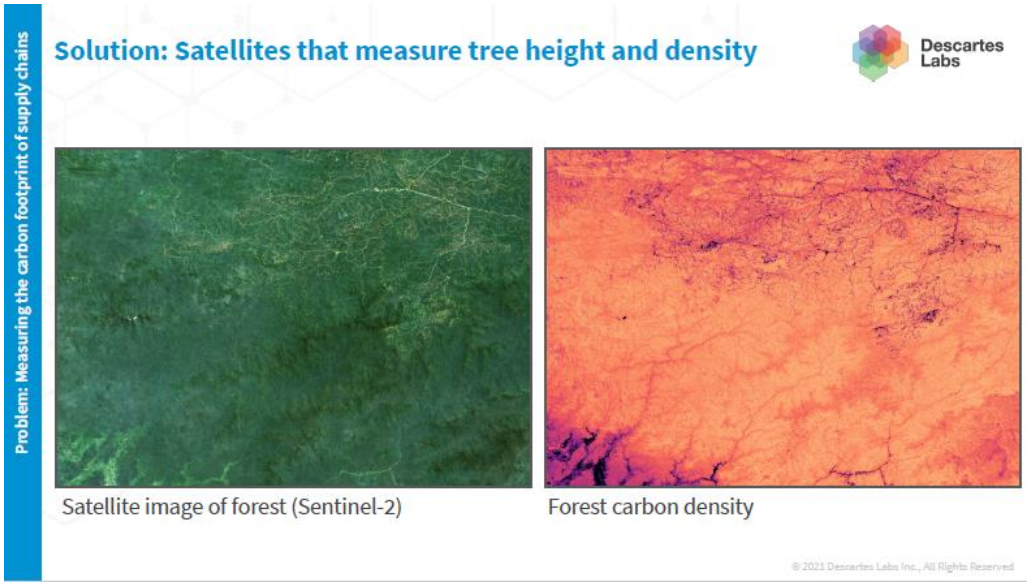
There is an array of commercial and publicly available instruments in orbit that provide insight into tree height and density. The data is incredibly large and difficult to process, requiring architecture like that of Descartes Labs to enable efficient and analysis-ready data. Descartes Labs leverages data from the GEDI sensor (on the left of Exhibit 30) on the International Space Station to create wall-to-wall estimates of the above ground biomass carbon over the world's tropical forests.

EXHIBIT 31:



Source: Descartes Labs

EXHIBIT 32:

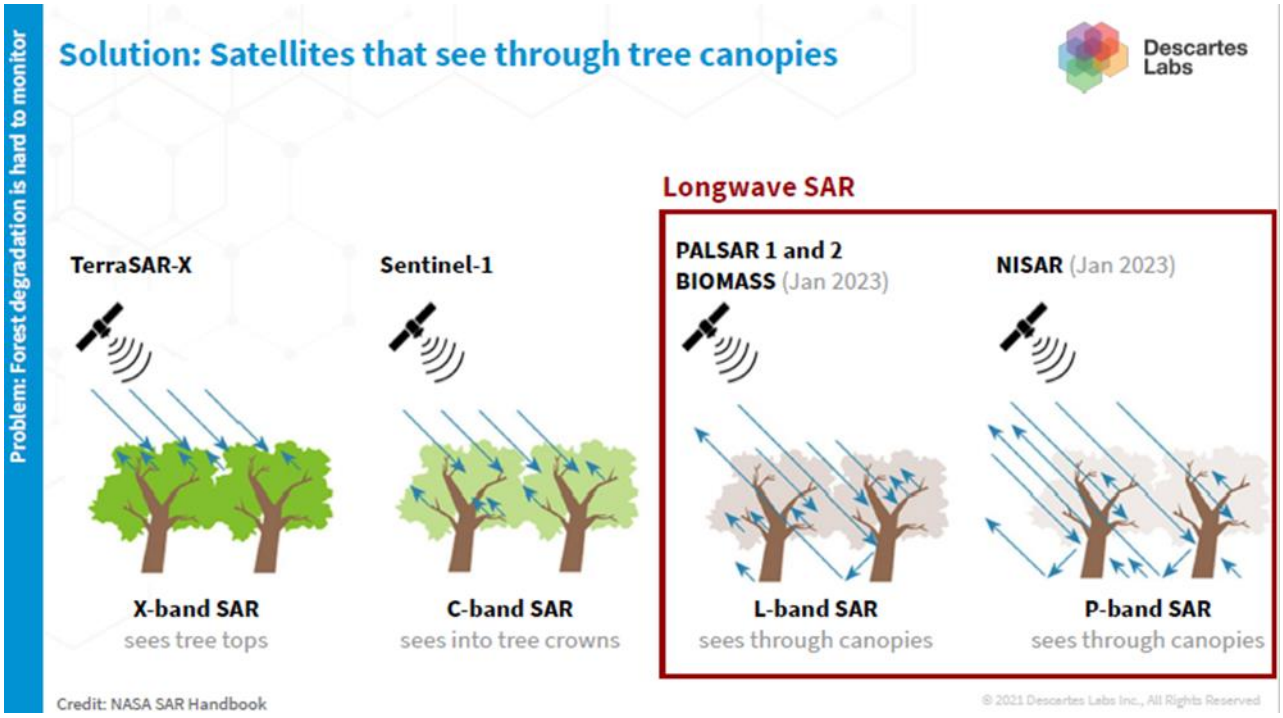


Source: Descartes Labs

Exhibit 31 shows the above ground biomass density of forests over Indonesia and Malaysia at high resolution (30 meters scale). This enables us to understand the composition of the forest and map deforestation events to the carbon carrying capacity of that area. We can also analyze changes in forest composition over time, from the early 2000s to today, in the context of the increasing prevalence of palm plantations and agricultural activities.

Exhibit 32 zooms into a specific region in Borneo. The left-hand side shows an optical image of a forest. On the right, this image represents the predicted above ground biomass density of that forest, and the bright colors indicate higher density. Therefore, we can understand the impact of land-clearing events if such events take place in the region.

EXHIBIT 33:

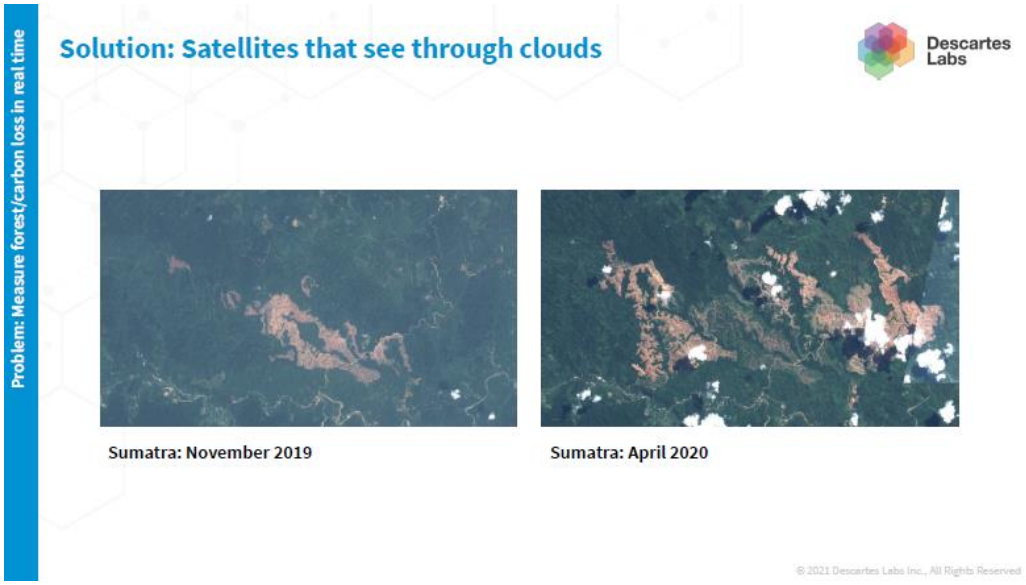


Source: Descartes Labs

The next challenge is measuring forest degradation. There have been various efforts in place from optical-based systems to the current world of radar-based solutions.

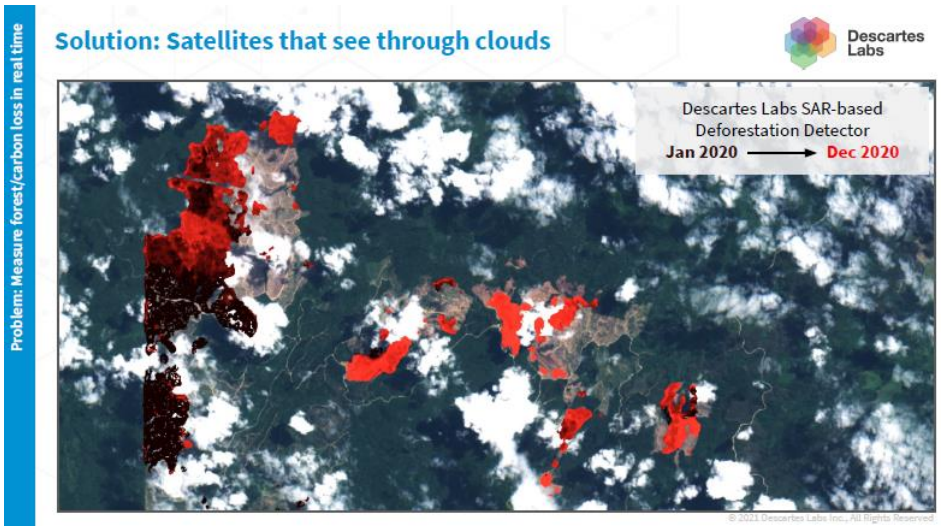
Exhibit 33 shows the next evolution of satellites that can see through tree canopies. Most forest monitoring tools use short wavelength radar (seen at the left). These instruments can see through clouds but don't penetrate far into the tree canopy, allowing us to see forest loss, but not the degradation which is prevalent among shade-growing commodities like coffee or cocoa. The right showcases a whole class of instruments designed specifically to monitor changes below the tree canopy. We have the PALSAR satellites from the Japanese Space Agency as well as two new instruments expected to launch in 2023 that will provide openly available and ongoing monitoring of forest biomass and degradation everywhere in the world. This development is exciting as we've been waiting for data like this to become publicly available for years.

EXHIBIT 34:



Source: Descartes Labs

EXHIBIT 35:

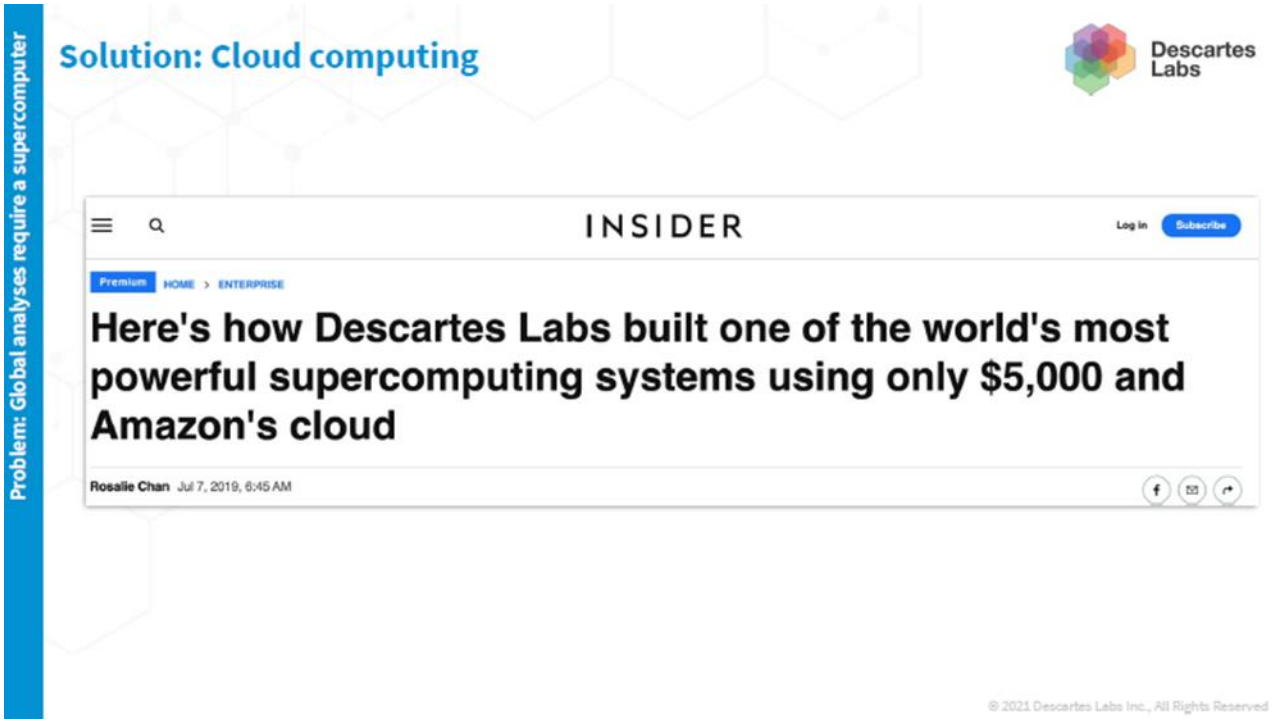


Source: Descartes Labs

The next problem tackles measuring forest loss and carbon loss in real time, and the solution is satellites that see through clouds. Exhibit 34 provides an example of the challenges we face by solely relying on optical imagery. These are both images over the same area of forested land in Sumatra. The left shows an image from November 2019 where initial forest clearing has occurred. On the right, you can see the next available optical image that has few enough clouds to act on this information. This image was taken six months later and shows a significant amount of deforestation and land clearing that's occurred in this time. This tells us that the cloud cover in tropical regions of the world prevents optical visibility to massive devastating events on an actionable timescale.

Exhibit 35 shows an image from Descartes Labs radar-based alerts, using synthetic aperture radar and interfere metrics synthetic aperture radar to generate alerts that penetrate clouds and detect deforestation in all weather. As a result, alters occur on average more than 100 days earlier than optically based systems which is huge progress.

EXHIBIT 36:

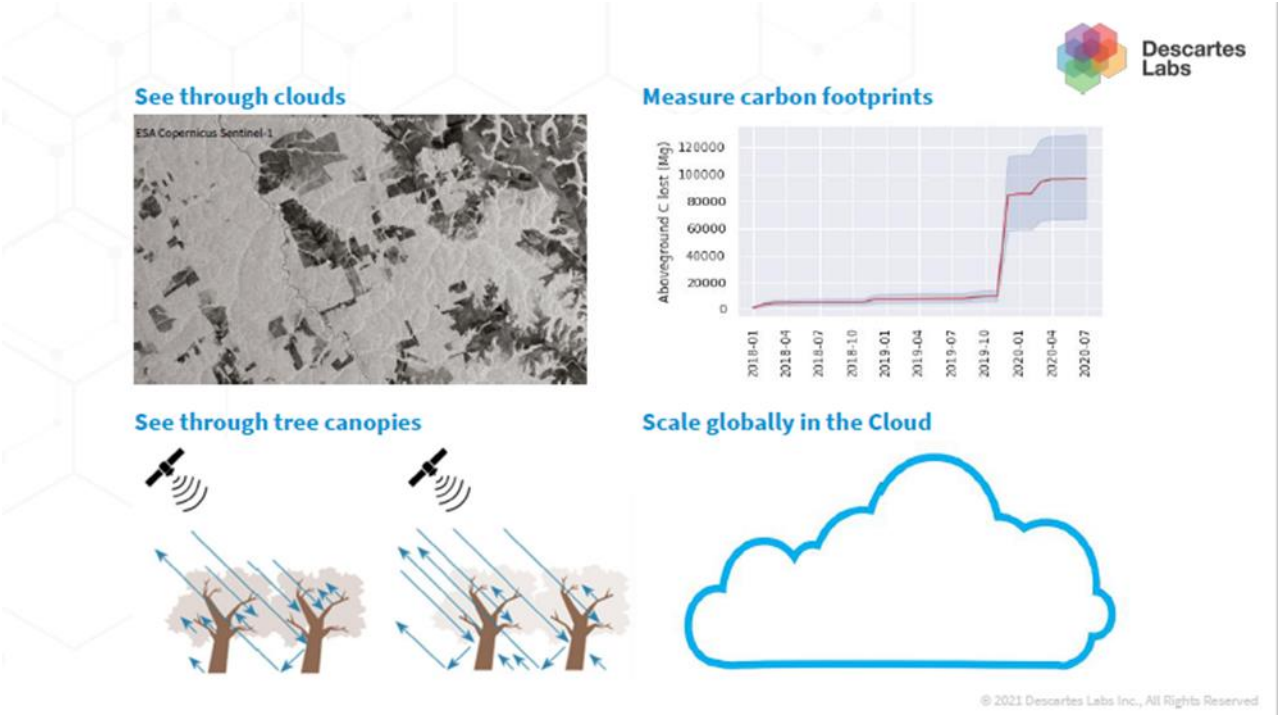


Source: Descartes Labs

The next challenge is that deploying these technologies at a global scale requires the ability to compute at a global scale. Our most recent top 500 run on AWS puts us as the #40[1] fastest supercomputer in the world. We've improved our performance by 417% and in a two-year period we were able to outperform gains from traditional on-premise computers by a factor of 10. The growth in cloud computing, which we're seeing across the board, enables the ability to efficiently deploy at a global scale.

[1] https://aws.amazon.com/blogs/aws/planetary-scale-computing-9-95-pflops-position-41-on-the-top500-list/

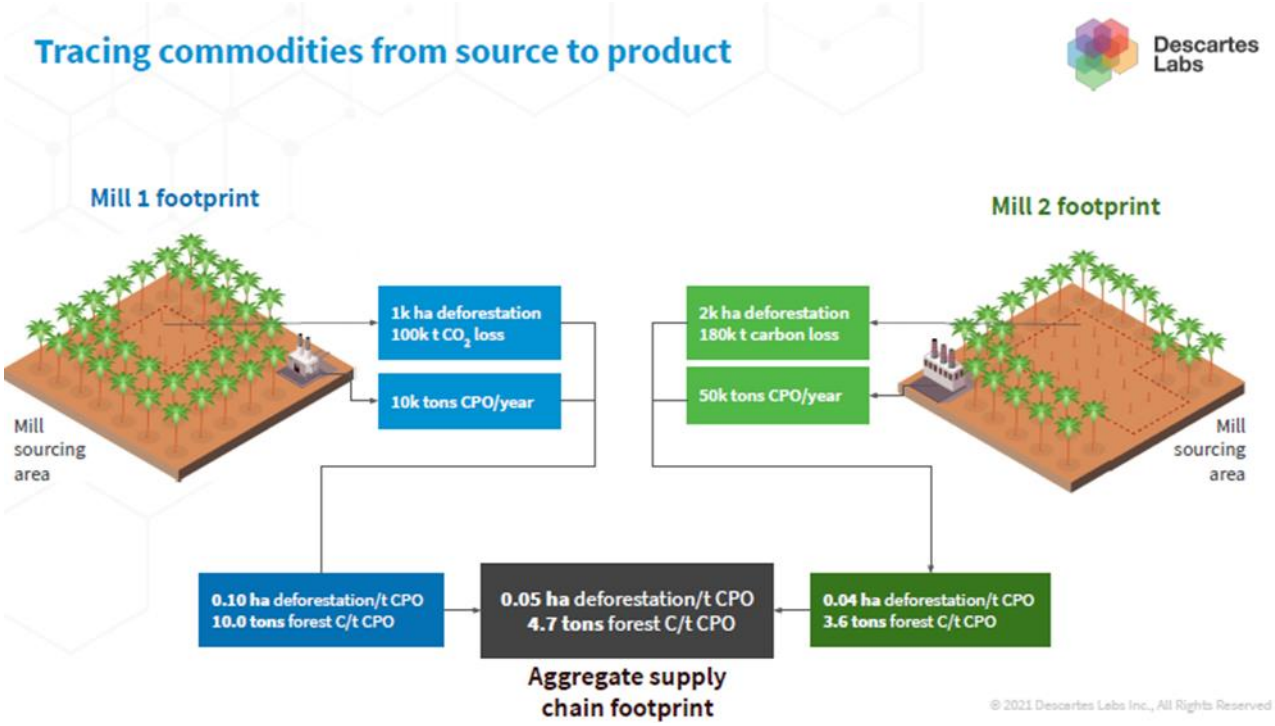
EXHIBIT 37:



Source: Descartes Labs

Exhibit 37 shows a summary of emerging technology. We've discussed 1) the ability to see through clouds with radar-based technology, 2) measuring carbon footprints using remote sensing data 3) using new satellite technology to see through tree canopies and 4) scaling these technologies globally in the cloud to give us real time visibility at a planetary scale.

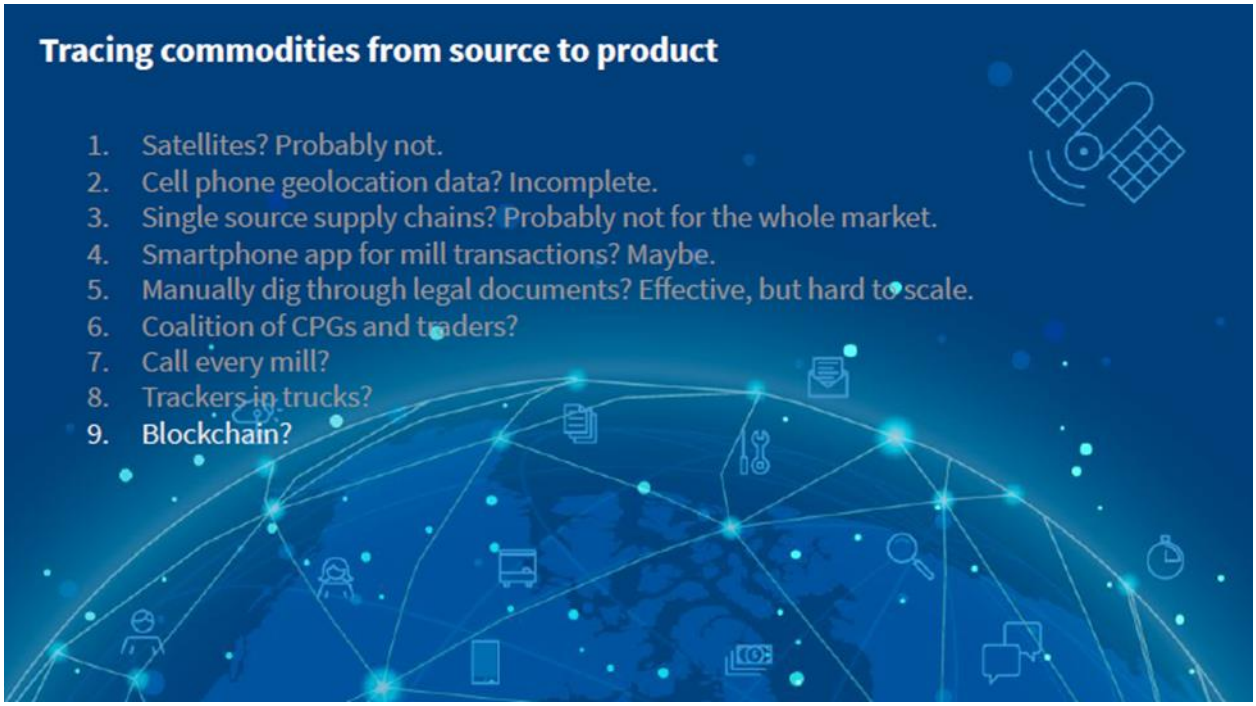
EXHIBIT 38:



Source: Descartes Labs

What's missing from this equation is the ability to accurately trace these commodities from source product. Many of the companies we work with on monitoring and reducing deforestation in their supply chain have a moderate understanding of the full range of entities and supply chain nodes involved in getting a product from the source to their final product. Therefore, we need to discuss technologies that enable closing this last piece of the puzzle.

EXHIBIT 39:



Source: Descartes Labs

Here are some examples of a number of technologies that have been tested or are being tested to enable us to trace commodities from source to product. Satellites don't have the granularity to enable us to do this. We've also worked with cell phone geo-location, but it lacks sufficient coverage in many parts of the world to obtain a complete picture. A lot of these possibilities have been tested or are in progress and I put forward the challenge to this group in this audience as this is a problem that we can solve together. I'll leave you with these ideas as food for thought and a lead into our next discussion, which is focused on blockchain for supply chain traceability.

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

Thank you so much Erika. That's a great segue to the last section of the discussion, but before I move over to Sai about blockchain applications, Erika could you talk about some other use cases of geospatial imaging? For example, does it work on tracking overfishing and are there other types of nature-based impacts that we can track?

Erika Randolph, Director of Sustainability, Descartes Labs

The applications for geospatial imagery and remote sensing are vast. Descartes labs focuses our efforts on enabling better supply chain sustainability decisions by companies in commodity supply chains. I've discussed an example of monitoring existing events and what it will take to actually impact deforestation or overfishing. In the future, we will be able to leverage remote sensing combined with machine learning to create predictive models that understand when environmentally destructive activities will occur. We can assess the signature of the likely lead up to a deforestation event and create a predictive model.

Similarly, for overfishing or illegal fishing we can use remote sensing to understand the signatures of what is considered normal behavior versus what is considered illicit behavior. The information can be supplied to governments or other entities involved in the space to prevent the occurrence of these types of events, rather than responding to them after the fact.

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

That all sounds very exciting and we look forward to it. Thank you, Erika and with that I'll turn it over to Sai to address the outstanding question of how to improve traceability back to the product and producer level to provide greater transparency around which organizations are responsible for potential climate impacts or biodiversity loss.

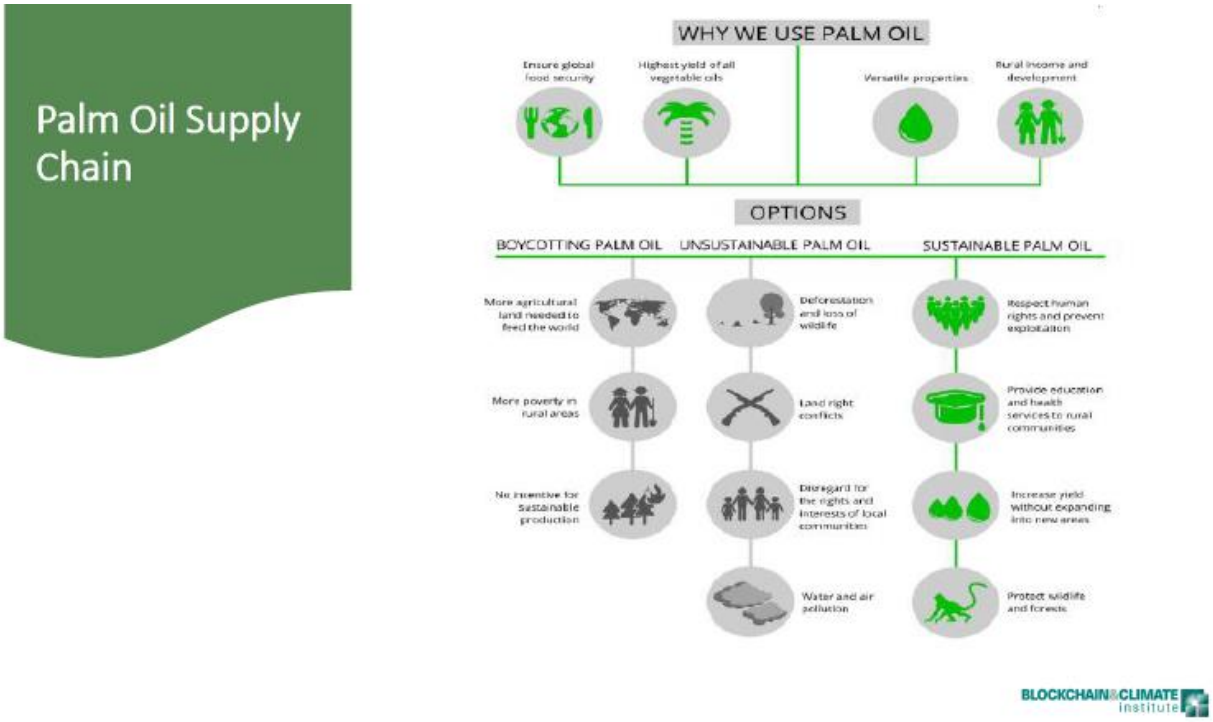
Sai Nellore, Principal Assistant Director-General, Fellowship Scheme Bureau, Blockchain & Climate Institute

EXHIBIT 40:

Source: Blockchain & Climate Institute

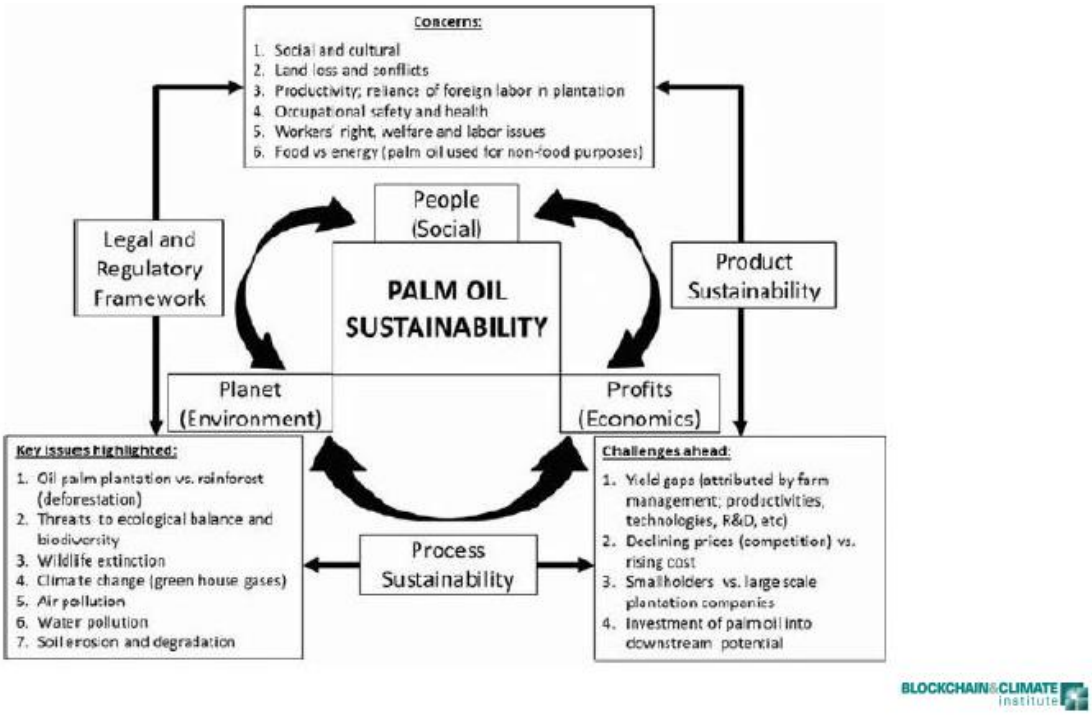
The Blockchain and Climate Institute is an instrument that has been established specifically on the sidelines of COP 23. We work as a facilitator to bring awareness about blockchain to multiple stakeholders and also provide a platform for policymakers to discuss the role of blockchain in addressing climate change issues. We focus on capacity building, technology sharing, enabling environments, and mechanisms for technology transfers.

EXHIBIT 41:



Source: Blockchain & Climate Institute

EXHIBIT 42:



Source: Blockchain & Climate Institute

One of the issues we currently are working on, along with the roundtable for sustainable palm oil based out of Southeast Asia, is to look at the supply chains of palm oil (Exhibit 41). This also critically considers the issue of protecting biodiversity in the context of supply chains.

When we talk about sustainable supply chains, palm oil plantations cause massive deforestation in the southeast Asian region which leads to biodiversity loss. The question is how to bring in traceability (Exhibit 42).

EXHIBIT 43:

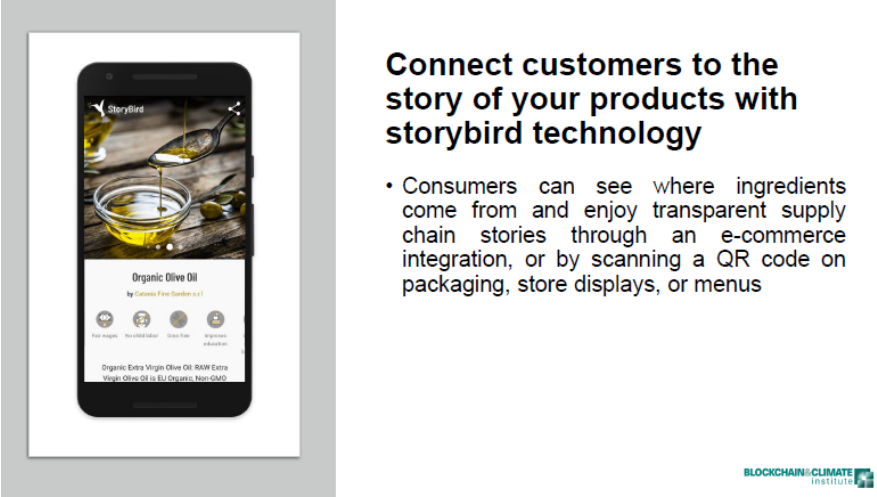
Source: Blockchain & Climate Institute

We are looking at the entire value chain and currently implementing a solution called 'PalmTrace' to increase transparency in supply chains. This solution aims to address the fact that when consumers buy and source the end product, they don't currently have vision on whether palm oil was sustainably produced or not.

The existing system in place can trace palm oil from the plantation to the mills or refineries. However, the mills or refineries accept palm oil fruits that are produced both sustainably and unsustainably, and therefore as the two are mixed together it becomes challenging to distinguish the products that are actually produced sustainably from those that are not. By introducing and using blockchain, we aim to address this issue by tracing the sustainably sourced produce from the mills or refineries (which is separated as mass balance) to the intermediaries which process the palm oil for use. The enhanced traceability of sustainably sourced products to the intermediaries ultimately means greater transparency for the end consumer.

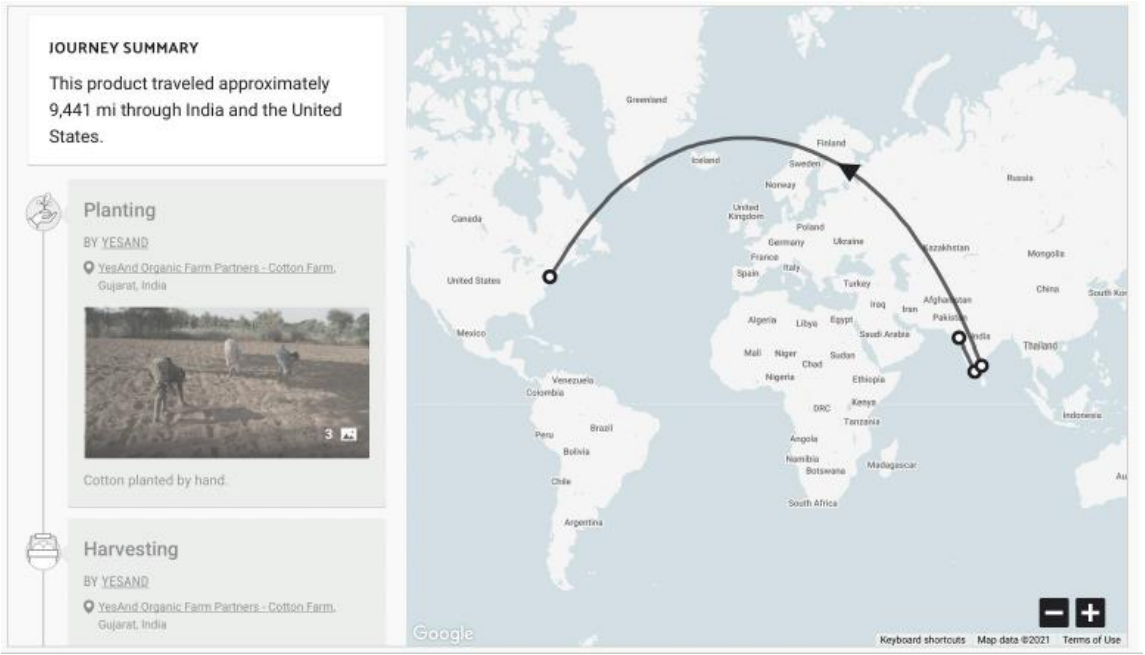
We are currently working on this area and in discussion on how to achieve this goal. Therefore, the solution has not yet fully materialized, but it has been completely tested and piloted.

EXHIBIT 44:



Source: Blockchain & Climate Institute

EXHIBIT 45:



Source: Blockchain & Climate Institute

There is also a second side to the story from the consumer perspective. A particular organization called Producers Market connects customers to the story of a product rather than using a certification or standard. The organization tells the story of the set of practices on farmlands, such as whether the practices are regenerative or are natural-based systems. On the other end, the consumer can scan a QR code available on the produce to provide transparency on production practices as seen in Exhibit 44.

Using blockchain, we enhance visibility of the whole supply chain. Exhibit 45 shows a system for producing cotton on India, where garments are processed and manufactured in the southern part of India and then exported to America. As a result, leveraging blockchain as an enabling technology can provide greater supply chain traceability.

Zhihan Ma, Global Head of ESG & Senior ESG Analyst

Thank you Sai and it sounds promising that we could use blockchain technology to potentially improve traceability. When do you think will make economic sense to utilize this technology given that a lot of the agricultural producers already have laser thin margins? Ultimately who pays for it – is it the consumers, is it the government regulators, or is it the manufacturers?

Sai Nellore, Principal Assistant Director-General, Fellowship Scheme Bureau, Blockchain & Climate Institute

As an example, right now consumers pay a premium or certified or organic produce, and at the end of the day consumers will pay for these technologies. In terms of the intermediary expenses, blockchain is as good as a certification as it addresses how certification standards bring credibility to the produce. Now, blockchain can bring that credibility to a transparent system which provides consumers with more information and flexibility to make an informed decision.

Right now, we don't have connectivity within the supply chain, and therefore a product is produced in another part of the world and the consumer is not aware of the underlying practices behind a purchase. Bringing that connectivity provides transparency and brings more value to the organizations involved because they can showcase whether they follow sustainable practices (e.g., source from sustainable lands) and can also drive engagement with consumers.

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