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Navigating climate transition risks

Climate Transition Risk Analyst Brief

Colombian Beef

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ORBITAS
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Climate Transition Risk
Analyst Brief

Colombian Beef

TABLE OF CONTENTS

What we cover in this Brief:

1. How Colombian beef cattle actors are exposed to climate transition risks. **2.** How these risks can have material, yet varying, impacts on different actors in the industry value chain. **3.** How silvopastoral farms reduce vulnerability to transition risks while also increasing market access and profitability.

FEBRUARY 2021

Section I
Key Findings

The Colombian beef industry is an important part of the country's economy and cultural heritage, yet suffers from low financial returns, suboptimal land use, and limited quality standards relative to peers. Under the spectre of slowing demand growth, warming temperatures and society's inevitable shift toward lower carbon pathways, these challenges will only grow.

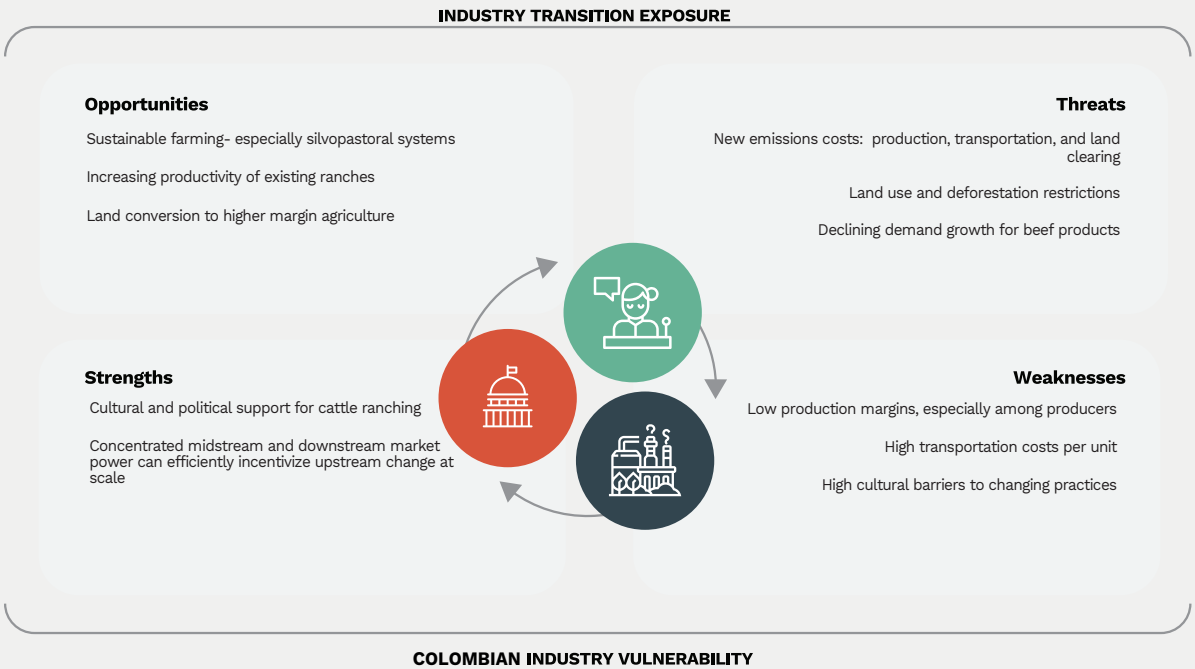
This report specifically examines how "climate transitions" are poised to materially influence Colombia's beef industry[1] in the coming decades. These transitions range from government policies to shifts in consumer demands, and could disrupt the industry status quo.

We examine three climate transitions pathways--Historical, Modest, and Aggressive--each representing varying levels of global and Colombian ambition to address the climate crisis through public policies, corporate actions, and consumer dietary shifts. The analysis draws from a preceding report, "Transition Scenarios for Tropical Agriculture,"[2] which projects changes in global commodity prices, agricultural yields, emissions costs, and land use competition under different global climate transition pathways.

The topline results from our analysis are:

- The industry's high emissions intensity, suboptimal land use, and association with deforestation expose it to three climate transition trends:
  - Declining global and regional growth in consumer demand for beef.
  - Deforestation restrictions that drive up land competition and land values.
  - Emissions costs on forest to pasture conversion and cattle production.
- Faced with these drivers, we project:
  - Declining domestic production as rising land and production costs spur conversion to higher margin agricultural uses. For example, converting clear pastures to palm oil cultivation currently provides 15 times higher margins.
  - Rising local beef prices (up to 2.3 times higher in our Aggressive scenario) and production costs even as demand growth slows, leave the industry vulnerable to import and product substitution.

Figure 1:
CLIMATE TRANSITION SWOT ANALYSIS: COLOMBIAN BEEF



Source: Concordian. Note: This figu e does not consider social, labor, and community concerns, which are important threats and weaknesses for the Indonesian palm oil industry and may be exacerbated by climate risks.

Continued
Key Findings

- Large, carbon-intensive upstream producers face the greatest risks of cost increases. Large commercial breeders could face greenhouse gas (GHG) emissions costs of up to six times higher than projected production costs within 20 years. Smaller producers are not likely to be subject to emissions pricing.

- An influx of low cost imports could fundamentally alter industry supply chains, including by cutting into the market power of domestic midstream traders and wholesalers.

- Industry actors--such as Grupo Nutresa (including El Corral), Grupo Exito, Presto, and McDonald's--can counteract these risks by adopting sustainable strategies, particularly intensive silvopastoral systems (ISPS) (Figure 1):
  - Conversion to ISPS can generate internal rates of return (IRR) as high as 32% to 37% on a ~$2,000/ha investment--a payback period of just three to four years.[3]
  - Under climate transitions, ISPS relative benefits are even greater. For an indicative average-sized dual purpose farm, relative to traditional techniques:
    - Emissions and associated costs are up to 44% lower for industrial actors.
    - Sustainably-certified price premiums boost revenues by up to 23%.
    - New carbon sequestration revenues--available to small and commercial operations--are as high as $485 per hectare.

- Given the industry's material exposure to climate transitions alongside the significant opportunities offered by sustainable practices, we recommend that investors and lenders:
  - Request investees assess and disclose climate transition exposure and vulnerability inline with guidance from the Financial Standard Boards' (FSB) Task Force on Climate-related Financial Disclosures (TCFD).
  - Predicate lending to, and investment in, beef producers on their adoption of sustainable practices and sourcing from sustainable suppliers, including by providing technical and capital assistance to small and medium ranchers.
  - Further broaden silvopastoral investment programs, financial products, and technical assistance to small- and medium-sized producers.

While greater ambition broadly has more material consequences for Colombia's cattle producers, it also means the industry has a better shot at avoiding the much worse physical and economic impacts of warming temperatures. The Colombian government, industry actors like FEDEGAN, and financiers like FINAGRO have an important opportunity to scale up ISPS deployment--including through more flexible and subsidized financing--which provide triple bottom line returns to both public and private investment.

This report specifically examines how "climate transitions" are poised to materially influence Colombia's beef industry in the coming decades.

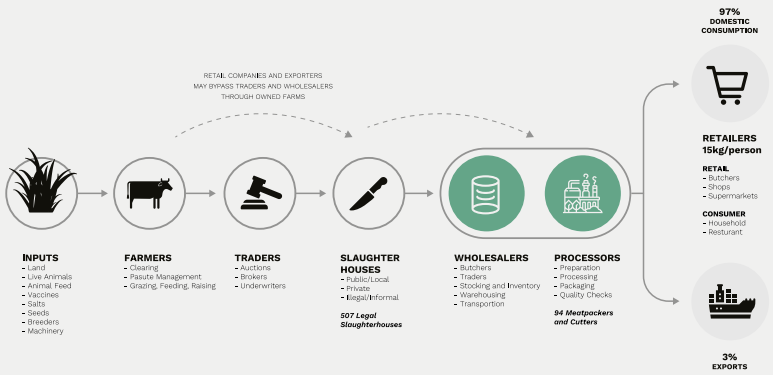
Section II
Industry Exposure to Climate Transitions

KEY TAKEAWAYS

Colombia's domestically focused beef industry is dominated by small, extensive upstream production with low profit margins.

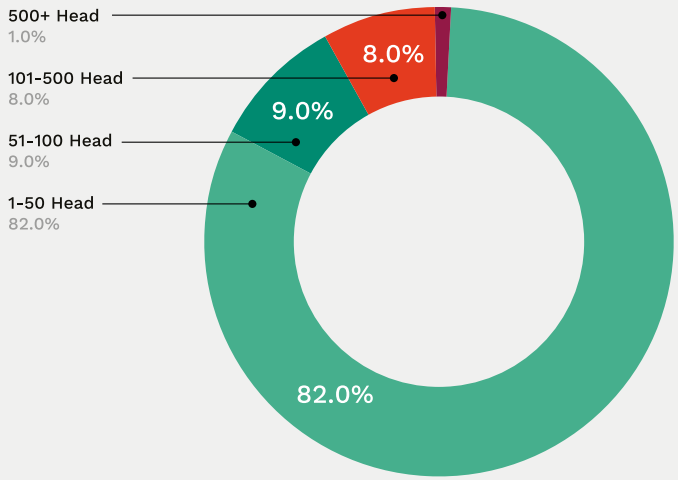
The industry's high emissions intensity and suboptimal land use exposes it to several sources of climate transition risks, including rising imports and poultry substitution.

Figure 2:
COLOMBIAN BEEF CATTLE VALUE CHAIN



Source: Concordian based on Nelson et al 2015 (USDA Forest Carbon Markets and Communities Program)

Figure 3:
COLOMBIA BOVINE CENSUS BY FARM SIZE



Source: ICA 2020

Colombia produces 1.2% of the world's beef, almost exclusively for domestic consumption. The 17th largest global and 4th largest regional producer, Colombia produced 886,000 metric tons of beef in 2018: a 42% increase over thirty years ago.[4,5] Last year, 96% of Colombian beef was consumed domestically and 4% was exported[6] to several Middle Eastern countries, Russia and Vietnam, among others.[7] Exports have grown slowly and are limited by Colombia's quality and sanitation practices. Imports--primarily from the U.S. and Argentina-- are similarly limited but growing, reaching 23 million USD in 2019.[8]

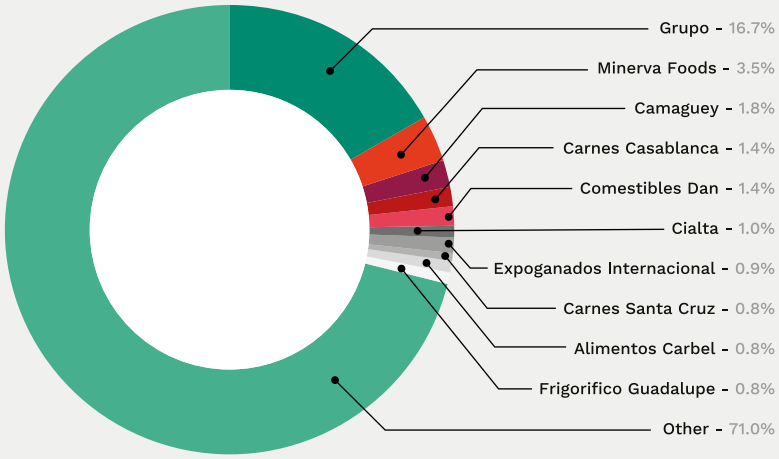
The industry (Figure 2 illustrates the value chain) is characterized by extensive systems on unsuitable land. The country has 34 million hectares of pasture land--28% of which is classified as unmanaged pasture--where 28 million cattle graze[9,10] on 655,661 sites.[11] Only 15 million hectares of total land cover is identified as suitable for cattle ranching.[12] Most production occurs within extensive systems with low stocking rates and low productivity, and is mainly based on grazing.

Upstream cattle production in Colombia is dominated by small producers: half have less than 10 animals and the vast majority own less than 50 head.[13] Only 1% of producers run commercial-scale operations with more than 500 animals (Figure 3).[14] Smaller ranches are often operated by poor subsistence farmers--"campesinos"--with low access to capital and low margins.[15] Others are operated from afar by wealthy landowners as a means to secure land claims (including by aggregating and buying campesino-developed farms en bloc) with minimal effort. For these wealthy ranchers, profitable operations are not always the highest priority. Smaller ranches are less productive and face 1.5 times (or more) higher costs per head.[16]

Midstream traders and wholesalers have significant

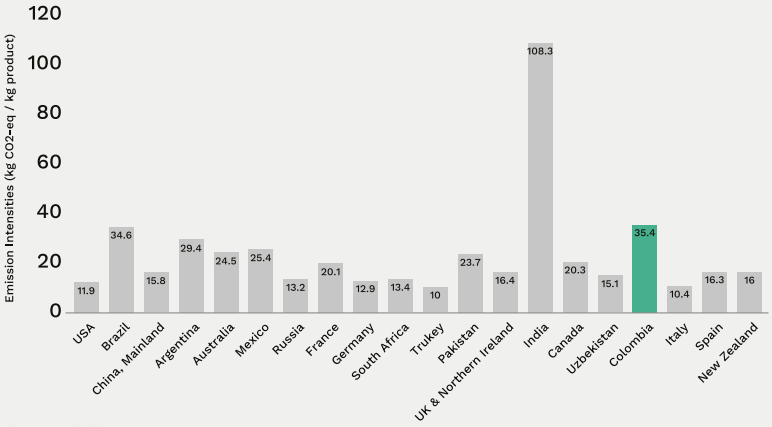
Continued
Industry Exposure to Climate Transitions

Figure 4:
MARKET SHARE OF COLOMBIAN BEEF PROCESSORS



Source: LaNota 2018. Notes: Aggregate market value used was 3,640 million USD reported by FEDEGAN, cited by Chain Reaction Research

Figure 5:
COUNTRIES WITH HIGHEST BEEF PRODUCTION EMISSIONS INTENSITY AMONG TOP 25 PRODUCERS



Source: FAO 2017
Notes: These emissions intensities are significantly higher than emissions intensity estimates used for specific ranches in this paper; part of this discrepancy is due to the inclusion of land clearing in FAO statistics.

Colombia's beef industry is the world's second most emissions-intensive. This will need to change for it to meet its climate goals.

market power. These middlemen are paid immediately by downstream purchasers but take their time to pay sellers. Some middlemen take advantage of this dynamic to lend to (and earn interest from) cattle sellers, often earning more from these cash and lending services than commodity margins. Middlemen take animals to (or buy from) one of 507 authorized slaughterhouses,[17] many of which are close to major cities.[18,19] From there, the meat enters downstream butchering or processing through 94 meat cutting and packing establishments (Figure 2).[20]

Downstream sales are dominated by local butchers selling unprocessed beef. 80% of slaughtered and deboned cattle are sold unprocessed, mainly via local butchers like Koller.[21] 20% is processed and sold mainly via independent retailers, and large supermarkets, primarily Grupo Exito.[22] Beef processors Grupo Nutresa (17% market share) and Minerva Foods (4% market share) are the only publicly-listed companies in the value chain. Most processors have less than 1% market share (Figure 4).[23]

Colombia's small beef industry is the world's second most emissions-intensive (Figure 5)[24]. Around 43% of Colombia's greenhouse gas emissions are related to agriculture, forestry and land use change; almost 30% of those emissions are related to enteric fermentation from cattle, and around 35% are related to deforestation (particularly in Meta, Caquetá, and Guaviare).[25,26,27,28]

To meet Colombia's domestic climate goals, it will need to reduce emissions from its cattle industry. Colombia's contribution to Paris Agreement is to reach 20% below business as usual by 2030, with another 10% in reductions achievable with international support. The cattle industry is its largest source of agricultural GHG

Continued
Industry Exposure to Climate Transitions

Figure 6: CLIMATE TRANSITION RISKS FOR COLOMBIAN CATTLE INDUSTRY

TCFD Risk Category	Risk Event	Example or Potential Source
Policy & Legal	Government restrictions on deforestation.	The Supreme Court has passed laws to restrict deforestation in Amazonia.
	Introduction of greenhouse gas (GHG) taxes or pricing systems that cover agricultural producers.	Colombia has committed to reduce its greenhouse gas emissions by 20% below BAU by 2030.
Technology	New planting technologies enable higher yields	Emerging agroforestry techniques like intensive silvopastoral systems (ISPS) provide opportunities to boost yields, diversify income, and reduce emissions.
Market	Declining demand for carbon intensive protein sources like beef.	Both current trends and future transition scenarios project increasing consumer substitution of ruminant meats in favor of lower carbon protein sources.
	Retailers or wholesalers require new environmental standards from their suppliers	Colombian Tropical Forest Alliance partners Grupo Exito and Alqueria have committed to zero deforestation supply chains Grupo Nutresa, Minerva, Burger King and other large beef actors have expressed interest in sustainable beef sourcing.
	Corporate and consumer demand for sustainable palm oil grows	Studies indicate that sustainable beef can command a price premium in Colombian markets.
	Land competition from lower carbon crops	As security risks abate and land values rise, conversion cattle ranchers may convert or sell land to higher margin, lower carbon crops.
	Capital providers link financing to improvements in greenhouse gas emissions	FINAGRO provides specialized financing for ISPS conversions.
Reputation	Shareholders or capital providers divest or express concerns about environmental commitments.	Seven major European investment firms have threatened to divest from nearby Brazil's beef producers and grains traders over deforestation concerns.
	Increased NGO and stakeholder concern about issues such as deforestation or climate change increase scrutiny of tropical commodity supply chains.	NGOs play a highly active role in monitoring deforestation in Colombia, particularly around Amazonia.

Source: Concordian and Reuters, June 2020.[31]

emissions. Therefore, in its low carbon growth strategy, the government identifies livestock intensification and addressing pasture conversion as important emissions reduction strategies.[29] Across the economy, Colombia has enacted a carbon tax, with an emissions trading system planned, and Supreme Court has passed laws to conserve Amazonian forests. These policies will impact the cattle industry, either directly or indirectly by affecting the market for inputs like fuel or agricultural land.

In addition to government policy, domestic consumer demand is poised to follow a global trend toward beef substitutes. Meat consumption in Colombia has grown in line with GDP growth; but Colombians are increasingly shifting toward poultry consumption-- which has doubled since 2002. In 2019, beef consumption in Colombia was 18.6 kilograms per person while poultry consumption was 35.6 kilograms per person.[30]

Colombia's environmental policies will impact the cattle industry both directly and indirectly via input costs.

As ambition to address the climate crisis intensifies, these trends will also intensify, creating material risk events for Colombian producers, whether driven by new climate and land use policies, market purchasing shifts, or technology developments as outlined in Figure 6.

Section III
Financial Implications of Climate Transitions

KEY TAKEAWAYS

Emissions costs and land use restrictions would squeeze already tight margins--especially for large cattle breeders--and impede geographic expansion.

Greater land competition and tighter margins are likely to spur land sales and ranch conversion to higher margin agricultural activities like palm oil.

A. CLIMATE TRANSITION SCENARIOS

To assess the effect of future climate transitions on Colombian cattle ranching, we evaluate three scenarios: Historical Ambition ("Historical"), Modest Ambition ("Modest"), and Aggressive Ambition ("Aggressive"). As summarized in Figure 7, each transition scenario considers both global and corresponding local pathways--including consumer trends--to achieve global warming temperature targets.[32] Specifically, we assume the following Colombian actions in line with global pathways:

- **Historical:** The Historical scenario assumes limited global and local ambition to address the climate crisis. In Colombia, we project a pathway that reflects the status quo in which agricultural emissions are neither regulated nor taxed and in which deforestation restrictions are not enforced.
- **Modest:** In this scenario, the world pursues modest GHG pricing[33] alongside investment in bioenergy pathways, among other factors. In Colombia, we assume very modest GHG pricing, increased consumer interest in certified-sustainable beef, as well as deforestation restrictions that cover industrial cattle producers.
- **Aggressive:** The Aggressive scenario amplifies the Modest scenario, with higher GHG pricing, significant local demand for certified-sustainable beef, as well as significant declines in global and regional ruminant meat consumption.

Figure 7:
CLIMATE TRANSITION SCENARIO ASSUMPTIONS

	Historical Ambition	Modest Ambition	Aggressive Ambition
Warming Target (Degrees Celsius)	4+	3	1.5
Global Carbon Price Land Sector* (2019 USD per ton CO2)	None	$3 in 2030 $7 in 2040	$14 in 2030 $69 in 2040
Regional Carbon Price: Land Sector* (2019 USD per ton CO2)	None	$1 in 2030 $7 in 2040	$10 in 2030 $64 in 2040
Global Protected Natural Areas** (Mha)	352	352	2,707
Colombian Land Development Restrictions	Deforestation allowed	No Deforestation	No Deforestation
Bioenergy Pathways (EJ by 2100)	27	70	70
Ruminant Meat Consumption***	No reduction	No reduction	No reduction
Maximum Price Premiums for Sustainable Beef****	None	10%	23%

Source: Concordian and Vivid Economics, based on MAgPIE assumptions and REMIND carbon price modeling results from the report "Transition Scenarios for Tropical Agriculture." Notes: *Carbon prices presented are averages in 2019 USD; this report's financial analysis uses regional GHG prices. GHG emissions prices reflect land sector GHG prices, rather than energy or economy-wide GHG prices which may be higher. **Global Protected Natural Areas are defined by the International Union for the Conservation of Nature (IUCN). The Historical and Modest Scenarios protect IUCN Categories I and II while the Aggressive Scenario protects IUCN Categories I to VI, both designated and proposed. ***Ruminant meat fadeout – this is a gradual decrease in the role of ruminant meats (beef, lamb, mutton and goat) as a protein source. Fadeout scenarios replace ruminant meat with less carbon intensive protein sources, including poultry, fish, eggs, and alternative meats. **** Price premiums are based on Charry et al 2019.[34]

Our models broadly project rising beef prices while production and demand growth slow with greater climate ambition (Figure 8, on next page). Over the next 15 years, global and regional beef prices and production under the Historical and Modest scenarios track each other closely, while the Aggressive scenario's results diverge immediately. These pricing trends reflect underlying assumptions in each scenario. In the Historical and Modest scenarios producers see limited cost increases and production rises to meet growing demand, thereby moderating price increases. In the Aggressive scenario, emissions pricing and area protections raise production costs, leading to production declines and higher prices even in the face of declining demand.

After 2035, regional (Central and South American) beef prices under the Aggressive scenario spike much higher while production falls faster than global trends. By 2040,

Continued
Financial Implications of Climate Transitions

Aggressive regional beef prices are 1.6 times higher, and global beef prices are 2.3 times higher, relative to the Historical scenario. Notably, regional price increases may be moderated by future imports in the absence of import restrictions.

B. IMPACTS ON PRODUCERS

Climate transitions will incentivize emissions-intensive and inefficient producers to leave the market. Depending on the level of climate ambition and the nature of policy mechanisms,[35] commercial operators in Colombia's beef value chain could face:

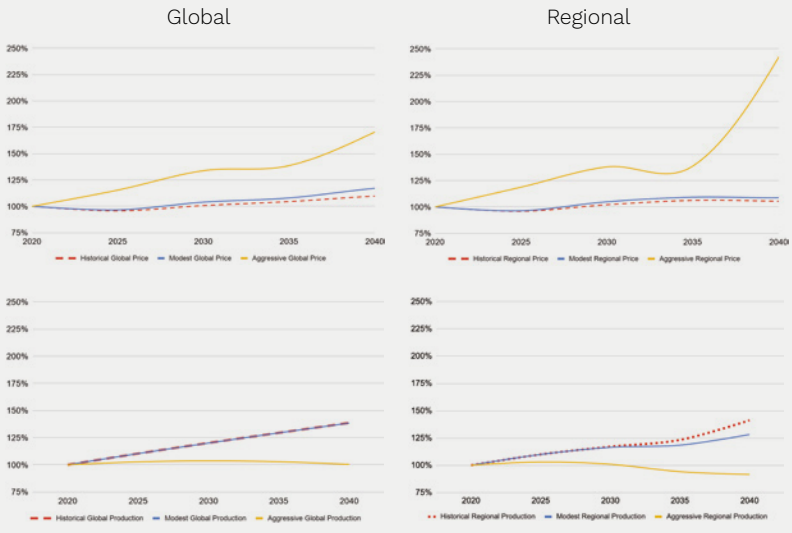
- Higher production and transportation costs related to GHG emissions.
- New GHG emissions costs on converting forests to pasture.
- Laws preventing deforestation or other area protections, and
- Land competition from higher margin agricultural uses.

Emissions costs will squeeze already tight margins. Charging emissions costs directly to small ranchers may not be administratively or politically feasible. But larger, commercial breeders, finishers, and dual purpose farms will likely face significant operational emissions costs. Traders and wholesalers will also face higher transportation costs (Colombia's rural-urban transportation routes are already notoriously inefficient) as diesel and other fossil fuels face carbon taxes or pricing.

Cattle breeders will be particularly hard hit due to their emissions intensity. Cattle breeders achieve comparatively high margins among beef producers, but are also some of the most emissions-intensive within the beef value chain. Under an Aggressive climate transition, large breeders (over 250 head) could see emissions costs rise to the **same level as projected production costs within 10 years (Figure 9, next page). Within 20 years, emissions costs rise to over 6 times the projected production costs.** Smaller breeders, while more emissions-intensive than larger breeders, are not likely to be subject to GHG pricing policies and their associated costs.

Producers and processors can't easily pass these costs downstream and still compete with higher margin crops and cheaper international substitutes. Colombian beef prices are currently low but profits are low relative to both beef imports and common domestic agricultural crops. Palm oil, for example, is 15 times more profitable than beef cattle per hectare (Figure 10 next page). Meanwhile, beef imports are cheaper due in part to their relatively cheaper transportation costs. For example, FEDEGAN states that it is cheaper to send a container from Shanghai to Cartagena than from Bogotá to Cartagena. Subject to trade policies, if Colombia continues to produce high emissions- and transportation-intensive beef, it will likely face an influx of lower-cost imports.

Figure 8:
PROJECTED BEEF PRICES AND PRODUCTION UNDER HISTORICAL, MODEST AND AGGRESSIVE SCENARIOS



Source: Concordian, based on modeling results from the report "Transition Scenarios for Tropical Agriculture."

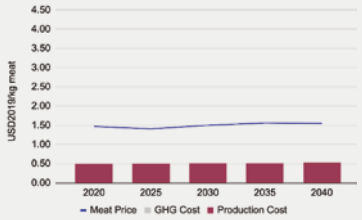
C. GROWTH CONSTRAINTS

Land use restrictions alongside GHG pricing spur increases in net forest areas, reducing the potential for legal and economically feasible cattle expansion. If the Colombian government were to restrict deforestation alongside even the Modest scenario's carbon price, we project forest cover gains of 1.3 million hectares by 2030 and 2.6 million hectares by 2040 (Figure 11, next page). The zero deforestation restriction alongside the "Modest" carbon price reduces total available commercial cattle-suitable land[38] (i.e., contiguous tracts of over 200 hectares)[39] from 13.7 million hectares (Historical) to 11.9 million hectares of land by 2040. For smaller operators (i.e., land tracts less than 50 hectares), expansion potential shows little variation relative to that for commercial operators, though zero deforestation policy enforcement may be more lax for small scale operations.

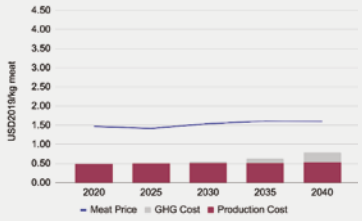
Continued
Financial Implications of Climate Transitions

Figure 9:
ANNUALIZED PRODUCTION AND EMISSIONS COSTS FOR LARGE BREEDERS

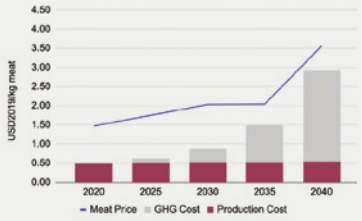
A. Historical Ambition



B. Modest Ambition



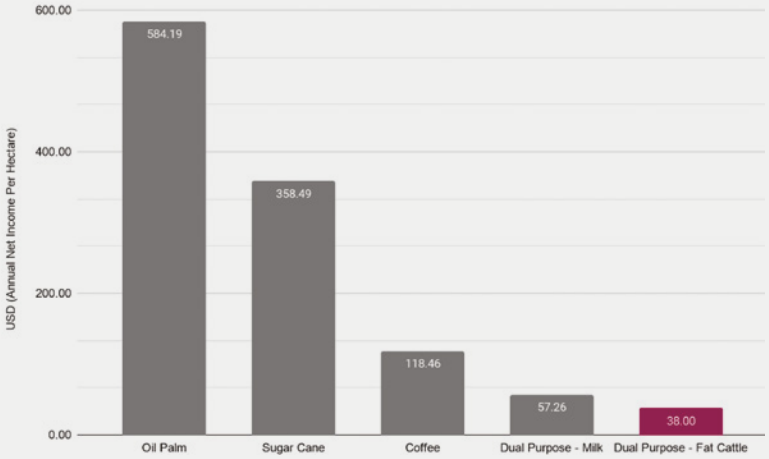
B. Aggressive Ambition



Source: Concordian using data from Gonzalez et. al 2019.[36] Notes: See technical annex for methods, data sources, and caveat[37]s related to these projections. These projections reflect a "steady state,"i.e., they do not reflect projected cash flows or income over time; rather they provide a snapshot in each year of relative production and emissions-related costs based on the prevailing GHG prices for the land sector in that time step. Emissions costs are based on an estimated emissions intensity for larger breeders (251-500 head) of 37.3 kg CO2eq per kg of live weight gain (LWG).

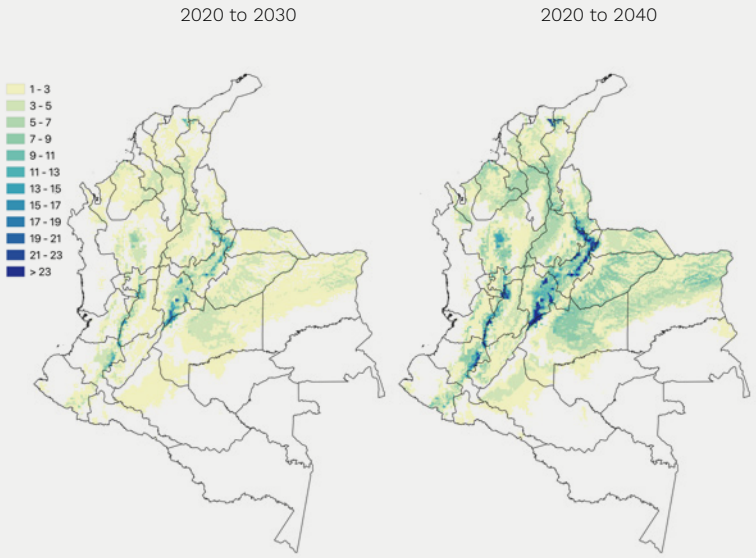
- Projected production costs also assume increases in factor costs including labor, energy, and equipment; they do not consider increases in fertilizer nor land costs; we assume fertilizer-related cost increases are driven by emissions costs within the farm gate rather than fertilizer prices.
- Emissions from transportation are not included in this chart, but are likely to also be material throughout the value chain, further impacting profits for the industry as a whole. Emissions from land clearing are also not considered.

Figure 10:
PROFITABILITY BY AGRICULTURAL ACTIVITY IN COLOMBIA



Source: FEDEGAN, 2015

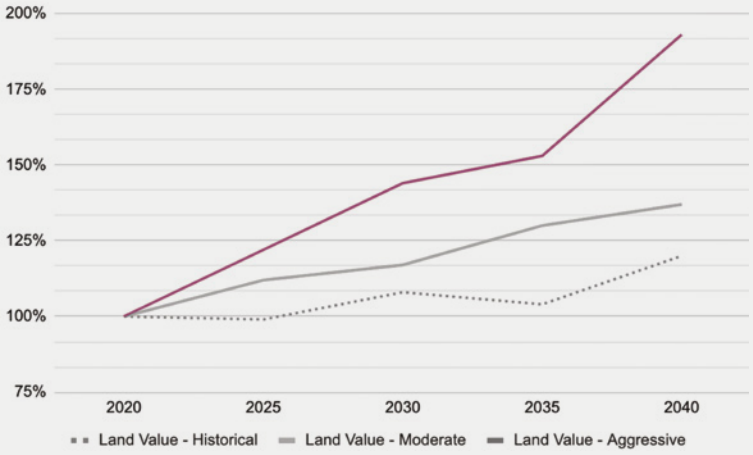
Figure 11:
FOREST COVER EXPANSION: MODEST AMBITION SCENARIO



Source: Authors. Forest cover projections at 5.5 km x 5.5 km spatial resolution are based on the OSIRIS model.[37] Plotted values indicate the percentage of the grid cell area that has experienced an increase in forest cover over the 10- or 20-year time period; changes <1% appear white. Nationally, grid-cell-level forest cover expansion ranges from 0% to +22.0% for 2020–2030 and 0% to +41.9% for 2020–2040 for the Modest scenario with zero-deforestation restrictions enforced; the equivalent ranges for the Aggressive scenario with zero-deforestation restrictions enforced are 0% to +23.4% for 2020–2030 and 0% to +56.7% for 2020–2040. Administrative boundaries are from GADM (version 3.6, https://gadm.org). See technical annex for more information on data sources and methods. Notes: This scenario assumes no deforestation is permitted and that a modest carbon price incentivizes larger net forest areas.

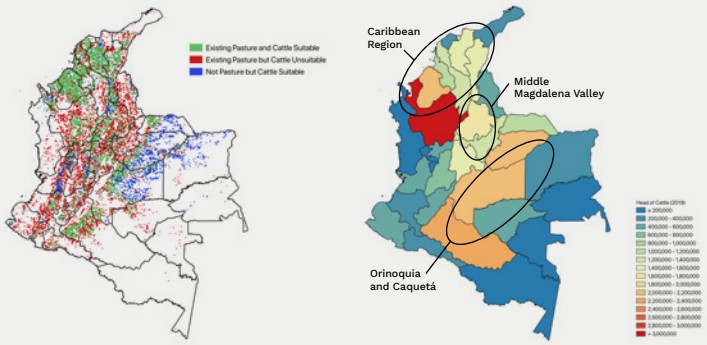
Continued
Financial Implications of Climate Transitions

Figure 12:
REGIONAL LAND VALUES



Source: Concordian, based on modeling results from the report "Transition Scenarios for Tropical Agriculture."

Figure 13:
CATTLE SUITABILITY MAP AND MAJOR CATTLE FARMING REGIONS



Source: Concordian, on left, combining IDEAM 2012 land use map[42] and SIPRA 2020 suitability map[43] to show overlap of existing pastures and cattle-suitable land. SIPRA defines suitability based on a number of factors including biophysical suitability, socio-economic considerations, and ecological considerations. For these maps we defined "Unsuitable" as any areas with low or no suitability as defined by SIPRA. Administrative boundaries are from GADM.[44] The map on the right shows the locations of cattle herds, with values indicating heads of cattle in 2019 from ICA 2020.[45] For more details, see Technical Annex.

Figure 14:
CATTLE SUITABILITY MAP AND MAJOR CATTLE FARMING REGIONS

Source: Concordian, combining a land use map from IDEAM 2012[46] and an oil palm biophysical suitability map from Pirker et al. 2016.[47] Administrative boundaries are from GADM.[48] See Technical Annex for more information

Even in scenarios where deforestation is permitted, GHG pricing could make forest-to-pasture conversion prohibitively expensive. As security risks abated following the peace deal with the Revolutionary Armed Forces of Colombia (FARC), cattle ranching proliferated on previously forested lands in Amazonia as a means to secure land ownership. Under climate transitions, clearing forest to establish a cattle ranching operation would result in $584 (Modest) to $5,840 (Aggressive) in upfront GHG emissions costs per hectare by 2030.[41] At the current average net income of US$38 per hectare for a dual purpose farm, it would take 15 years (on a cash basis, i.e., no interest considered) to recover this upfront cost in even the Modest scenario. Within 20 years, these clearing-related emissions costs rise to $4,088 (Modest) and $37,000 (Aggressive) per hectare.

Greater land competition and tighter margins will spur land sales and conversion to higher margin agricultural activities. In the Aggressive scenario where deforestation is restricted, regional land values are projected to nearly double within 20 years (Figure 12) as a result of both emissions pricing and area protections. Given both cattle ranching's currently thin profit margins and suboptimal land use (Figure 13), we expect climate transitions to incentivize the conversion of inefficient, emissions-intensive pasture lands either back into forests, and/or into higher margin agricultural activities such as palm oil, sugar cane, or coffee.

63% of the country's existing pasture overlaps with land that is biophysically suitable for palm--a crop which provides 15 times higher margins (Figure 14). The impact of this conversion on midstream beef processing, trading, and wholesaling will largely depend on trade restrictions--without restrictions, lower cost, lower-emissions imports are likely to flood the market and moderate domestic price increases.

Section IV
Climate Transition Opportunities

KEY TAKEAWAY

Sustainable farming techniques like intensive silvopastoral systems protect against future cost increases and price volatility by reducing emissions, increasing productivity, diversifying income sources, and expanding market access.

Embracing a "local and sustainable" beef label can counteract slowing demand... Such an approach would play into the cultural heritage of ranching in Colombia while also creating a premium product that justifies higher prices. One study found that Colombian consumers may be willing to pay a 23% price premium for eco-friendly beef; 25% for animal welfare friendly-beef; and 10% for beef labels that addressed environmental impacts. A maximum price premium of 50% could be achieved by addressing multiple consumer concerns.[49]

... while sustainable techniques like intensive silvopastoral systems (ISPS) boost profitability and diversify income sources. Sustainable farming techniques range from simple investments in fences and dispersed trees, to highly productive ISPS, which carefully combine trees, pasture, and livestock (Box 1). The dry Caribbean region of Colombia is particularly promising for private investment in ISPS.[50] Here, one ISPS conversion generated *6 times higher income and reversed net losses to 8 times the profit in absolute terms.*[51] This implies a 32-37% IRR and a payback period of just 3-4 years on $2,000-$4,000 of initial capital investment depending on the mix of trees and shrubs used.[52] Profit gains are driven by greater productivity (Figure 15 shows statistics for a dual-purpose farm) and new sources of revenue from timber or fruit sales.

One study found that Colombian consumers may be willing to pay a 23% price premium for eco-friendly beef; 25% for animal welfare friendly-beef; and 10% for beef labels that addressed environmental impacts.

The relative profitability of sustainable approaches would be even higher under climate transitions, bolstered by emissions cost savings, sequestration payments, and potential price premiums. As shown in Figure 16, average methane emissions per produced kilogram of meat are 44% lower in ISPS relative to traditional techniques, resulting in relative savings. In addition, ISPS' carbon sequestration could generate revenues of up to $485 per hectare in 2040 under the Aggressive scenario. Sustainable techniques also reduce dependence on, and thus costs related to, fertilizer and weed killers, cutting operational costs by an estimated 70%.[56]

Under climate transitions, converting to silvopasture becomes substantially more profitable

The profitability of ISPS conversion substantially rises relative to traditional techniques. Figure 16 illustrates the relative cost, productivity, and price premium benefits achievable under each transition scenario for an illustrative dual purpose farm (based on Figure 16's data) that is subject to GHG emissions pricing. In the Aggressive scenario, ISPS profits per hectare are up to 8 times and 13 times higher than conventional systems by 2030 and 2040, respectively. *Notably, these results may be less relevant to large scale operations that have higher*

BOX 1: SILVOPASTORAL FARMING EXPLAINED

Silvopastoral farming is an agroforestry approach that integrates trees, bushes, pasture and livestock in a mutually-beneficial way. Depending on its execution, this technique can provide ecosystem services, boost dairy and beef productivity, and diversify producers' incomes. In Colombia, ISPS typically combines live fences, trees, fodder crops, and plants that keep soil fertile with cattle pastures. Compared to pastures with no trees, ISPS systems store more carbon, improve soil properties, enhance environmental resilience, reduce runoff, and promote greater biodiversity. ISPS systems provide more nutrient-dense and diverse fodder for livestock which boosts meat and milk productivity. Greater fodder density also enables producers to stock more cattle per hectare, enabling more efficient land use. Though ISPS systems allow for denser production by providing an improved diet, they also lower greenhouse gas emissions per animal, and by providing shade they improve cattle welfare and reduce health risks from overheating, ticks, and anxiety from lack of concealment.[53] ISPS farming also improves economic outcomes for producers by increasing milk and beef productivity and adding additional sources of revenue, such as timber sales, while reducing the need for costly inputs such as fertilizer and weed killers.

Source: Chará, Julian, Ernesto Reyes, Pablo Peri, Joachim Otte, Fritz Schneider, and Eduardo Arce, "Silvopastoral Systems and their Contribution to Improved Resource Use and Sustainable Development Goals: Evidence from Latin America" FAO, CIPAV, and Agri Benchmark, 2019, http://www.fao.org/3/ca2792en/ca2792en.pdf.

Continued
Expansion Challenges Under Climate Transitions

Figure 15:
PRODUCTION AND EMISSIONS:
AVERAGE-SIZED DUAL-PURPOSE CATTLE PRODUCTION SYSTEMS[57]

Measure	Conventional Extensive Pastures	"Improved Pastures" - No Trees	ISPS- With Trees
Animal Load (large animals per ha)	0.5	1	3
Weight Gain (kg per animal, per day)	0.37	0.5	0.75
Weight Gain (kg per hectare)	0.185	0.5	2.25
Average Methane Emissions (kg per hectare per year)	15.5	38	105
Annual Meat Production - live weight (kg per ha per year)	67.5	182.5	821.3
Methane Emissions per tonne of meat (kg per ton)	229.5	208.2	127.9
	No reduction	No reduction	No reduction
Fattening Days	514	380	253

Source: Broom et al 2013[54], using CIPAV data and Murgueitio et al 2008;[55] FEDEGAN.

carrying capacities and productivity; for these types of operators, alternative sustainable farming techniques like industrial-scale intercropping may make better sense. Additionally, not all ranches are ideal candidates for conversion to ISPS.

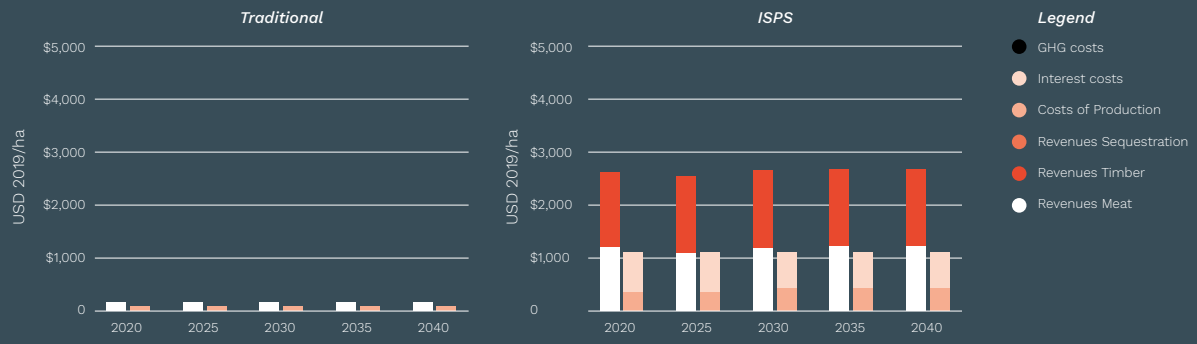
Despite clear financial benefits even in today's market, only 2 to 3 million hectares of land utilize silvopastoral systems.[58] The World Bank/GEF, FINAGRO, FEDEGAN, FAO, and many others, have introduced several sustainable cattle ranching pilot and scaling programs. Many of these programs support favorable, subsidized, financing instruments. But uptake of these financing options, and the adoption of silvopastoral systems generally, have been slow. Instituting ISPS requires technical knowledge, upfront capital, and time. Many ranchers in Colombia are resistant to giving up the extensive ranching traditions of recent generations. Smaller ranchers also struggle to access capital without clear land titles. Finally, many ranchers do not have the patience either to wait for returns or to invest more resources in their ranches when losses are already piling up.

Uptake of silvopasture has been slow because of lack of capacity, cultural resistance to new techniques and unclear land titles.

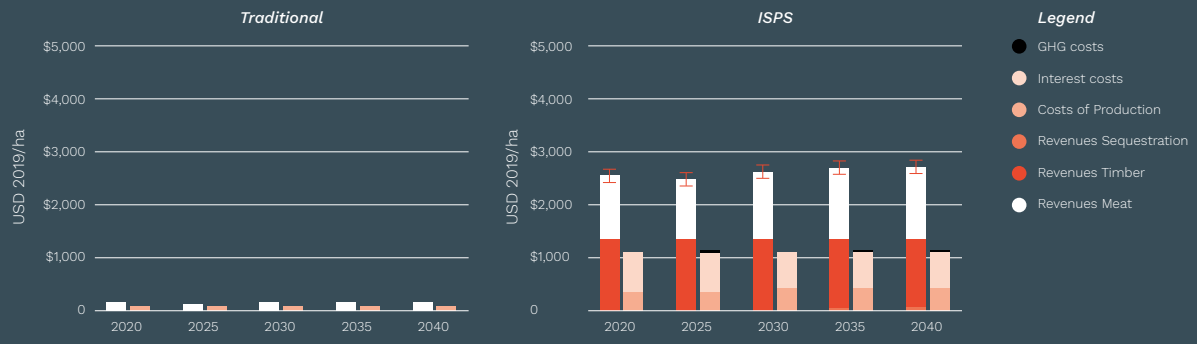
Continued
Expansion Challenges Under Climate Transitions

Figure 16:
ANNUAL REVENUES AND COSTS: DUAL PURPOSE ISPS VERSUS TRADITIONAL SYSTEMS

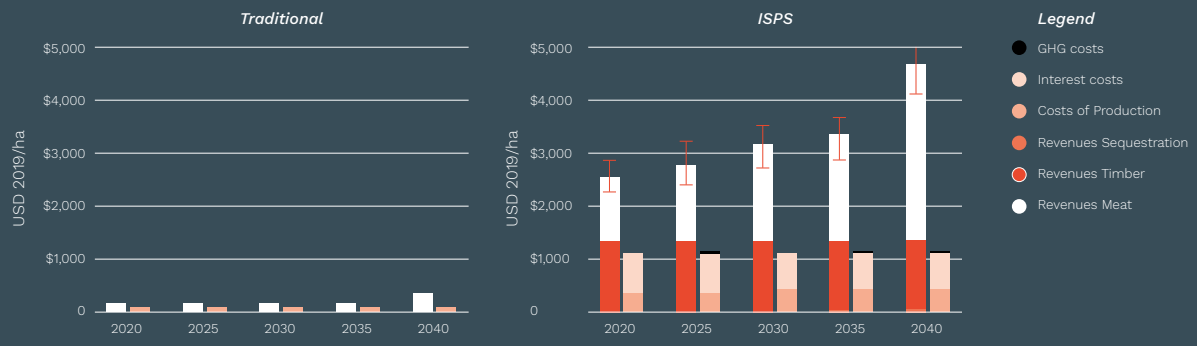
A. Historical Ambition Scenario: No ISPS Price Premium



B. Modest Ambition Scenario: Up to 10% ISPS Price Premium



C. Aggressive Ambition Scenario: Up to 23% Price Premium



Source: Concordian, based on data from FEDEGAN, Broom et al 2013, Nelson and Durschinger 2015, Charry et al 2019, and Cardona et al. 2012. See technical annex for additional details regarding calculations and data sources.
Notes:
- This chart only includes methane emissions, largely related to enteric fermentation due to data constraints.
- This chart's intention is to give an indication of the cost differences for ISPS versus traditional systems. Not all producers will face these costs. The calculation makes several simplistic assumptions as outlined in the Technical Annex.
- This figure's underlying data assumes an average-sized dual purpose farm that is subject to emissions pricing, using land sector GHG prices.

Section V
Recommendations

Sustainable farming represents a clear opportunity for Colombia's beef industry to boost returns while also mitigating vulnerability to climate transition risks. But scaling up these approaches requires significant upfront capital--up to $17.5 billion to convert 14 million hectares by some estimates[59]--alongside sustained technical assistance and outreach. The Colombian government has a unique opportunity to align industry incentives and environmental goals through carbon pricing, land use restrictions, and other climate regulations.

Scaling up sustainable farming in Colombia requires up to $17.5 billion in capital investment.

As such, our research underscores the following recommendations:

Producers:
Large corporate producers and buyers should immediately institute, and allocate capital to supporting, sustainable livestock purchasing policies (see Box 2 for context). This will require adjusting corporate policies, educating suppliers, and providing direct education and technical assistance to poorer farmers.

Financiers:
Commercial-scale investors and banks must tie investment and lending to:

- Sustainable practices that allow for market differentiation and thus, reduce repayment losses under climate transition pathways.
- Disclosure of climate transition risks and how these risks will be mitigated.

Policymakers:
ISPS and other sustainable cattle ranching techniques provide a triple bottom line win, reducing Colombia's emissions, maintaining livelihoods, and increasing the industry's economic value. A strong carbon price on a wide range of emissions-intensive sectors could provide the scale of revenues necessary for policymakers to provide much needed technical assistance, grants, subsidized financing, and public guarantees that leverage further private investment.

The Colombian government has a unique opportunity to align industry incentives and environmental goals through carbon pricing, land use restrictions, and other climate regulations.

BOX 2:
CORPORATE SUSTAINABILITY STRATEGIES

Colombian beef value chain actors are increasingly recognizing the importance of sustainability:

- Grupo Nutresa--the country's largest beef processor--has identified silvopastoral systems as an important sustainability strategy.[60]
- Minerva--Colombia's second largest beef processor--has made a public commitment to deforestation-free cattle in its supply chains.[61,62]
- Nestle--the third-largest buyer of milk in Colombia--has a Dairy Development Plan that promotes silvopastoral management to improve the quality and quantity of milk.[63]
- Grupo Exito--the country's largest supermarket retailer--has expressed interest in more sustainable supply chains.[64]
- Cargill, McDonald's, Restaurant Brands International (the parent company of Burger King), the WWF, Mesa Ganadería Sostenible Colombia, and Minerva Foods, among others, are part of the Global Roundtable on Sustainable Beef (GRSB).[65]

Nevertheless, as most of these corporate strategies lack measurable capital and/or corporate policy commitments to sustainable practices, they are unlikely to result in the meaningful shifts companies must make to effectively address climate transition risks.

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AUTHORS

Concordian:
Shally Venugopal, Markus Walther, Kandice Harper, and ***Emily McGlynn***

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ORBITAS CONTACTS

Mark Kenber, Managing Director
(kenber@orbitas.finance)

Ameer Azim, Chief Economist
(azim@orbitas.finance)

Contact Us
—
info@orbitas.finance
orbitas.finance

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linkedin.com/company/orbitas-finance