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Navigating climate transition risks

Climate Transition Risk Analyst Brief

Peruvian Palm Oil

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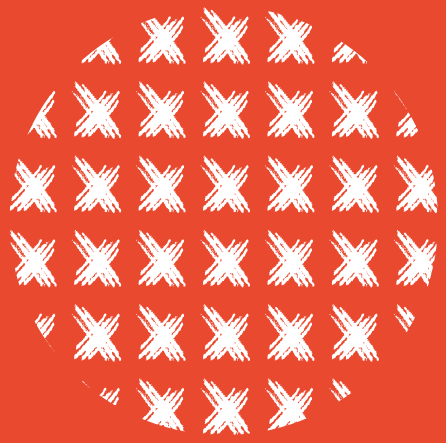

Climate Transition Risk Analyst Brief

Peruvian Palm Oil

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What we cover in this Brief:

1. How Peruvian palm oil actors are exposed to climate transition risks and opportunities. **2.** How climate transitions can affect production costs, profitability, capital needs, and growth strategies. **3.** How a sustainability and smallholder focus can protect companies from transition risks while also expanding market access.

Climate Transition Risk Analyst Brief
DECEMBER 2021

Section I
Key Findings

While the Peruvian palm oil industry is small, it has an opportunity to grow as global demand climbs and production capacities in other regions — like Indonesia and Malaysia — hit their limits. All producers, including industry leaders Grupo Palmas and Alicorp can take advantage of this opportunity, so long as they concurrently manage emerging climate risks.

In this vein, this report projects how "climate transitions" — actions taken by governments, consumers, and the private sector to address the climate crisis — could materially influence Peru's palm oil industry[1].

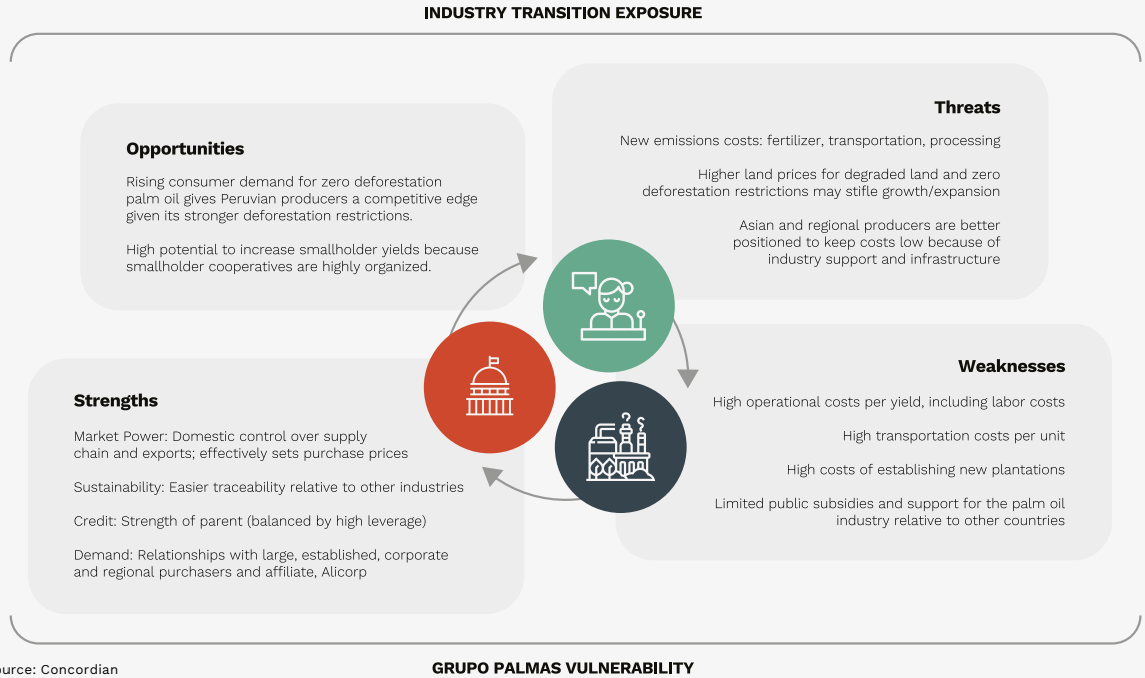
We examine three climate transition pathways — Historical, Modest, and Aggressive — that represent varying levels of global and local ambition to address the climate crisis, including through greenhouse gas (GHG) pricing and land use restrictions. For each scenario, we evaluate relative impacts on Peruvian palm oil producers' operational costs, capital expenditures, and growth strategies. The analysis draws from a preceding report, "Transition Scenarios in Tropical Agriculture," which projects changes in global commodity prices, agricultural yields, emissions costs, and land use competition under different global climate transition pathways[2].

The Peruvian palm oil industry is exposed to climate transitions due to its historical deforestation practices; reliance on converting land for plantations; use of emissions-intensive fertilizer and diesel fuels; and high operational costs relative to yields. As Peru seeks to grow its exports and compete globally, pursuing sustainable land use strategies — including meaningful support to smallholder farmers — can mitigate its vulnerability to climate transitions and expand its market access (Figure 1).

The topline highlights from our analysis include:

- Under all climate transition scenarios, global palm oil demand grows faster than production, resulting in real — but likely volatile — price increases of up to 46% by 2040 as countries adjust their respective climate mitigation, agricultural and land use, and trade policies.
- While rising palm oil prices can boost the profitability of existing plantations, concurrent rises in production and capital costs will favor low carbon, efficient operators with capital access:

Figure 1:
CLIMATE TRANSITION SWOT ANALYSIS: GRUPO PALMAS



Source: Concordian

Continued
Key Findings

- A company with an archetypical mill-plantation project would see its Enterprise Value — a measure of a company's value considering both debt and equity — rise by more than 1.5 times in absolute terms under an Aggressive ambition pathway versus the Historical ambition pathway.
- However, this rise is dependent on a producer being able to increase yields cheaply and keep operational emissions costs — which rise up to 15% of operating expenses by 2040 — manageable.

- Land use restrictions and the significant cost to deforest under transitions will push palm oil producers — including Peru's leading palm oil cultivator, Grupo Palmas--to expand production via yield improvements rather than geographic expansion:
  - An Aggressive climate transition would limit economically feasible industrial palm expansion to just 257,000 ha within 20 years — 78% lower than in the Historical ambition scenario.

- Yield-enhancing capital investments and operational costs may strain debt service coverage ratios initially, though Grupo Palmas' and Alicorp's credit profiles benefit from their affiliation with Grupo Romero, one of the largest and most powerful private conglomerates in Peru.

- To compete with low-cost Asian producers and sustainability-focused regional producers like Colombia, Grupo Palmas and other Peruvian producers must immediately focus on:
  - Smart and low carbon yield-improvement practices, such as intercropping.
  - Smallholders and suppliers with the greatest potential to increase yields.
  - Emissions reduction technologies like methane capture and biogas cogeneration.
  - Adherence to No Deforestation, No Peat, and No Exploitation (NDPE) commitments and 100% supply chain traceability.

Given the industry's material exposure to climate transitions, we recommend that investors with Peruvian palm oil exposure:

- Request investees assess and disclose climate transition exposure and vulnerability in line with recommendations from the Financial Standard Boards' (FSB) Task Force on Climate-related Financial Disclosures (TCFD).

- Tie investments and financing to sustainable practices.

On balance, greater climate ambition will protect the industry from the much worse physical and economic impacts of warming temperatures while also promoting efficient and low carbon production. Ultimately, focusing on sustainability will allow Peruvian palm producers to expand access to global markets, harness future certified-sustainable palm oil premiums, and compete against higher-yielding producers and soybean oil substitutes.

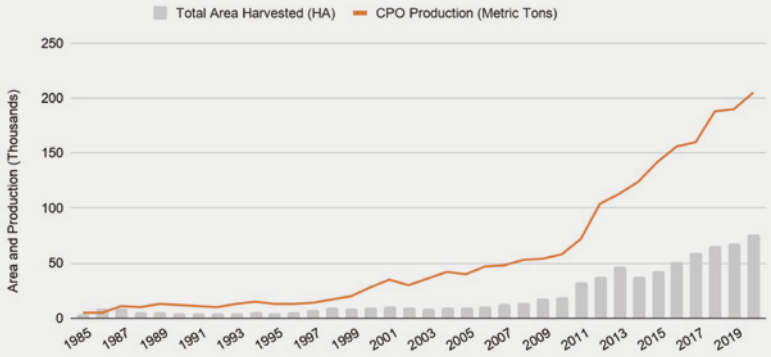
Section II
Industry Exposure to Climate Transitions

KEY TAKEAWAYS

The industry's contributions to deforestation expose it to several sources of climate transition risks, including reputational, policy, legal, market, and technology risks.

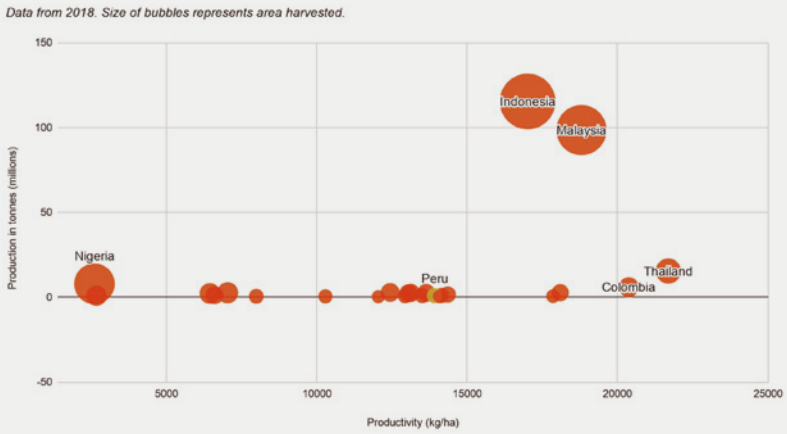
Low yields and high production and transportation costs create vulnerabilities relative to global competitors.

Figure 2:
PERU HARVESTED AREA AND CRUDE PALM OIL PRODUCTION (1985-2020)



Source: USDA, https://apps.fas.usda.gov/psdonline/app/index.html#/app/downloads

Figure 3:
PALM TREE YIELDS, PRODUCTION, AND AREA HARVESTED BY COUNTRY, 2018



Source: Adapted from Global Canopy, using FAO data. https://www.globalcanopy.org/sites/default/files/documents/resources/SustainablePalmOilProductioninPeru.pdf

Peru's palm oil industry is small but has room to grow. Producing 190,000 metric tons of crude palm oil (CPO) in 2019 (Figure 2), Peru accounts for less than 1% of the annual global output.[3] 75% of Peruvian palm oil is consumed domestically, cultivated, processed, or refined by Grupo Palmas, Alicorp, and their suppliers.[4] Even with most palm oil remaining in Peru for domestic consumption, Peru remains a major importer of soy oil as well as CPO-derived biodiesel--both of which are important domestic palm oil substitutes.[5]

Within Latin America, Peru is one of the most biophysically suitable regions for palm oil development, but the costs of production, transportation, and barriers to entry are high.[6,7,8] Relative to Asia, Peru has high labor costs, permitting costs, overages due to delays, and limited industry and transportation infrastructure. Field experts estimate production and transportation costs are at least 10% higher in Peru compared to Asia. Yields in these regions are also lower relative to both global producers and regional competitors like Colombia (Figure 3). In 2018, the average palm oil fruit yield from Peruvian plantations was 14 tonnes FFB per hectare, relative to 17 in Indonesia and 19 in Malaysia.[9,10]

The Peruvian market is largely controlled by Grupo Palmas and Alicorp, who together represent the largest producers, refiners, and exporters of Peruvian palm oil.[11] Grupo Palmas owns and operates the vast majority of domestic plantations. The remaining plantations are largely operated[12] by small and medium-sized growers who sell their product either directly to Grupo Palmas and/or via intermediate mills to Alicorp. Both Alicorp and Grupo Palmas are affiliated with Grupo Romero--one of Peru's largest corporate conglomerates. Besides Alicorp and Grupo Palmas, CPO purchasers include domestic biodiesel refiners and refined cooking oil manufacturers like Industrial Alpamayo SA (which is also part owner of OLPESA, an affiliate of smallholder cooperatives) and Oleoficio Lima SA.[13]

Continued
Industry Exposure to Climate Transitions

Despite its small size, the Peruvian palm industry is highly exposed to transition risks (Figure 4) from public policies; consumer demand; civil society and indigenous community rights as they relate to deforestation; and emerging government actions to address deforestation and GHG emissions. In 2018, Peru made its Paris Agreement commitments legally binding through the Climate Change Framework Law.[14] In 2019, the Peruvian Ministry of Agriculture and Irrigation reiterated its commitment to zero deforestation from agriculture. Meanwhile, JUNPALMA, the Peruvian Palm Oil Producers' Association, Grupo Palmas, Alicorp and Grupo Romero all committed to future zero deforestation growth, starting within the next decade. Peruvian civil society and indigenous communities will continue to play an outsized role in holding palm oil producers accountable for deforestation (see Box 1).

Figure 4: CLIMATE TRANSITION RISKS FOR THE PERUVIAN PALM OIL INDUSTRY

TCFD Risk Category	Risk Event	Example or Potential Source
Policy & Legal	Government restrictions on deforestation and peatland conversion for agricultural uses.	Peruvian Ministry of Agriculture and Irrigation's zero deforestation pledge.
	Introduction of greenhouse gas "GHG" taxes or pricing systems that cover agricultural producers.	Peru's binding commitments to reduce GHG emissions.
	Importing countries restrict or ban non-certified products, or those associated with deforestation.	The E.U. plans to phase out palm-oil derived biodiesel.
Technology	New planting technologies enable higher yields.	Emerging agroforestry techniques provide opportunities to boost yields, diversify income, and reduce emissions.
Market	Purchasers or standard-setting bodies require new environmental standards from suppliers.	The Peruvian Palm Oil Producers' Association, Alicorp, and Grupo Palmas have committed to future zero deforestation growth.
	Corporate and consumer demand for sustainable palm oil grows.	Sustainable palm oil can command a price premium in some markets, and expands market access to some corporate purchasers.
	Capital providers link financing to improvements in greenhouse gas emissions.	Rabobank and others arranged a sustainability-linked credit facility for Olam International.
Reputation	Shareholders or capital providers divest or express concerns about environmental commitments.	Norges Bank Investment Management (NBIM)--the Norwegian Sovereign Wealth Fund--divested from Alicorp over civil society concerns.
	Increased NGO and stakeholder concern about issues such as deforestation or climate change increases scrutiny of tropical commodity supply chains.	NGOs play a highly active role in monitoring deforestation in Peru.

Source: Concordian

BOX 1: REPUTATIONAL RISKS FACED BY PERUVIAN PALM PRODUCERS

Grupo Palmas has increasingly embraced sustainability principles, partly in response to mounting civil society pressure. Grupo Palmas owns three large plantations: Palmas del Espino, Palmas del Shanusi, and Palmas del Oriente. Between 2006 and 2011, Palmas del Shanusi and Palmas del Oriente led to 6,974 hectares of direct primary forest loss and 9,840 hectares of forest loss on the outskirts of the two projects. Following stakeholder opposition, Grupo Palmas was forced to limit its plans for future expansion and subsequently embarked on a more sustainable pathway, including by making zero deforestation commitments.[16]

Peruvian Palm Holdings and Palmas del Huallaga, two larger corporate producers, have also faced community backlash. Peruvian Palm Holdings, owned by Anholt Services, owns the Ucayali-based Ocho Sur plantation, which was previously owned by the Melka Group. Under Melka's ownership, Ocho Sur was mired in legal battles due to the original creation and expansion of the Ocho Sur plantation caused the destruction of 7,000 hectares of old growth forest.[17,18] In June 2019, the Shipibo community (who were impacted by Ocho Sur's development) asked the world's largest sovereign wealth fund, Norges Bank Investment Management (NBIM), to pressure Alicorp, the Peruvian consumer goods company, to remove Ocho Sur from its supply chain. By December of 2019, NBIM had divested a total of $12.3 million USD from Alicorp.[19] Palmas del Huallaga has also faced opposition from civil society, though in a less publicized fashion.

Source: Concordian; MAAP; Chain Reaction Research; Earthsight; Forest Peoples; Climate Links/USAID

Section III
Financial Implications of Climate Transitions

KEY TAKEAWAYS

With greater climate ambition, producers will see higher palm oil prices, but also face stranded assets, rising land values, and new emissions costs.

Low carbon, high-yielding ("sustainable") producers stand to gain the most as climate transitions become more ambitious.

Under all scenarios, unsustainable producers-- especially those with weak financial standing-- may find it more profitable to sell their concessions and exit the market.

Figure 5:
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
Peruvian Development Restrictions	A. Deforestation allowed B. No peat and no forest development permitted	A. Deforestation allowed B. No peat and no forest development permitted	A. Deforestation allowed B. No peat and no forest development permitted
Bioenergy Pathways (EJ by 2100)	27	70	70

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.

To assess the effect of future climate transitions on Peruvian palm oil, we evaluate three scenarios: Historical Ambition ("Historical"), Modest Ambition ("Modest"), and Aggressive Ambition ("Aggressive"). As summarized in Figure 5, each transition scenario considers both global and corresponding local actions to achieve global warming temperature targets as well as assumptions about future technology development and bioenergy pathways.[20] Specifically, we assume the following local transitions in line with global pathways:

- **Historical:** The Historical scenario assumes limited global and local ambition to address the climate crisis. In Peru, 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 meaningfully enforced.
- **Modest:** In this scenario, the world pursues modest GHG pricing alongside investment in bioenergy pathways, among other factors. In Peru, we assume similarly modest GHG pricing and test projections with and without deforestation restrictions.
- **Aggressive:** The Aggressive scenario amplifies the Modest scenario, with higher regional GHG pricing and global area protections. Again, we test projections with and without deforestation restrictions.

Our models project rising palm oil prices and production with greater climate ambition. Over the next 10 to 15 years, the Modest and Aggressive climate transition scenarios drive up global and regional palm oil prices compared to the Historical scenario (Figure 6). In the longer term (post-2035), regional palm oil prices under the Modest scenario trend closer to the Historical ambition scenario. In contrast, under the Aggressive scenario, even with significant increases in agricultural productivity, we see substantial price increases. By 2040, regional palm oil prices are 46% higher relative to the Historical scenario, driven by higher production costs and land competition.

> By 2040, regional palm oil prices are 46% higher relative to the Historical scenario.

For low carbon, efficient operators, we project higher profitability under climate transitions relative to a Historical pathway. For an illustrative mill with a 10,000 hectare plantation and 6% dual mill sourcing from third parties, profitability rises as climate transitions become more ambitious. (see separate Technical Annex

Continued
Financial Implications of Climate Transitions

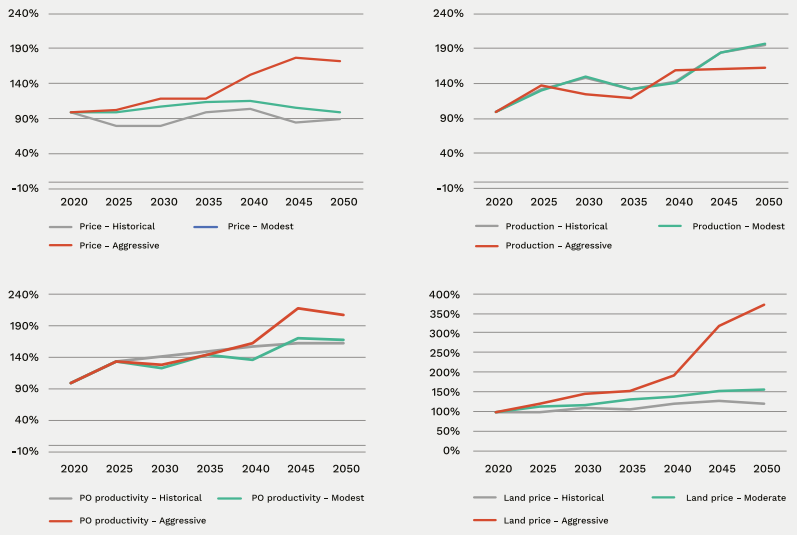
document for additional assumptions). This results in higher enterprise value[21] ("EV") (Figures 7 A and B) even as production costs rise. These differences are driven primarily by higher prices in the Aggressive, and to a lesser extent, the Modest, scenarios relative to the Historical scenario. Readers should note that although we present results in dollar terms for visual ease, this analysis is meant to compare the overall magnitude and direction of impacts between scenarios rather than provide precise results.

GHG emissions costs could reach 15% of total operational costs by 2040.

Operational GHG emissions costs are limited at first but become material in later years (Figure 8). The mill-plantation's GHG emissions costs from non-deforestation activities--like mill processing, fertilizer use, and diesel fuel--comprise 1% (Modest) and 3% (Aggressive) of total operational costs by 2030. By 2040, these percentages rise to 3% (Modest) and 15% (Aggressive). as a reference, fertilizer, one of the most significant cost items for producers, typically comprises 20 to 30% of operating costs.

While industry-wide profitability improves with greater transition ambition, an individual company's fate will largely depend on its ability to boost yields at a low cost. Growing demand for palm oil and rising prices create new windows of opportunity for the industry as a whole. But we also expect greater polarity within the global palm oil sector. Specifically, EV changes under each transition scenario depending on the cost of yield improvements as shown in Figure 9.[22] For example, under the Aggressive scenario, the mill-plantation's EV decreases substantially--from $52 million to $10 million--as the cost-to-yield multiplier rises from 0.5 to 1.5.

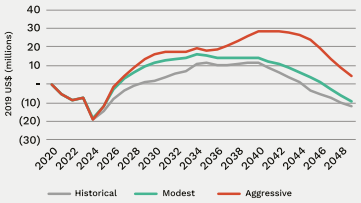
Figure 6:
REGIONAL PALM OIL PRICES, PRODUCTION, PRODUCTIVITY (OIL PALM YIELDS), AND LAND VALUES



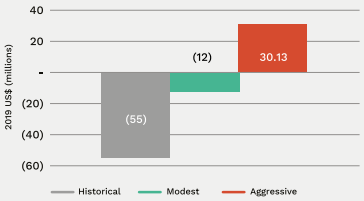
Source: Concordian, based on modeling results from the report "Transition Scenarios for Tropical Agriculture."

Figure 7:
PALM OIL PROFITABILITY AND ENTERPRISE VALUE: INDICATIVE MILL-PLANTATION

A. Net Income by Scenario



B. Estimated Enterprise Value Today



Source: Concordian, based on proprietary pro forma modeling using the results from the report "Transition Scenarios for Tropical Agriculture" Notes: Based on a case study of a Peruvian mill-plantation with 10,000 hectares of owned plantation and 6% sourcing from third parties; this is not representative of all industry assets. This modeling contains many assumptions that may not reflect reality for a new or existing project. Key assumptions include a base CPO price of $656 (15-year average); discount rate of 12%; corporate tax rate of 30% on profits; a cost-to-yield multiplier of 1, i.e., every 1% increase in yields requires a 1% increase in USD costs. Assumes a 2% growth rate in future cash flows after 30 years to calculate the assets' terminal value.

Peruvian producers are at an operational disadvantage when compared to Asian producers. As mentioned, Peruvian plantations tend to have 10% higher production costs while also having lower average yields relative to Asian counterparts. Expanding production will require substantial industry investments in increasing fresh fruit bunch (FFB) yields, the raw material produced by oil palm trees which is processed into crude palm oil "CPO". According to our modeling, the worldwide investment required to increase yields across all agricultural commodities could reach $1.2 Trillion annually. Even with partial government

Continued
Financial Implications of Climate Transitions

subsidies, it is likely that companies themselves will have to undertake significant capital investments and operational spending to enhance yields as land availability shrinks.

*Ultimately, vulnerability to **climate transitions** will be determined by how a company manages future growth, including the cost-effectiveness of yield investments, the timing of land acquisitions, financial leverage, and cost of finance.*

PROJECTED TRANSITION IMPACTS ON PALM OIL COMPANIES

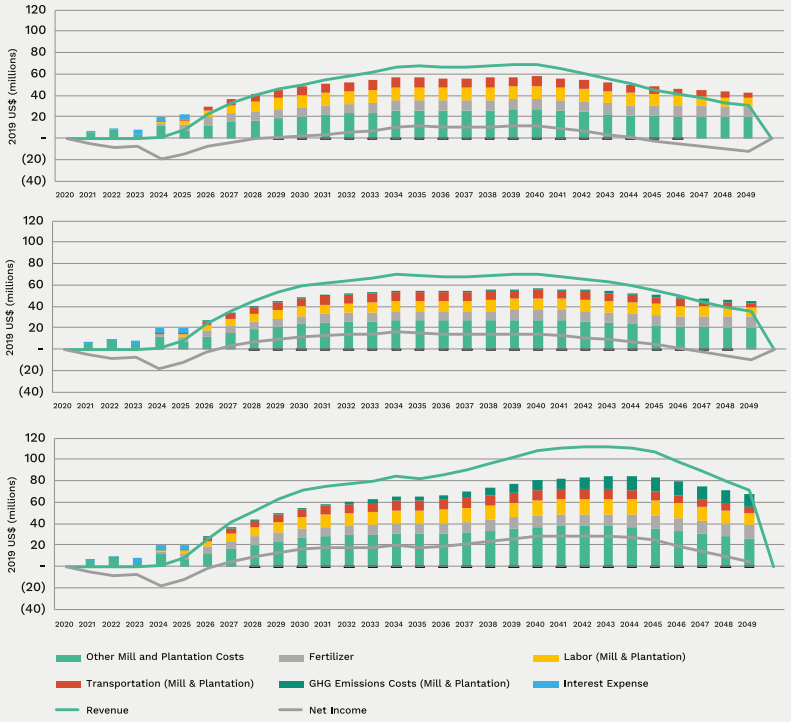
Strong Revenue Increases
- Higher palm oil prices
- Higher yields

Moderate Operational Cost Increases
- Production-Driven Emissions Costs
- Transportation-Related Emissions Costs
- Yield Enhancement Costs

Strong Capital Expenditures Requirements
- Higher Replanting Costs
- Higher Land Prices
- New Land Clearing Emissions Costs

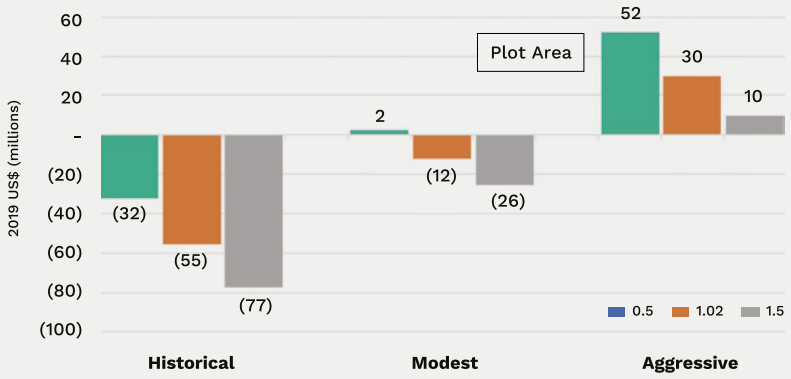
Profitability increases for existing palm oil plantations with low cost-to-yield improvement ratios. Geographic expansion may be untenable with higher land prices and deforestation-related emissions costs.

Figure 8:
REVENUES AND COSTS: INDICATIVE MILL-PLANTATION



Source: Concordian, based on proprietary pro forma modeling using the results from the report "Transition Scenarios for Tropical Agriculture" Notes: Based on a case study of a Peruvian mill-plantation with 10,000 hectares of owned plantation and 6% sourcing from third parties; this is not representative of all industry assets. This modeling contains many assumptions that may not reflect reality for a new or existing project. Key assumptions include a base CPO price of $656 (15-year average); discount rate of 12%; corporate tax rate of 30% on profits; a cost-to-yield multiplier of 1, i.e., every 1% increase in yields requires a 1% increase in USD costs. Assumes a 2% growth rate in future cash flows after 30 years to calculate the assets' terminal value. GHG emissions prices reflect land sector rather than energy or economy-wide prices.

Figure 9:
ENTERPRISE VALUE BY COST-TO-YIELD MULTIPLIER



Source: Concordian, based on modeling using the results from the report "Transition Scenarios for Tropical Agriculture" Notes: Based on a case study of a Peruvian mill-plantation with 10,000 hectares of owned plantation and 6% sourcing from third parties; this is not representative of all industry assets. This modeling contains many assumptions that may not reflect reality for a new or existing project. Key assumptions include a base CPO price of $656 (15-year average); discount rate of 12%; corporate tax rate of 30% on profits; a cost-to-yield multiplier of 1, i.e., every 1% increase in yields requires a 1% increase in USD costs, with additional sensitivities at 0.5 and 1. Assumes a 2% growth rate in future cash flows after 30 years to calculate the assets' terminal value.

Section IV
Expansion Challenges Under Climate Transitions

KEY TAKEAWAYS

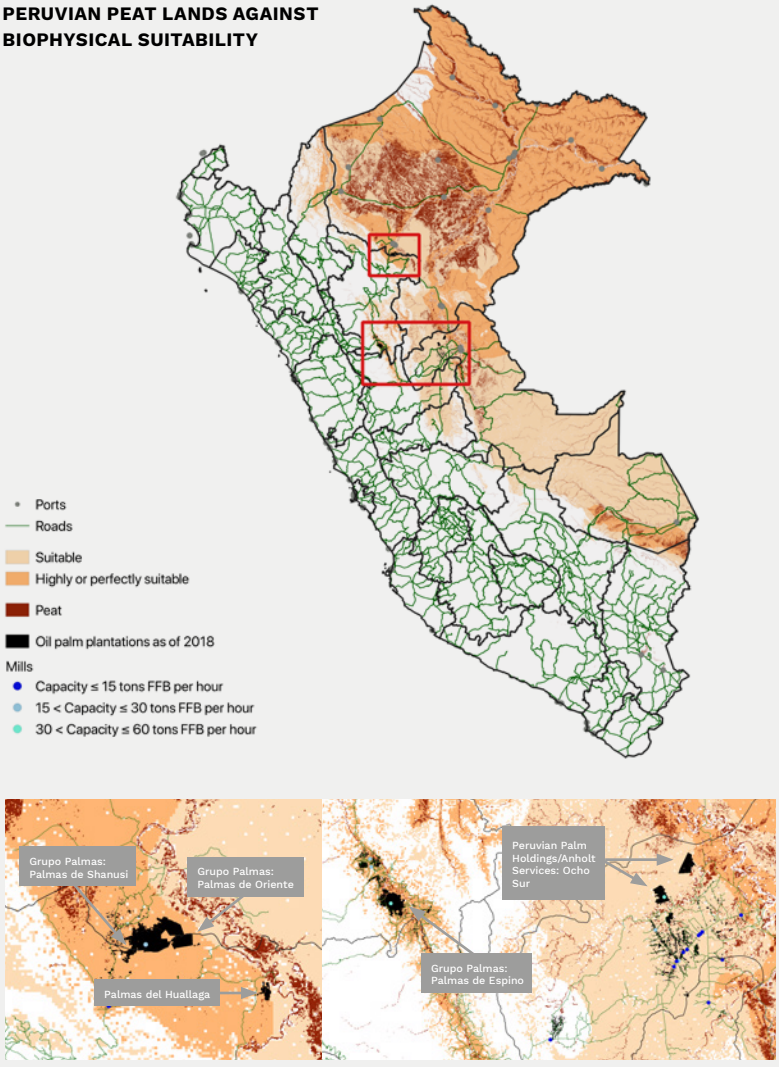
Geographic expansion may be legally and/or economically infeasible under climate transitions, underscoring the importance of companies investing in sustainable yield enhancements, including through support for smallholders.

Geographic expansion is limited under climate transitions, as governments and companies adopt "No Deforestation, No Peat, No Exploitation" (NDPE) restrictions. Historically, both the global and Peruvian palm oil industries have grown by expanding their geographic footprints. While much of Peru's land is biophysically-suitable for palm development, most of this potential overlaps with current forests, peatlands, or both (Figure 10). In fact, 97% of biophysically-suitable land for palm cultivation in Peru is unusable under NDPE restrictions to which many global palm oil purchasers have recently subscribed.

97% of biophysically-suitable land for palm cultivation in Peru is unusable under NDPE restrictions.

Under NDPE restrictions, forest cover expands, further limiting economically feasible expansion. Enforcing zero deforestation restrictions alongside even a modest carbon price results in forest expansion near existing plantations within a 20-year timeframe (Figures 11 and 12). In fact, forest cover expands by as much as 252,000 hectares between 2020 and 2040 within a 100-km radius of existing mills, limiting expansion near existing industrial infrastructure and transportation routes.

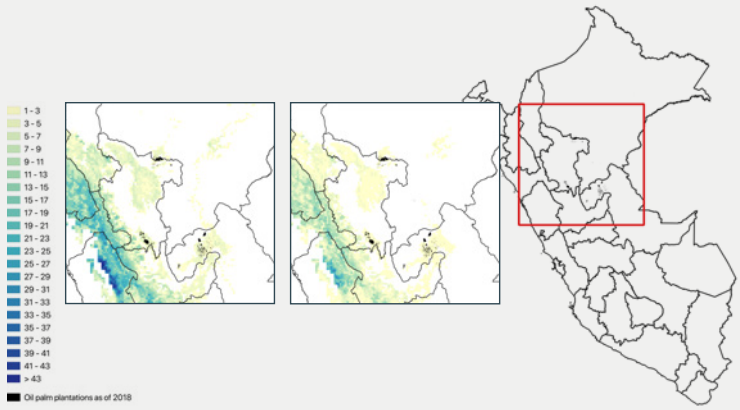
Figure 10:
PERUVIAN PEAT LANDS AGAINST BIOPHYSICAL SUITABILITY



Notes: Labeled plantations belong to Grupo Palmas with the exception of Ocho Sur, which belongs to Peruvian Palm Holdings/ Anholt Services, and Palmas del Huallaga. Based on 2018 data. Source: Figure compiled by Concordian using the following data sources. The red boxes in the plot at left indicate the area of zoom for the two plots on the right. The peat and biophysical suitability datasets are shown here in their native resolution, but for subsequent analysis, were re-gridded to match the spatial resolution of the forest projections, which are not shown here. Administrative boundaries are from GADM (version 3.6, https://gadm.org). Oil palm plantation data were provided by M. Finer [Finer, M., Vijay, V., and Mamani, N. (2018). Oil Palm Baseline for the Peruvian Amazon. Monitoring of the Andean Amazon project (MAAP): 95.]. Peat data are from Gumbricht et al. (2017) [Gumbricht, T., Román-Cuesta, R.M., Verchot, L.V., Herold, M., Wittmann, F, Householder, E., Herold, N., Murdiyarso, D. (2017). Tropical and Subtropical Wetlands Distribution version 2. Center for International Forestry Research (CIFOR). doi: 10.17528/CIFOR/DATA.00058. V3, UNF:6:Bc9aFtBpam27aFOCMgW71Q== [fileUNF]]. Biophysical suitability data are from Pirker et al. (2016) [Pirker, J., Mosnier, A., Kraxner, F., Havlík, P., and Obersteiner, M. (2016). What are the limits to oil palm expansion? Global Environmental Change, 40, 73–81. doi: 10.1016/j.gloenvcha.2016.06.007]. Pirker et al. (2016) delineate six tiers: not suitable, marginally suitable, moderately suitable, suitable, highly suitable, and perfectly suitable; included here are three tiers (suitable, highly suitable, and perfectly suitable). Road and port data are from the Peruvian Ministry of Transport and Communications (2018 data; https://portal.mtc.gob.pe/estadisticas/descarga.html). National & departmental roads are shown in all plots while local roads are shown only in the zoomed plots. Port data is plotted only in the national plot on the left. Mill data (2020) were compiled by Sociedad Peruana de Ecodesarrollo (SPDE) and Junta Nacional de Palma Aceitera del Perú (Junpalma Perú). Mill capacities refer to installed capacity. Mills are shown only in the zoomed plots. See technical annex available at http://orbitas.finance for more information on data sources and methodology.

Continued
Expansion Challenges Under Climate Transitions

Figure 11:
FOREST COVER CHANGES BY GRID CELL:
ZERO DEFORESTATION RESTRICTION AND MODEST CARBON PRICE



Source: Concordian. Forest cover projections at 5.5 km x 5.5 km spatial resolution are based on the OSIRIS model [Busch, Jonah, Jens Engelmann, Susan C. Cook-Patton, Bronson W. Griscom, Timm Kroeger, Hugh P. Possingham, and Priya Shyamsundar, "Potential for Low-Cost Carbon Dioxide Removal through Tropical Reforestation," Nature Climate Change, 9(6), (June 2019): 463–466, doi:10.1038/s41558-019-0485-x]. Plotted values indicate the percentage of the grid cell area that has experienced a net increase in forest cover over the 10- or 20-year time period; changes <1% appear white. Nationally, grid-cell-level net forest cover changes range from 0% to +31.6% for 2020–2030 and 0% to +45.2% 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 +31.8% for 2020–2030 and 0% to +46.4% for 2020–2040. The red box in the right image indicates the area of zoom. Administrative boundaries are from GADM (version 3.6, https://gadm.org). Oil palm plantation data were provided by M. Finer [Finer, M., Vijay, V., and Mamani, N. (2018). Oil Palm Baseline for the Peruvian Amazon. MAAP: 95.]. See technical annex available at http://orbitas.finance for more information on data sources and method.

The potential for future industrial (1,000 hectares plus) palm expansion substantially shrinks under zero deforestation climate transitions (Figure 12).[23] The Aggressive NDPE-compliant scenario limits economically feasible industrial palm expansion to 257,000 ha within 20 years--similar to the Modest scenario but 78% lower than in the Historical scenario. Without NDPE restrictions, the results are very different: net forest losses translate to large areas of economically feasible industrial palm expansion potential. By 2040, 1.15 Million ha are available in the Modest scenario, and 1 Million ha in the Aggressive scenario.

In 2040, clearing forest to establish a palm plantation could cost up to $37,000 in GHG emissions costs alone.

Even without NDPE restrictions, upfront expansion costs would be daunting due to deforestation-related GHG emissions costs and rising land values. On average, clearing forest to establish a palm plantation would result in $37,000 per hectare in upfront GHG emissions costs in 2040 under the Aggressive scenario: nearly 5 times the $8,000 per hectare upfront capital costs to establish a new plantation today. Even if companies are able to procure degraded land for expansion, our models project rapidly rising regional real estate land values due to increasing land competition, with 2040 land values nearly double their 2020 values.

Future palm expansion could decline up to 78% by 2040 with NDPE restrictions in place.

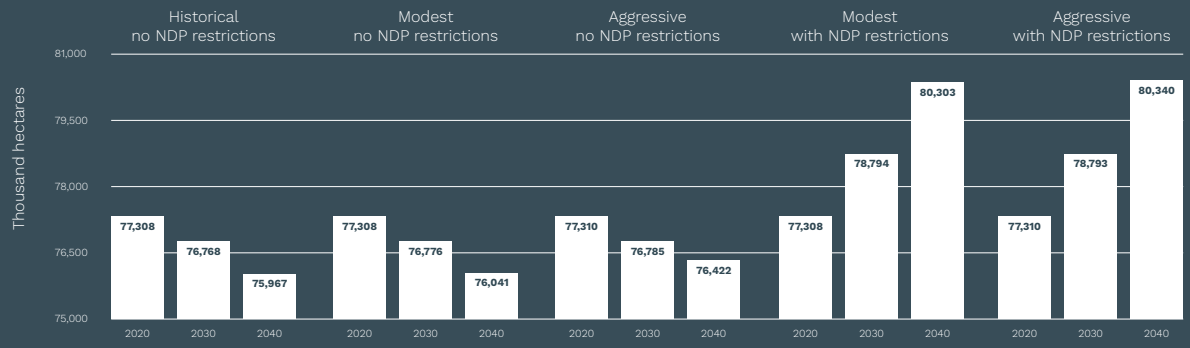
Smallholders are likely to face less severe NDPE enforcement relative to industrial actors due to the administrative and political burdens associated with regulating smallholders. Nevertheless, smallholders are limited to expansion around mills and transportation infrastructure. With no size restrictions on plantations, but allowing expansion only within 100 kilometers of existing mills, the land available for economically feasible smallholder palm expansion in 2030 is 549,000 hectares under the Modest and Aggressive scenarios with NDPE restrictions, 35% lower than in the Historical scenario (Figure 12 C). Within 20 years, this figure further shrinks to 521,000 hectares, 54% lower than the 1,135,000 hectares in the Historical scenario but 51% higher than the corresponding land available for industrial palm expansion. These results underscore the importance of industrial actors working with smallholders to increase yields.

Though not a core part of this analysis, transportation infrastructure is a key barrier to palm oil expansion. Palm-suitable land is often far from major cities, ports, and modernized roads. With transportation costs comprising as much as 20-30% of total delivered FFB production costs,[24] Peruvian producers are also exposed to projected increases in diesel costs due to climate transitions.

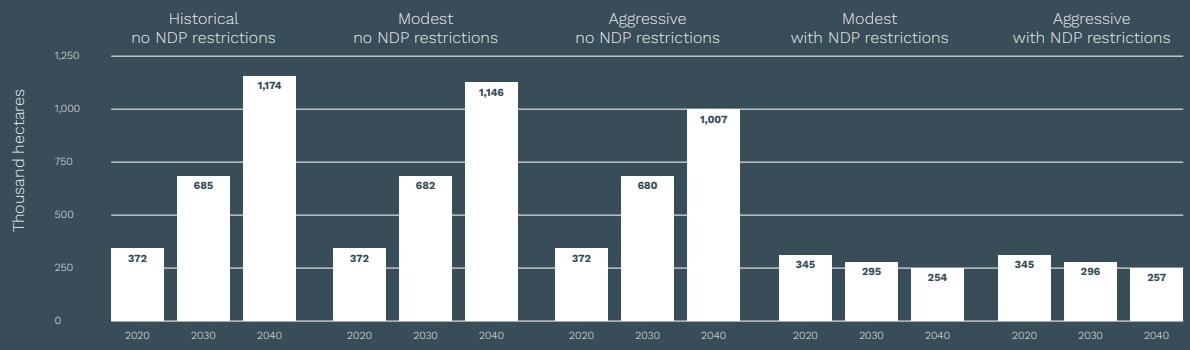
Continued
Expansion Challenges Under Climate Transitions

Figure 12:
FOREST AREA AND INDUSTRIAL OIL PALM CULTIVATION

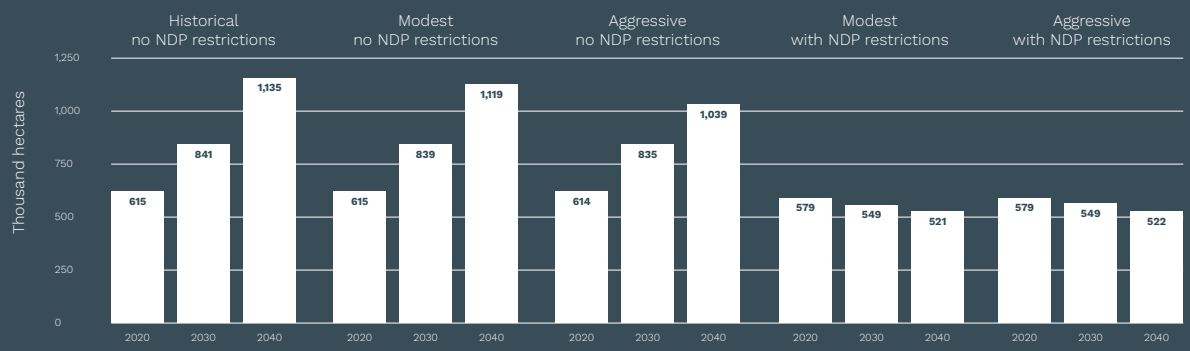
A. Projected Peat and Forest Areas



B. Projected Suitable Land Available for Industrial Palm Oil Cultivation



C. Projected Land Available for Smallholder Palm Oil Cultivation within 100 km of Existing Mills



Source: Forest cover projections are based on the OSIRIS model (Busch et al. 2019). Peat data are from Gumbricht et al. (2017). Biophysical suitability data are from Pirker et al. (2016). See the Technical Annex available at http://orbitas.finance for more information on data sources and method. Notes: "Peat and forest area" includes land combinations: non-peat forest, peat forest, and non-forest peat; suitability status is not considered in the estimation of combined forest and/or peat area. For scenarios that allow deforestation ("Historical," "Modest," and "Aggressive" with no NDPE restrictions), we estimate the land available for palm expansion as the amount of non-forest land—as determined by the OSIRIS model based on competition between agriculture and forest land uses—that is biophysically suitable for palm; development on peat is allowed. For scenarios that enforce an NDPE policy, we estimate the land available for palm expansion (i.e., land available for palm under NDPE restrictions) as the amount of non-forest land—as determined by the OSIRIS model—that is not on peat and is biophysically suitable for palm. For estimation of area of land availability for industrial plantations, both with and without an NDPE restriction, we apply a minimum tract size of 1,000 ha at the 5.5 km x 5.5 km grid cell level. We do not account for current palm plantations in our estimates. For estimation of land availability for smallholder plantations, we do not apply a minimum plantation size, but we restrict smallholder development to be within 100 kilometers of existing mills.

Section V
Climate Transition Opportunities

KEY TAKEAWAYS

To expand market access and compete in global markets, the industry must enforce sustainable practices throughout their supply chain, particularly NDPE commitments.

Emerging agroforestry techniques will enable industrial and smallholder producers to diversify income and better position themselves for likely price volatility.

Climate transitions are likely to create winners and losers in the global palm oil sector, driven by capital access and operational efficiency. While existing producers may benefit from rising prices, not all of them will be able to stay competitive in the future. Over the past 5 to 10 years, many global palm oil producers have borrowed heavily to expand production. Under transitions, companies with low operational costs relative to yields, greater liquidity, lower leverage, and better access to finance will survive and thrive on existing land, while others with higher operational and finance costs will find land intensification challenging. Government support, in the form of agricultural productivity investments, will also play an important role in either enabling or hampering Peru's global competitiveness.

Alicorp and Grupo Palmas wield domestic market power, but may find it even more challenging to compete with Asian producers under transition scenarios. Because Grupo Palmas has the backing of its parent Grupo Romero and control over much of Peruvian palm oil production, it is well-positioned to deal with production cost increases vis-a-vis other domestic producers. However, with limited geographic room to grow and rising operational costs to maintain yield growth under transition scenarios, Grupo Palmas may have less free cash flow while also needing to take on additional debt. Relative to high volume producers like Malaysia and Indonesia, Peruvian producers may face disproportionate burdens because:

- The Peruvian government is less likely to backstop and bolster the industry, given its small size and modest economic importance.
- The Peruvian industry has both lower yields and higher production and transportation costs than major international producers.

Climate transitions will drive market fragmentation as consumers become more attuned to sustainability concerns, creating both reputational risks and differentiation opportunities for Grupo Palmas and Alicorp. In past years, certified-sustainable palm oil has sold at a premium of around $30 per CPO ton and cost around $10 per CPO ton to certify, providing a strong profit margin.[25] While current CPO pricing levels do not support a premium for sustainable palm oil, this could change under transition scenarios as CPO prices rise and consumer concerns about climate change and deforestation increase. Furthermore, Grupo Palmas and others have already noted that a sustainability differentiation has provided a comparative advantage in securing contracts with large food conglomerates like PepsiCo, Nestle, Mondelez, Carosi in Chile, and Arco in Argentina[26]

Sustainability and yield improvements can help the Peruvian palm oil industry create a competitive advantage. While the industry's small size creates economic disadvantages, it also provides an opportunity for the industry to leapfrog Asian palm oil by providing truly deforestation-free palm oil. Tracking and traceability, while still challenging in Peru, will be significantly easier than in Asian countries that have a long and significant history of deforestation and a complex industry structure.

> Grupo Palmas is relatively ahead of the curve: it has made a 100% zero deforestation pledge and aims to achieve 100% RSPO certifications for its estates and mills by 2023 and 100% RSPO certification for all of its operations by 2025.

The faster zero deforestation commitments are made, the better positioned Peruvian palm will be under transitions. While Grupo Romero and its affiliates Romero and Alicorp have already begun to embrace zero deforestation principles, they are still not 100% deforestation-free, exposing investors to risks. Grupo Palmas is relatively ahead of the curve: it has made a 100% zero deforestation pledge and aims to achieve 100% RSPO certifications for its estates and mills by 2023 and 100% RSPO certification for all of its operations, including smallholders, by 2025. Alicorp similarly aims to be using 100% RSPO-certified sustainable palm oil by 2030. The delay in Alicorp's zero deforestation implementation will continue to expose it to risks, as NBIM's recent $12.3 million divestiture demonstrates.

Smallholders will play an important role in the transition to deforestation free palm oil in Peru. Our transition scenarios underscore the importance of investments in boosting agricultural yields as land availability decreases and land values increase. Corporate CPO yields tend to be almost double those of smallholder CPO yields (Figure 13, next page), with the exception of J.C. Mariategui (an association that has collaborated with Grupo Palmas) implying that increasing smallholder productivity

Continued
Climate Transition Opportunities

could be low hanging fruit to increase land use intensification. Importantly, smallholders have a better historic track record of avoiding deforestation, and have focused their expansion on previously deforested or degraded lands.

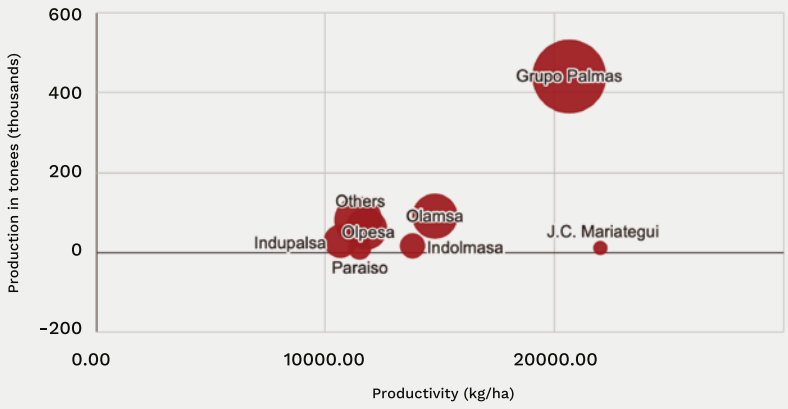
Corporate producers like Grupo Palmas should scale up credit and guarantees to smallholders, as done previously with J.C. Mariategui. Not only will Grupo Palmas benefit from higher yields and production in their supply chains, but also, unlike banks, corporate producers can mitigate loan guarantee-related credit risks through direct technical assistance to smallholder farmers.

Emerging agroforestry techniques can help both corporate producers and smallholder farmers diversify income and better position themselves for price volatility. For example, emerging research shows that mixed use palm oil systems--i.e., intercropping food crops with oil palm-- can improve yields, increase financial stability, and maximize positive environmental outcomes, especially outside of ideal growing conditions.[30] Income diversification is especially important as climate transitions are likely to increase CPO price volatility.

A sustainability focus can help Peruvian producers access a wider range of export markets traditionally served by Asian counterparts. With already higher production costs and future exposure and vulnerability to transition impacts, Grupo Palmas, Romero and Alicorp, and their suppliers must find avenues to differentiate Peruvian palm oil. While most crude palm oil produced in Peru is domestically-consumed, their regional exports have dramatically increased in recent years, setting the stage for expansion. Shaping a sustainable pathway--including by helping smallholder farmers increase yields, utilizing agroforestry techniques like intercropping, diversifying income sources, and enforcing NDPE commitments--can ensure that Peru is competitive in the global market while also addressing environmental concerns.

Figure 13:
PERUVIAN PRODUCER YIELDS AND PRODUCTION

Data from JUNPALMA, 2013. Size of bubbles represents area harvest.



Source: Adapted from Global Canopy using data from JUMPALMA, 2013. https://www.globalcanopy.org/sites/default/files/documents/resources/SustainablePalmOilProductioninPeru.pdf. Notes: Size of bubbles represent area harvested. J.C. Mariategui is an association of smallholder farmers arising from a land dispute with Grupo Palmas, and has subsequently received financial and technical support from Grupo Palmas.

Section VI
Recommendations

As global demand for palm oil rises, profits are there for the taking. But to maximize profitability, stay competitive, and differentiate Peruvian products, Grupo Palmas and Alicorp, alongside their financiers and the Peruvian government, must emphasize sustainable and NDPE-compliant palm oil growth.

Specifically, we recommend that:

Investors:
- Require those who purchase or participate in the Peruvian palm oil supply chain to assess and disclose climate transition risks per TCFD guidelines.
- Arrange results-based financing to incentivize company investments in low carbon pathways--like intercropping and methane capture/ biogas cogeneration technologies-- that are well-positioned under climate transitions.

Companies:
- Provide direct support, low cost finance, and loan guarantees to help smallholders diversify income sources while improving yields through environmentally-sustainable planting, maintenance, and harvesting techniques.
- Improve traceability, transparency, and enforcement related to NDPE commitments.

Policymakers:
- Provide clear, Provide clear and enforceable NDPE guidelines to avoid further deforestation that could hurt the reputation of Peruvian palm oil production.
- Improve clarity on land use rights and tenure, especially for smallholders.
- Support data development to identify high conservation value lands.
- Invest in much-needed transportation infrastructure.

Report
References

(1) Physical impacts of warming temperatures will also materially impact the agricultural sector, but are out of the scope of this report. Notably, we examine the impacts of climate transitions in isolation; readers should keep in mind that the projections described herein are limited to modeling climate transition projections. There are many other factors that could impact future agricultural production and prices (like the physical impacts of climate change) which are not considered in this report. **(2)** This report is part of a series of reports that examine how climate transitions will impact the agricultural sector. All reports are available at http://orbitas.finance. **(3)** "Oil, Palm 2019," Crop Explorer, United States Department of Agriculture, 2019, https://ipad.fas.usda.gov/cropexplorer/cropview/commodityView.aspx?startrow=1&cropid=4243000&sel_year=2019&rankby=Production. **(4)** Food and Agriculture Organization of the United Nations, FAOSTAT Statistical Database, http://www.fao.org/faostat/en/#rankings/commodities_by_country_exports. **(5)** Hajek, Frank and Timothy Killeen, "Toward Zero-Deforestation Oil Palm in Peru: Understanding Actors, Markets, and Barriers," ClimateLinks, USAID, March 2015, https://www.climatelinks.org/sites/default/files/asset/document/FCM%2013-01%20Oil%20Palm%20in%20Peru_DRAFT_EN_CLEARED.pdf. **(6)** Stickler, Claudia, Michael Coe, Daniel C. Nepstad, Greg Fiske, Paul Lefebvre, "Readiness for REDD: A Preliminary Global Assessment of Tropical Forested Land Suitability for Agriculture," IPAM Amazônia, WHRC, December 3, 2007, https://ipam.org.br/wp-content/uploads/2007/12/readiness_for_redd_a_preliminary_global_.pdf **(7)** "Palm oil growth in Peru slows as land suitability and sustainability take top priority," Commodity Intelligence Report, United States Department of Agriculture, September 21, 2016, https://ipad.fas.usda.gov/highlights/2016/09/peru/index.htm. **(8)** Pirker, J., Mosnier, A., Kraxner, F., Havlík, P., and Obersteiner, M. (2016). What are the limits to oil palm expansion? Global Environmental Change, 40, 73–81. doi: 10.1016/j.gloenvcha.2016.06.007. **(9)** Ritchie, Hannah and Max Roser, "Palm Oil Yields," Our World in Data, last modified September 2019, https://ourworldindata.org/grapher/palm-oil-yields. **(10)** Different data sources measure fresh fruit bunch yields in different ways; some data sources derive fresh fruit bunch (FFB) yields from oil extraction rates while others provide direct data on yields. For this reason, the average yield stated in this comparison is different from the average yield we may use in other parts of our analysis for Indonesia and Peru. **(11)** Steinweg, Tim, Gabriel Thoumi, and Bruna Tomaidis Lima, "Grupo Palmas: First Peruvian NDPE Policy Creates Business Opportunities but Strands Land," Chain Reaction Research, April 6, 2017, https://chainreactionresearch.com/wp-content/uploads/2017/04/grupo-palmas-first-peruvian-ndpe-policy-170406-final.pdf.

(12) Other major corporate palm plantations include Ocho Sur--owned by Peruvian Palm Holdings--and Palmas del Huallaga, whose ownership is not publicly available. **(13)** Hajek, Frank and Timothy Killeen, "Toward Zero-Deforestation Oil Palm in Peru: Understanding Actors, Markets, and Barriers," ClimateLinks, USAID, March 2015, https://www.climatelinks.org/sites/default/files/asset/document/FCM%2013-01%20Oil%20Palm%20in%20Peru_DRAFT_EN_CLEARED.pdf. **(14)** Pinto-Bazurco, Jose Felix, "Peru Passes New Framework Climate Change Law: Top Nine Developments," Columbia Law Blog, Columbia Law School, April 26, 2018, http://blogs.law.columbia.edu/climatechange/2018/04/26/peru-passes-new-framework-climate-change-law-top-nine-developments/. **(15)** Finer, Matt and S Novoa, "MAAP #16: Oil Palm-driven Deforestation in the Peruvian Amazon (Part 2: Shanusi)," Monitoring of the Andean Amazon Project, October 12, 2015, https://maaproject.org/2015/image16-shanusi/. **(16)** Steinweg, Tim, Gabriel Thoumi, and Bruna Tomaidis Lima, "Grupo Palmas: First Peruvian NDPE Policy Creates Business Opportunities but Strands Land," Chain Reaction Research, April 6, 2017, https://chainreactionresearch.com/wp-content/uploads/2017/04/grupo-palmas-first-peruvian-ndpe-policy-170406-final.pdf. **(17)** "Prosecutor Targets 'Ringleader' Dennis Melka in Peru Coca Case," Earthsight, August 19, 2019, https://www.earthsight.org.uk/news/idm/prosecutor-targets-ringleader-dennis-melka-peru-cacao-investigation. **(18)** "Peru: Indigenous Community Urges European Banks to Insist that Companies they Invest in Remove Ocho Sur P from their Palm Oil Supply Chains," Forest Peoples Programme, September 20, 2019, https://www.business-humanrights.org/en/peru-indigenous-community-urges-european-banks-to-insist-that-companies-they-invest-in-remove-ocho-sur-p-from-their-palm-oil-supply-chains. **(19)** "Press release: World's largest sovereign wealth fund divests from Peruvian consumer goods giant over human rights violations and deforestation in palm oil supply chain," Forest Peoples Programme, March 5, 2020, https://www.forestpeoples.org/en/lands-forests-territories-palm-oil-rspo/press-release/2020/press-release-worlds-largest-sovereign. **(20)** Please visit http://orbitas.finance for detailed information regarding our detailed global scenario modeling results, our overall methodology, and a summary of all of our industry reports. **(21)** Enterprise Value (EV) is the measure of a company's total value considering market capitalization as well as any short-term and long-term debt. This EV calculation is based on a $656/ton "free on board" starting CPO price in 2020 alongside many other assumptions outlined in this report's Technical Annex. **(22)** The "Cost-to-Yield Multiplier" the relationship between yield increases and operational expenses, e.g. due to more intensive application of fertilizer and harvesting practices. A multiplier of 1 implies that a 1% increase in yield requires a 1% increase in certain operational costs (like fertilizer and labor, but not transportation and overhead). A multiplier of 0.5 means a 1% increase in yield only requires a 0.5% increase in operational costs. **(23)** See technical annex for detailed description of methods and important caveats. **(24)** "Plan Nacional de Desarollo Sostenible de la Palma Aceitera en el Peru (2016-2025)," MINAGRI, 2016, https://www.minagri.gob.pe/portal/download/pdf/p-agraria/pnds_2016-2025_propuesta.pdf **(25)** "World Awash in Sustainable Palm Oil, but Consumers Unwilling to Pay Premium for Environmentally Friendly Supply," The Japan Times, January 14, 2019, https://www.japantimes.co.jp/news/2019/01/14/world/world-awash-sustainable-palm-oil-consumers-unwilling-pay-premium-environmentally-friendly-supply/ **(26)** Based on Interview with CEO of Grupo Palmas, July 5, 2020. **(27)** Bracamonte, Carlos and Aramís Castro, "Exportación de aceite de palma no garantiza el uso total de insumos sin deforestación," OjoPúblico, June 8, 2020, https://ojo-publico.com/1858/mercado-de-palma-no-garantiza-productos-sin-deforestacion. **(28)** "Press release: World's largest sovereign wealth fund divests from Peruvian consumer goods giant over human rights violations and deforestation in palm oil supply chain," Forest Peoples Programme, March 2020, https://www.forestpeoples.org/en/lands-forests-territories-palm-oil-rspo/press-release/2020/press-release-worlds-largest-sovereign. **(29)** Hajek, Frank and Timothy Killeen, "Toward Zero-Deforestation Oil Palm in Peru: Understanding Actors, Markets, and Barriers," ClimateLinks, USAID, March 2015, https://www.climatelinks.org/sites/default/files/asset/document/FCM%2013-01%20Oil%20Palm%20in%20Peru_DRAFT_EN_CLEARED.pdf. **(30)** Khasanah N, van Noordwijk M, Slingerland M, Sofiyudin M, Stomph D, Migeon AF and Hairiah K (2020) Oil Palm Agroforestry Can Achieve Economic and Environmental Gains as Indicated by Multifunctional Land Equivalent Ratios. 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