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NATURAL CAPITAL

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Building resilient natural capital portfolios through diversification

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In traditional stock-bond portfolios, opportunities to improve efficiency through diversification may be limited because the average correlation across securities can be high. This is especially true in crises, when traditional asset classes virtually all move down together. In contrast, the lack of correlation across diverse natural capital investment strategies offers great potential for efficiency improvements via portfolio design.

INTRODUCTION

Portfolio diversification is a basic building block of modern portfolio theory and practice for investors in traditional asset classes and real assets alike. We believe combining uncorrelated assets in a portfolio increases expected returns without additional risk, thereby improving portfolio efficiency—making higher returns achievable at every level of risk.

Diversified natural capital portfolios could help investors reduce risks, some inherent to timberland and farmland—like weather, operating strategy, and crop type—and others common across real asset portfolios—such as policy and geopolitical dynamics. Ultimately, diversified natural capital portfolios should result in more consistent returns because volatility in one investment can be offset by another uncorrelated market.

Here we explore the primary sources of diversification in natural capital investments, focusing on **geography**, **market,** and **crop/species**. Diversification across these dimensions

Figure 1: Sources of diversification

SOURCE	RISK MITIGATED	EXAMPLES OF DIVERSIFICATION	
Geography	Geopolitical	Developed	US; Australia; New Zealand; Europe
	Policy	Emerging	Brazil; Chile; Uruguay; Paraguay; Costa Rica; Panama
	Climate	Climatic zone	Precipitation regime; temperature characteristics; exposure to El Niño and La Niña events
	Growth and yield	Hazard exposure	Likelihood of extreme weather events (e.g., drought; flooding; wildfire; hurricanes/tropical storms)
		Growing season	Seasonality in northern and southern hemispheres
Market Crop/species	Price Demand	Commodity	Row crops (e.g., barley, beans, chickpeas ,corn, cotton, rapeseed, rice, sorghum, soybeans, sunflower, wheat, sugarcane) Softwood and hardwood species for pulp and lumber markets (e.g., pine, Douglas-fir, hemlock, eucalyptus, birch)
		High-value	Permanent crops (e.g., almonds, pistachios, avocados, cherries, mandarins, navels, table grapes, wine grapes) Temperate and tropical hardwood species for solidwood markets (e.g., cherry, oak, maple, teak)
		Environmental	Carbon; ecological restoration; biodiversity; conservation

Source: NNC.

is multifaceted. For each, we highlight risks with potential for mitigation through diversification and examine individual strategies for achieving meaningful diversification. Finally, at the portfolio level, we provide quantitative examples of how diversification can reduce risk and improve the expected performance of natural capital portfolios.

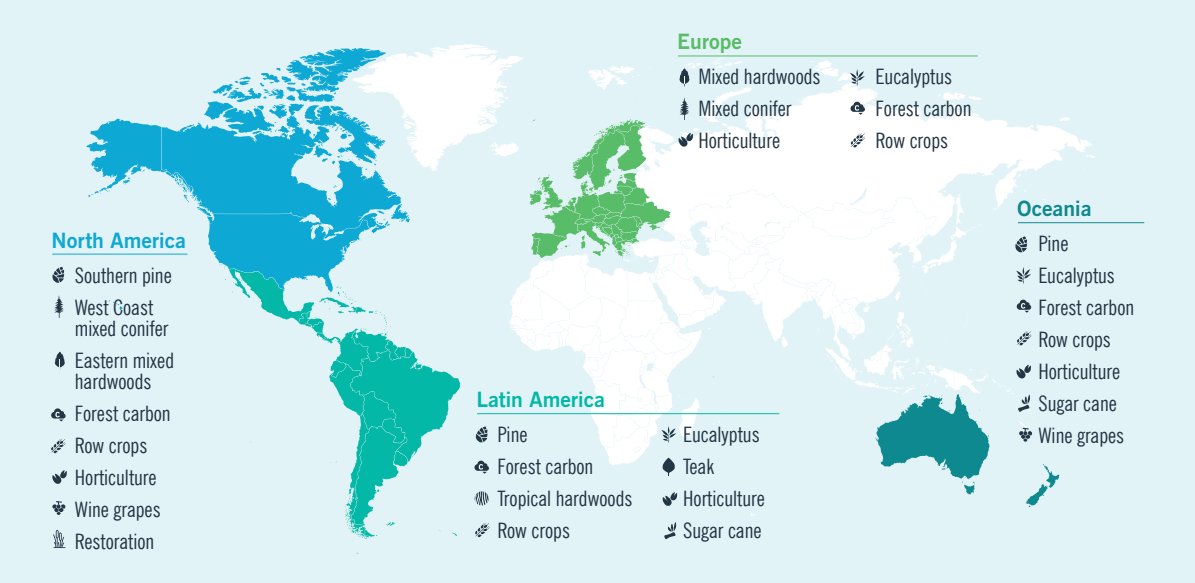
GEOGRAPHIC DIVERSIFICATION

Geopolitical and policy risk

Investing across geographies offers investors a way to diversify geopolitical and policy risks. Geopolitical risks are linked to diplomatic or military conflict and often result in trade restrictions between the engaged countries. Recent examples include sanctions against Russian exports after the invasion of Ukraine in 2022, China's restrictions on certain agricultural imports from Australia in 2020, and ongoing diplomatic tensions between the U.S. and China influencing global commodity trade flows. Because of the high volumes of agricultural and wood products traded internationally, trade restrictions like tariffs, quotas or import bans can have a major impact on markets and pricing in a single producing region. Policy risks, in contrast, tend to be specific to an individual country or jurisdiction and might include, for example, changes in regulation related to land management practices or shifts in macroeconomic policy.

A recent example of geopolitical risk impacting farmland is the ongoing diplomatic conflict between the U.S. and China. U.S. exports of soybeans to China have decreased as a result of trade restrictions, China's efforts to diversify sources of agricultural imports, and the availability of alternative, price-competitive supplies. Between 2016 and 2018, the U.S. share of China's soybean market fell from 56% to 8%. As demand from China, the world's largest consumer, shifted away from the U.S., U.S. row crop farmland experienced lower appreciation due to reduced export demand and lower U.S. soybean prices. At the same time, demand from China for Brazilian soybeans increased, lifting local prices and producer profitability which spurred higher farmland appreciation. Between 2016 and 2018, Brazil's share of China's soybean market increased from 33% to 74%. In this instance, having Brazilian farmland exposure in a portfolio alongside U.S. farmland helped mitigate the negative impact of these trade tensions.

Figure 2: Mapping opportunities for diversification across geography and market



Source: NNC.

Geographic diversification within a single country can also mitigate policy risk. For example, in the U.S., forest management practices are set by state law and having timberland exposure in several states can potentially mitigate impacts from policy changes. In the Pacific Northwest, the Oregon Forest Practices Act and Washington State Forest Practice Rules establish standards for all aspects of timberland management, from road construction to harvesting as well as the protection of water quality and habitat. In 2022, rules of the Oregon Forest Practices Act were changed in a way that expanded protections for fish and amphibians. After more than a year of negotiations, these regulatory changes were detailed in the Private Forest Accord agreement between timber industry and conservation groups. Meanwhile, just across the border in Washington state, timberland owners were not exposed to the same policy uncertainty. Here, a portfolio that included both Washington and Oregon timberland mitigated the impact of policy uncertainty and eventual policy changes.

In addition to mitigating geopolitical and policy risk, natural capital portfolios can benefit from geographic diversification by adding emerging market exposure to a portfolio concentrated in developed markets. Emerging markets offer investors the opportunity to enter farmland and timberland at attractive valuations relative to developed markets, which can provide greater potential for value appreciation as infrastructure develops and scale increases. Additionally, the land sector in emerging market countries can be highly fragmented. Consolidating smaller parcels into more efficient blocks adds value from both a property management and commercial perspective. These value drivers are generally unique to emerging markets and diversify the type of value investments bring to a natural capital portfolio.

Climate, growth and yield risk

Climate risk is a key determinant of crop and tree growth and yield, directly impacting natural capital portfolio returns, and can also be mitigated through geographic diversification. Annual crop yields are highly dependent on intra-year weather conditions as well as longer-term trends. Timber yields tend to be less sensitive to variability in a single year, but long-term shifts in weather patterns as well as extreme weather events can have a significant impact on growth and yield. Constructing a portfolio that considers climate variability and physical risk exposure can minimize potential impacts to financial performance.

The El Niño Southern Oscillation (ENSO) phenomenon contributes significantly to seasonal climate fluctuations and shifting rainfall patterns in

many parts of the world. The regions and seasons shown on the maps below indicate typical but not guaranteed impacts of El Niño and La Niña events, which occur every few years. Climatic conditions linked to the ENSO phenomenon may damage production in one region and lead to a bumper crop in another, highlighting the importance of climate-based diversification.

Figure 3a. El Niño and typical rainfall patterns

Wet Dry

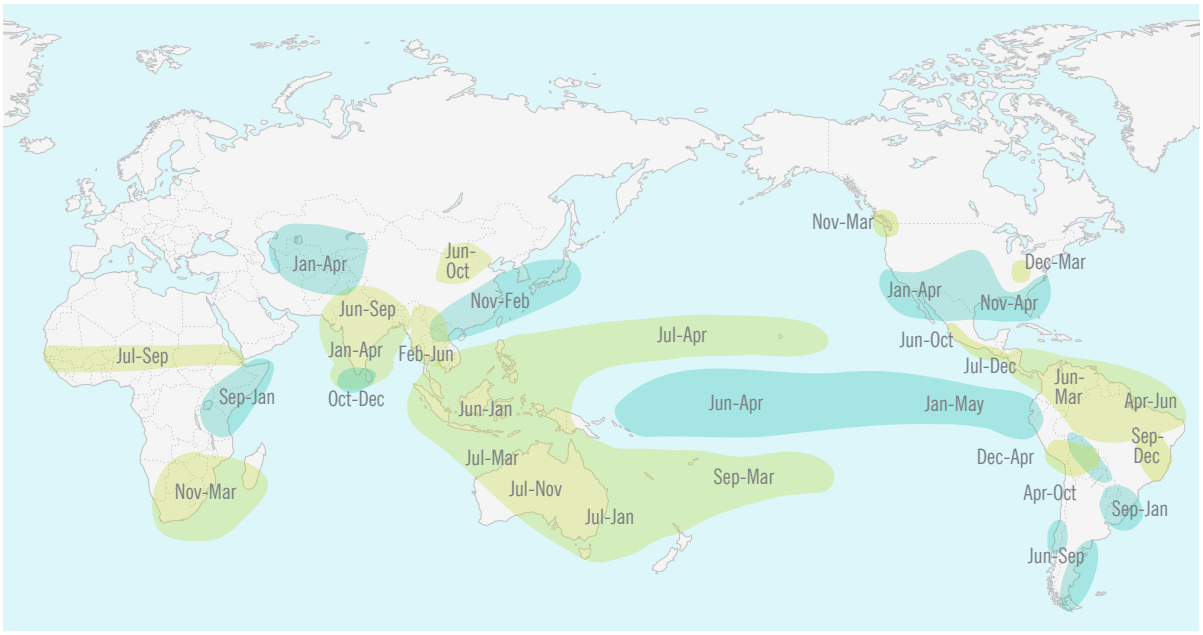
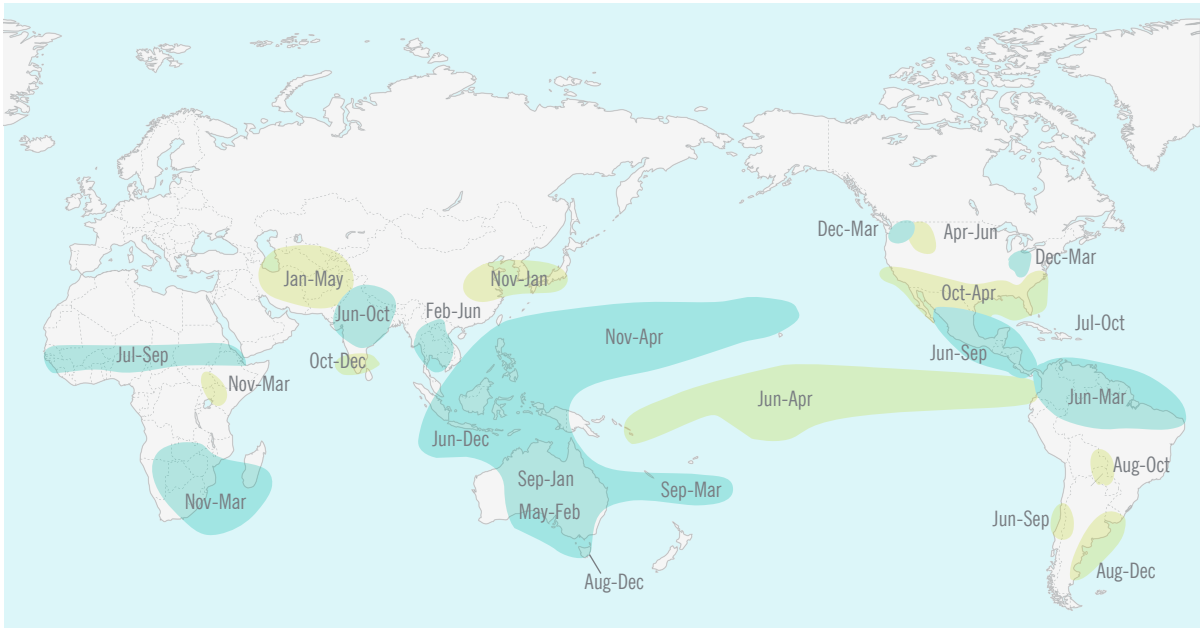


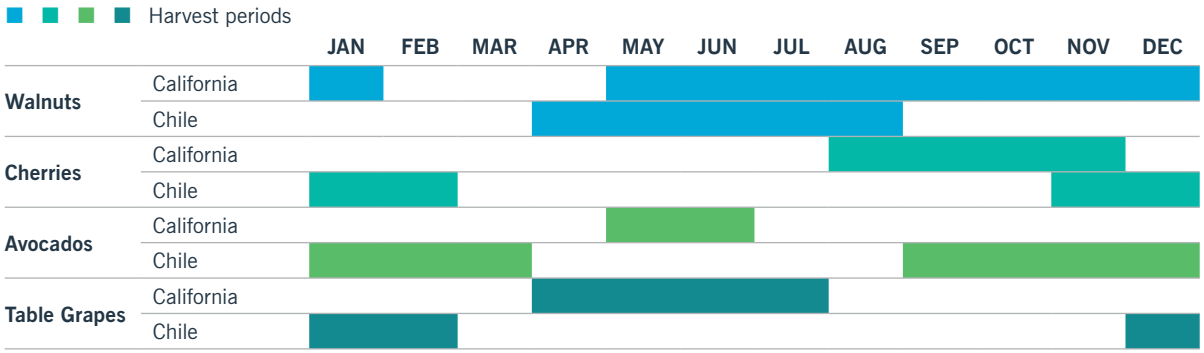
Figure 3b. La Niña and typical rainfall patterns

Wet Dry



Source: Columbia Climate School https://iri.columbia.edu/our-expertise/climate/enso/

Figure 4. Harvesting windows in the northern and southern hemispheres for select crops



Source: NNC.

Independent of the ENSO phenomenon, different growing seasons and harvesting windows provide another potential source portfolio of diversification for farmland investors. Seasonality can vary across regions within the same country and more significantly across the northern and southern hemispheres. Figure 4 highlights the complementary harvesting windows for select permanent crops in California compared to Chile. Producers in the southern hemisphere can at times receive a premium price on their crop when northern hemisphere supplies are constrained by seasonality of production.

Climate change is increasing both the frequency and severity of extreme weather events like drought, heat waves, wildfire, and flooding (see for example *Climate Change 2021: The Physical Science Basis*[1]), with some regions more affected than others. A diversified portfolio, together with active management to mitigate impacts of these extreme events when they do occur, can insulate against the impacts of extreme weather events on investment performance. In some cases, the likelihood of extreme weather linked to climate change and resulting financial impacts may be so great that an investment region becomes uninvestable from a natural capital perspective.

MARKET AND CROP/SPECIES DIVERSIFICATION

Different agricultural crop types and tree species supply a wide range of end-use markets, creating a second source of diversification in natural capital

Operating models: Lease vs operating

Whereas timberland investments in major investment geographies are typically owner-operated, farmland portfolios may include a mix of owner-operated and lease strategies. Operating a farmland asset can add income-return upside but can come with additional operational risks. Diversifying across these strategies within a portfolio allows investors to gain additional income upside while mitigating some of the volatility associated with operating farmland investments.

Leased assets represent farmland investments that are purchased and then leased out to a local farmer. For these assets, investment returns are composed of modest, stable income return and by appreciation of the underlying land. Generally, underlying appreciation of the land is the primary driver of return.

Operating a property allows an investor to directly operate or hire a farmland manager to farm the property. The return characteristics are almost entirely income driven with modest appreciation.

From an income return perspective, while leased annual crops are remarkably consistent, typically providing 3–4% income return with limited volatility, operated permanent crop investments can experience years with remarkably high income returns. (Source: NCREIF Farmland Index)

Diversifying a farmland portfolio to include leased annual crops and operated permanent crops helps investors gain exposure to years of very high income returns while mitigating some of the volatility experienced in only a directly operated permanent crop portfolio.

portfolios. End-use markets span commodity markets—like sugar, grains, building materials, and pulp—and high-value crop and solidwood product markets—like wine grapes, pistachios and teak. In addition to crop and timber markets, growing environmental markets are expanding opportunities for market diversification.

Because crop markets feature unique demand drivers, supply conditions and pricing cycles, they tend to be uncorrelated. Annual crops provide exposure to vegetables, berries, hay, grains and oilseeds. Permanent crops provide exposure to tree nuts, wine grapes and tree fruit. Including a range of crop types in a portfolio results in exposure to different demand drivers while also mitigating exposure to supply driven imbalances that inherently exist as planted acreage and yields change over time. As shown in Figure 5, we observe low or negative correlations across a range of farmland investment strategies.

Similarly, diverse timber markets feature unique demand drivers, end-use markets, and local "wood-basket" supply conditions. Softwood sawlogs, like pine, Douglas-fir and hemlock, are typically milled into lumber and used in the housing or construction sectors. Eucalyptus pulplogs grown in Latin America are primarily used to produce pulp, which is exported and then made into tissue products. High-value hardwoods like teak are used to produce furniture, case goods and decking, for example. As a result of these diverse markets, here too we observe low or negative correlations across a range of investments (Figure 6).

Figure 5. Farmland investment strategy correlation

	AU Almond	CL Avocado	CA Wine Grapes	NZ Wine Grapes	Europe Row	US Avocado	US Row Cornbelt	US Row Delta	US Row West	US Almond
AU Almond	1.00	-0.23	-0.09	0.33	0.22	0.27	0.02	0.15	-0.20	0.28
CL Avocado		1.00	-0.20	-0.35	-0.30	0.30	0.00	-0.02	0.45	-0.12
CA Wine Grapes			1.00	-0.12	-0.27	0.19	-0.07	-0.06	-0.11	0.02
NZ Wine Grapes				1.00	0.28	-0.52	-0.03	0.00	0.22	-0.06
Europe Row					1.00	-0.33	0.28	0.41	-0.35	0.55
US Avocado						1.00	-0.07	0.04	-0.09	-0.17
US Row Cornbelt							1.00	0.82	-0.28	0.27
US Row Delta								1.00	-0.39	0.61
US Row West									1.00	-0.35
US Almond										1.00

Sources: NNC Research using USDA, UN FAO, ABARES, ODEPA, World Bank, 1995–2021.
Note: AU: Australia; CL: Chile; NZ: New Zealand.

Figure 6. Timber and carbon price correlation

	New Zealand Pine	US Douglas-fir	US Hemlock	US South Pine	Brazil Eucalyptus	Central America Teak	Carbon
New Zealand Pine	1.00	0.51	0.48	-0.06	0.33	0.12	0.14
US Douglas-fir		1.00	0.90	0.16	0.15	-0.02	0.42
US Hemlock			1.00	0.26	0.16	0.03	0.15
US South Pine				1.00	0.28	-0.46	-0.08
Brazil Eucalyptus					1.00	0.04	0.46
Central America Teak						1.00	-0.20
Carbon							1.00

Sources: NNC Research using WoodMarket Prices, Government of India Trade Statistics, and California Air Resources Board, 1996–2023.

Exposure to environmental markets can provide an additional source of uncorrelated return for timberland and farmland investors. For example, forest management for carbon alongside commercial timber production can provide exposure to verified carbon credit markets. Beyond market diversification, allocations to low-carbon, land-based asset classes can reduce the overall carbon intensity of a traditional portfolio. This carbon diversification can provide a hedge against more carbon intensive allocations and reduce potential volatility of an institutional portfolio as countries and economies decarbonize.

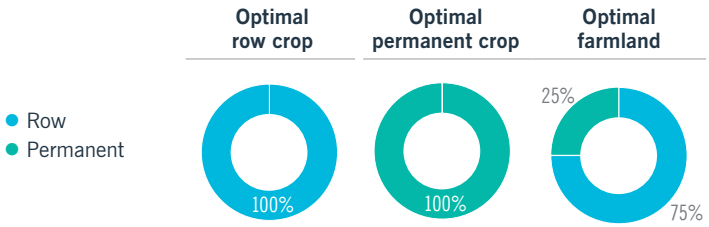
WHAT DOES THIS MEAN FOR INVESTORS?

From the qualitative analysis above, it's clear that diversification across geography, markets, and crop/species has the potential to reduce risk and improve performance of natural capital portfolios. And looking ahead, as geopolitical alliances intensify, climate risks build and markets for a range of ecosystem services grow and mature, we expect the benefits of diversification will increase. So, for investors seeking a diversified natural capital portfolio, how can the portfolio-level benefits of diversification be quantified and used to build optimally diversified timberland and farmland portfolios?

There are two basic approaches to constructing a diversified portfolio—portfolio allocation modeling and allocation target-setting. The advantage of the allocation modelling approach (via a mean-variance portfolio optimization, for example) is that it can be used as a tool to achieve optimal diversification. The solution to the allocation model is an efficient frontier—the set of portfolios that maximizes return at every level of risk. Further, in practice, individual investors have the flexibility to customize the model to include any relevant constraints, specific to investable scale requirements of the individual investor, as well as specify the objective (e.g., total return, income return or both). However, required input data including historical performance, may not always be available, especially outside of the U.S. Where data limitations exist, allocation target-setting is an alternative approach that can be used to build a diversified portfolio.

Here we provide two simple examples of the allocation modeling approach to optimal portfolio design for farmland and timberland investments in the U.S. Beginning with farmland, we explore optimal diversification across row and permanent crop investments. For the model, we use NCREIF Farmland Index performance data from 1996 to 2022 for three row crop strategies (Corn Belt, Delta and Mountain) and three permanent crop strategies (wine grapes, almonds and pistachios). Optimizing for total return, we find that an optimally diversified portfolio includes a 75%/25% mix of row and permanent crop types, respectively. In this example, though the optimal row crop portfolio offers a higher Sharpe ratio, by adding an allocation to permanent crops, the increase in expected return for the optimal farmland portfolio more than makes up for the higher risk, increasing the Sharpe ratio of the diversified portfolio (Figure 7).

Figure 7. Optimally diversified U.S. farmland portfolio example

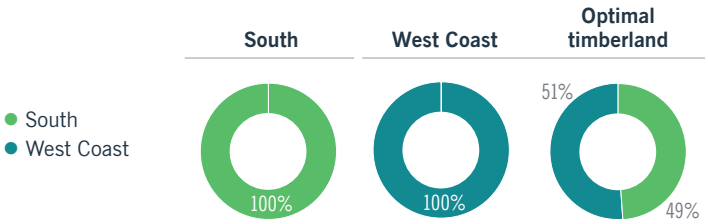


	Optimal row crop	Optimal permanent crop	Optimal farmland
Expected Return	10.0%	17.8%	11.1%
Std Dev	4.8%	10.7%	5.2%
Sharpe Ratio	1.54	1.42	1.64

Source: Nuveen, using NCREIF Farmland Index performance data. **Past performance is no guarantee of future results.**

Next, we explore optimal diversification across the two largest timberland investment regions in the U.S. Using NCREIF Timberland Index performance data for the South and the West Coast, again from 1996 to 2022, we find that the optimally diversified portfolio includes a 49%/51% allocation across the two regions, respectively. In this example, though the West Coast offers a higher Sharpe ratio, by adding an allocation to the South, the reduction in portfolio risk more than makes up for the modestly lower expected return, increasing the Sharpe ratio of the diversified optimal timberland portfolio (Figure 8).

Figure 8. Optimally diversified U.S. timberland portfolio example



	South	West Coast	Optimal timberland
Expected Return	6.6%	8.4%	7.6%
Std Dev	7.0%	9.2%	7.2%
Sharpe Ratio	0.57	0.63	0.69

Source: Nuveen, using NCREIF Timberland Index performance data. **Past performance is no guarantee of future results.**

As the examples above illustrate, it is possible to build diversified timberland and farmland portfolios across regions and/or crop types within a single country. For investors constrained by a focus on a single geography or currency, a regionally diversified portfolio may be preferred to a globally diversified portfolio. Geographies where meaningful diversification within a farmland portfolio is feasible include the U.S., California, Brazil, Europe and Australia. Similarly for timberland, meaningful diversification is achievable within the U.S., Brazil and Australia.

While diversification has the potential to be accretive to an investment portfolio, these benefits must be weighed against the potential costs or increased risk that come with diversification. If not carefully considered, potential costs or increased risk from diversification may reduce or offset the portfolio-level benefits of geographic and market diversification for natural capital investors.

FX volatility

For all investors, diversification within and across countries needs to be evaluated within the context of structure, tax and foreign currency exchange rates, where relevant. In particular, foreign currency exchange rate volatility is a critical consideration for land-based investors. Timberland and farmland investments typically include land and associated structures. Land in most markets transacts in local currency. Depending on entry and exit timing, exchange rates can be a significant factor in the amount of capital eventually returned to investors. In some countries, currency volatility may be too extreme or the cost of hedging too high to compensate for the diversification benefit the country could offer. Insight into the tradeoffs between foreign currency exchange rate volatility and diversification benefits can be evaluated using the portfolio optimization modeling framework with model inputs and returns adjusted to reflect the investor's (or local) currency.

For more information, please visit our website, nuveen.com/naturalcapital.

Endnotes

Sources

1 Climate Change 2021: The Physical Science Basis, IPPC, August 2021, https://www.ipcc.ch/report/ar6/wg1/

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