Defining Regenerative Agriculture and the Intersection with Sustainable Forestry

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Introduction

A drive toward true sustainability is a shared objective in many sectors - including agriculture and forestry. As articulated in the UN Sustainable Development Goals (SDGs), all sectors are necessary contributors to environmental, social, and economic sustainability.[1] Within forestry, there has been an evolution in terminology over the past 100 years to define sustainability, including "multiple use" and "sustainable forest management" and the emergence of public policy and private sector initiatives like certification to guide advancements. Similar evolutions have been occurring in agriculture, with terms like "organic", "sustainable", and "regenerative" being advanced in policy and practice. Specifically, the term regenerative agriculture has reemerged in recent years and is reflective of efforts to achieve greater sustainability, particularly within food systems.

This report explores the definition of regenerative agriculture, including the expression of principles and practices that may intersect with the greater use of trees and forestry within food systems. The integration of farming and forestry at greater scales may provide significant social, environmental, and economic benefits. However, there are substantial barriers to achieving this integration that exist within public agencies, policies and programs, research and educational institutions, and markets. Regenerative agriculture clearly intersects with forestry in its philosophy and stronger cross-sector collaboration should be supported through public and private sector leadership.

Background

Food systems have always been under pressure to meet the needs of a growing population. These pressures have increased in recent years as farm products are also major contributors to meeting energy and material needs as well as food supplies. Over the past 100 years, intensified agriculture production systems have been able to produce food surpluses, but there have been mounting impacts to natural resources and soil health in particular. Expanding agriculture continues to be the leading cause of deforestation, forest degradation, and loss of forest biodiversity globally.[2] According to the most recent Global Land Outlook[3] report, the global food system is responsible for 80 percent of the world's deforestation, 70 percent of freshwater use, and is the greatest driver of land-based biodiversity loss.[4]

Just within the U.S., soil erosion, largely associated with agriculture, costs the economy about $37.6 billion per year in productivity losses and is occurring at a rate that is 10 times faster than natural replenishment.[5] Most of the soil erosion associated with stormwater runoff ends up polluting waterways, contributing to flooding, and carrying fertilizer and chemical contaminants. Soil erosion associated with wind is an air pollutant, carries infectious diseases, and harms human health.

Global actions to transform farming practices and support restoration are underway and include 61 nations pledging to collectively restore 1 billion hectares (an area about the size of the United States). Analysis suggests that 5 billion hectares could be restored by 2050. The necessary changes to achieve this impact include mostly low-tech adaptations in agricultural practices, such as reduced tillage, integrating trees with crops and livestock (agroforestry), and stewardship of grasslands and forests. The estimated cost is $300 billion per year to meet land and soil restoration goals set for this decade.[6]

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[1]The United Nations Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The SDGs are 17 goals with 169 targets that all 191 UN Member States have agreed to try to achieve by the year 2030. Also see: The Sustainable Development Goals (SDGs): An introduction to what they are and how they can be applied in the forest sector, 2018, Dovetail Partners. Available at: https://dovetailinc.org/portfoliodetail.php?id=5e260bba17982

[2]Large-scale commercial agriculture (primarily cattle ranching and cultivation of soya bean and oil palm) accounted for 40 percent of tropical deforestation between 2000 and 2010, and local subsistence agriculture for another 33 percent. FAO. 2020. State of the World's Forests. https://www.fao.org/state-of-forests/en/

[3]https://www.unccd.int/resources/global-land-outlook/overview

[4]https://insideclimatenews.org/news/27042022/agriculture-land-report/

[5]https://news.cornell.edu/stories/2006/03/slow-insidious-soil-erosion-threatens-human-health-and-welfare

[6]https://insideclimatenews.org/news/27042022/agriculture-land-report/

Defining Regenerative Agriculture

With pressure, and emerging market opportunities, to produce more while doing less harm, new approaches to agriculture are of great interest to private sector investors as well as public agency regulators. References to "regenerative agriculture" can be traced to the late 1970s with greater use developing through the leadership of the Rodale Institute in the 1980s.

Robert Rodale (1983) defined Regenerative Agriculture as:

> *'...one that, at increasing levels of productivity, increases our land and soil biological production base. It has a high level of built-in economic and biological stability. It has minimal to no impact on the environment beyond the farm or field boundaries. It produces foodstuffs free from biocides. It provides for the productive contribution of increasingly large numbers of people during a transition to minimal reliance on non-renewable resources'. (Source: Giller 2021)*

These themes are repeated and refined through more recent regenerative agriculture definitions, including Burgess et al. (2019): 'Regenerative Agriculture 'generates agricultural products, sequesters carbon, and enhances biodiversity at the farm scale.'

The two measures of success most frequently linked to Regenerative Agriculture are:

1. Restoration of soil health (including, the capture of carbon (C) to mitigate climate change)
2. Reversal of biodiversity loss

These goals are expounded upon within the philosophy of regenerative agriculture (Box 1).

Box 1. Regenerative Agriculture Philosophy

The Regenerative Agriculture Philosophy as presented by Harwood (1983: 31).

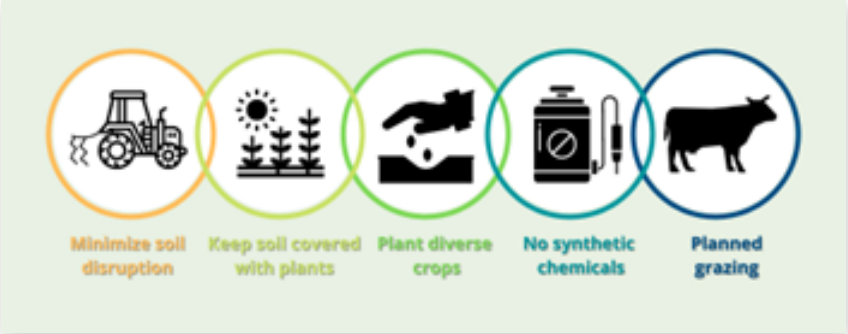
1. *Agriculture should produce highly nutritional food, free from biocides, at high yields.*
2. *Agriculture should increase rather than decrease soil productivity, by increasing the depth, fertility and physical characteristics of the upper soil layers.*
3. *Nutrient-flow systems which fully integrate soil flora and fauna into the pattern often are more efficient and less destructive of the environment, and ensure better crop nutrition. Such systems accomplish a new upward flow of nutrients in the soil profile, reducing or eliminating adverse environmental impact. Such a process is, by definition, a soil genesis process.*
4. *Crop production should be based on biological interactions for stability, eliminating the need for synthetic biocides.*
5. *Substances which disrupt biological structuring of the farming system (such as present-day synthetic fertilizers) should not be used.*
6. *Regenerative agriculture requires, in its biological structuring, an intimate relationship between manager/participants of the system and the system itself.*
7. *Integrated systems which are largely self-reliant in nitrogen through biological nitrogen fixation should be utilized.*
8. *Animals in agriculture should be fed and housed in such a manner as to preclude the use of hormones and the prophylactic use of antibiotics which are then present in human food.*
9. *Agricultural production should generate increased levels of employment.*
10. *A Regenerative Agriculture requires national-level planning but a high degree of local and regional self-reliance to close nutrient-flow loops.*

Source: Giller KE, Hijbeek R, Andersson JA, Sumberg J. Regenerative Agriculture: An agronomic perspective. Outlook on Agriculture. 2021;50(1):13-25. doi:10.1177/0030727021998063

Regenerative Agriculture in Principle and Practice

The definition of regenerative agriculture continues to evolve and various descriptions of the principles that translate into on-farm practices are available, as shown by just two examples in Figures 1 and 2. As these examples show, there are differences related to the use of synthetic chemicals[8] and the role of farm operators; however, there is strong alignment around minimized soil disturbance (tillage practices), soil protection (continuous cover), crop diversity, and inclusion of livestock.

Figure 1. The 5 Principles of Regenerative Agriculture



Source: https://noharm-uscanada.org/regenerativeagriculture

Figure 2. Six Core Principles of Regenerative Agriculture

Source: https://noharm-uscanada.org/regenerativeagriculture

[8]Regenerative agriculture has also been seen as closely related to organic agriculture. There are many parallels between regenerative and organic practices, but with the establishment of organic certification and prescriptive definitions of organic production there are clear distinctions between the two management systems. Rodale Institute continues to refer to 'regenerative organic agriculture' (Rodale Institute, 2014). Regenerative agriculture also has connections with Permaculture. Similar to permaculture being described as an ethic, regenerative agriculture is described as a philosophy, also see the Dovetail Report, Permaculture 101: An Introduction to Regenerative Design .

Glossary of Agriculture Terms

Cover crop: Any plant that is planted as soil cover rather than for the purpose of being harvested. Cover crops may be used to manage soil erosion, soil fertility, water content, weeds, pests, agricultural diseases, and biodiversity on land that is repeatedly farmed. They are commonly off-season crops planted after harvesting a cash crop in order to help conserve the integrity of the land through a fallow period.

Crop rotation: The practice of cultivating a series of different crops in the same space over the course of multiple growing seasons, often in a specific sequence that repeats in a cycle every few seasons. Crop rotation can reduce reliance on fertilizer and pesticides by making better use of natural ecosystem services from a diverse set of crops, often improving soil quality and reducing the probability of pests and weeds developing resistances to control measures.

Tillage: The preparation of agricultural soil by any of various types of mechanical agitation, whether human-powered, animal-powered, or mechanized, such as digging, hoeing, raking, plowing, and harrowing.

Conservation Tillage: Any tillage practice which aims to reduce soil erosion and preserve natural soil conditions, generally by leaving significant amounts of crop residue to cover previously harvested agricultural land; such practices can also enhance biological pest control and reduce fuel consumption and soil compaction. Conservation tillage includes no-till, strip-till, and mulch-till systems.

Source: https://en.wikipedia.org/wiki/Glossary_of_agriculture

The principles and practices of regenerative agriculture have evolved over the decades to increasingly focus on soil biology as the key component. The focus on minimized soil disturbance, keeping soils covered, and integrating livestock (including perennial pasture cover) are all principles that are directly related to prioritizing soil protection and restoration. This focus on soil health has emerged in recognition that farming systems profoundly affect soil resources and these effects can be measured and monitored - and mitigated.

Box 2. Benefits of Regenerative Agricultural Practices

No till or low till - Minimizes disruption to the soil ecosystem and keeps plant roots connected to unique communities of microorganisms that are key in the processes to build healthy soil and store carbon.

Cover crops - Keeping the ground covered with plants allows for water and carbon to be absorbed by the soil which keeps the soil alive, helps eliminate soil erosion by preventing the soil from blowing or washing away, and prevents desertification.

Diversified production systems - Multiple crops rotated in fields, perhaps with integration of livestock, mimics natural ecosystems and enhances biodiversity which contributes to healthy soil.

Reduction or elimination of synthetic chemicals - Utilizing synthetic chemical fertilizers discourages the plant to seek nutrients deeper in the soil and work with microbes for its nutrition, which results in less carbon sequestration. Utilizing chemical pesticides disrupts the soil microbial community, impacts biodiversity, and contributes to land and water pollution and human health impacts.

Planned grazing - Planned or rotational grazing of grasses mimics the patterns of animal herds which ensures land is not overgrazed, and manure fertilizes the soil and contributes to carbon sequestration.

Source: https://noharm-uscanada.org/regenerativeagriculture

Intersecting Regenerative Agriculture and Sustainable Forestry

There are several ways that regenerative agriculture and sustainable forestry intersect, including products, practices and production systems, measures of success, producer and consumer communities, and ecosystem scale benefits.

Intersections via products

A number of forest products can be inputs to regenerative agriculture. For example, biochar from wood can serve as an agricultural input to meet soil carbon objectives for regenerative agriculture.[9] Harvested wood and fiber and timber processing waste may be used in the generation of compost that is utilized in food systems. The practice of collecting yard waste and wood to generate mulch and composts is common in urban and urban interface areas.

Intersections via practices and production systems

Recognized regenerative agriculture practices include implementation of agroforestry systems.[10] Agroforestry uses principles of agricultural science, forestry, husbandry, ecological conservation, economics, and policy to sustainably manage crops through the combination of annuals, perennials, trees, and livestock. By integrating trees, perennials or livestock into a conventional annual cropping agricultural system, agroforestry promotes the efficient use of sunlight, moisture, plant nutrients, and other ecological services for increased ecological, economic and social benefits. The integration of perennial crops, livestock and tree species has implications for sustainable agricultural practices, improved product diversification, improved human nutrition, reduced system risk and instability, labor equity and increased use of renewable resources.[11]The ecological benefits of successful agroforestry systems include improved soil health, reduced microclimate extremes and increased rates of biodiversity. This land management system aims to reduce risk and increase total productivity while also providing specialized socioeconomic services to individual farmers and their communities.

Intersections in values, measures of successes, and goals

Both forestry and agriculture have been evolving to address sustainability concerns. The two sectors have experienced parallel emergence of sustainable, certified, and responsible management systems in recent decades. These developments have included use of technology, monitoring systems, global/national reporting, and policy changes. Food systems and forestry represent the dominant land uses in many countries, including the United States, and they interact with each other across the landscape. The geographic connection between the sectors is readily apparent and the philosophical and value-driven interactions through regenerative principles offer opportunities for greater innovation.

Intersections in producer and consumer communities

Landowners in the United States often have responsibility for a mix of land uses, including some farm and croplands as well as natural or planted forest areas. Landowners and producers are often looking for information and systems that allow them to work across these different land uses. On the consumer side of the equation, eco-conscious consumers are looking for a range of food products and other goods that will reduce their environmental footprint and provide positive social and environmental impacts, such as living wages for workers and reduced carbon emissions. Common production and marketing opportunities could be developed for producer and consumer interests.[12]

Intersections in providing ecosystem scale benefits and enabling access to ecosystem service markets.

Forests are natural systems and are a common part of the landscape in many agricultural regions. The forested areas in these regions provide many benefits, including serving as biological refugia and habitat for pollinators and beneficial wildlife, and providing a variety of ecosystem systems. Both farms and forests sequester carbon and can qualify for carbon credit markets.[13] The growing interest in ecosystem restoration and markets for ecosystem services may create additional incentives for optimizing the farm and forest balance across the landscape.

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[9]For additional information about biochar, see: Biochar 101, available at: https://dovetailinc.org/portfoliodetail.php?id=5e28c20e735a8

[10]For additional information about agroforestry, see; Agroforestry 101, available at: https://dovetailinc.org/portfoliodetail.php?id=5e28c29ae5046

[11]Worldwide, agroforestry is known for strengthening the social and economic climate of rural communities while bolstering sustainable agricultural practices. For further discussion, including case studies, see: https://dovetailinc.org/portfoliodetail.php?id=5e28c29ae5046

[12]For further discussion of effective green marketing, see: Green Marketing: Growing Sales in Growing Markets, available at: https://dovetailinc.org/portfoliodetail.php?id=5e4809bbbf48c

[13]For further discussion, see: Agriculture and Forestry Offsets in Carbon Markets: Background and Selected Issues, CRS, 2021. https://crsreports.congress.gov/product/pdf/R/R46956

Challenges and Opportunities for Integrating Regenerative Agriculture and Sustainable Forestry

Besides the challenges associated with achieving regenerative agriculture, there are also barriers to its integration with forestry.

> *"The barriers to integrating regenerative agriculture and sustainable forestry include the current structure of public and private organizations that treat farm and forest practices, products, research, and policy as separate, competing, and/or conflicting fields."*

Despite the US Forest Service being within the US Department of Agriculture, there is little intersection in federal programs. At the state level, many farm programs are in agriculture agencies while forestry is more commonly addressed in natural resource agencies. Exceptions to this approach and models of cross-sector collaboration worth considering for replication include:

Vermont Farm & Forest Viability Program

The mission of the Vermont Farm & Forest Viability Program is to enhance the economic viability of Vermont farms and forestry enterprises. This is accomplished by offering business advising to eligible farmers, agriculturally-related businesses, forest products enterprises, and forest landowners.

https://www.vhcb.org/viability

Oregon Farm & Forest Land Use Report

This report provides information on the background and structure of the Goal 3 (Agricultural Lands), and Goal 4 (Forest Lands), components of the land use program; reports data on applications approved and denied for certain land uses in exclusive farm use (EFU) and forest zones; and highlights challenges and emerging issues pertaining to the protection of agricultural or forest land.

https://www.oregon.gov/lcd/Publications/2018-2019_Farm_Forest_Report.pdf

Louisiana Department of Agriculture & Forestry

The Louisiana Department of Agriculture and Forestry is responsible for administering many of the programs and enforcing the regulations that impact every aspect of the state's agriculture and forestry. At the farm and forest level, these industries contribute $11.7 billion annually to the state's economy.

https://www.ldaf.state.la.us/about/

Agriculture and forestry related research and education have not been well integrated within colleges and universities. For example, the history of land grant universities[14] establishes the separation in education, research, and career paths.[15] The financial support for agriculture and forestry come from separate programs and regulatory authorities and the level of funding is dramatically different. As shown in Table 2, only one program is specific to forestry (McIntire-Stennis Cooperative Forestry Act) and the amount of funding is about 10% of the largest agriculture appropriation.[16] As interest in regenerative agriculture and sustainable forestry continue to develop, an examination of enabling policy, research agendas, and educational structures could be beneficial.

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[14] *A land-grant college or university is an institution that has been designated by its state legislature or Congress to receive the benefits of the Morrill Acts of 1862, 1890, and 1994. The original mission of these institutions, as set forth in the first Morrill Act, was to teach agriculture, military tactics, and the mechanic arts as well as classical studies so members of the working classes could obtain a liberal, practical education. Source:* https://www.aplu.org/about-us/history-of-aplu/what-is-a-land-grant-university/

[15] The U.S. Land-Grant University System: An Overview, CRS, 2019. https://crsreports.congress.gov/product/pdf/R/R45897

Table 2. NIFA Discretionary Appropriations

(in $millions)

Program	FY2015	FY2016	FY2017	FY2018	FY2019
Research and Education					
Agriculture and Food Research Initiative (AFRI)†	325.0	350.0	375.0	400.0	415.0
Hatch Act*	243.7	243.7	243.7	243.7	259.0
Evans-Allen Act*	52.5	54.2	54.2	54.2	58.0
McIntire-Stennis Cooperative Forestry Act*	34.0	34.0	34.0	34.0	36.0
1994 Institutions Endowment Appropriations*	3.4	3.4	3.4	3.4	3.4
Research Grants for 1994 Institutions†	1.8	1.8	1.8	3.8	3.8
Other research and education	131.6	132.6	137.4	148.1	152.4
Total Research and Education	***792.0***	***819.7***	***849.5***	***887.2***	***927.6***

[38] An exception to the competitive awarding of Smith-Lever 3(d) funds is the Expanded Food and Nutrition Education Program in which funds are distributed on a formula basis.

[39] See NIFA webpage for more details, at https://nifa.usda.gov/funding-opportunity/tribal-colleges-research-grants-program-tcrgp.

Source: The U.S. Land-Grant University System: An Overview, CRS, 2019. https://crsreports.congress.gov/product/pdf/R/R45897

Integration of agriculture and forestry related academic programs has already begun with regard to non-food products. In several major universities, what were once separate academic units focused on agricultural engineering and wood science or forest products have merged into single departments. This has come about with recognition of the considerable commonality in efforts to develop bioproducts (bioenergy including bio fuels, bioplastics, bioremediation products, bio-based nanomaterials and products, building materials, and more) from agricultural and forest-derived plants and residues.

Regenerative agriculture faces criticism related to risks of reduced productivity, either in the short-term during the transition to regenerative practices or in the long-term through a reversal in the trend of intensification. In a comparison of hundreds of food production systems, researchers concluded that grass-fed beef, commonly associated with regenerative agriculture, requires more land and emits similar greenhouse gas emissions as grain-fed beef.[17] However, it is also recognized that regenerative systems can be more productive and provide greater efficiencies as well. For example, regenerative systems that expand from summer annual cropping to include perennial and winter cropping systems address regenerative principles for soil protection and diversification while expanding productive capacity.[18] Research of alternative corn production systems found lower grain yields with regenerative practices but higher profits and other benefits.[19] Further research will be needed to better understand trade-offs in production systems and the associated short and long-term impacts. Food companies have shown interest in advancing regenerative practices as well as the associated research. For example, General Mills recently announced expansion from a 115,000 acre regenerative agriculture program to a partnership for monitoring 175 million acres that will enable progress towards their sustainability goal of advacing regenerative agriculture on 1 million acres by 2030.[20]

[16] *The McIntire-Stennis Cooperative Forestry Act of 1962 as amended authorizes research appropriations for certified cooperating forestry schools, including 1862 Institutions. The 1890 Institutions were made eligible for McIntire-Stennis funding through Section 7412 of the 2008 farm bill. The 1994 Institutions that offer associate or baccalaureate degrees in forestry were made eligible in Section 7604 of the 2018 farm bill. Source:* https://crsreports.congress.gov/product/pdf/R/R45897

[17] A meta-analysis of life cycle assessments that includes 742 agricultural systems and over 90 unique foods produced primarily in high-input systems, see: https://iopscience.iop.org/article/10.1088/1748-9326/aa6cd5/pdf?mkt_tok=MjExLU5KWS0xNjUAAAGEDs3V57i2VahJ2G-0xOgNdDsCrsBbwmFlwl7ovl2ZkEuqE5qQNuAPrJpkeObY1nwg0EceuKBHBcPE-p69EfSKQdYioio2AjfLioc_q6m9XWIbkys

[18] For examples and further discussion, see the Forever Green Project: https://forevergreen.umn.edu/about

[19] LaCanne CE, Lundgren JG. Regenerative agriculture: merging farming and natural resource conservation profitably. Peer J. 2018 Feb 26;6:e4428. doi: 10.7717/peerj.4428. PMID: 29503771; PMCID: PMC5831153. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5831153/

[20] GreenBiz. J. Klein. July 6, 2022. "Regrow partnership with food giants aims to scale regenerative agriculture" https://www.greenbiz.com/article/regrow-partnership-food-giants-aims-scale-regenerative-agriculture

The Bottom Line

Farming and forestry both have strong interests in sustainability and the opportunity to contribute to environmental benefits and improvements. Sustainable forestry and regenerative agriculture offer natural intersections through practices and products for multiple benefits and to address common goals. However, the two sectors are not well aligned in policy, programs, education and research systems, and other existing institutions and structures. Optimizing the relationship between farms and forests will require significant leadership from public and private interests that recognize the potential. Through the expanded focus on regenerative and sustainable practices there is the possibility of meeting global food and material needs with reduced impact and improved outcomes for people and the planet.

Resources

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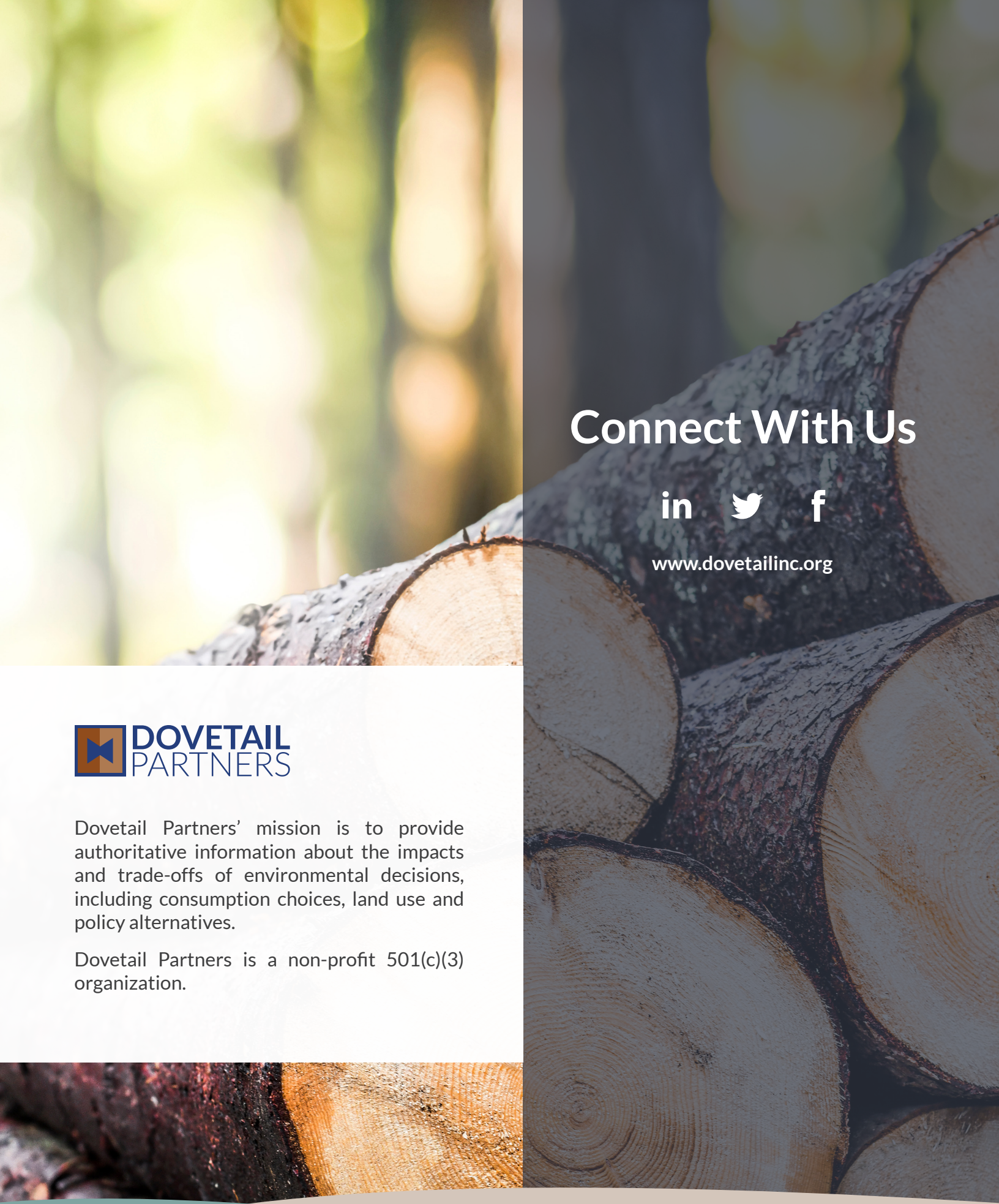

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