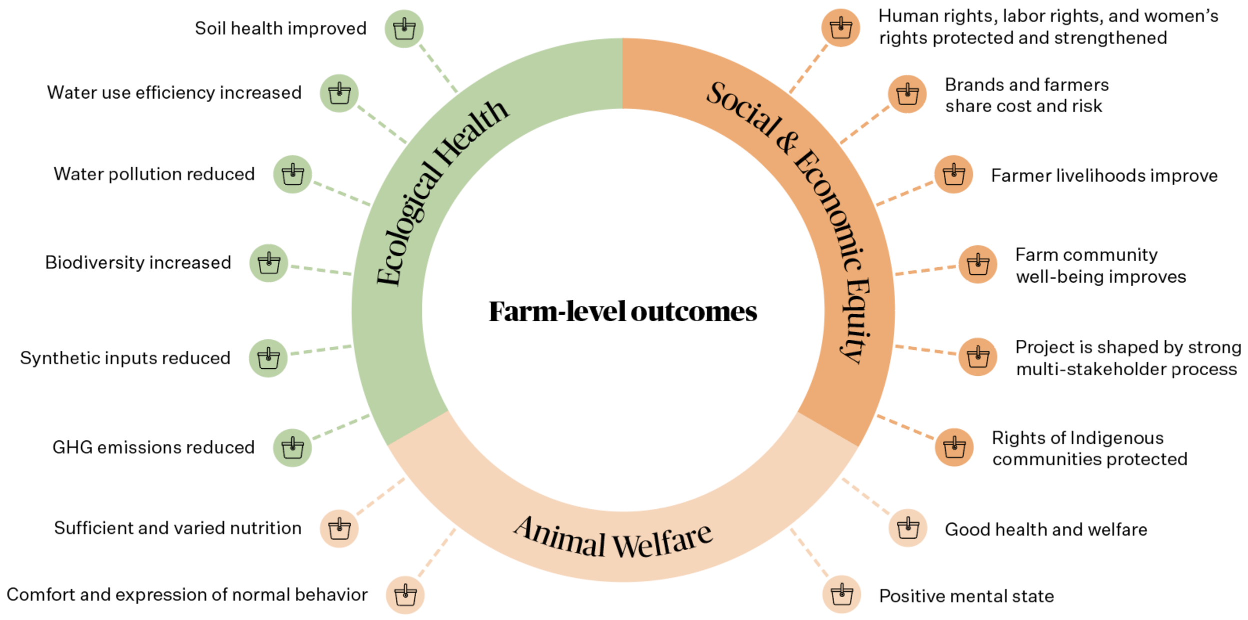
Background and Guidance for the Textile Exchange Regenerative Agriculture Outcome Framework V1

Regenerative Agriculture Outcome Framework



Brand expectations

Social & Economic Equity

- Human rights, labor rights, and women's rights safeguards in place
- Brands and farmers share cost and risk
- Multi-stakeholder process in place
- Grievance process in place
- Free, Prior, and Informed Consent (FPIC) process in place (if applicable)

Ecological health

- Water risk assessed
- Biodiversity risk assessed
- *SBTN land targets set**
- *SBTN freshwater targets set**
- *GHG Protocol LSR targets set**

Animal Welfare

- 3rd party certification in place

* Emerging indicator

Contents

Acknowledgements

Report Team:

Lead Researcher and Author:
- Sarah Kelley, Common Threads Consulting

Textile Exchange Team:
- Beth Jensen, Director, Climate+ Impact
- Hanna Denes, Senior Manager, Climate+ Impact
- Zachary Angelini, Consultant
- Debra Guo, Consultant

Sponsors:
Special thanks to the sponsors of this project and the representatives from each company for their support throughout the process:

Kering
- Yoann Regent, Head of Sustainable Sourcing and Nature Initiatives
- Sabrina Gonçalves Krebsbach, Sustainable Sourcing and Biodiversity Specialist

J.Crew Group
- Liz Hershfield, SVP and Head of Sustainability
- Gonzalo Pertile, Director Corporate Social Responsibility

CottonConnect
- Agnieszka Dziedzic, Senior Sustainability Executive
- Arif Makhdum, Senior Agriculture Advisor

lululemon
- Greg Doudican, Product Sustainability
- Crispin Wong, Senior Director of Product Sustainability and Environment

Additional thanks to *VF Corporation* for gifting its Regenerative Guidelines three-step approach for use by Textile Exchange, including alignment with the Textile Exchange Regenerative Agriculture Outcome Framework for step two:
- Sara Hill, Senior Director of Sustainable Materials and Products, VF Corporation
- Carol Shu, Senior Manager of Global Sustainability, The North Face
- Natalie Kaner and the Pure Strategies team

Acknowledgements:
The report team gratefully acknowledges the following individuals and organizations who generously shared their time and expertise to shape and strengthen this report in countless ways:

- All participants in the Community of Practice and expert review process (See Appendix 1)
- Sarah Benabdallah, Senior Sustainability Manager, *CHANEL*
- Terra Genesis
- Soil Health Institute

- The Biodiversity Consultancy
- One Planet Business for Biodiversity (OP2B) – Dana Rakha-Michalon and working group team

Textile Exchange Project Supporters and Reviewers:

- Claire Bergkamp
- Bronwyn Botha
- Siobhan Cullen
- Ashley Gill
- Anne Gillespie
- Anna Heaton
- Nicholas Johnson
- Marzia Lanfranchi
- Rita Luppino
- Gökçe Okulu
- La Rhea Pepper
- Megan Stoneburner
- Eleni Thrasyvoulou

1. Introduction to the Textile Exchange Regenerative Agriculture Outcome Framework

1.1. Introduction

Background and goals

Textile Exchange's Regenerative Agriculture Landscape Analysis, released in January 2022, drew on extensive interviews and research to establish that the fashion, textile, and apparel industry must move beyond a single standard or set of practices for regenerative agriculture. Instead, the report calls for the industry to develop an **outcome-based and context-based approach** that includes the development of **equitable partnerships with farming communities and fair financing approaches.**

Textile Exchange Regenerative Agriculture Working Statement

While there is no standardized definition of regenerative agriculture, Textile Exchange takes the view that the concept is inclusive of the following:

- A view of agriculture that works in alignment with natural systems, recognizing the value and resilience of interconnected and mutually beneficial ecosystems vs. extractive agriculture systems.
- An acknowledgement that Indigenous and Native peoples have been employing this approach to growing food and fiber for centuries—it is not a new concept—and that regenerative agriculture must include a focus on social justice.
- A holistic, place-based, outcome-focused systems approach, not a "one-size-fits-all" checklist of practices.

Regenerative agriculture practices are relevant to all natural fibers, whether produced by cropping (cotton, bast fibers, other row crops used as biosynthetic feedstocks); grazing (leather, wool, and other animal fibers); or forestry (man-made cellulosic fibers, rubber plantations). Examples of regenerative practices include but are not limited to: crop rotations, cover cropping, reduction of off-farm inputs alongside maximization of on-farm inputs, diversification of pasture species, managed grazing rotations, silvopasture (combining trees with livestock and forage production), windbreaks, and alley cropping (growing agricultural crops alongside long-term tree crops). It is important to note that best practices will vary based on unique landscapes, ecosystems, communities, and other context.

Textile Exchange also takes the view that over the long term, regenerative agriculture systems should phase out reliance on synthetic pesticides, herbicides, and fertilizers. These synthetic inputs have known negative impacts on soil health, biodiversity, and human health—outcomes antithetical to the values of regenerative. Similarly, regenerative systems should move away from reliance on genetically modified seeds wherever possible, and toward locally controlled and adapted seed stocks. While acknowledging the right of farmers to transition to regenerative practices in a way that works for their individual farm operations, Textile Exchange believes that any project that chooses to allow continued use of pesticides or herbicides during the transition to regenerative practices should only do so in a transparent, place-based, time-limited approach that lays out a clear pathway to transitioning away from synthetic inputs and towards a more holistic regenerative approach.

Examples of desired outcomes for regenerative systems in cropping, grazing, and agroforestry include not only carbon sequestration but also positive outcomes related to biodiversity, soil health, water quality and availability, and other environmental impacts, alongside the equally important outcomes of animal welfare, social justice, Indigenous rights, gender equity, and farmer and community resilience. Over time, regenerative practices can increase productivity, naturally reduce the need for external inputs, and improve economic stability for producers.

In summary, Textile Exchange believes that all regenerative agriculture programs should include the following, in line with the consensus elements identified by recent research and grounded in a context-based respect for local knowledge:

- Minimize and ideally eliminate external inputs; maximize on-farm inputs
- Integrate livestock whenever possible given the cropping system
- Reduce tillage to preserve the life in the soil (by utilizing no-, minimal-, or conservation-tillage)
- Aim for and monitor a broad and holistic set of outcomes including soil health, biodiversity, animal welfare, social justice, and the economic well-being of farmers and communities.

However, during the development of the Regenerative Agriculture Landscape Analysis report, it became clear that there were differing opinions on what constitutes a meaningful and rigorous "outcome-based" assessment of a regenerative agriculture program or project.

In addition, recommendation five from the Regenerative Agriculture Landscape Analysis states the following:

> *"Interviews and research for this project also revealed an emerging consensus against the development of new standards or certifications for regenerative agriculture.*
>
> *"Instead, brands could assess the development of add-on modules that respect the rigor of existing standards and the inherent place-based nature of regenerative agriculture, while developing outcome-based methods for assessing regenerative impacts on soil health, water systems, biodiversity, and social justice and livelihoods."*

Finally, as Textile Exchange continues to build out its Climate+ strategy and impact targets for the industry beyond greenhouse gas emissions, as well as to evolve its standards, we need a shared, collaboratively and scientifically developed approach to identifying priority indicators and outcomes.

The Regenerative Agriculture Outcome Framework is designed to address the considerations above, offering a **concrete guidance framework for credible outcome measurement in regenerative agriculture systems, across a range of fibers, farm scales, and geographic contexts.**

While the framework can be used in conjunction with existing standards, it is important to note that **it is not a standard;** rather, it is a framework of shared outcome indicators that can be referenced and used alongside existing standards where appropriate.

In the development of this framework, we sought to:

- Develop a concrete and rigorous, yet flexible, framework for outcomes and indicators that would represent a holistic regenerative agricultural system, in keeping with the Regenerative Agriculture Landscape Analysis report's statement;
- Pull from and synthesize existing vetted frameworks, versus trying to create new metrics;
- Create a common understanding and shared expectation on the subject of regenerative outcome measurement across the value chain;
- Ensure flexibility and applicability of the framework to various geographic regions and production systems;
- Provide a basis for add-on modules that can be used in conjunction with existing standards.

With this effort, Textile Exchange has taken a leading position in the outcomes-based approach now being brought forward by many recent reports on regenerative agriculture. For example, a January 2023 report by the Food and Land Use Coalition (FOLU) advocates for "moving away from practice-based definitions of regenerative agriculture and towards alignment around results to accurately measure and report on the potential to contribute to positive social and environmental co-benefits."[1] Furthermore, the FOLU report notes that an outcome-based approach "enables inclusion of all other sustainable agriculture movements and schools of thought, such as agroecology, conservation agriculture, climate smart agriculture and organic agriculture, recognizing they have many positive overlaps and complementarities."[2]

With increasing regulation aimed at targeting greenwashing and the term "regenerative" not yet regulated in major markets, this Framework also provides a foundation for the further development of the ecosystem of accountability for regenerative outcome claims.

1.2. Principles

The core principles of the Framework are informed by and aligned with the Textile Exchange Regenerative Agriculture Landscape Analysis, which was in turn informed by a combination of interview-based input and scientific literature research. These include:

1) A strong message that brands must share cost and risk with growers through the implementation of specific fair financing approaches and meet basic best-practice criteria before projects can be considered fully regenerative—in line with the holistic concept emphasized in the Landscape Analysis;
2) Emphasis on the human element of regeneration and a strong focus on socioeconomic indicators;
3) A clear acknowledgement of the Indigenous roots of regenerative agriculture and the importance of Free, Prior and Informed Consent processes, and full inclusion of Indigenous communities and other underserved and historically disadvantaged farmers including Black, Latino, and other People of Color farmers;
4) Full inclusion of animal welfare as a component of regenerative systems and an outcome that is linked with human health and ecosystem health;
5) Rigorous research and synthesis of work from other outcome frameworks, related sector methodologies (Science Based Targets for Nature (SBTN), Greenhouse Gas Protocol, etc.), and scientific literature, while allowing scope for local farm community knowledge to be respected in outcome development;
6) Prioritization of open-source, globally relevant research and frameworks, vs. proprietary tools or indices;
7) A focus on positive progress, not just avoidance of negative outcomes, and on regeneration in the process as well as the outcomes of data gathering;
8) An emphasis on suitability for smallholders and limited-resource farming contexts;
9) A shift toward farmer-centric data governance approaches; and,
10) An understanding that fully regenerative systems require, as one reviewer put it, "dismantling the power dynamics" of extractive agricultural models.

1.3. Scope and intended uses

Scope:

The Regenerative Agriculture Outcome Framework is intended to have basic applicability worldwide in any fiber crop system, including cropping, grazing, and agroforestry systems. Special consideration was given to ensure applicability to smallholder and limited-resource farmers.

The Framework is designed to be applicable to any natural fiber or raw material, whether part of standards / programs / certifications or not.

Intended uses:

The Framework is intended to create a shared understanding and expectation on the subject of regenerative outcome measurement across the value chain.
Specific potential uses by value chain partners include:

All users:

- Support common understanding for what constitutes a regenerative system;
- Support shared expectations for outcome measurement;
- Clarify alignment between regenerative projects and existing standards, frameworks, and/or industry guidance;
- Provide transparency across the value chain about the level of effort required to measure various indicators; and,
- Support the identification and development of pilot testing projects for different indicators (which will further refine the Framework).

Brands and retailers:

- Serve as a screening tool to assess the comprehensiveness of programs and approaches to outcome measurement;
- Provide a set of options for discussion with producers during project development.

Project developers and technical assistance providers:

- Provide a set of options for discussion with brands and producers during project development;
- Provide a tool to clarify the partnership roles of brands and farmers.

Producers and suppliers:

- Help navigate the landscape of outcomes and available indicators;
- Provide a tool to support producers in conversations with brands and project developers on regenerative agriculture projects; and,
- Support producers to seek fair financing approaches and full project engagement.

The Framework is designed to provide a shared set of measurable, quantifiable outcomes and indicators that can be selected as relevant for regions and production systems. It is not designed to provide specific measurement thresholds or requirements for regenerative agriculture indicators.

It is important to note that selection of indicators in this Framework is only a first step. Training, development of baselines, development of recordkeeping and data tracking systems, and determination of specific testing cadences will all be needed to put the Framework into practice in specific geographic and farming contexts. Developing these implementation elements will be a key goal of the pilot testing phase.

1.4. Key terms and definitions for the Framework

The Framework is focused on outcome metrics and indicators to the greatest extent possible.

In discussing outcome-based approaches to regenerative agriculture, the Outcome Framework follows the five-step pathway presented in the “Glossary of Key Terms in Evaluation and Results Based Management” developed by the OECD:

- “Inputs: The financial, human, and material resources used for the development intervention.
- “Activities [often called Practices]: Actions taken or work performed through which inputs, such as funds, technical assistance and other types of resources, are mobilized to produce specific outputs.
- “Outputs: The products, capital goods and services which result from a development intervention; may also include changes resulting from the intervention which are relevant to the achievement of outcomes.
- “Outcomes: The likely or achieved short-term and medium-term effects of an intervention’s outputs.
- “Impact: Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.”[3]

In a related term, outcome-based standards are defined as those standards that define the outcomes that are to be achieved but allow for flexibility in how this is done rather than requiring a defined set of practices. The term outcome measurement refers to measurement of outcomes rather than earlier stages of the causal pathway such as inputs or practices. Standards that take an outcome-based approach to developing standards criteria and designing assurance systems, *and* to measuring and monitoring outcomes, are considered to take a fully outcome-based approach.

In the development of the Framework, the term “indicator” has been prioritized over “metric.”

Metrics: “The basic variables that standard systems measure and collect data on … e.g. the number of hectares (ha). Metrics can be analyzed independently (e.g. total number of ha) or be combined to serve as indicators for sustainability performance (e.g. the farm size (ha) combined with production output (kg) provides an estimation of yield (kg/ha)).”[4]

Indicator: “Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development actor.”[5]

Indicator has been also defined as: “Readily measurable attributes that reflect the condition and dynamics of broader, more complex attributes of [system] health. Indicators are an attempt to represent a highly complex [system] using a set of defined, measurable attributes.”[6]

The term “indicator” better conveys that our efforts will often only give a proximate understanding of the dynamics of complex ecological and socioeconomic systems.

For other relevant definitions, please see the glossary in Textile Exchange’s Regenerative Agriculture Landscape Analysis.

1.5. Criteria for indicators and levels of applicability

In identifying the indicator options for the Framework, the following aspects were taken into consideration:

- Reflect the holistic understanding of regenerative agriculture outlined in Textile Exchange's Regenerative Agriculture Landscape Analysis;
- Select outcome indicators as opposed to input, practice, or output indicators to the greatest extent possible;
- Select primarily farm-level indicators;
- Include at least one brand-level indicator per outcome area to emphasize shared responsibility; consolidate these in the Brand Expectations section;
- Indicators should be measurable and quantifiable to the greatest extent possible, ideally with a specific unit;
- Indicators should be science- and data-backed, including references in the peer-reviewed literature or industry reports, while allowing scope to respect local community input;
- Information about the indicator should be publicly available; de-emphasize proprietary tools or indices;
- Ensure a selection of indicators that have applicability in cropping, grazing, and agroforestry systems; and,
- Allow a set of options that include more basic and more advanced indicators for a particular outcome, aiming to balance pragmatism and rigor.

Levels of applicability: brand-level and farm-level indicators

Farm-level indicators:

A key principle of this Framework is that **producers are not expected to implement monitoring for regenerative outcomes alone**. Thus, the terminology of "farm-level indicator" means that the indicator could be implemented and assessed with support from any of the following:

- brand
- project developer
- extension agent
- testing lab
- grower group
- and/or farmers themselves

Brand-level indicators:

Brand-level indicators were developed to reinforce the message that companies must share cost and risk with growers and meet basic criteria before projects can be considered, or claimed, to be fully regenerative.

In many cases, these brand-level indicators are closer to the "Input" or "Activity" (often called "practice") stage of the ISEAL results-based evaluation hierarchy. To emphasize the key role of brands, clarify this difference in indicator types, and keep the central focus on farm-level indicators, the brand-level indicators were moved to a separate section.

The Brand Expectations section specifies that the following should be in place (could be met by existing standards):

Expected:

- Human rights protections
- Animal welfare protections
- At least one specific cost-sharing mechanism to share cost and risk with growers
- Strong multi-stakeholder engagement process
- Strong grievance process
- If applicable, Free Prior and Informed Consent (FPIC) process with Indigenous Communities
- Initial assessment of water risk status to guide indicator selection
- Initial assessment of biodiversity risk status to guide indicator selection
- Greenhouse gas emissions targets that are inclusive of Scope 3 emissions

The Brand Expectations section also includes the following indicators that are considered recommended / emerging:

- SBTN Targets for Freshwater (released May 24, 2023)
- SBTN Targets for Land (released May 24, 2023)
- GHG Protocol—Land Sector and Removals (LSR) Guidance (scheduled for Summer 2023)

Landscape-level indicators

The need for indicators that work at a broader scale than the farm level is mirrored in several other outcome-based framework tools. For example, as the Food and Agriculture Organization of the United Nations (FAO) Tool for Agroecology Performance Evaluation (TAPE) background document notes, "while the elementary unit for agricultural management is the farm/household, the territory/community is the scale where a number of processes necessary for the agroecological transition take place."[7]

The Food and Land Use Coalition (FOLU) "Aligning Regenerative Agricultural Practices with Outcomes" report concurs: "Positive outcomes on the farm do not always lead to positive outcomes at the landscape and global level. For example, increased on-farm carbon capture without emissions reductions will fail to tackle climate change in the same way that increasing on-farm biodiversity without halting deforestation will fail to address biodiversity loss. Therefore, it is critical for an outcome-based framework to include metrics that measure all levels of the system to ensure that regenerative agricultural practices at scale are able to help meet global goals."[8]

This Framework includes both brand-level and farm-level indicators that could be suited to the development of landscape-level approaches. Further refinement of these landscape-level indicators will require brand collaboration and cost-sharing to develop shared data at the landscape scale. The testing process for the Framework will help determine how brand-level expectations and the farm-level metrics can roll up to landscape-level data.

The recent release of the first Science Based Targets for Nature will also make an important contribution to this goal, since the targets are stated in terms of landscape- and ecosystem-level goals, or basin-level goals in the case of freshwater targets. Furthermore, this process will connect with other industry harmonization efforts for indicator frameworks, including those being led by the World Business Council for Sustainable Development (WBCSD) and the Taskforce on Nature Related Financial Disclosure (TNFD). Future versions of the Framework will integrate new developments in landscape-level indicators.

1.6. Emerging indicator areas, tools, and methods

As noted above, this Outcome Framework is designed to provide a shared set of outcomes and indicators that can be selected as relevant for regions and production systems. It is not designed to specify all details of how these indicators should be measured in a given context. However, in many cases, emerging new measurement technologies are opening possibilities for simplifying measurement or allowing altogether new indicators that were not previously measurable. Given the emerging nature of these technologies, the Framework focuses on the basic indicators to be measured, while this sector covers new approaches for *how* to measure these. A few examples of emerging indicator tools and technologies include:

- **Environmental DNA (eDNA)**

  This powerful emerging technology can analyze trace amounts of DNA from biological samples, including soil, plant material, or water samples, and use it to rapidly and accurately identify the presence of individual species and biological communities.[9] Currently, eDNA-based monitoring requires precision equipment as well as ultra-clean laboratories to prevent sample contamination, both resources that are often in short supply in many farming regions. However, research is underway to identify possible alternatives, including loop-mediated isothermal amplification (LAMP) assays, that would allow the benefits of eDNA technology with greater field applicability. The Biodiversity Consultancy provides a useful overview of eDNA advantages and limitations for use in biodiversity assessments, noting in particular that the technique's usefulness relies on the availability of global genetic databases to serve as a reference point and that "it remains important to integrate ecological and environmental expertise relevant to the specific project site."[10]

- **Satellite monitoring / remote sensing**

  As with eDNA, satellite monitoring approaches have the potential to revolutionize both data collection and the range of potential indicators for regenerative agriculture projects, including the monitoring of cropping, grazing, and agroforestry systems. The use of remote sensing is based on the fact that, during their growing cycle, plants can either reflect, absorb, or transmit sunlight (including both the visible and non-visible wavelengths) depending on many growth factors. Therefore, according to Segarra et al. (2020), "in situations where crops interact with any given aspect of their environment (seasonal climatic variations, meteorological extreme events, pests, soil properties, etc.) or as crops grow and pass through different phenological stages, the interactions between plants and light reflectance translate into changes in plant signal patterns that can be interpreted using satellite data."[11]

  This concept offers the potential for monitoring agricultural system indicators in a way that overcomes the labor- and cost-intensive nature of many manual sampling systems. As Segarra et al. (2020) note, "[r]emote sensing provides coverage of large areas with high precision and can be a very efficient tool for improved management across scales. In this sense, remote sensing using multispectral images is a proxy for extensive manual crop monitoring operations in the field and provides potential savings in precious time and resources."[12]

  Currently, remote sensing applications for agriculture are made possible by a patchwork of satellites above Earth, each with a different combination of temporal, spatial, and spectral resolution. Segarra et al. (2020) state that the 2015 launch of the European Space Agency's Sentinel-2 satellite greatly increased the potential of this field, in particular due to its improved image resolution and the open-source nature of Sentinel-2 data: "Contrasted with previous satellite image systems, the Sentinel-2 A + B twin platform has dramatically increased the capabilities for agricultural monitoring and crop management worldwide."[13]

  As just one recent example of the kinds of possible applications, Ogungbuyi et al. (2023) specifically examined the accuracy of one such satellite monitoring technology tool, the PastureKey app from the Australian company Cibo Labs, which utilizes imagery provided by the Sentinel-2 satellites. They compared the Cibo Labs system's predictions for total standing green and dry matter with physically sampled and measured samples in Tasmanian regenerative grazing paddocks. While the satellite system over-estimated some elements of pasture biomass and under-estimated others, and the authors encountered challenges due to cloud cover and the lag time of satellite data, they concluded that the satellite system showed promise for estimating pasture biomass through the development of a predictive machine learning model.[14]

The open-source nature of Sentinel-2 data has been an important driver of greater access to remote sensing tools and information for agricultural systems of all kinds, including regenerative agriculture. However, it should be noted that the technical nature of remote sensing technologies increases the likelihood that for-profit companies will aim to simplify and monetize the tools needed to benefit from this technology. In the field of regenerative agriculture currently, for-profit providers such as Cibo Labs, Hummingbird Technologies, Regrow, and others dominate the space.[15] In addition, several companies are layering on artificial intelligence (AI) approaches to improve the accuracy of modelling and predictions made with satellite data. Where brands and farm groups are able to engage with these companies as partners and provide the upfront vetting and support to make these technologies fully useful at the farm-level, there is great potential for more scalable and cost-effective assessment of regenerative agriculture outcome indicators. However, as Weiss et al. note in a 2020 meta-review, "one of the current challenges consists of finding solutions to qualify the data so that users are able to understand which product they are using and how trustful they can be in the context of their application."[16]

- **Soil probes for rapid carbon measurement**

  Closer to the ground, another set of emerging measurement tools aims to simplify the sampling and measurement processes currently needed to evaluate soil health measurements such as the Soil Health Institute suite of indicators included in this Framework. The startup Yard Stick is one of several companies aiming to transform these processes through the development of handheld soil probes. The company promises that farmers and researchers can "let Yard Stick's spectral hardware eliminate the backache and headache of cores, bags, and labs."[17] Yard Stick works in partnership with Soil Health Institute and is currently accepting applications to pilot its in-field measurement device and its associated data platform. The project has received support from the U.S. government's ARPA-E technology research program,[18] which is also supporting a number of other research grants on innovative agricultural soil probe approaches, including the University of Utah Soil Organic Carbon Networked Measurement System (SOCNET)[19] and the University of Illinois SYMFONI system, which integrates new field-level sampling approaches with the type of remote sensing technologies described above to estimate soil organic carbon and nitrous oxide emissions.[20] A 2021 review from a cleantech perspective gives an additional snapshot in time of some of the many companies proliferating in this space.[21]

- **Automated birdsong detection**

  In the area of biodiversity indicators for regenerative agriculture, farm groups and researchers are finding promise in the development of automated birdsong detectors as one tool to simplify the assessment of birds as indicator species. The BirdNET platform at Cornell University combines citizen scientist collection of birdsong samples globally with artificial intelligence and machine learning to predict the most likely bird species present, based on sound recordings.[22] BirdNET's tools are open-source and backed by many peer-reviewed publications.[23] For-profit companies developing this technology include Wildlife Acoustics[24] and Carbon Rewild.[25]

- **Digital monitoring of insects**

  The artificial intelligence approaches deployed by the emerging measurement tools above are also being put to work to assess insect samples and extrapolate their populations and diversity over larger scales. The Danish company FaunaPhotonics offers a stationary insect detector that can be trained using machine learning to "identify individual insects based on wing beat frequency, body size, and other features unique to each insect."[26] The data can be used to make management decisions based on insect pest levels and fed into larger databases to generate insect biodiversity reports. Currently, the technology can only recognize seven species of insects,[27] but like other AI-based indicator technologies this approach should evolve rapidly in the coming years. The US NGO

Ecdysis is reportedly developing a similar approach focused on regenerative agriculture systems in wheat and oat fields.[28]

Overall, the field of regenerative agriculture is seeing rapid technological innovation in measurement technologies. These developments have great potential to make measurement more feasible and less burdensome or expensive in the future. However, they also increase the chance that for-profit, proprietary measurement technologies will keep this goal out of reach. For the purposes of this Framework, focusing on building alignment on a common set of meaningful indicators will help set the stage for the development of open-source and low-cost technological tools that will, in turn, allow farmers of all scales and resource levels to benefit from these information technology advances.

In other cases, emerging indicators are not a function of technology, but of better approaches to assessing the socioeconomic elements of regenerative systems. These areas include: simplified community surveys with tablet-based interfaces, refinement of indicators for supply chain equity, deeper research into resilience indicators such as income diversification and community networks, and a greater focus on the critical outcome of the successful transition of farmland into the hands of the next generation of regenerative land stewards. Initial versions of such indicators have been selected for the Framework, with the goal of testing and refinement in future versions.

1.7. Putting the Framework into practice

Our Framework offers a choice of indicators for each outcome area, which we have referred to as a "basket of indicators." This approach respects the context-based nature of regenerative agriculture and allows programs in different regions—or at different stages of the regenerative journey—to select indicators that work for them.

- Projects are not expected to demonstrate progress towards every outcome indicator listed. However, they are expected to select, establish a baseline for, and show meaningful efforts to track progress towards a context-appropriate selection of indicator(s) within each outcome area, as indicated in the detailed Excel Framework.
- For each indicator, references for standard operating procedures, methods, or specific guidance on assessment methods from existing sources are included, but others can be engaged if already in use. Details on the unit, reference, notes, and method/standard operating procedure for each indicator are summarized in the Excel Framework and provided in full in Section 3 of this document below.
- Textile Exchange recommends that brands use this framework as part of a broader three-step process:[29]

    1. Identify best practices that are contextually appropriate for your company's fiber and raw material production systems and regions;
    2. Utilize the Regenerative Agriculture Outcome Framework to identify a set of contextually appropriate outcome indicators; and,
    3. Ensure robust verification and reporting mechanisms.

This three-step process was developed by VF Corporation and gifted to Textile Exchange for use in conjunction with the Regenerative Agriculture Outcome Framework.

2. Process to Develop the Outcome Framework

Task	Q4 2022	Jan 2023	Feb 2023	March 2023	April 2023	May 2023	June 2023	July 2023
Scoping	■							
Research	■	■	■	■	■	■		
Drafting		■	■					
Review			CoP – High level review	Expert review	Expert review			
Revisions from review						■	■	
Release of V1 Framework								■

The Regenerative Agriculture Outcome Framework is being developed through a rigorous, research-based, and collaborative process.

Major steps to date have included:

1. Desktop research and an inventory review of over a dozen existing outcome frameworks, representing hundreds of potential indicators for the assessment of sustainable agriculture, agroecology, regenerative agriculture, and other fields; as well as dozens of peer-reviewed articles and industry reports for each outcome area (Aug. 2022-Dec. 2023);
2. Internal consultation with Textile Exchange experts and related organizational process leads; Informational calls with a sample of other known multi-brand regenerative agriculture outcome frameworks (Jan.- Feb. 2023);
3. High-level review by the Textile Exchange Regenerative Community of Practice (Feb. 2023);
4. Extensive internal and external Expert Review process with over 70 invited reviewers and 40 sets of comments, processing, and revisions (March-May 2023). This process:
   - Prioritized balance between brands, NGOs, professional services, larger farms, and smallholder farms;
   - Aimed for geographic diversity and representation across crop and fiber types;
   - Included subject matter experts on human rights, Indigenous community rights, livelihoods, fair financing, soil, water, biodiversity, and animal welfare;
5. Release of the V1 Regenerative Agriculture Outcome Framework (summer 2023).

Next step: Testing the V1 Regenerative Agriculture Outcome Framework by the Textile Exchange Round Table Working Groups and subsequent modifications to further refine the Framework (Q3-Q4 2023).

Specific detail of the development process, sources, Community of Practice (CoP) Review, and Expert Review are provided in Appendix 1.

3. Detail of Specific Outcome Indicators

Each indicator in the sections below includes the following information:

- Unit
- Reference(s)
- Notes
- Method/Standard Operating Procedure (SOP), if available

Brand-level indicators

3.0. Brand expectations section

Summary table: Brand expectations

Outcome	Expectation	Ref #	Indicator	Unit	Stage	Application
Social and Economic Equity						
Project results in a more equitable sharing of costs, risks, and benefits with farmers	Expected	3.0.1.	Project involves at least one of the following cost/risk-sharing mechanisms: - Brand covers the cost of training, additional inputs etc. up front. - Separate payment for data as a farm product; project advances and rewards farmer data sovereignty - Brand provides up front grant, low or no-interest loan, or loan guarantee to support data collection. - Brand provides guaranteed multi-year contract with allowance for yield impacts. - Textile Exchange Impact Incentives Outcome - Farmers pay < 50% of overall transition cost	Presence of cost-sharing program / USD and local currency equivalent per year	Input + Outcome	Brand + Farm Level [Shared]
Project is shaped by strong multi-stakeholder process	Expected	3.0.2.a.	Strong collaborative mechanism is in place, such that the voices of stakeholder groups are represented and engaged from the beginning of project development and on an ongoing basis.	Presence or absence of collaborative mechanism that aligns with UNDP guidance.	Input	Brand + Farm Level [Shared]
	Expected	3.0.2.b.	Strong grievance mechanism is in place, meeting UNGP effectiveness criteria.	Presence or absence of grievance mechanism that follows UNGP criteria.	Input	Brand + Farm Level [Shared]
The rights of indigenous communities are protected	Expected if applicable	3.0.3.	Free, Prior and Informed Consent (FPIC) process in place	Outcome of FPIC process could include: 1) consent to the activity proposed; 2) consent with conditions; or 3) no consent	Input + Outcome	Brand + Farm Level [Shared]
Human rights, labor rights, and women's rights are protected and strengthened	Expected	3.0.4.a.	Human rights safeguards must be in place via implementation of standard / certification scheme, verified supplier program, or other 3rd party verified means.	Presence or absence of documented safeguards.	Input	Brand Level
	Recommended/ Emerging	3.0.4.b.	OECD Due Diligence Guidance for Responsible Business Conduct / Responsible Agricultural Supply Chains is implemented. At brand level: Responsible Business Conduct At farm level: Responsible Agricultural Supply Chains	Program actively integrates the OECD framework	Input	Brand Level
Ecological Health						
Water use efficiency is increased	Expected	3.0.5.a	Brand conducts initial assessment of average water stress or risk of catchment or basin where producers operate	WWF Water Risk Filter Unit: Risk or stress score or rating depending on tool used.	Input	Landscape level: Measuring
	Recommended/ Emerging	3.0.5.b.	Science Based Targets for Freshwater: Freshwater Quantity and Quality Targets Target 1: "Company X will reduce its water withdrawal in the ____ basin to ____ ML/ year by the year ____."	ML per year or percent reduction	Outcome	Brand Level
Water quality is increased	Recommended/ Emerging	3.0.6.a	Target 2: "Company X will reduce its nutrient load in the ___ basin to ___ kg P (or N)/year by the year ___."	Kg per year or percent reduction	Outcome	Brand Level
Biodiversity increases (Plant, Animal, Microbial)	Expected	3.0.7.a.	Brand conducts initial assessment of biodiversity stress or risk of area where producers operate.	WWF Biodiversity Risk Filter, Biodiversity Intactness Index, or IBAT. Unit: Index score depending on tool used.	Input	Landscape level: Measuring
	Recommended/ Emerging	3.0.7.b	Science Based Targets for Land: Target 1: No Conversion of Natural Ecosystems	a. Hectares of natural ecosystems converted on land owned, controlled or managed by the company's direct operations after the baseline year 2020. b. Hectares of natural ecosystems converted on production units or in sourcing areas known to be in the company's supply chain after the baseline year 2020.	Outcome	Brand Level
	Recommended/ emerging	3.0.7.c	Target 2: Land Footprint Reduction	a. Hectares of working land under direct operational or sourcing footprint. b. Hectares of working land needed to produce a commodity unit.	Outcome	Brand Level
	Recommended/ emerging	3.0.7.d	Target 3: Landscape Engagement	Various	Outcome	Brand Level
GHG Emissions are reduced	Expected	3.0.8.a	Greenhouse gas emissions targets that are inclusive of Scope 3 emissions	Metric tons of CO_2e	Outcome	Brand Level
	Recommended/ Emerging	3.0.8.b	Company accounts for land sector emissions and removals	Metric tons of CO_2e	Outcome	Brand Level
Animal Welfare						
Good health and welfare	Expected if applicable	3.0.9	Animal welfare safeguards via implementation of standard or other third-party verified means are in place	Presence or absence of documented safeguards	Input	Brand Level

The brand expectations section of the Framework reflects the principle that brands and retailers should not begin developing regenerative agriculture systems, or make any claims about regenerative approaches or outcomes, until basic elements of ethically and ecologically sound farming systems are in place.

Adding to these "table stakes" requirements, the Brand Expectations system also reflects the core message of the first Regenerative Agriculture Landscape Analysis: brands must share the cost and risk with growers in the transition away from extractive systems and towards more regenerative systems.

Finally, a core tenet of the initial Textile Exchange Regenerative Agriculture Landscape Analysis is that humans are inextricably linked with nature, and community regeneration is inseparable from ecosystem regeneration.

Within the Brand Expectations area, we consider **four Indicators to be shared at both the brand and farm level**, since they represent key collaborative and cost-sharing agreements between brand and farmer. These are repeated in both the Brand-Level and the Farm-Level sections and designated as "Shared Indicator." These are:

- Project results in a more equitable sharing of cost and risk
- Strong multi-stakeholder process
- Strong grievance process
- Rights of Indigenous communities protected (FPIC agreement)

Social and Economic Equity

3.0.1. Project results in a more equitable sharing of costs, risks, and benefits with farmers [Expected]

[Shared indicator]

Project involves at least one of the following cost/risk-sharing mechanisms:

- Brand covers the cost of training, additional inputs, implementation of monitoring systems or devices, or other key regenerative conversion elements upfront
- Brand provides separate payment for data as a farm product; project advances and rewards farmer data sovereignty
- Brand provides upfront grant, low- or no-interest loan, or loan guarantee to producers to support equipment costs, baselining, data collection, or other elements
- Brand provides guaranteed multi-year contract with allowance for yield impacts
- Textile Exchange Impact incentives

Outcome: Farmers pay < 50% of overall transition cost

Note: Premiums or payments that are not awarded until post-harvest are **not** considered to satisfy this indicator, as they still require growers to assume the upfront costs and risks of conversion.

Unit: Presence of cost-sharing program: the brand should disclose the specific cost**-** and risk-sharing mechanism they are using.
Local currency unit and USD equivalent per year of the value of the support

Reference: Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis."
https://textileexchange.org/app/uploads/2022/01/Regenerative-Agriculture-Landscape-Analysis.pdf

For inclusion of farmer data sovereignty in outcome frameworks, see the work of Smallholder Data Services and Terra Genesis, "Methods for Measurement of Regenerative Agriculture in Practice" (available upon request) and the Terra Genesis "White Paper for Ethos Regenerative Outcome

Verification™" (forthcoming).

See also: van Geuns, J. et al., 2023. "Farmer-Centric Data Governance: Towards A New Paradigm." USAID. https://developmentgateway.org/wp-content/uploads/2023/02/Farmers_Report-Full_vFebFiNAL.pdf

Notes: See Textile Exchange Regenerative Agriculture Landscape Analysis, Appendix D. (pg. 99), for specific equitable financing models and details.

Social and Economic Equity

3.0.2. Project is shaped by strong multi-stakeholder process [Expected]

a. Strong collaborative mechanism is in place [Expected]
[Shared indicator]

The brand should work together with stakeholder groups to ensure that a strong collaborative mechanism is in place, such that the voices of stakeholder groups are represented and engaged from the beginning of project development and on an ongoing basis. These could include, as applicable:

- Farmers (including underserved and historically disadvantaged groups such as Black, Latino, Native American, or other underserved farmer groups)
- Land stewards
- Indigenous people
- Local community members

Unit: Presence or absence of collaborative mechanism following the guidance below.

Reference: Biggs, S. D. 1989. "Resource-poor farmer participation in research: a synthesis of experiences from national agricultural research systems." OFCOR, comparative Study No. 3. International Service for National Agricultural Research, The Hague, The Netherlands. https://pdf.usaid.gov/pdf_docs/PNABD218.pdf

Notes: The term "Collaborative" in this context is part of continuum of farmer participation types that move from "Contractual" through "Consultative," "Collaborative," and "Collegial." "Collaborative" is defined as: "Scientists and farmers collaborate as partners in the research process." (Biggs 1989).

Method/SOP/Protocol: Extensive additional guidance is provided by the United Nations Development Program (UNDP) in a 2021 publication:
United Nations Development Program, 2021. "A Guide to Effective Collaborative Action: Deep collaboration for systemic change in food and agricultural commodity systems." https://www.undp.org/facs/publications/effective-collaborative-action

b. Strong grievance mechanism is in place, meeting UNGP effectiveness criteria. [Expected]
[Shared indicator]

Brands should implement a grievance process following the United Nations Guiding Principles (UNGP) Reporting Framework, ideally as part of a collaborative project mechanism as described above, and share the process details with community members.

Unit: Presence or absence of grievance mechanism following principles below.

Reference:

United Nations Guiding Principles Reporting Framework, Human Rights Reporting and Assurance Frameworks Initiative, Section C6, "Remediation." https://www.ungpreporting.org/reporting-framework/management-of-salient-human-rights-issues/remediation/

United Nations Human Rights, Office of the High Commissioner, 2021. "OHCHR Accountability and Remedy Project: Meeting the UNGPs' Effectiveness Criteria Summary of ARP III Guidance." https://www.ohchr.org/sites/default/files/2022-01/arp-note-meeting-effectiveness-criteria.pdf

Notes: UNGP 31 states that the characteristics of effective non-judicial grievance mechanisms include:

a) Legitimate
b) Accessible
c) Predictable
d) Equitable
e) Transparent
f) Rights-compatible
g) A source of continuous learning
h) Operational-level mechanisms should also be based on engagement and dialogue

Method/SOP: United Nations Human Rights, 2011. "Guiding Principles on Business and Human Rights: Implementing the United Nations 'Protect, Respect and Remedy' Framework." https://www.ohchr.org/sites/default/files/Documents/Publications/GuidingPrinciplesBusinessHR_EN.pdf#page=32

Social and Economic Equity

3.0.3. The rights of Indigenous communities are protected [Expected if applicable]

[Shared indicator]

The topic of the rights of Indigenous communities in regenerative agriculture is both critical and highly complex. For the purposes of this Framework, the established body of work on the development of Free, Prior and Informed Consent (FPIC) is utilized as a minimum expected approach to recognizing and protecting these human rights.

As defined by the Accountability Framework, "Free, Prior and Informed Consent (FPIC) is a collective human right of Indigenous Peoples and Local Communities (IP/LC) to give or withhold their consent prior to the commencement of any activity that may affect their rights, land, resources, territories, livelihoods, and food security. This right is exercised through representatives of their own choosing and in a manner consistent with their own customs, values, and norms. FPIC exists to promote, protect, and safeguard the full enjoyment and exercise of numerous underlying, fundamental human rights, including the rights to property, culture, and self-determination."[30]

The Accountability Framework further notes that "FPIC is both a process and an outcome" and that "the FPIC outcome is a written document that specifies what was or was not agreed to."[31]

Unit: Presence of FPIC documents and one of several possible results: 1) consent to the activity proposed; 2) consent with conditions, such as modification of the activity or agreement to a benefit-sharing package; or 3) no consent.

Reference: Accountability Framework Initiative, 2019. "Operational Guidance on Free, Prior and Informed Consent." https://accountability-framework.org/fileadmin/uploads/afi/Documents/Operational_Guidance/OG_FPIC-2020-5.pdf

Notes: See also: ISEAL, "Safeguarding the right of Indigenous peoples to FPIC," Report and FPIC-360° Tool: https://www.isealalliance.org/innovations-standards/innovations-projects/safeguarding-right-Indigenous-peoples-fpic

Method/SOP: The Accountability Framework overview above provides numerous references for additional guidance on the implementation of effective FPIC processes.

Social and Economic Equity

3.0.4. Human rights, labor rights, and women's rights are protected and strengthened

a. Human rights safeguards in place [Expected]

For any regenerative agriculture project or pilot, safeguards for human rights, labor rights, including forced labor and child labor, and women's rights must be in place via implementation of a standard or certification scheme, internal company risk assessment program, verified supplier program, or other third-party verified means.

Unit: Presence or absence of documented safeguards

Reference: Textile Exchange, "Human Rights." https://textileexchange.org/human-rights/
Links to multiple human rights due diligence resources available at this link.

b. OECD Due Diligence Guidance for Responsible Business Conduct / Responsible Agricultural Supply Chains implemented. [Recommended / Emerging]

The OECD Due Diligence Guidance for Responsible Business Conduct and OECD Due Diligence Guidance for Responsible Agricultural Supply Chains provide a common framework of expectations for multinational enterprises and agri-businesses respectively.

Unit: Presence or absence of OECD Due Diligence policies and action plan for addressing the due diligence steps.

References:

At company level: OECD, 2018. "OECD Due Diligence Guidance for Responsible Business Conduct." http://mneguidelines.oecd.org/OECD-Due-Diligence-Guidance-for-Responsible-Business-Conduct.pdf

At producer level:
OECD/FAO, 2016. "OECD-FAO Guidance for Responsible Agricultural Supply Chains" https://www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-guidance-for-responsible-agricultural-supply-chains_9789264251052-en

Notes: The OECD Due Diligence for Responsible Business Conduct includes six steps:
1. Embed responsible business conduct into policies and management systems
2. Identify and assess actual and potential adverse impacts associated with the enterprise's operations, products, or services
3. Cease, prevent, and mitigate adverse impacts
4. Track implementation and results
5. Communicate how impacts are addressed
6. Provide for or cooperate **in** remediation when appropriate

Method/SOP: Detailed guidance on implementation is provided in the OECD Guidance document above.

Ecological Health

3.0.5. Water use efficiency is increased

a. Brand conducts initial assessment of water risk in project area [Expected]

Before attempting to assess farm-level indicators of water use, water health, or water pollution in a regenerative agriculture project, brands should first take responsibility for conducting a baseline water risk assessment. Across all impact areas, assessment is an important step in biodiversity action frameworks, including the Science-Based Targets for Nature “AR3T” approach and the Taskforce on Nature-Related Financial Disclosures “LEAP” approach. More information on these frameworks and details about risk assessment can be found in the Biodiversity Landscape Analysis report from Textile Exchange, The Fashion Pact, and Conservation International, launching summer 2023.

As discussed in that report, several tools are or will soon be available for this purpose:

- Textile Exchange Materials Impact Explorer, which includes risk ratings and suggestions for recommended actions (forthcoming fall 2023)
- WWF Water Risk Filter (https://waterriskfilter.panda.org/), part of the WWF Risk Filter Suite, which also includes a Biodiversity Risk Filter (see below).

Unit: Risk or stress score or rating (WWF Water Risk Filter, 1-5 scale, Low to High); scores can be highly contextualized with matrix visualizations, maps, and more.

References:

WWF, 2023. “Water Risk Filter Methodology Documentation.” https://cdn.kettufy.io/prod-fra-1.kettufy.io/documents/riskfilter.org/WaterRiskFilter_Methodology.pdf

Biodiversity Landscape Analysis report from Textile Exchange, The Fashion Pact, and Conservation International (forthcoming summer 2023)

Textile Exchange Materials Impact Explorer (forthcoming fall 2023)

Notes:

These tools are free, open-source, and designed to support key global initiatives and reporting frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD), Task Force on Climate-Related Financial Disclosures (TCFD), Science Based Targets Network (SBTN), Alliance for Water Stewardship (AWS), Carbon Disclosure Project (CDP), Global Reporting Initiative (GRI), and European Sustainability Reporting Standards (ESRS).

b. Brand sets SBTN targets for Freshwater Quantity [Recommended / Emerging]

On May 24, 2023, the Science Based Targets Initiative released the first technical guidance for companies to set Science Based Targets for Nature (SBTNs) in the areas of freshwater and land.

For Freshwater, these include:

i. Target 1: Water quantity

Freshwater withdrawals from surface water bodies and groundwater; and

ii. Target 2: Freshwater quality
The total amount of nitrogen and phosphorus entering a surface water body during a given time.

Extensive guidance documents, FAQs, and other resources are available at:
https://sciencebasedtargetsnetwork.org/resources/

Unit:
i. Water Quantity: Volume per month, e.g., ml/month; % reduction in basin-wide withdrawal

Reference: Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf

Notes: As noted in the first Regenerative Agriculture Landscape Analysis, Science Based Targets for Nature "will fill a key gap of developing targets for the other connected areas of natural systems beyond GHG emissions—which coincides with the impact areas for holistic regenerative agriculture systems."[32] While the SBTN targets are newly released, we expect that they will be increasingly adopted by fashion, apparel and textile brands in the coming years.

Ecological Health

3.0.6. Water pollution is reduced

a. Brand sets SBTN targets for Freshwater Quality [Recommended / Emerging]

As noted above, on May 24, 2023, the Science Based Targets Initiative released the first technical guidance for companies to set Science Based Targets for Nature in the areas of Freshwater and Land.

Extensive guidance documents, FAQs, and other resources are available at:
https://sciencebasedtargetsnetwork.org/resources/

Unit:
i. Water Quality: mg per Liter (mg/L) for individual samples.

SBTN Freshwater Quality targets can be set in the following units:

- When setting targets on an annual basis, using direct or secondary measurement (with units of nutrient load), targets will be stated as "Company X will reduce its nutrient load in the ___ basin to ___ kg P (or N)/year by the year ___."
- When setting targets on a seasonal basis, using direct or secondary measurements (with units of nutrient load), targets will be stated as "Company X will reduce its nutrient load in the ___ basin to ___ kg P (or N)/month for each of the following months. The reductions will occur by the year ___."
- When setting targets on an annual basis, using gray-water footprint(s), targets will be stated as "Company X will reduce its gray-water footprint in the ____ basin to ___ ML/year by the year ___."

Reference: Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf

As noted in STBN guidance, the development progress for these targets led to the identification of global threshold loading values for total N (0.70 mg-N/L) and total P (0.046 mg-P/L), which represent acceptable levels of algal growth. These concentrations were based on a literature review of studies defining local N and P thresholds related to algal growth.[33]

These thresholds can provide useful guidance for companies beginning to assess freshwater targets to understand the degree of reduction in N and P loading required.

Method/SOP: Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf

Ecological Health

3.0.7. Biodiversity increases

a. Brand conducts initial assessment of biodiversity risk in project area [Expected]

As in the case of the Water Risk area above, before attempting to assess farm-level indicators of biodiversity in a regenerative agriculture project, brands should first take responsibility for conducting a baseline biodiversity risk assessment. As detailed in the Biodiversity Landscape Analysis Report (coming summer 2023), there are a number of tools that companies can use to assess their biodiversity risk, including:

- The Textile Exchange Material Impact Explorer, which is designed specifically for the textile industry, can be used by brands for a macroanalysis of the risks associated with raw material sourcing at national level.
- Alongside this, brands can use WWF's Risk Filter Suite for a deeper sub-national analysis of biodiversity and water risks in their supply chains.
- Additional resources include:
- Biodiversity Intactness Index (BII)
- Integrated Biodiversity Assessment Tool (IBAT)

Unit: Varies depending on tool selected

References:

WWF Biodiversity Risk Filter: https://riskfilter.org/biodiversity/home

WWF, 2023. "Biodiversity Risk Filter Methodology." https://cdn.kettufy.io/prod-fra-1.kettufy.io/documents/riskfilter.org/BiodiversityRiskFilter_Methodology.pdf

Biodiversity Intactness Index (BII):
Original source:
Scholes, R.J. and R. Biggs, 2005. "A biodiversity intactness index." *Nature*, volume 434, pages 45–49. http://dx.doi.org/10.1038/nature03289

Recent work: Natural History Museum, "About the Biodiversity Intactness Index." https://www.nhm.ac.uk/our-science/data/biodiversity-indicators/about-the-biodiversity-intactness-index.html

Integrated Biodiversity Assessment Tool (IBAT): https://www.ibat-alliance.org/
Additional IBAT information: https://www.ibat-alliance.org/pdf/ibat-annual-report-2021.pdf

b. Brand sets science-based targets for Land [Recommended / Emerging]

As noted above, on May 24, 2023, the Science Based Targets Initiative released the first technical guidance for companies to set Science Based Targets for Nature in the areas of Freshwater and Land. One goal of the Framework is to align with these industry guidance processes, which represent the desired direction of travel for the industry.

For the Land area, the SBTN Targets, as specified and defined by SBTN, include:

i. Target 1: No Conversion of Natural Ecosystems

"Avoids one of the primary drivers of biodiversity loss and source of GHG emissions."
The No Conversion target references and relies on the SBTN Natural Lands map:
https://wri-datalab.earthengine.app/view/sbtn-natural-lands

ii. Target 2: Land Footprint Reduction

"Reduces one of the most globally persistent and highly degrading processes that impacts biodiversity, climate and land."

iii. Target 3: Landscape Engagement

"Puts company action and effort within the context of collaborative stakeholder groups at the landscape scale to regenerate working lands, restore degraded or converted ecosystems, and transform the ways that they act in, and source from, landscapes."

For all targets:

Unit: Generally, hectares, with some data sources stated in metric tons or equivalent of product produced from each area. Additional metrics and units are provided by SBTN for Target 3.

Reference: Science Based Targets Network, 2023. "Step 3: Measure, Set, Disclose: LAND (Version 0.3)." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Land-v0.3.pdf

Notes: As SBTN specifies, "The land targets are designed to work together to incentivize the most important actions needed to achieve nature goals in land systems: halting conversion of natural ecosystems (Target 1), freeing up agricultural land for increased ecological productivity (Target 2), and improving the ecological condition of landscapes, including working lands, to enhance ecosystem structure, composition, and function and the social systems that depend on such landscapes (Target 3)."[34]

Furthermore, the guidance specifies that "Generally, it is expected that companies work on all targets for which they are responsible simultaneously, though target dates may differ among or within the three targets."[35] Specific guidance on which companies would be expected to set which of the three targets is provided by SBTN in the recent release.

SBTN specifically describes the connections with regenerative agriculture for Target 3:
"The intention of landscape engagement is to enable regenerative, restorative, and transformational actions in landscapes that are relevant for a company's operations and supply chains. The third Land target therefore complements Target 1 and Target 2, which are focused on avoiding and reduction of impacts. This trio of Land targets incentivizes actions that span all categories of the SBTN AR3T Framework (Avoid, Reduce, Restore & Regenerate, Transform)."[36]

Ecological Health

3.0.8. Greenhouse gas emissions are reduced

a. Brand sets greenhouse gas emissions targets that are inclusive of Scope 3 emissions [Expected]

Unit: Metric tons of CO_2e

References:

Greenhouse Gas Protocol, 2004. "GHG Protocol Corporate Accounting and Reporting Standard." https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

Greenhouse Gas Protocol, 2022. "GHG Protocol Agricultural Guidance: Interpreting the Corporate Accounting and Reporting Standard for the agricultural sector." https://ghgprotocol.org/sites/default/files/2022-12/GHG%20Protocol%20Agricultural%20Guidance%20%28April%2026%29_0.pdf

The GHG Protocol Agricultural Guidance is a supplement to GHG Protocol Corporate Standard and covers all agricultural subsectors, including livestock, crop production, and land use change.

b. Brand follows GHG Protocol Land Sector and Removals Guidance for any removals [Recommended / Emerging]

The GHG Protocol is currently developing additional guidance on Land Sector and Removals that will be highly relevant to regenerative agriculture.

The Land Sector and Removals Guidance, as described by the GHG Protocol, "builds on the Corporate Standard and Scope 3 Standard, explaining how companies should account for and report GHG emissions and removals from agricultural and forest management practices, land use change, bioenergy, carbon dioxide removal technologies, and related activities in GHG inventories."[37]

The GHG Protocol Land Sector and Removals Guidance is currently undergoing an intensive stakeholder review process. Guidance is scheduled to be released in Q3 2023.

Unit: Net change in tons of carbon per year. Conversion from carbon to CO_2 is necessary for stock-change accounting as carbon stock changes are measured in units of carbon, while emissions and removals are measured in units of CO_2.

See additional detail on units and conversions in the GHG Protocol draft Land Sector and Removals guidance, pg. 46.

References:

Greenhouse Gas Protocol, "Land Sector and Removals Guidance." https://ghgprotocol.org/land-sector-and-removals-guidance

Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance, Draft for Pilot Testing and Review, Part 1." https://ghgprotocol.org/sites/default/files/standards_supporting/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-1.pdf

Animal Welfare

3.0.9 Animal welfare safeguards in place [Expected if applicable]

Animal welfare is inextricably linked with both human welfare and ecosystem and soil health. Accordingly, animal welfare safeguards—via implementation of standard or other third-party verified means—must be in place before companies begin to implement or make claims about regenerative agriculture systems. This indicator is considered to apply when animals are the main focus of the production system.

Unit: Presence or absence of third-party verified animal welfare standard.

Reference: Textile Exchange Responsible Animal Standards, https://textileexchange.org/standards/.

Notes: The Textile Exchange Responsible Animal Standards above can be used to certify wool, mohair and alpaca. In addition, there are a range of animal welfare certification schemes available that cover different topics to different degrees. With some exceptions for their welfare, grazing animals must spend their lives on pasture. The Preferred Fibers and Materials Matrix, due to be released in fall 2023, will provide an assessment of a range of standards and impact areas, including animal welfare.

Farm-Level Indicators

3.1. Socioeconomic outcomes

Based on interviews and literature, Textile Exchange's Regenerative Agriculture Landscape Analysis concluded that socioeconomic elements play a critical role in holistic regenerative agriculture systems. It included, in particular, an "acknowledgement that Indigenous and Native peoples have been employing this approach to growing food and fiber for centuries—it is not a new concept—and that regenerative agriculture must include a focus on social justice."[38] The report also emphasized the need for brands to share cost and risk with farmers in the transition to regenerative agriculture and ensure that those who are the direct stewards of the land—including Indigenous people, communities of color, and farmers, as applicable—have an active decision-making role in any regenerative agriculture project from the start.[39] Accordingly, socioeconomic outcomes are given equal weight with ecological outcomes in the Framework, and indicators have been selected to reflect the principles above.

Summary table: Socioeconomic indicators

Outcome	Expectation	Ref #	Indicator	Unit	Stage	Application
Project results in a more equitable sharing of costs, risks, and benefits with farmers	Basket of Metrics: Select 1 or more payment option(s) from list	3.1.1.	Project involves at least one of the following cost/risk-sharing mechanisms: - Brand covers the cost of training, additional inputs etc. up front. - Separate payment for data as a farm product; project advances and rewards farmer data sovereignty - Brand provides up front grant, low or no-interest loan, or loan guarantee to support data collection. - Brand provides guaranteed multi-year contract with allowance for yield impacts. - Textile Exchange Impact Incentives Outcome - Farmers pay < 50% of overall transition cost	Presence of cost-sharing program / USD and local currency equivalent per year	Input + Outcome	Brand Level + Farm Level [Shared]
Project is shaped by strong multi-stakeholder process	Basket of Metrics: Recommend 2 or more	3.1.2.a.	Strong collaborative mechanism is in place, such that the voices of stakeholder groups are represented and engaged from the beginning of project development and on an ongoing basis.	Presence or absence of collaborative mechanism that aligns with UNDP guidance	Input	Brand Level + Farm Level [Shared]
		3.1.2.b.	Strong grievance mechanism is in place, meeting UNGP effectiveness criteria.	Presence or absence of grievance mechanism that follows UNGP criteria	Input	Brand Level + Farm Level [Shared]
		3.1.2.c.	Farmers are supported to track and see improvement in at least one additional outcome that they have identified as a priority (can be from any of the major outcome areas)	TBD based on farmer input	Input + Outcome	Farm Level with Brand support
The rights of indigenous communities are protected	Required if applicable	3.1.3.	Free, Prior, and Informed Consent (FPIC) process in place; outcome documented	Outcomes could include: 1) consent to the activity proposed; 2) consent with conditions; or 3) no consent	Input + Outcome	Brand Level + Farm Level [Shared]
Human rights, labor rights, and women's rights are protected and strengthened	Basket of Metrics: Recommend 1	3.1.4.a.	Delta Framework Composite Indicator for Women's Empowerment	Women's Empowerment Score [Scale of 1-10]	Outcome	Farm Level with Brand support
		3.1.4.b.	IFPRI Women's Empowerment in Agriculture Index (WEAI)	A number ranging from zero to one, where higher values indicate greater empowerment.	Outcome	Farm Level with Brand support
Farmer livelihoods improve	Basket of Metrics: Recommend 2 or more	3.1.5.a.	Increase in presence of secure land tenure or land ownership arrangements (or secure mobility for Pastoralists).	Presence of absence of secure land title, land tenure agreement, Indigenous Land Management policy, or Indigenous land use agreement (ILUA)	Outcome	Farm Level
		3.1.5.b.	Gross margin from crop / product production	USD per ha of each crop or product that contributes to the farm's aggregate profit	Outcome	Farm Level
		3.1.5.c.	Productivity / farm output value by hectare (all crops, not just main crop)	Aggregate of (quantity x value) for each crop/product, calculated in local currency, divided by number of hectares	Outcome	Farm Level
		3.1.5.d.	Reduction in average input costs per hectare	USD per ha	Input	Farm Level
		3.1.5.e.	Living income Indicator: Gap between the median actual household income and the Living Income Benchmark	Local currency unit & USD equivalent per year	Outcome	Farm Level: Actual Income Project Level: Benchmark
		3.1.5.f.	Living wage Indicator: Gap between prevailing wages and the living wage benchmark for a given country / industry.	Local currency unit & USD equivalent per year	Outcome	Farm Level: Actual Wage Project Level: Benchmark
		3.1.5.g.	Diversity of farm income sources	Income Diversity Index	Outcome	Farm Level
Farm community well-being improves	Basket of Metrics - Recommend 1 or more	3.1.6.a.	Restoration of / increase in cultural relationships and/or transfer of Traditional Ecological Knowledge (TEK)	TBD based on collaborative process with community	Outcome	Farm Level
		3.1.6.b.	Increase in generational transfer of farms and farming enterprises and professionalization of agriculture for young people	TBD based on collaborative process with community	Outcome	Farm Level
		3.1.6.c.	Increase in farm worker opportunities for education, self-improvement, leadership training, advancement opportunities, etc.	TBD based on collaborative process with community	Outcome	Farm Level

Social and Economic Equity

3.1.1. Project results in a more equitable sharing of costs, risks, and benefits with farmers

[Shared indicator]

Project involves at least one of the following cost- and risk-sharing mechanisms:

- Brand covers the cost of training, additional inputs, implementation of monitoring systems or devices, or other key regenerative conversion elements upfront.
- Brand provides separate payment for data as a farm product; project advances and rewards farmer data sovereignty.
- Brand provides upfront grant, low- or no-interest loan, or loan guarantee to producers to support equipment costs, data collection, or other elements.
- Brand provides guaranteed multi-year contract with allowance for yield impacts.
- Textile Exchange Impact incentives

Outcome - Farmers pay < 50% of overall transition cost

Note: Premiums or payments that are not awarded until post-harvest are **not** considered to satisfy this indicator, as they still require growers to assume the upfront costs and risks of conversion.

Unit: Presence of cost-sharing program: the brand should disclose the specific cost/risk-sharing mechanism they are using.
Local currency unit and USD equivalent per year of the value of the support

Reference: Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis," https://textileexchange.org/app/uploads/2022/01/Regenerative-Agriculture-Landscape-Analysis.pdf

For inclusion of farmer data sovereignty in outcome frameworks, see the work of Smallholder Data Services and Terra Genesis, "Methods for Measurement of Regenerative Agriculture in Practice" (available upon request) and the Terra Genesis "White Paper for Ethos Regenerative Outcome Verification™" (forthcoming).

See also: van Geuns, J. et al., 2023. "Farmer-Centric Data Governance: Towards A New Paradigm." USAID. https://developmentgateway.org/wp-content/uploads/2023/02/Farmers_Report-Full_vFebFiNAL.pdf

Notes: See Textile Exchange Regenerative Agriculture Landscape Analysis, Appendix D. (pg 99), for specific equitable financing models and details.

Social and Economic Equity

3.1.2. Project is shaped by strong multi-stakeholder process

a. Strong collaborative mechanism is in place
[Shared indicator]

Stakeholder groups and the brand should work together to ensure that a strong collaborative mechanism is in place, such that the voices of stakeholder groups are represented and engaged from the beginning of project development and on an ongoing basis. These could include, as applicable:

- Farmers (Including underserved and historically disadvantaged groups such as Black, Latino, Native American, or other underserved farmer groups)
- Land stewards
- Indigenous people
- Local community members

Unit: Presence or absence of collaborative mechanism following the guidance below.

Reference: Biggs, S. D. 1989. "Resource-poor farmer participation in research: a synthesis of experiences from national agricultural research systems." OFCOR, comparative Study No. 3. International Service for National Agricultural Research.
https://pdf.usaid.gov/pdf_docs/PNABD218.pdf

Notes: The term "Collaborative" in this context is part of continuum of farmer participation types that move from "Contractual" through "Consultative," "Collaborative," and "Collegial." "Collaborative" is defined as: "Scientists and farmers collaborate as partners in the research process." (Biggs 1989).

Method/SOP: Extensive additional guidance is provided by UNDP in its 2021 publication:
Melvin, L. et al., 2021. "A Guide to Effective Collaborative Action: Deep collaboration for systemic change in food and agricultural commodity systems." UNDP.
https://www.undp.org/facs/publications/effective-collaborative-action

b. Strong grievance mechanism is in place, meeting UNGP effectiveness criteria

[Shared indicator]

Brands should implement a grievance process following the UN Guiding Principles (UNGP) Reporting Framework, ideally as part of a collaborative project mechanism as described above, and share the process details with community members.

Unit: Presence or absence of grievance mechanism following principles below.

Reference:
UN Guiding Principles Reporting Framework, Human Rights Reporting and Assurance Frameworks Initiative, Section C6, "Remediation." https://www.ungpreporting.org/reporting-framework/management-of-salient-human-rights-issues/remediation/

United Nations Human Rights, Office of the High Commissioner, 2021. "OHCHR Accountability and Remedy Project: Meeting the UNGPs' Effectiveness Criteria Summary of ARP III Guidance."
https://www.ohchr.org/sites/default/files/2022-01/arp-note-meeting-effectiveness-criteria.pdf

Notes: UNGP 31 states that the effectiveness criteria for non-judicial grievance mechanisms include:
(a) Legitimate
(b) Accessible
(c) Predictable
(d) Equitable
(e) Transparent
(f) Rights-compatible
(g) A source of continuous learning
(h) Operational-level mechanisms should also be based on engagement and dialogue

Method/SOP: United Nations Human Rights, 2011. "Guiding Principles on Business and Human Rights: Implementing the United Nations 'Protect, Respect and Remedy' Framework." https://www.ohchr.org/sites/default/files/Documents/Publications/GuidingPrinciplesBusinessHR_EN.pdf#page=32

c. Farmers are supported to track and see improvement in at least one additional outcome that they have identified as a priority (can be from any of the major outcome areas)

While the entire Outcome Framework is designed to support collaborative development between brands, farmers, and project developers, this indicator option is foundational for ensuring that projects respect and reflect local community knowledge and goals.

Unit: TBD Based on indicator selected

Reference: Terra Genesis, "White Paper for Ethos Regenerative Outcome Verification™" (forthcoming).

Notes: Recommended, and demonstrated valuable, by the work of Terra Genesis with communities of farmers.[40]

Social and Economic Equity

3.1.3. The rights of Indigenous communities are protected

a. The concrete outcome of an FPIC process should be documented in a written agreement that is widely shared with members of the affected IP/LC and with its current and successive leadership.
[Shared indicator]

The topic of the rights of Indigenous communities in regenerative agriculture is critical and highly complex. For the purposes of this Framework, the established body of work on the development of Free, Prior and Informed Consent (FPIC) is utilized as a minimum expected approach to recognizing and protecting these human rights.

As defined by Accountability Framework, "Free, Prior and Informed Consent (FPIC) is a collective human right of Indigenous Peoples and Local Communities (IP/LC) to give or withhold their consent prior to the commencement of any activity that may affect their rights, land, resources, territories, livelihoods, and food security. This right is exercised through representatives of their own choosing and in a manner consistent with their own customs, values, and norms. FPIC exists to promote, protect, and safeguard the full enjoyment and exercise of numerous underlying, fundamental human rights, including the rights to property, culture, and self-determination."[41]

Accountability Framework further notes that "FPIC is both a process and an outcome" and that "the FPIC outcome is a written document that specifies what was or was not agreed to."[42]

Unit: "The outcome document will likely reflect one of three outcomes: 1) consent to the activity proposed; 2) consent with conditions, such as modification of the activity or agreement to a benefit sharing package; or 3) no consent at all."

Reference: Accountability Framework Initiative, 2019. "Operational Guidance on Free, Prior and Informed Consent." https://accountability-framework.org/fileadmin/uploads/afi/Documents/Operational_Guidance/OG_FPIC-2020-5.pdf

Notes: See also: ISEAL, "Safeguarding the right of Indigenous peoples to FPIC," Report and FPIC-360° Tool: https://www.isealalliance.org/innovations-standards/innovations-projects/safeguarding-right-Indigenous-peoples-fpic

Method/SOP: The Accountability Framework overview provides numerous references for additional guidance on the implementation of effective FPIC processes.

Additional recommended resources on Indigenous community contributions and rights:

Kennedy, C. M. et al., 2021. "Indigenous Lands at Risk: Identifying Global Challenges and Opportunities in the Face of Industrial Development." Preprint (Version 2). https://doi.org/10.21203/rs.3.rs-1202963/v2

WWF, UNEP-WCMC, SGP/ICCA-GSI, LM, TNC, CI, WCS, EP, ILC-S, CM, and IUCN, 2021. "The State of Indigenous Peoples' and Local Communities' Lands and Territories: A technical review of the state of Indigenous Peoples' and Local Communities' lands, their contributions to global biodiversity conservation and ecosystem services, the pressures they face, and recommendations for actions." https://wwfint.awsassets.panda.org/downloads/report_the_state_of_the_Indigenous_peoples_and_local_communities_lands_and_territor.pdf

Fa, J. E. et al., 2020. "Importance of Indigenous peoples' lands for the conservation of intact forest landscapes." *Front. Ecol. Environ*. 18, 135–140. https://doi.org/10.1002/fee.2148

Social and Economic Equity

3.1.4. Human rights, labor rights, and women's rights are protected and strengthened

Women's rights and roles are central to the goals of sustainability, improved livelihoods, and improved community well-being. In addition to the brand-level expectations for basic human rights and labor rights safeguards noted above, the following additional indicators can strengthen farm-level assessment of women's rights as a component of holistic regenerative agriculture systems.

a. Delta Framework Composite Indicator for Women's Empowerment

The Delta Framework Project worked to develop a simplified index for women's empowerment, based on the more detailed International Food Policy Research Institute (IFPRI) Women's Empowerment in Agriculture Index (see below).

Unit: Women's Empowerment score (range of 0 to 9)

Reference: Better Cotton / Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators." https://www.deltaframework.org/wp-content/uploads/2022/08/Delta-Framework-Sustainability-Indicators-3.pdf

Notes: As the Delta Framework Sustainability Indicators document notes, "This composite indicator for Women's Empowerment, developed in partnership with CARE International UK with reference to the IFPRI Women's Empowerment in Agriculture Index, is made up of 6 tried and tested sub-indicators across three domains: i) leadership, ii) decision-making, and iii) control of economic assets (for smallholder farms) or gender equality in the workplace (for large farms)."[43]

Method/SOP: Detailed information on definitions, calculations, and methods for conducting the composite indicator for Women's Empowerment, including specific questionnaires and training materials for survey enumerators, are provided in the Delta Framework indicators document above and in a set of five detailed Annexes at www.deltaframework.org/resources/.

b. IFPRI Women's Empowerment in Agriculture Index (WEAI)

The Women's Empowerment in Agriculture Index (WEAI) was launched by International Food Policy Research Institute **(**IFPRI**),** Oxford Poverty and Human Development Initiative (OPHI), and USAID's Feed the Future in 2012. The WEAI tool is now available in multiple versions to support different contexts, including a project-level approach (pro-WEAI) that appears well-suited to the development of regenerative agriculture projects.

Unit: Score of zero to one, where higher values indicate greater empowerment.

References:

International Food Policy Research Institute (IFPRI) Women's Empowerment in Agriculture Index, https://www.ifpri.org/project/weai

For an accessible summary of the overall WEAI, including discussion of the formulas used in calculation, see the Women's Empowerment in Agriculture Index Brochure, 2012. https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/126937/filename/127148.pdf

For peer-reviewed detail on the project-level pro-WEAI specifically: Malapit, H. et al., 2019. "Development of the project-level Women's Empowerment in Agriculture Index (pro-WEAI)," *World Development*, Volume 122, Pages 675-692. https://doi.org/10.1016/j.worlddev.2019.06.018.

Notes: After over 10 years of use, IFPRI notes that over 230 organizations have used the WEAI across 58 countries, making it the most robust and tested women's empowerment tool available. However, the tool does require more complex survey instruments and calculations than the simplified Delta Composite Indicator above.

The project-focused Pro-WEAI is made up of 10 indicators (and 2 optional indicators) that measure three types of agency: intrinsic agency (power within), instrumental agency (power to), and collective agency (power with).

The FAO TAPE Methodology, referenced elsewhere in this Framework, utilizes an adapted version of the Abbreviated WEAI, known as the A-WEAI.[44]

Method / SOP: IFPRI offers extensive resources to support the tool, including distance learning training, webinars, guides and more on its resource pages, from the starting point of: https://weai.ifpri.info/choosing-the-right-weai/.

Social and Economic Equity

3.1.5. Farmer livelihoods improve

As the FAO TAPE Guidelines note, "Diversified production systems can enhance the overall productivity [of a farm] … Productivity metrics therefore need to go beyond the mere calculation of yield per hectare (or per animal) and allow the aggregation of various agricultural products."[45] Additionally, a specific focus on yield of the cash crop can result in farm-level economic choices that reduce income source diversity, food security, and system resilience. In keeping with this approach, livelihood indicators selected for the Framework do not focus on yield of the main cash crop. Instead, the Framework includes indicators that can help track improvements in the overall economic stability of a farm, farm family, or farming community.

a. Increase in presence of secure land tenure or land ownership arrangements (or secure mobility for pastoralists).

Unit: Presence or absence of secure land title, land tenure agreement, Indigenous Land Management policy, or Indigenous land use agreement (ILUA)

References:

Calo, A. 2020. "Who Has the Power to Adapt?" Frameworks for Resilient Agriculture Must Contend with the Power Dynamics of Land Tenure. *Front. Sustain. Food Syst.* 4:555270. https://doi.org/10.3389/fsufs.2020.555270

Hill, R. et al., 2013. "Indigenous Land Management in Australia: Extent, scope, diversity, barriers and success factors." CSIRO Ecosystem Sciences. https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/natural-resources/landcare/submissions/ilm-report.pdf

WWF, UNEP-WCMC, SGP/ICCA-GSI, LM, TNC, CI, WCS, EP, ILC-S, CM, and IUCN, 2021. "The State of Indigenous Peoples' and Local Communities' Lands and Territories: A technical review of the state of Indigenous Peoples' and Local Communities' lands, their contributions to global biodiversity conservation and ecosystem services, the pressures they face, and recommendations for actions." https://wwfint.awsassets.panda.org/downloads/report_the_state_of_the_Indigenous_peoples_and_local_communities_lands_and_territor.pdf

Notes: As Calo writes in the article "Who Has the Power to Adapt?", "Land tenure, the relationships of social and legal order that allocate resources to people, is the sieve through which agricultural decisions are ultimately made."[46] Land tenure is also the first of the 10 Core Criteria identified by the FAO TAPE system. Calo further notes that land tenure can serve as "a lens to observe the power relations that mediate any benefits of agricultural diversification."[47] For this reason, this indicator of land tenure comes first in the farmer livelihoods outcome area, as a necessary pre-condition to both allow the tracking of additional indicators in the Framework and ensure that farmers can benefit from these improvements.

b. Gross margin from crop production

Unit: USD or Local currency equivalent per ha of each crop, or per head of livestock, that contributes to the farm's aggregate profit

Reference: Better Cotton/Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators." https://www.deltaframework.org/wp-content/uploads/2022/08/Delta-Framework-Sustainability-Indicators-3.pdf

Notes: Per the Delta Framework definition, "Gross Margin (GM) is the average gross income from seed cotton or coffee [in Delta context] minus the cost of production (variable costs). GM analysis represents the most widespread basis for farm planning of the next year's production, and it should be calculated for each crop that contributes to a farm's aggregate profit."

The Delta Framework guidance also specifies that "GM is not the same as net profit because it does not include fixed or overhead costs such as amortization and depreciation, interest payments, rental rates, permanent labour, administrative costs, etc."[48]

The Delta Framework specifically notes that Living Income should be the indicator in the future: "A more refined measure of the economic sustainability of farming is the living income, a concept that looks at the net annual income required for a household in a particular place to afford a decent standard of living for all members of that household. Although there is a variety of methodologies available or in development to calculate the living income, the data efforts required by these methodologies as of today are very significant. It is hoped that the living income indicator will be integrated in a future revision of the Delta Framework."[49]

c. Productivity / farm output value by hectare (all crops, not just main crop)

Unit: Aggregate of (quantity x value) for each crop/product, calculated in local currency or USD equivalent, divided by number of hectares

Reference: Food and Agriculture Organization of the United Nations, 2019. "TAPE: Tool for Agroecology Performance Evaluation: Process of Development and Guidelines for Application. Test Version." https://www.fao.org/3/ca7407en/ca7407en.pdf

See also: Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)." *Front. Sustain. Food Syst*. 4:579154. https://doi.org/10.3389/fsufs.2020.579154.

Notes: As the FAO TAPE Guidelines note, "Diversified production systems can enhance the overall productivity [of a farm] … Productivity metrics therefore need to go beyond the mere calculation of yield per hectare (or per animal) and allow the aggregation of various agricultural products."[50]

As a result, the method utilized by TAPE for measuring productivity is: "the gross output value per hectare … and the gross output value per person working within the productive system, in order to better account for productivity in extensive and often mobile systems such as pastoralism."[51]

Since not all agricultural products are measured in the same units, FAO specifies that "outputs are converted to monetary terms by multiplying them with the prices at the gate in local currency and converted to purchasing power parity (OECD, 2019)."[52]

Method / SOP: Farm Survey as outlined in FAO TAPE, 2019.
https://www.fao.org/3/ca7407en/ca7407en.pdf

This general approach to assessing productivity is referred to as "Total System Yield" by the Food and Land Use Coalition (FOLU) in its recent report is also an area that FOLU has targeted for further development in its Regen10 project.[53]

d. Reduction in average input costs per hectare

Unit: USD or local currency equivalent per ha

Reference: Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)." *Front. Sustain. Food Syst*. 4:579154. https://doi.org/10.3389/fsufs.2020.579154.

Notes: Reduction in input costs is a component of family net income and Living Income calculations, so this can be considered a steppingstone metric. As defined by Mottet et al. (2020) in their discussion of the overall income indicator in the FAO TAPE system:

"The family net agricultural income is calculated as follows:

> "Revenue from agricultural activities (quantity of crops, animals, animal products, and other activities sold multiplied by the price at the gate for these items):
>
> + Subsidies
>
> - Cost of inputs (seeds, fertilizers, pesticides, breeding stock, feed, veterinary products and services, energy)
>
> - Taxes, cost of hired labor, interest on loans, cost of renting land and depreciation of machinery and equipment over time."[54]

Reduction in input costs can be calculated separately; however, it is important to ensure that an increase in on-farm inputs does not result in labor costs or opportunity costs for other income-generating or well-being activities.[55]

For example, if production of sufficient compost to increase on-farm fertility requires that crop residues—previously fed to animals such as goats or pigs—are redirected to composting, overall farm income from the sale of such animals, or food security benefits from these animals as livestock, may decline as a result. Hence, net income, or ideally Living Income, is a more comprehensive indicator for the overall outcomes of regenerative agriculture integration.

Method / SOP: See FAO TAPE, 2019, pg. 74-78 for the specific survey questions used to generate farmer-reported data for the Productivity and Family Net Agricultural Income Indicators. As noted, these are designed to be appropriate for smallholder contexts and can be conducted through a farm walk or a combination of farm walk and household survey.
https://www.fao.org/3/ca7407en/ca7407en.pdf

e. Living income

For the next two indicators, as Komives et al. (2015) note, "the concepts of 'living wage' and 'living income' are both about achieving a decent standard of living for households. The idea of a living wage, however, is applied in the context of hired workers (in factories, on farms, etc.), whereas living income is discussed in the context of any income earner, such as self-employed farmers."[56]

Living income is defined as "The net annual income required for a household in a particular place to afford a decent standard of living for all members of that household."[57]

Unit: The living income indicator is expressed as the gap between the actual household income for a region and the living income Benchmark, either as a currency value (local currency unit and USD equivalent) or a percentage:

- Gap = Median Living Income Benchmark – Median Actual Household Income
- Gap % = ((Median Living Income Benchmark – Median actual household income)/ Median Living Income Benchmark))*100

References:

Living Income Community of Practice: www.living-income.com/

Komives, K. et al., "Defining, Calculating and Using a Living Income Benchmark in the context of Agricultural Commodities." Discussion note, working version May 2015.
https://sustainablefoodlab.org/wp-content/uploads/2016/04/Living-Income-Discussion-Note-May-13-2015.pdf

Grillo, J., 2018. "From Living Wage to Living Income: Considerations for the use of the Anker methodology for calculating living wages to inform living income estimates." https://www.living-income.com/_files/ugd/0c5ab3_2bbad4d58dbb48d7acc03a2d54fbd6f8.pdf

Living Income Community of Practice, "Measuring Living Income."
https://www.living-income.com/measurement-living-income
https://www.living-income.com/licopresources

Living Income Value/Benchmark: Country level value specific to rural areas. See: https://align-tool.com/resource-library?types[]=benchmark

Notes: Both the Living Income Community of Practice (LICOP) and the Global Living Wage Coalition (below) support the use of the Anker Methodology for estimating living wages globally. This methodology, developed by living wage experts Richard Anker and Martha Anker, uses a combination of primary and secondary data to create estimates that are transparent, internationally comparable, and locally specific.

Method / SOP: Living Income Community of Practice, "Looking to measure incomes and the income gap?" LICOP FAQ V.1.0, October 2021.
https://www.living-income.com/_files/ugd/0c5ab3_3f1005e97de84a3195f03a68b204ac75.pdf

f. Living wage

As noted above, the living wage indicator can be applied in cases where hired workers are engaged in an agricultural system.

Drawing on extensive research and consultation, the Global Living Wage Coalition has adopted a common definition for living wage:

"The remuneration received for a standard workweek by a worker in a particular place sufficient to afford a decent standard of living for the worker and her or his family. Elements of a decent standard of living include food, water, housing, education, health care, transportation, clothing, and other essential needs including provision for unexpected events."[58]

Unit: Gap between prevailing wages and the living wage benchmark for a given country or industry, in local currency unit and USD equivalent per year

References:

Global Living Wage Coalition: https://globallivingwage.org/

Living Wage Benchmarks: https://align-tool.com/resource-library?types[]=benchmark

Anker, R. 2011. Estimating a Living Wage: A Methodological Review, ILO.
https://www.ilo.org/travail/info/publications/WCMS_162117/lang--en/index.htm

Method / SOP: As noted above, The Global Living Wage Coalition supports the use of the Anker Methodology for estimating living wages globally.
Anker, R. and Anker, M. 2017. "Living Wages Around the World." Chapter 18: Suggested outline of a living wage report. https://www.elgaronline.com/display/9781786431455/chapter18.xhtml

g. Diversity of farm income sources

One often-cited benefit of regenerative agriculture systems is the potential for increased diversification of cropping systems—which, along with improved biodiversity, has the potential to deliver income diversity benefits that could help increase the economic resilience of farm families and communities.

Unit: Several methods are possible. The Income Diversity Index developed by Singh et al. (2020) is one option:

"The Income Diversity Index (IDI) was calculated using the percentage of family income from different farm and non-farm sources such as crop production, non-crop activities e.g. dairy, poultry, bee-keeping etc., business, government or private employment and the 1-H formula." In this formula, "H takes a value of 1 when there is a monoculture and approaches zero with increasing diversity."[59]

Importantly, Singh et al. base this unit on their assumption that "asking farmers the percent of income that comes from each source, as opposed to total income, leads to more reliable self-reports of income as most farmers do not maintain income and expenditure accounts; furthermore, in some cases, farmers may not want to disclose their non-farming income sources because non-farming income is taxable in India."[60]

Confidentiality concerns around revealing income amounts is a factor across geographic contexts, so the approach taken by Singh et al. should help to address such concerns as income diversity indicators are further developed.

Reference: Singh, S. et al., 2020. "The association between crop and income diversity and farmer intra-household dietary diversity in India." *Food Sec.* 12, 369–390. https://doi.org/10.1007/s12571-020-01012-3

Notes: Singh et al note that their results "did not find a significant association between income diversity and dietary diversity … Overall, this suggests that diversifying farmer livelihood portfolios may have a modest effect on intra-household dietary diversity." Based on these results and this emerging area of research, income diversity should be seen more as an indicator of income resilience to changes in market and climate conditions than as a direct contributor to dietary diversity or food security overall.

Social and Economic Equity

3.1.6. Farm community well-being improves

Alongside economic livelihood, interviews and research for the Regenerative Agriculture Landscape Analysis (as well as emerging frameworks such as the Ethos Regenerative Outcome Verification™ system developed by Terra Genesis) emphasize the importance of non-financial community well-being indicators. Expert reviewers for this Framework suggested several well-being indicators for addition; local community input will be especially key to refining these general indicators for specific contexts.

a. Restoration of/increase in cultural relationships and/or Traditional Ecological Knowledge (TEK):

As defined by the Convention on Biological Diversity, Traditional Ecological Knowledge (TEK) refers to the knowledge, innovations, and practices of Indigenous and local communities around the world. Initial work by Berkes (1999) described TEK as including components of: knowledge based on empirical observations essential for survival, understanding of ecological processes and natural resources, socioeconomic systems necessary for effective coordination and co-operation relating to natural resources, and the worldview or beliefs developed to underlie this knowledge. Since this initial work, research on the importance of TEK has greatly expanded.

Unit: TBD based on collaborative process with Indigenous and local community. Includes documentation of increase in inter-generational knowledge and practices that connect to place, local biodiversity, and heritage.

References:

Terra Genesis, "White Paper for Ethos Regenerative Outcome Verification™" (forthcoming).

Berkes, F. 1999. *Sacred ecology: traditional ecological knowledge and resource management.* Philadelphia: Taylor & Francis.

WWF, UNEP-WCMC, SGP/ICCA-GSI, LM, TNC, CI, WCS, EP, ILC-S, CM, and IUCN, 2021. "The State of Indigenous Peoples' and Local Communities' Lands and Territories: A technical review of the state of Indigenous Peoples' and Local Communities' lands, their contributions to global biodiversity conservation and ecosystem services, the pressures they face, and recommendations for actions." https://wwfint.awsassets.panda.org/downloads/report_the_state_of_the_Indigenous_peoples_and_local_communities_lands_and_territor.pdf

Fa, J. E. et al., 2020. "Importance of Indigenous peoples' lands for the conservation of intact forest landscapes." *Front. Ecol. Environ*. 18, 135–140. https://doi.org/10.1002/fee.2148.

b. Increase in generational transfer of farms and farming enterprises and "professionalization" of farming

In a 2022 Policy Paper, the FAO Committee on Food Security (CFS) notes that "[y]oung people are one of the keys to achieving sustainable development, in particular in developing countries, where the vast majority of them reside, often in rural areas … Yet, poor access to land, natural resources, infrastructure, finance, technology, knowledge, and poor remuneration for agricultural and food workers turn youth away from agriculture and from remaining rural areas … Actions are needed to make the agrifood sector more attractive to young people and to promote their capacity to generate incomes."[61]

Based on this critical development need, an important outcome of regenerative agriculture systems is the degree to which they can increase the inter-generational transfer of farms, provide secure livelihoods for young community members, and contribute to the professionalization of agriculture by allowing young people to apply their business, administration, agronomy, or other degrees to advance regenerative agriculture.

Unit: # of farms with next generation family member(s) actively involved in farm management or stewardship, or % of young people actively involved in farming in the community

References:

Girdziute, L. et al, 2022. "Youth's (Un)willingness to work in agriculture sector." *Frontiers in Public Health*, Vol. 10. https://doi.org/10.3389/fpubh.2022.937657

FAO Committee on World Food Security, 2022. "CFS Policy Recommendations on Promoting Youth Engagement and Employment In Agriculture And Food Systems: Zero Draft – January 2022." https://www.fao.org/fileadmin/templates/cfs/Docs2122/Youth/Zero_Draft/CFS_Policy_Recs_Youth_Zero_Draft.pdf

Terra Genesis, "White Paper for Ethos Regenerative Outcome Verification™" (forthcoming).

c. Increase in farm worker opportunities for education, self-improvement, leadership training, advancement opportunities, etc.

Duval et al. (2021) note that "[t]here is a general consensus concerning the fact that the acquisition of new skills, experience, and informal and/or formal knowledge is necessary to adopt agroecological practices and/or stimulates the adoption of agroecological practices."[62] Furthermore, "when considering agroecology as a way to contribute to social equity, we can argue that dimensions related to job security, social benefits, income, and political experience at work should also be included to evaluate farmers' and farm workers' working conditions."[63] For regenerative agriculture systems to achieve their full potential for community regeneration, it will similarly be necessary to support the full inclusion of farm workers in education and training.

Unit: TBD based on collaborative process with community

Reference: Duval, J. et al., 2021. "Livestock farmers' working conditions in agroecological farming systems. A review." *Agron. Sustain. Dev.* 41, 22. https://doi.org/10.1007/s13593-021-00679-y.

Notes: The Action Against Hunger Agroecology Monitoring toolkit[64] offers one formal indicator on "Employment and Workload (Hardship)," with accompanying smallholder-appropriate data collection tools. However, this indicator focuses mainly on reduction of hardship and does not incorporate the type of positive progress and advancement requested by reviewers of this Framework. Further work will be needed during the pilot testing phase to determine specific elements, units, and data collection approaches in this area.

3.2. Ecological Health Outcomes

Textile Exchange's Regenerative Agriculture Landscape Analysis drew from an extensive scientific literature review to emphasize the potential co-benefits of regenerative agriculture, including linked enhancements in overall soil health, biodiversity, and water availability and quality along with animal welfare and community resilience and livelihoods.[65] The report specifically emphasized the need to move beyond "Carbon Tunnel Vision" to assess a range of other ecological benefits. Since the report was released, additional research, new frameworks, and the release of key industry guidance in the first Science Based Targets for Nature have all reinforced this message and provided new tools and indicators to assess a range of ecological outcomes.

Summary table: Ecological health indicators - Soil health and water

Outcome	Expectation	Ref #	Indicator	Unit	Stage	Application
Soil health is improved:	Basket of Metrics: Recommend 3 or more indicators, including at least 1 Chemical, Physical, and Biological from upper Soil Health Section	3.2.1.a.	Soil pH	Negative log10 of the activity of hydrogen ions (H+). (Range of 0-14; most soils fall in range of 3-9; ideal range for plant growth 6.0-7.5)	Input	Farm Level
		3.2.1.b.	Soil texture	Relative percentages of sand, silt, and clay particles	Input	Farm Level
		3.2.1.c.i.	Soil Health Institute suite of 3 indicators: 1) Soil organic carbon concentration (Chemical)	Grams of C (g) per kilogram (kg) of soil on an oven-dry basis	Outcome	Farm Level
		3.2.1.c.ii.	2) Carbon mineralization potential (Cmin) (Biological)	Milligram CO_2-C per kilogram of dry soil per 24 hours.	Outcome	Farm Level
		3.2.1.c.iii	3) Aggregate stability (Physical)	% water-stable at 10 min – SLAKES test using smartphone	Outcome	Farm Level
		3.2.1.c.i.	Color, odor, and organic matter (Chemical)	Score from 1-5: 1 = Pale, chemical odor, and no presence of humus 3 = Light brown color, odorless, and some presence of humus 5 = Dark brown, fresh odor, and abundant humus	Outcome	Farm Level
		3.2.1.c.ii.	Soil structure (Physical)	Score from 1-5: 1 = Loose, powdery soil without visible aggregates 3 = Few aggregates that break with little pressure 5 = Well-formed aggregates – difficult to break	Outcome	Farm Level
		3.2.1.c.iii.	Presence of invertebrates (Biological)	Score from 1-5: 1 = No signs of invertebrate presence or activity 3 = A few earthworms and arthropods present 5 = Abundant presence of invertebrate organisms	Outcome	Farm Level
Soil carbon stock is increased:		3.2.1.d.	Bulk density (Physical)	Dry weight of soil in a given volume, g/cm3	Outcome	Farm Level
		3.2.1.e.	Soil organic carbon content (stock) (Physical)	Tons of carbon per ha	Outcome	Farm Level
Water use efficiency is increased	Basket of Metrics: Recommend 1 or more	3.2.2.a.	Infiltration rate	Mm per hour	Outcome	Farm Level
		3.2.2.b.	Readily available soil moisture (RAM)	Mm or between -10 and -200 kPa water tension	Outcome	Farm Level
		3.2.2.c.i.	3. Irrigation water management 3.1 Water extracted for irrigation (blue water)	ML[Megaliter] per hectare of harvested land [ML/ha]	Outcome	Farm Level
		3.2.2.c.ii.	3.2 Irrigation efficiency	Ratio of water actually required for irrigation over water extracted for irrigation [%]	Outcome	Farm Level
		3.2.2.c.iii.	3.3 Water productivity (WP)	Yield (kilograms of cotton lint or Green Bean Equivalent (GBE)) per cubic metre of water consumed per hectare of harvested land [kg/m3/ha]	Outcome	Farm Level
		3.2.2.d.	Freshwater quantity: Freshwater withdrawals from surface water bodies and groundwater*	Ml per year or percent reduction from current rate	Outcome	Brand Level + Farm Level
Water pollution is reduced	Basket of Metrics: Recommend 1 or more	3.2.3.a.	Freshwater quality: Load of nitrogen (N) and phosphorus (P) to surface water bodies*	Kg per year or percent reduction from current rate	Outcome	Brand Level + Farm Level
		3.2.3.b.	Riparian zone health indicator	TBD based on elements selected	Outcome	Farm Level

Ecological Health

3.2.1. Outcome: soil health is improved

As noted in Section 1, one key principle of this Framework was to select from existing vetted frameworks and scientific literature to identify pragmatic and widely appliable indicators. Amid the growing interest in regenerative agriculture, it is also necessary to cut through the confusion and proliferation of indicators often found in soil health assessment.

Due to its rigorous design, clear conclusions, and recent, peer-reviewed, open-source results, the Soil Health Institute (SHI) North American Project to Evaluate Soil Health Measurements (NAPESHM) met multiple criteria and provided a key source of indicators for this Framework. The principles of the original Textile Exchange Regenerative Agriculture Landscape Analysis and input from smallholder farmer representatives for this Framework have also emphasized the need for outcome indicators that are practical and accessible in smallholder contexts. For this goal, the FAO Tool for Agroecology Performance Evaluation (TAPE) system provided well-documented and smallholder-appropriate indicators with clear accompanying documentation. This two-indicator set forms the basis for the soil health outcome area of this Framework. Depending on the partners, resources, lab access, level of training, and other factors, we encourage adoption of the SHI indicator set as best practice where possible, while the TAPE indicators provide a smallholder-appropriate option when resources or lab testing capacity are limited.

a. Soil pH (baseline only)

Soil pH is a measure of the acidity or alkalinity of a soil. As the FAO's Global Soil Laboratory Network (GLOSOLAN) notes, "Soil pH is important because it influences several soil factors affecting plant growth, such as (1) micro-organisms that are responsible for breaking down organic matter, (2) nutrient leaching, (3) nutrient solubility, (4) toxicity and deficiency of essential nutrients, (5) suppression and enhancement of soil-borne plant diseases, and (6) soil structure."[66] Measurement of pH is thus recommended as a baseline measurement for assessing changes in soil health. However, pH alone is not a suitable soil health outcome indicator. If soils have very low or high pH, further adjustment of pH level will be needed before other soil health improvements can be successful. However, if soils are in the normal pH range of ~6 to 7.5, further testing of pH as an outcome indicator for regenerative agriculture projects is not essential.

Unit: Range of 0 to 14, normal range of soils 3 to 9; desired range for plant growth generally 6.0 to 7.5.

Reference: FAO, Global Soil Partnership, "Standard Operating Procedures, Volume 2.1, pH." https://www.fao.org/global-soil-partnership/glosolan-old/soil-analysis/sops/volume-2.1/en/

Method/SOP: FAO, Global Soil Partnership, 2021. "Standard operating procedure for soil pH determination." Rome. https://www.fao.org/3/cb3637en/cb3637en.pdf

b. Soil texture (baseline only)

In a soil science context, "texture" refers specifically to the relative proportion of three types of particles in the soil: sand, silt and clay. Sand is defined as having a particle size of >0.06 mm; silt varies between 0.06 and 0.002 mm; and clay is defined as having a particle size of <0.002 mm. As with pH, soil texture is an important baseline characteristic that influences other soil properties. However, soil management and regenerative practices will not change the native ratio of sand, silt, and clay particles present in the soil. Soil texture alone is therefore not suitable as an outcome indicator for regenerative systems.

Unit: Soil texture as determined by the relative percentages of sand, silt, and clay, using the Soil Texture Triangle.

Fig 1. USDA Soil Texture Triangle.

doi:10.1371/journal.pone.0131299.g001

Reference: USDA NRCS, 2022. "Soil Health: Soil Texture and Structure." https://www.nrcs.usda.gov/sites/default/files/2022-11/Texture%20and%20Structure%20-%20Soil%20Health%20Guide_0.pdf

Method/SOP: The USDA reference above includes both the formal soil texture triangle and a simplified method for determining soil texture by feel.

USDA NRCS also offers a Soil Texture Calculator: https://www.nrcs.usda.gov/resources/education-and-teaching-materials/soil-texture-calculator

c. Soil Health Institute suite of three indicators

The Soil Health Institute (SHI) North American Project to Evaluate Soil Health Measurements (NAPESHM) provided a key source of indicators for this Framework. During this project, SHI scientists partnered with over 100 collaborators to evaluate over 30 soil health indicators at 124 long-term agricultural research sites across North America, specifically where conventional systems were being compared with regenerative soil health systems.[67]

As SHI describes its process:

> "Soil health measurements for evaluation were identified via a committee of scientists from public and private sectors, farmers, field conservationists, and soil test laboratories based on the criteria that the measurement could (a) be applied both regionally and continentally; (b) have a clear range of responses based on desired agricultural goals; and (c) be responsive to varying management practices.
> "Based upon these criteria, measures of soil physical, chemical, and biological properties were selected along with three existing soil health evaluation programs."[68]

The field research progress then tested each potential indicator against the criteria above using statistically robust methods, and evaluated the results through a conceptual filter.

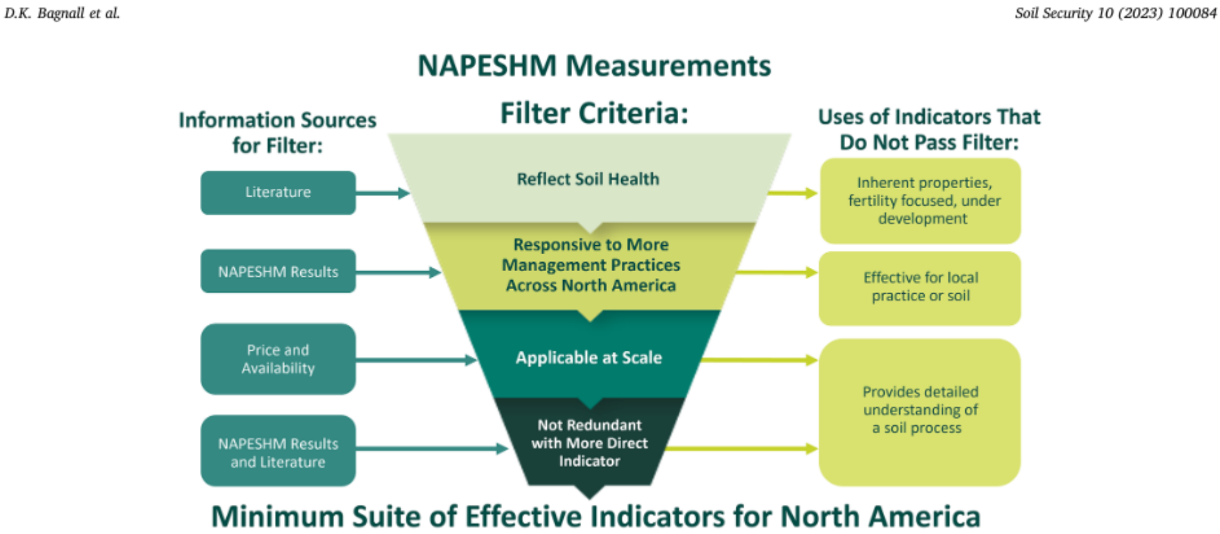


Fig. 1. Conceptual diagram of the process for filtering soil health indicators to determine a minimum suite of most effective indicators of soil health for the North American Continent. NAPESHM is North American Project to Evaluate Soil Health Measurements.

Through this rigorous process, SHI identified what they term "A minimum suite of soil health indicators for North American agriculture."[69]

These are:

i. soil organic carbon concentration
ii. carbon mineralization potential
iii. aggregate stability

These are combined with a fourth indicator in the water category, which can be derived from the three indicators above using mathematical functions:

iv. predicted available water holding capacity.

As SHI notes, "Using this minimum suite, as few as three laboratory measurements can be made to assess and track improvement in soil functioning as a result of soil management changes."[70]

Importantly, the SHI process reviewed and assessed the sets of indicators used in four prevalent soil health indices:[71]

- Cornell Comprehensive Assessment of Soil Health (CASH)[72]
- Haney Soil Health Test[73]
- Soil Management Assessment Framework (SMAF)[74]
- USDA NRCS Suite of Soil Health Indicators[75]

Thus, for the purposes of this project, we considered the SHI findings to be the most current, documented, and streamlined set of indicators available and therefore to supersede the other soil health indices listed above.

Overall Reference: Bagnall, D.K. et al., 2023. "A minimum suite of soil health indicators for North American agriculture." *Soil Security*, Volume 10. https://doi.org/10.1016/j.soisec.2023.100084

Since the SHI indicators were developed in a North American context, the FAO Global Soil Partnership's Global Soil Laboratory Network (GLOSOLAN) was used as a reference to ensure that guidance on these indicators was available for farms and regenerative agriculture projects in a global context.

GLOSOLAN's Standard Operating Procedures, currently being developed, provide detailed guidance that has been developed and cross-checked by scientists working in soil labs across the world. https://www.fao.org/global-soil-partnership/glosolan-old/soil-analysis/standard-operating-procedures/en/

i. Soil organic carbon concentration

Unit: Grams of C (g) per kilogram (kg) of soil, g/kg. Results must be reported on an oven-dry soil basis.

References:

Summary publication: Morgan, C. et al., 2020. "Assessing Soil Health: Soil Carbon Cycling and Storage." *Crops & Soils Mag.*, 53: 43 - 47. https://doi.org/10.1002/crso.20076

Peer-reviewed article: Liptzin, D. et al, 2022. "An evaluation of carbon indicators of soil health in long-term agricultural experiments." *Soil Biology and Biochemistry*, Volume 172. https://doi.org/10.1016/j.soilbio.2022.108708.

Basic Reference for all methods and conversions: Nelson, D.W. & Sommers, L.E. 1996. "Total carbon, organic carbon and organic matter." In D.L. Sparks (Ed.), Soil Science Society of America, book series 5. *Methods of soil analysis, Part 3, Chemical methods*. Madison, Wisconsin: Soil Science Society of America, Inc.

Notes:

Dry Combustion: Dry Combustion measures complete oxidation of carbon to CO_2 using high temperature combustion (1100°C) and Non-Dispersive Infrared Detection (NDIR). Dry Combustion thus measures Total Carbon (both organic and inorganic). Organic carbon in soils comes from living or dead biological matter. Inorganic carbon in soils generally comes from carbonates such as calcites ($CaCO_3$), which are characteristic of soils with higher pH values. In soils with pH below about 7.2, Total Carbon and Soil Organic Carbon measures are essentially equivalent. In soils with pH above about 7.2, where larger amounts of carbonates are present, an additional test, called the Pressure Calcimeter, must be used to measure inorganic carbon and then subtract inorganic carbon from Total Carbon.

The GLOSOLAN SOP set continues to recommend the Walkley-Black method for calculating Soil Organic Carbon directly. However, as they clearly indicate, this test entails high risk for human health and high environmental risk for waste disposal.[76] Accordingly, this Framework follows the SHI recommendation that labs should use the Dry Combustion and, when necessary, Pressure Calcimeter methods to determine Soil Organic Carbon. While it is still utilized by many soil laboratories, the Loss on Ignition method is less accurate, and Dry Combustion is considered the preferred method.

Once Soil Organic Carbon is known, this value allows for the calculation of Soil Organic Matter with the following formulas, based on the standard estimate that Soil Organic Matter is 58% carbon.

- Soil organic carbon (%C) = Soil organic matter x 0.58
- Soil organic matter (%) = Soil organic carbon (%C) x 1.72

Thus, soil organic matter can be reported using the recommended indicators, if desired.

In all cases, it is essential to maintain consistent methods and calculation approaches over the course of a regenerative agriculture project, in order to ensure accurate measurements of and claims about changes in soil organic carbon over time.

Method / SOP:

Initial soil sampling: Soil Health Institute resources provided detailed guidance on soil sampling protocols and soil depth: https://soilhealthinstitute.org/app/uploads/2022/06/SOP_SoilSampling-v1.1.pdf

Soil Health Institute, 2021. "Standard Operating Procedure: Soil Total Carbon and Nitrogen by Dry Combustion." https://soilhealthinstitute.org/app/uploads/2021/10/SOP_TCTN_drycombustion_v1.3.pdf.

FAO, Global Soil Partnership. 2019. "Standard operating procedure for soil total carbon: Dumas dry combustion method." https://www.fao.org/3/ca7781en/ca7781en.pdf

For the SOP for measuring Inorganic Carbon when needed for calcareous soils, see: https://soilhealthinstitute.org/app/uploads/2021/10/SOP_IC_PressureCalcimeter_v1.2.pdf.

ii. Carbon mineralization potential (Cmin) / soil respiration

Carbon mineralization potential (Cmin) is a commonly used indicator of soil health that is recommended by the Soil Health Institute as part of its minimum suite of soil health indicators. This indicator is also commonly described as "CO_2 burst" or "soil respiration."[77]

The term "mineralization" refers to the fact that soil organic carbon compounds are converted by soil microorganisms from their organic form (i.e., part of living or dead biological matter) to carbon dioxide (CO_2), a non-organic or "mineral" form of carbon. When soil is dried and then rewetted, a sudden resurgence of microbial activity causes a "burst" of CO_2 to be released. The strength of the mineralization reaction (i.e., the amount of CO_2 generated) has been shown to correlate with the amount of microbial biomass in the sample.[78]

After evaluating multiple indicators of microbially-influenced carbon cycling in soils, including potential C mineralization, permanganate oxidizable C (POXC), water extractable organic C, and β-glucosidase enzyme activity, SHI concluded that "[b]alancing the cost, sensitivity, interpretability, and availability at commercial labs, a 24-hr potential C mineralization assay could deliver the most benefit to measure in conjunction with SOC."[79]

Unit: milligram CO_2-C per kilogram of dry soil per 24 hours

References:

Overview: https://soilhealthinstitute.org/our-work/initiatives/measurements/#overview

https://soilhealthinstitute.org/app/uploads/2022/10/SHI_SoilHealthMeasurements_factsheet.pdf

Summary publication: Morgan, C. et al., 2020. "Assessing Soil Health: Soil Carbon Cycling and Storage." *Crops & Soils Mag.*, 53: 43 - 47. https://doi.org/10.1002/crso.20076

Peer-reviewed article: Liptzin, D. et al., 2022. "An evaluation of carbon indicators of soil health in long-term agricultural experiments," *Soil Biology and Biochemistry*, Volume 172. https://doi.org/10.1016/j.soilbio.2022.108708

Notes: The FAO TAPE assessment of presence of invertebrates (see 3.2.1.d.iii on page 52 below) can serve as a proxy for biological activity in the soil if laboratory assessment of Cmin is not feasible. While these tests clearly measure different groups of species, research has demonstrated a clear positive and mutualistic interaction between earthworms and soil microbial communities.[80]

Method/SOP:
Varying soil health systems measure Cmin/soil respiration over either a 24-hour or 96-hour period. After its analysis, SHI recommends the 24-hour method as the best balance between practicality and results. https://soilhealthinstitute.org/app/uploads/2021/10/SOP_Cmin_v1.2.pdf

The GLOSOLAN SOP provides details for the 96-hour method:
FAO, Global Soil Partnership, 2023. "Standard operating procedure for soil respiration rate."
https://www.fao.org/3/CC4082EN/CC4082EN.pdf

iii. Aggregate stability

As described by the Soil Health Institute:

"Soil structural units, or aggregates, form when fresh organic matter is decomposed and transformed by soil microbes into binding agents among mineral soil particles. Because soil structure is difficult to measure, aggregate stability is often used as an indicator. Wet aggregate stability is a measure of a dry soil aggregate's ability to resist dispersion when rewetted. Increases in aggregate stability are linked to improved water infiltration and reduced erodibility."[81]

Unit: % water-stable at 10 min, as determined by SLAKES test using smartphone

References:
Summary: Soil Health Institute, 2022. "Comparing Aggregate Stability Methods."
https://soilhealthinstitute.org/news-events/comparing-aggregate-stability-methods/

Peer-reviewed Article: Rieke, E. et al., 2022. "Evaluation of aggregate stability methods for soil health," *Geoderma*, Volume 428. https://doi.org/10.1016/j.geoderma.2022.116156.

Notes: As SHI notes, "Aggregate stability is a soil health indicator that integrates many outcomes of soil functioning and is mechanistically related to compaction, infiltration, and plant-available water-holding capacity."[82] Based on the extensive testing in the NAPESHM project, aggregate stability has been selected for this Framework as an alternative to other related indicators of compaction.

Method/SOP:

SLAKES is a smartphone application created by the University of Sydney that quantifies aggregate stability through a simple and inexpensive test which has nonetheless been shown to have high accuracy.

- Fajardo, M. et al., 2016. "Soil slaking assessment using image recognition." *Soil & Tillage Research*, 163, 119–129. https://doi.org/10.1016/j.still.2016.05.018
- Fajardo, M. and McBratney, A., 2019. "Slakes: A soil aggregate stability smart-phone app [Mobile application software]." Retrieved from https://play.google.com/store/apps/details?id=slaker.sydneyuni.au.com.slaker&hl=en.

Soil Health Institute, 2022. "Standard Operating Procedure Wet Aggregate Stability by Image Quantification."
https://soilhealthinstitute.org/app/uploads/2022/06/SOP_AggStability_ImageRecogn_simplified_v1.2.pdf

See also: Flynn, K.D. et al., 2020. "Evaluation of SLAKES, a smartphone application for quantifying aggregate stability, in high-clay soils." *Soil Sci. Soc. Am. J.* ; 84: 345–353. https://doi.org/10.1002/saj2.20012.

d. FAO TAPE – selected soil health indicators

As noted above, both the principles of the original Textile Exchange Regenerative Agriculture Landscape Analysis and input from smallholder farmer representatives emphasized the need for regenerative agriculture outcome indicators that are practical and accessible in smallholder contexts. The Food and Agriculture Organization (FAO) Tool for Agroecology Performance Evaluation (TAPE) system provided useful and well-documented indicators to help meet this goal. The development of the TAPE system included its own extensive stakeholder engagement process, including:

> "(i) a review of existing frameworks and indicators for assessing sustainability in agriculture, (ii) a participatory and inclusive multi-stakeholder consultation phase based on a review and prioritization of over 70 indicators by more than 450 participants over 4 months and (iii) an international in-person workshop with 70 participants from academia, non-profit, government, social movement, private sector, and from international organizations. After this workshop, a technical working group of 16 people was formed, including scientists and civil society representatives working on agroecology in different parts of the world. The technical working group in collaboration with the FAO coordination team further developed an analytical framework upon which an operable tool could be built to assess performance indicators that go beyond standard measures of productivity (e.g., yield/ha) and that better represent the benefits and trade-offs associated with different types of agricultural systems (FAO, 2019a)."[83]

Data collection for the TAPE indicators is designed to be conducted during the course of a field walk with the producer or producers (ideally including both a man and woman if in a farming family situation). The survey results are recorded on a tablet using the free, open-source KoboToolbox software.[84, 85, 86]

The TAPE was developed as a comprehensive tool that is capable of assessing the multi-dimensional elements of agroecological systems—a consideration that indicates the close parallels with holistic regenerative systems. The TAPE system has the further advantage of aligning with the UN Sustainable Development Goals (SDGs), for companies that have adopted SDGs as a reference for their sustainability efforts.

For the purposes of this Framework's soil health section, three linked indicators were selected from TAPE:

- Color, odor, and organic matter (Chemical)
- Soil structure (Physical)
- Presence of invertebrates (Biological)

The "presence of invertebrates" indicator was identified as particularly important during the Community of Practice (CoP) Review of this Framework, since participants noted that the carbon mineralization (Cmin) indicator recommended by SHI may not be practical in many locations due to the lack of specific lab capacity. As noted above, while these tests clearly measure different groups of species, research has demonstrated a clear positive and mutualistic interaction between earthworms and soil microbial communities.[87]

Other TAPE indicators have been utilized in the Ecological health – Water, Ecological health - Biodiversity, and Socioeconomic sections above and below.

Brands and project developers implementing a regenerative agriculture project from scratch in smallholder or limited-resource contexts are encouraged to review the full TAPE tool to assess whether it could be implemented in large part or in full.

i. Color, odor, and organic matter

Unit: Score from 1-5:
1 = Pale, chemical odor, and no presence of humus
3 = Light brown color, odorless, and some presence of humus
5 = Dark brown, fresh odor, and abundant humus

References: Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)." *Front. Sustain. Food Syst*. 4:579154. https://doi.org/10.3389/fsufs.2020.579154.

FAO, 2019. "TAPE: Tool for Agroecology Performance Evaluation—Process of development and guidelines for application. Test version." https://www.fao.org/documents/card/en/c/ca7407en/. Adapted from Nicholls, C. et al, 2004. "A Rapid, Farmer-Friendly Agroecological Method to Estimate Soil Quality and Crop Health in Vineyard Systems." *Biodynamics*. https://www.researchgate.net/publication/253208812_A_Rapid_Farmer-Friendly_Agroecological_Method_to_Estimate_Soil_Quality_and_Crop_Health_in_Vineyard_Systems

Notes: Suitable for smallholder farms. While soil color and odor can have wide variation and subtleties across contexts, this indicator can be used to assess change over time if it is used consistently in a given farm setting over time. Soil odor is also related to biological elements of the soil, such as bacterial and fungal populations, but is retained here in combination with other soil chemical elements as developed by the FAO TAPE system.

Method/SOP: Mottet et al., 2020, Supplementary Material; FAO TAPE, 2019.

ii. Soil structure

Unit: Score from 1-5:
1 = Loose, powdery soil without visible aggregates
3 = Few aggregates that break with little pressure
5 = Well-formed aggregates—difficult to break

References: Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)." *Front. Sustain. Food Syst*. 4:579154. https://doi.org/10.3389/fsufs.2020.579154

FAO, 2019. "TAPE: Tool for Agroecology Performance Evaluation—Process of development and guidelines for application. Test version." https://www.fao.org/documents/card/en/c/ca7407en/

Notes: Suitable for smallholder farms

Method/SOP: Mottet et al., 2020, Supplementary Material; FAO TAPE, 2019.

iii. Presence of invertebrates

Unit: Score from 1-5:
1 = No signs of invertebrate presence or activity
3 = A few earthworms and arthropods present
5 = Abundant presence of invertebrate organisms

References: Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)." *Front. Sustain. Food Syst*. 4:579154. https://doi.org/10.3389/fsufs.2020.579154

FAO, 2019. "TAPE: Tool for Agroecology Performance Evaluation—Process of development and guidelines for application. Test version." https://www.fao.org/documents/card/en/c/ca7407en/.

Notes: Suitable for smallholder farms.

As noted above, the FAO TAPE "Presence of Invertebrates" indicator is placed in the Framework in the Soil Health section as a proxy for the Cmin indicator included in the SHI indicator suite above.

The "Presence of Invertebrates" indicator is not placed in the biodiversity section of this Framework because presence of certain soil invertebrates alone is not an indicator of soil biodiversity. However, if a species such as a particular earthworm were identified as an indicator species using the types of sources and methods outlined below in the biodiversity section, this smallholder-friendly indicator could serve a joint soil health / biodiversity function.

Method/SOP: Mottet et al., 2020, Supplementary Material; FAO TAPE, 2019.

e. Bulk density

Unit: Dry weight of soil in a given volume, g/cm^3

Reference: Walter, K. et al., 2016. "Determining Soil Bulk Density for Carbon Stock Calculations: A Systematic Method Comparison." *Soil Science Society of America Journal* 80(3). https://doi.org/10.2136/sssaj2015.11.0407

Notes: Bulk density (BD) measurement is required for the calculation of soil organic carbon stock (below), the total amount of soil organic carbon (SOC) contained in soil over a certain area. Bulk density is not required for the measurement or assessment of improvement in soil health on a particular farm or landscape over time, although it can be an additional indicator.

To accurately represent soil organic carbon stock, bulk density must be measured between 15-30 cm depth. Bulk density measurements are known to be very difficult to conduct accurately. For example, Walter notes that "[e]ven though BD is a basic parameter in soil science and can be deduced simply from gravimetric and volumetric analyses, accurate and precise determination of BD is challenging." Other researchers "identified BD as one of the most important sources of uncertainty when determining SOC stocks in agricultural soil at the field scale, and this is particularly the case for the topsoil."[88]

To illustrate the major inaccuracies that may arise, Walter adds that the systematic errors found with certain sampling methods in her analysis "would cause a systemic error in estimated SOC stocks [that is] is equivalent to the range of SOC stock changes within 10 yr observed in repeated regional-scale inventories … Thus, a change in the methods used for BD quantification between repeated inventories could completely obscure SOC stock changes."[89]

As a result of these factors, the bulk density indicator is only recommended if companies and projects are committed to a robust carbon stock measurement program in the long term. This should be developed in conjunction with the guidance on long-term monitoring of carbon storage and removals claims currently emerging from the GHG Protocol Land Sector and Removals Guidance (see below).

Method/SOP: Walter, K. et al., 2016. "Determining Soil Bulk Density for Carbon Stock Calculations: A Systematic Method Comparison." *Soil Science Society of America Journal* 80(3). https://doi.org/10.2136/sssaj2015.11.0407

The GLOSOLAN network is also scheduled to release a SOP on Bulk Density in the near future: https://www.fao.org/global-soil-partnership/glosolan-old/soil-analysis/standard-operating-procedures/en/

f. Soil organic carbon content (carbon stock)

Soil carbon content (carbon stock) is a calculation based on the product of soil organic carbon concentration x bulk density. In general, a carbon stock is the mass of carbon contained in a carbon pool at a given time.[90]

Unit: Tons of carbon / ha

Reference: Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance, Draft for Pilot Testing and Review, Part 1." https://ghgprotocol.org/sites/default/files/standards_supporting/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-1.pdf

Bagnall, D.K. and Morgan, C.L.S., 2022. "Components of Soil Carbon Accounting." *Crops & Soils Mag.*, 55: 38-43. https://doi.org/10.1002/crso.20172

Notes: In September 2022, the Greenhouse Gas Protocol released draft "Land Sector and Removals Guidance" aimed at "providing clarity on the steps, methods and data needed to calculate GHG emissions and removals from land-based activities and 12 technological CO_2 removal activities."[91] As of this writing, the guidance has not been finalized. Under the draft guidance, companies are required to implement a rigorous carbon storage monitoring process that accounts for net carbon stock changes over time.[92] Brands will therefore need consistent and accurate calculations of carbon stocks if they wish to include carbon removals accounting as a component of their holistic regenerative systems.

See additional notes above on bulk density.

Method/SOP:
Morgan, C.L.S. et al., 2021. "Sampling Design for Quantifying Soil Organic Carbon Stock in Production Ag Fields." *Crops and Soils* 55(1). https://doi.org/10.1002/crso.20156

Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance, Draft for Pilot Testing and Review, September 2022. Part 1."
https://ghgprotocol.org/sites/default/files/standards_supporting/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-1.pdf

---

Ecological Health

3.2.2. Water use efficiency is increased

In a 2022 review, Lankford and Orr examined multiple water-related indicators referenced in publications connected to regenerative agriculture—one of few articles to specifically focus on this intersection. They concluded that "desired 'RA [regenerative agriculture] and water' outcomes depend on the management and optimal levels of two key soil properties; **readily available moisture and infiltration rate.**"[93] These two indicators were thus selected for inclusion in the Framework.

a. Infiltration rate

Measuring the rate at which water infiltrates soil—using either a single- or double-ring infiltrometer—is one of the simplest, least expensive, and most intuitive ways to assess a soil's potential for efficient and productive water use. As SHI notes, "[m]easuring soil infiltration is so useful because it is a direct measurement of a desired soil function and units like 'inches of water infiltrated in one hour' are meaningful."[94]

Unit: mm of water per hour

Reference: Lankford, B. and Orr, S., 2022. "Exploring the Critical Role of Water in Regenerative Agriculture; Building Promises and Avoiding Pitfalls." *Frontiers in Sustainable Food Systems*, Vol. 6. https://doi.org/10.3389/fsufs.2022.891709

Notes: It should be noted that soil moisture at the time of testing will have a significant effect on the infiltration rate, so the test should be performed at the same time of year and, ideally, under similar weather and soil moisture conditions over time. Infiltration rate is influenced by soil texture, but knowing the details of soil texture is not necessary to monitor changes in soil infiltration rate on a given farm over time.

Method / SOP:
FAO offers a simple, plain-language set of instructions for constructing a dual-ring infiltrometer from everyday materials in its publication "Irrigation Water Management: Irrigation Methods. Annex 2: Infiltration rate and infiltration test." https://www.fao.org/3/s8684e/s8684e0a.htm

b. Readily available soil moisture (RAM)

Unit: mm, or between -10 and -200 kPa water tension

Reference: Lankford, B. and Orr, S., 2022. "Exploring the Critical Role of Water in Regenerative Agriculture; Building Promises and Avoiding Pitfalls." *Frontiers in Sustainable Food Systems*, Vol. 6. https://doi.org/10.3389/fsufs.2022.891709

Morgan, C.L.S., 2020. "Assessing Soil Health: Soil Water Cycling." *Crops & Soils Mag*., 53: 35-41. https://doi.org/10.1002/crso.20064.

Notes: Understanding Lankford and Orr's conclusion on the importance of RAM as a key regenerative agriculture indicator requires navigating multiple terms and acronyms used by different authors for the same soil water properties.

As defined by Lankford and Orr, total available moisture (TAM) is the difference between field capacity (the upper limit of water that can be held in soil) and permanent wilting point (the lower limit). Readily available moisture (RAM) is a subset of this soil water that is most easily available to plants.

TAM is referred to as plant available water (PAW) by SHI and other authors. Other authors refer to this water fraction as available water capacity (AWC).

Lankford and Orr provide a thorough explanation of the relationship between the indicator of readily available moisture and the soil health and aggregate stability indicators outlined above in this Framework:

"Readily available moisture (RAM) is the part of the TAM which is readily available to plants to allow "easier and more productive transpiration" which helps maximize growth and yield (In soil water tension terms, RAM occurs between –10 and –100 to –200 kPa, reflecting water held in meso-sized pores). So, while a clay soil holds a lot of water (high TAM), much of that water might be very tightly held in lots of very small soil pores under high tension and not be readily available (low RAM).

"RAM rather than TAM is the key metric for the physical health of a soil under RA [regenerative agriculture] because RAM reflects changes in soil structure and aggregation over time and because a restored soil will have a crumb-size and pore-size distribution that "produces" greater porosity, soil water storage and hydraulic conductivity in this RAM/meso-pore zone."[95]

While understanding these relationships and soil properties is important for data interpretation, SHI scientists are working to develop a mathematical function, known as a pedotransfer function, that will allow the derivation of soil water status without the need for separate water measurements:

"Both field capacity and permanent wilting point are functions of soil texture and organic carbon content. Field capacity depends on soil structure. Management practices that increase soil organic carbon and improve soil structure thereby enhance drought resilience … The Soil Health Institute anticipates publishing a pedotransfer function that relates soil texture and organic carbon to changes in PAW [plant available water, also called TAM or AWC]. When this function is available, measuring PAW directly could be eliminated if desired."[96]

The availability of these functions opens the possibility for easily accessible, web-based calculation tools that can be used by farmers and project developers to input known soil data and derive soil water estimates, along the lines of the Cornell Environmental Impact Quotient (EIQ) tool for pesticide measurement described below. Further development of these pedotransfer functions will be reflected in future versions of this Framework.

Method/SOP for pedotransfer function:
Bagnall, D. K., et al., 2022. "Carbon-sensitive pedotransfer functions for plant available water." *Soil Science Society of America Journal*, 86, 612– 629. https://doi.org/10.1002/saj2.20395

c. Delta Framework 3-indicator set for Irrigation water management (only applies to farms that use irrigation)

Lankford and Orr state clearly that "[i]rrigated regenerative agriculture is categorically different to rainfed regenerative agriculture." As they explain, "[t]his is because in irrigation, water is withdrawn, conveyed, distributed, applied, consumed, drained away, slowed down and contaminated with salts or agrochemicals. At each stage there are errors, opportunity costs for, and perspectives on, that water."[97]

Thus, a separate set of indicators for farms that use irrigation, sourced from the Delta Framework, has been included in this Framework in full.

i. Delta 3.1: Water extracted for irrigation (blue water)
ii. Delta 3.2: Irrigation efficiency
iii. Delta 3.3: Water productivity (WP)

Unit:
i. Water extracted for irrigation—water extracted for irrigation (blue water) expressed as Megalitre (1000 cubic meters) per hectare of harvested land [ML/ha]
ii. Irrigation efficiency—expressed as the ratio of water actually required for irrigation over water extracted for irrigation [%]
iii. Water productivity (WP)—expressed as yield per cubic meter of water consumed per hectare of harvested land [kg/m3/ha]

Reference: Better Cotton / Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators." https://www.deltaframework.org/wp-content/uploads/2022/08/Delta-Framework-Sustainability-Indicators-3.pdf, pg. 18-23.

Notes: Only applies to farms that use irrigation. See Delta Framework documentation for full details and considerations.

In cases where irrigated lands are used for agricultural systems that integrate livestock into mixed cropping and grazing systems, these indicators could be extended to cover irrigated land that is used for grazing as well.

Method/SOP: See reference above.

Additional guidance: Delta Framework, 2022. "Annex 4. Guidance for Irrigation Efficiency and Water Productivity Indicators." https://www.deltaframework.org/wp-content/uploads/2022/08/Delta-Framework-Annex-4.-Guidance-for-Irrigation-Efficiency-and-Water.pdf

d. Water quantity: freshwater withdrawals from surface water bodies and groundwater*

On May 24, 2023, the Science Based Targets Initiative released the first technical guidance for companies to set Science Based Targets for Nature (SBTN) in the areas of Freshwater and Land.

As noted in the first Regenerative Agriculture Landscape Analysis, Science Based Targets for Nature "will fill a key gap of developing targets for the other connected areas of natural systems beyond GHG emissions—which coincides with the impact areas for holistic regenerative agriculture systems."[98] While the SBTN targets are newly released, it is expected that they will be increasingly adopted and expected for fashion, textile, and apparel brands in the coming years.

For Freshwater, these include:

i. Water quantity: freshwater withdrawals from surface water bodies and groundwater; and,
ii. Freshwater quality: the total amount of nitrogen and phosphorus entering a surface water body during a given time (see below).

Extensive guidance documents, FAQs, and other resources are available at: https://sciencebasedtargetsnetwork.org/resources/

Unit: Volume per month, e.g. ML/month; % reduction in basin-wide withdrawal

Reference: Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf

Notes: As the SBTN targets are increasingly developed, farm-level water withdrawal and quality data will be needed for brands to develop their landscape- and basin-level targets. This is a key opportunity for brands, farmers, and project developers to work together to support and implement water quantity and quality data collection at the farm level in ways that support farmer-centric data governance.

Ecological Health

3.2.3. Water pollution is reduced

a. Freshwater quality: load of nitrogen (N) and phosphorus (P) to surface water bodies

As noted above, a freshwater quality target was one of two initial Science Based Targets for Nature released in May 2023:

i. Water quantity: freshwater withdrawals from surface water bodies and groundwater; and,
ii. Freshwater quality: the total amount of nitrogen and phosphorus entering a surface water body during a given time (see below).

Extensive guidance documents, FAQs, and other resources are available at: https://sciencebasedtargetsnetwork.org/resources/

Unit: Freshwater quality unit: mg per liter (mg/L) for individual samples.

SBTN freshwater quality targets can be set in the following units, as described in SBTN guidance:

- "When setting targets on an annual basis, using direct or secondary measurement (with units of nutrient load), targets will be stated as 'Company X will reduce its nutrient load in the ___ basin to ___ kg P (or N)/year by the year ___.'
- "When setting targets on a seasonal basis, using direct or secondary measurements (with units of nutrient load), targets will be stated as 'Company X will reduce its nutrient load in the ___ basin to ___ kg P (or N)/month for each of the following months. The reductions will occur by the year ___.'
- "When setting targets on an annual basis, using gray-water footprint(s), targets will be stated as 'Company X will reduce its gray-water footprint in the ____ basin to ___ ML/year by the year ___.'"[99]

Reference: Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf

Notes:

The SBTN targets are newly released as of this writing. Additional work and piloting will be needed to determine the farm-level water quality indicators that best correspond with SBTN targets and allow the consolidation of water quality data from the farm level up to the landscape level. We will continue to track these developments and include these indicators in future versions of the Framework.

In addition, SBTN freshwater guidance notes that targets for toxic chemicals will be developed in subsequent versions.[100] Water ecotoxicity indicators will thus be considered for future versions of this Framework as well.

Method/SOP: Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf

b. Riparian zone health indicator

Multiple expert reviewers for this Framework suggested outcome indicators for the health of riparian zones, which include both the river habitat and the surrounding land surfaces.

A comprehensive 2022 review from CGIAR assesses dozens of potential river health assessment frameworks and indicators in multiple categories, including:

- Biological Indicators
- Water Quality Indices
- Hydrological Indicators
- Connectivity Indicators
- Habitat Indicators
- Spatial Extent Indicators
- Ecological Processes

- Ecosystem (social) service indices

Given the comprehensive work done by the Science Based Targets for Nature network to create standardized company targets for water quality indicators, this Framework currently prioritizes water quantity and water pollution indicators (see above).

Pilot testing of the Framework in areas with key riparian corridors will be an opportunity to develop additional specific riparian health indicators for regenerative agricultural systems that also support widespread adoption of the SBTNs for freshwater.

Individual regenerative agriculture projects that closely impact riparian areas can reference CGIAR's ongoing work to develop a comprehensive global river health assessment framework.

Reference: Dickens, J. et al., 2022. "Towards a global river health assessment framework. Project report submitted to the CGIAR Research Program on Water, Land and Ecosystems (WLE)." Colombo, Sri Lanka: International Water Management Institute (IWMI). https://doi.org/10.5337/2022.224

Summary table: Ecological health indicators – Biodiversity, synthetic inputs, greenhouse gas emissions

Outcome	Expectation	Ref #	Indicator	Unit	Stage	Application
Biodiversity increases (Plant, Animal)	Basket of Metrics: Select at least 1 each for Plant, Animal; Recommend 2 or more. Microbial area is emerging.	3.2.4.a.	Record of indicator species	Presence/absence/# of indicator species. Indicator species selection should be based on local knowledge backed by literature guidance.	Outcome	Farm Level
		3.2.4.b.	Agricultural Biodiversity Indicator	Uses modified Gini-Simpson Index of Diversity: $1-D = 1-\Sigma p_i^2$	Outcome	Farm Level
		3.2.4.c.	Ecological Health Index	Index of 15 separate indicators for rangeland health	Output	Farm Level
		3.2.4.d.	Hill Diversity Index	Hill diversity value "D"		Farm Level
		3.2.4.e.	Percentage of natural / restored habitats	% per km2	Output	Farm Level
Biodiversity increases (Plant)		3.2.4.f.	On-farm area planted in trees/perennials	Ha or % of farm area	Output	Farm Level
		3.2.4.g.	Tree sapling regeneration rate	Saplings per ha	Outcome	Farm Level
Biodiversity increases (Microbial)		3.2.4.h.	Soil microbial diversity	TBD based on emerging indicators	Outcome	Farm Level
Synthetic inputs are reduced	Basket of Metrics: Recommend 2 or more	3.2.5.a.	Reduction in use of Highly Hazardous Pesticides (HHPs)	Kg active ingredient (a.i.) of Highly Hazardous Pesticides (HHPs) applied per ha of harvested land	Output	Farm Level
		3.2.5.b.	Pesticide usage: Environmental Impact Quotient (EIQ)	EIQ Formula	Outcome	Farm Level
		3.2.5.c.	Fertilizer usage: Nitrogen use efficiency (NUE) (Specific indices below)	NUE	Outcome	Farm Level
		3.2.5.c.i.	NUE_{yield}	NUE_{yield} = N Uptake Efficiency x N Utilization Efficiency		
		3.2.5.c.ii.	NUE of a System (sNUE)	Yield N / (Yield N + N Loss)		
		3.2.5.d.	Ratio of non-synthetic inputs to synthetic inputs	Ratio of non-synthetic inputs (compost, etc.) to purchased synthetic inputs. Can be applied to either nutrient sources or pest control methods.	Outcome	Farm Level
GHG emissions are reduced	Basket of Metrics: Recommend 1 or more	3.2.6.a.	Greenhouse gas emissions per unit of production	Kg CO_2e per kg of main crop or total production	Outcome	Farm Level
		3.2.6.b.	Carbon dioxide removals (guidance still in review)	tCO_2e	Outcome	Brand + Farm Level

Ecological Health

3.2.4. Biodiversity increases (plant, animal, microbial)

In both the Regenerative Agriculture Landscape Analysis and this Framework, biodiversity indicators are considered in three categories: plant biodiversity, animal biodiversity, and soil microbial biodiversity. This approach mirrors the three-level definition of biodiversity referenced in the original Regenerative Agriculture Landscape Analysis,[101] while being simpler to grasp, and assesses biodiversity in the context of agricultural systems. Indicators below may measure either plant or animal biodiversity, or both. In the case of soil microbial diversity, the emerging understanding of the critical role of microbes is not yet matched by practical indicators that can meaningfully assess and track microbial diversity in agricultural systems over time, as discussed further below.

a. Record of indicator species

An indicator species is an organism whose presence, absence, or abundance reflects a specific environmental condition. A comprehensive review of indicators by ISEAL and 3Keel notes that "[e]vidence suggests that carefully selected indicator species can be used as a proxy for biodiversity … However, this relies on good coverage of all major taxonomic groups and/or functional ecological diversity (i.e. species with similar traits and habitat requirements)."[102] Detailed research is available to support the selection of indicator species; however, the general references below should be supplemented with locally specific research and knowledge. It is also critical to note that farmers and Indigenous land stewards often have deep knowledge of species that indicate ecological health. While the choice of indicator species should be backed by research, local ecological knowledge can play a key role in identifying candidate species and providing localized context.

Unit: Presence/absence/# of indicator species—should include both animal and plant species.

References: Siddig, A.A.H. et al., 2016. "How do ecologists select and use indicator species to monitor ecological change? Insights from 14 years of publication in Ecological Indicators." *Ecological Indicators*, Volume 60, 223-230. https://doi.org/10.1016/j.ecolind.2015.06.036

Carignan, V. and Villard, M.A., 2002. "Selecting indicator species to monitor ecological integrity: review." *Environ. Monit. Assess*. 78, 45–61. https://doi.org/10.1023/A:1016136723584

Chu, Ta-Jen et al., 2022. "Developing a Model to Select Indicator Species Based on Individual Species' Contributions to Biodiversity." *Applied Sciences* 12(13):6748. https://doi.org/10.3390/app12136748

Notes: Based on their review, Siddig et al. (2016) suggest a five-step process for selecting Indicator Species, referencing in particular the work of Carignan and Villard (2002). Chu et al. (2022) provide more recent guidance on the selection of indicator species using a new mathematical model.

Method/SOP: Lõhmus, A. et al., 2018. "A simple survey protocol for assessing terrestrial biodiversity in a broad range of ecosystems." *PLOS ONE* 13(12): e0208535. https://doi.org/10.1371/journal.pone.0208535

b. Agricultural Biodiversity Indicator

The FAO TAPE Agricultural Biodiversity Indicator was developed to be used in conjunction with smallholder-appropriate data collection during a transect walk on the farm. The advantage of this indicator is that it uses a simple mathematical formula to actually measure diversity (i.e., difference within the system), as opposed to relying on a count or "richness" of species, which can easily deliver misleading results if undesirable, invasive, or monoculture species are prevalent.

Unit: Uses modified Gini-Simpson Index of Diversity: $1–D = 1–\Sigma p_i^2$

Gini-Simpson index = $(1 - \sum p_i^2)$

where, $\boldsymbol{p_i} = \frac{number\ of\ individuals\ or\ hectares\ of species\ or\ variety\ i}{total\ number\ of\ individuals\ or hectares\ in\ system}$

D is then subtracted from 1 in order to have 100% as the highest diversity score and 0% as the lowest.

Reference: Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)." *Front. Sustain. Food Syst*. 4:579154. https://doi.org/10.3389/fsufs.2020.579154
(including Supplementary Material:
https://www.frontiersin.org/articles/10.3389/fsufs.2020.579154/full#supplementary-material)

Notes: Mottet et al. (2020) further explain the benefits of this indicator, noting that "[t]he proposed methodology corresponds to a composite indicator taking into account the diversity of species, varieties and breeds and their relative importance," including both crops, cultivated trees, animals, and the presence of natural vegetation, trees, pollinators, and other beneficial animals.

Method/SOP: The Supplementary Material to Mottet et al. (2020) provides the full questionnaire used during a field walk to gather information for the Agricultural Biodiversity Indicator, as well as the straightforward tables and formulas needed to calculate it. See Supplementary Material: https://www.frontiersin.org/articles/10.3389/fsufs.2020.579154/full#supplementary-material

c. Ecological Health Index (includes soil health and biodiversity indicators)

The Ecological Health Index (EHI) represents a combination of 15 different indicators covering a range of soil health and biodiversity elements. It is both a pragmatic and farmer-friendly approach and one that is challenging to categorize in the "basket" approach of this Framework. The EHI focuses on indicators that are relevant for grazing systems and may or may not be relevant for certain ecological contexts, such as capping and wind erosion.[103,104]. However, it is a smallholder-friendly system that uses indicators that are likely to be intuitive for land managers to monitor and capture. Xu et al. (2019)

conclude that overall, “EHI could be a useful method to detect the ecological health and productivity in grazing lands ... [and] is an effective short-term monitoring approach that ranchers could implement annually to monitor grazing lands and determine the impacts of ranch decision-making on important ecosystem indicators.”[105]

Unit: Cumulative score of for all indicators ranging from –130 to +110.[106]

Reference: Xu, S. et al., 2019. “Ecological Health Index: A Short Term Monitoring Method for Land Managers to Assess Grazing Lands Ecological Health.” *Environments*, 6, 67. https://doi.org/10.3390/environments6060067

For the original source of the EHI Indicators, see Tongway, D. and Hindley, N.L., 2004. “Landscape Function Analysis: Procedures for Monitoring and Assessing Landscapes - with Special Reference to Minesites and Rangelands.” CSIRO Australia. https://www.researchgate.net/publication/238748160

Notes: Applies to grazing systems; appropriate for smallholders.

It should be noted that the EHI is one component of the larger Ecological Outcome Verification (EOV) protocol, the central monitoring methodology behind The Savory Institute’s Land to Market (L2M) program.[107] However, the EHI itself is publicly available in the research literature as referenced above and in the Method/SOP section below.

The summary table below, taken from Xu et al. (2019), lists the indicators included in the EHI:

Table 2. Ecological processes and related indicators evaluated for Ecological Health Index (EHI). The Type columns explains if the indicator is evaluated as compared to the reference area or as a stand-alone, absolute indicator. The latter four columns indicate which of the key four ecosystem cycles this is an indicator of (white, not an indicator; gray, an indicator).

#	INDICATOR	UNIT	Source	Type	Water Cycle	Mineral Cycle	Energy Flow	Community Dynamics
1	Live Canopy Abundance	Total green biomass production/Site potential	[24,29]	Ref. Area				
2	Living Organisms	Evidence of microfauna	[24,30]	Absolute				
3	FG 1—Warm Season Grasses	Vigor, reproduction, crown integrity	[24,29,30]	Absolute				
4	FG 2—Cool Season Grasses	Vigor, reproduction, crown integrity	[24,29,30]	Absolute				
5	FG 3—Forbs/Legumes	Vigor, reproduction, crown integrity	[24,29,30]	Absolute				
6	FG 4—Desirable Trees/shrubs	Vigor, reproduction, crown integrity	[24,29,30]	Absolute				
7	Contextually Desirable Rare Species	Frequency	[24]	Ref. Area				
8	Contextually Undesirable Species	Abundance	[24,29,30]	Ref. Area				
9	Litter Abundance	% Cover	[23,24,29–31]	Ref. Area				
10	Litter Incorporation	Litter type, Soil contact	[23,24,29–31]	Absolute				
11	Dung Decomposition	Dung Disappearance rate	[24]	Absolute				
12	Bare Soil	% Bare soil	[23,24,29–31]	Ref. Area				
13	Capping	Soil surface resistance	[23,24,29,31]	Absolute				
14	Wind Erosion	Blowout/Deposition	[23,24,29–31]	Absolute				
		Active pedestals	[23,24,29–31]	Absolute				
15	Water Erosion	Rills/water flows	[23,24,29–31]	Absolute				
		Gullies	[23,24,29–31]	Absolute				

Method/SOP: See Xu, S. et al. (2019) Appendix A for an example of the EHI Evaluation Matrix for one specific ecoregion.

Further application detail is provided in: Borelli, P. et al., 2013. "GRASS: Grassland Regeneration and Sustainability Standard." FAO, First edition: 2012. Second edition: December, 2013. https://www.fao.org/fileadmin/user_upload/nr/sustainability_pathways/docs/GRASS%20english.pdf

d. Hill Index of Diversity

The Hill Index is an emerging indicator gaining favor in the biodiversity literature. As Roswell et al. (2021) note, "[t]hree metrics of species diversity—species richness, the Shannon index and the Simpson index—are still widely used in ecology, despite decades of valid critiques leveled against them."[108] As an alternative to these indicators, these authors write, "[t]here is an increasing consensus that Hill diversity is the preferred way to measure not only the species diversity of a community … but also differentiation among communities, functional and phylogenetic diversity, genetic diversity, and evenness."[109]

Hill diversity mathematically represents the basic concept that "a community consisting of species that are, on average, more rare has higher [bio]diversity."[110]

Unit: Hill diversity value "D" following the formula:

$$D = \left(\sum_{i=1}^{S} p_i \left(r_i \right)^{\ell} \right)^{1/\ell}$$

where *D* is diversity, *S* is the number of species, p_i is the proportion of all individuals that belong to species *i*, r_i is the rarity of species *i*, defined as $1/p_i$, and *l* is the exponent that determines the rarity scale on which the mean is taken.

Reference: Roswell, M. et al., 2021. "A conceptual guide to measuring species diversity." *Oikos*, 130: 321-338. https://doi.org/10.1111/oik.07202

Notes: This technical formula can be applied in a range of contexts, but will clearly require localized context and some level of specialized knowledge to apply and interpret.

Method/SOP: Lõhmus, A. et al., 2018. "A simple survey protocol for assessing terrestrial biodiversity in a broad range of ecosystems." *PLOS ONE* 13(12): e0208535. https://doi.org/10.1371/journal.pone.0208535.

e. Percentage of natural / restored habitats

Unit: % per km^2

Reference: World Business Council for Sustainable Development, "OP2B's Framework for Regenerative Agriculture, 2021." https://www.wbcsd.org/Projects/OP2B/Resources/OP2B-s-Framework-for-Regenerative-Agriculture

Mazur, E. et al., 2023. "Science Based Targets for Land Version 0.3 – Supplementary Material SBTN Natural Lands Map: Technical Documentation." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Land-v0.3-Natural-Lands-Map.pdf

Notes:

"Percentage of natural habitats" is one of two biodiversity indicators developed by OP2B for its regenerative agriculture framework. The wording has since been updated to "percentage of natural / restored habitats."

The OP2B indicator draws on the SBTN definition of "natural," which in turn adopted the Accountability Framework Initiative (AFi) definitions of natural ecosystems and forests. AFi defines a natural ecosystem as "one that substantially resembles—in terms of species composition, structure, and ecological function—what would be found in a given area in the absence of major human impacts," and the definition can include "managed ecosystems as well as degraded ecosystems that are expected to regenerate either naturally or through management."[111]

The addition of the term “restored” to the indicator reflects the SBTN definition of “restore” as follows: “Initiate or accelerate the recovery of an ecosystem with respect to its health, integrity, and sustainability with a focus on permanent changes in state.”[112]

Method/SOP: These definitions were used as the basis for the SBTN Natural Lands Map, which shows the whole world divided into two classes: natural and non-natural, according to the definitions found in the technical note. The map thus serves as a starting point for users to calculate this indicator.

The SBTN Natural Lands Map can be viewed at:
https://wri-datalab.earthengine.app/view/sbtn-natural-lands

f. On-farm area planted in trees/perennials

The next two indicators seek to ensure the Framework’s initial applicability to agroforestry systems, including those used for the production of rubber, cotton, and other textile crops in diversified agroforestry systems.

The Food and Land Use Coalition report includes an important note on the varying uses of the term “agroforestry”: “the term typically describes not only integration of trees into cropland and pasturelands, but also tree crop plantations (e.g., rubber, cocoa, oil palm, coffee), some energy crops, and timber plantations. The expansion of these tree crop plantations has generally been tied to loss of natural forests. In general, for agroforestry to provide net environmental benefits, it must replace or enhance production of annual crops or fodder and it must do so well on existing agricultural lands instead of creating incentives to clear new lands.”[113] This indicator was thus selected to focus specifically on “on-farm area.”

Unit: Hectares of on-farm area planted in trees/perennials, or % of farmland allocated to such species.

References:
Chamberlain, L. A. et al., 2022. “Rapid improvement in soil health following the conversion of abandoned farm fields to annual or perennial agroecosystems.” Frontiers in Sustainable Food Systems, Volume 6. https://doi.org/10.3389/fsufs.2022.1010298

Focuses on the conversion to perennial grain species (not woody species).

Muchane, M. N. et al, 2020. “Agroforestry boosts soil health in the humid and sub-humid tropics: A meta-analysis,” *Agriculture, Ecosystems & Environment*, Volume 295. https://doi.org/10.1016/j.agee.2020.106899

Notes: Relevant for agroforestry systems

Separate diversity indices could be run on only the perennial or woody crops on a farm, but this would not indicate the overall diversification of the plant, tree, and crop species mixture on the farm.

g. Tree seedling regeneration rate

Unit: Seedlings per ha

Reference: Díaz, M. et al., 2021. “Long-Term Tree Regeneration of Fragmented Agroforestry Systems Under Varying Climatic Conditions.” *Frontiers in Ecology and Evolution*, Volume 9, https://doi.org/10.3389/fevo.2021.640143

Notes: Relevant for agroforestry systems

In an agroecological context, Diaz et al. note that "[n]atural regeneration is a multistage process that ensures the long-term persistence of a plant population by the replacement of the old mature individuals by the new recruits … Regeneration is strongly determined by the processes occurring in the early stages of seed production, dispersal, and early seedling survival."[114] This indicator thus allows for the monitoring of tree regeneration at this key early growth stage.

Method/SOP: See Diaz et al. (2021) description of monitoring methods above.

h. Soil microbial diversity (Emerging)

Indicator: TBD based on continuing research

Unit: Depends on method

References:

Summary publication: Rieke, E. and Cappellazzi, S., 2021. "Assessing Soil Health: Measuring the Soil Microbiome." *Crops & Soils Mag.*, 54: 32-35. https://doi.org/10.1002/crso.20099

Peer-reviewed article: Rieke, E. et al., 2022. "Linking soil microbial community structure to potential carbon mineralization: A continental scale assessment of reduced tillage." *Soil Biology and Biochemistry*, Volume 168. https://doi.org/10.1016/j.soilbio.2022.108618.

Notes:

With the increasing understanding of the critical role that microbes play in soil health and ecosystem processes, there is great interest in identifying indicators of microbial diversity and, crucially, understanding the connections between specific microbial species and ecosystem health outcomes. However, this research is in the early stages, and there is not yet a consensus on soil microbial diversity indicators that are demonstrably linked with beneficial outcomes.

As SHI researchers noted in comments on this Framework, the scientific community has yet to agree on indicator species for soil microbial biodiversity. Microbial diversity is strongly influenced by inherent soil properties such as pH, meaning that the role of management in influencing soil microbial diversity is not yet clear, especially across varied geographic contexts. In addition, functional redundancy among soil microbes means that the correlation between diversity—having more different microbes in a soil system—and system health is not always direct. SHI and other researchers are actively assessing a range of microbial indicators, including targeted amplicon sequencing, which uses DNA sequences from bacteria and fungi to identify individual microbial community members, and metagenomic sequencing, which provides information on all genetic material contained in the soil.

However, as Rieke and Cappellazzi (2021) note in the reference above, "these measurements must first be linked to functional outcomes (e.g., carbon storage and efficient nutrient transformation) prior to application as indicators."

Overall, brands, farm groups, and farms are currently recommended to focus on the above known indicators of soil health and plant and animal biodiversity, and move towards adding soil microbial biodiversity indicators over time. Additional research on soil microbial biodiversity indicators will certainly continue to emerge during the pilot testing phase and in the overall field of regenerative agriculture in the near future.

3.2.5. Synthetic inputs are reduced

Textile Exchange's Regenerative Agriculture Landscape Analysis lays out clear principles on the need for reduction of synthetic inputs in regenerative agricultural systems:

> "Textile Exchange also takes the view that over the long term, regenerative agriculture systems should phase out reliance on synthetic pesticides, herbicides, and fertilizers. These synthetic inputs have known negative impacts on soil health, biodiversity, and human health—outcomes antithetical to the values of regenerative. … While acknowledging the right of farmers to transition to regenerative practices in a way that works for their individual farm operations, Textile Exchange believes that any project that chooses to allow continued use of pesticides or herbicides during the transition to regenerative practices should only do so in a transparent, place-based, time-limited approach that lays out a clear pathway to transitioning away from synthetic inputs and towards a more holistic regenerative approach."[115]

a. Reduction in use of Highly Hazardous Pesticides (HHPs)

Since HHPs are applied at the farm level, this indicator has been retained in the Farm-Level section. However, creation of a clear, time-bound plan to phase out the use of HHPs, as specified by the Delta Framework, and tracking the outcome of reduced use of these substances, is an especially important area for brand engagement and support.

Unit: Kg active ingredient (a.i.) of Highly Hazardous Pesticides (HHPs) applied per ha of harvested land

References:

Better Cotton / Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators." https://www.deltaframework.org/wp-content/uploads/2022/08/Delta-Framework-Sustainability-Indicators-3.pdf

Delta Framework Annex 3: www.deltaframework.org/resources

PAN International, "PAN International List of Highly Hazardous Pesticides, March 2021." https://www.pan-uk.org/site/wp-content/uploads/PAN-HHP-List-2021.pdf

Notes: Lists of HHPs differ by crop and are not fixed, and these lists are regularly updated based on emerging research and properties of these substances. Using this indicator will thus require determination of a context-specific and up-to-date list of HHPs for reference.

Method/SOP: The Delta Framework Indicator and Annex 3 can serve as a standard operating procedure for this indicator in cotton.

b. Pesticide usage – Environmental Impact Quotient (EIQ)

As described by Cornell University, "The Environmental Impact Quotient (EIQ) is a formula created to provide growers with data regarding the environmental and health impacts of their pesticide options so they can make better-informed decisions regarding their pesticide selection."

Unit: EIQ

The formula for determining the EIQ value of individual pesticides is the average of the farm worker, consumer, and ecological components:

EIQ={C[(DT*5)+(DT*P)]+[(C*((S+P)/2)*SY)+(L)]+[(F*R)+(D*((S+P)/2)*3)+(Z*P*3)+(B*P*5)]}/

Where:
DT = dermal toxicity
C = chronic toxicity
SY = systemicity
F = fish toxicity
L = leaching potential
R = surface loss potential
D = bird toxicity
S = soil half-life
Z = bee toxicity
B = beneficial arthropod toxicity
P = plant surface half-life.

Formula is covered and automatically calculated by the Cornell online EIQ calculator: https://cals.cornell.edu/new-york-state-integrated-pest-management/risk-assessment/eiq/eiq-calculator

References:
Kovach, J., et al., 1992. “A method to measure the environmental impact of pesticides.” New York’s Food and Life Sciences Bulletin 139:1–8. https://ecommons.cornell.edu/handle/1813/55750

Eshenaur, B., et al., EIQ. Environmental Impact Quotient: “A Method to Measure the Environmental Impact of Pesticides.” New York State Integrated Pest Management Program, Cornell Cooperative Extension, Cornell University. 1992 – 2020. https://cals.cornell.edu/new-york-state-integrated-pest-management/risk-assessment/eiq/eiq-calculator

Notes: The EIQ Calculator site provides detailed information on the pesticides that can be assessed using the EIQ.

c. Fertilizer usage – nitrogen use efficiency (NUE)

i. $\mathbf{NUE_{yield}}$

Unit: NUE_{yield} = N uptake efficiency x N utilization efficiency

Reference: Congreves, K. et al., 2021. “Nitrogen Use Efficiency Definitions of Today and Tomorrow.” *Frontiers in Plant Science*, Vol. 12. https://doi.org/10.3389/fpls.2021.637108

Notes: NUE_{yield} Interpretation: The contribution of N supplied from the soil that is allocated to the yield N; also often referred to as simply NUE.

To be a useful outcome indicator for reduction in synthetic inputs, the NUE indicator should be seen as a steppingstone. While it is desirable to see NUE increase, this increase alone does not indicate a reduction in synthetic N use. However, such an increase *does* indicate that whatever N is being applied is being used more efficiently, which in turn allows reduction in synthetic N without yield losses.

Growers and project developers could also certainly measure reductions in N fertilizer applications as an outcome indicator. However, this approach does not directly assess improvements in the capacity of the soil system to use N more efficiently overall, which is why the NUE indicator was selected for this Framework.

Method/SOP: Congreves et al. (2021) includes multiple references for different approaches to NUE and a discussion of the strengths and limitations of each.

ii. NUE of a system (sNUE)

Unit: Yield N / (Yield N + N Loss)

Reference: Congreves, K. et al., 2021. "Nitrogen Use Efficiency Definitions of Today and Tomorrow." *Frontiers in Plant Science,* Vol. 12. https://doi.org/10.3389/fpls.2021.637108

Notes: sNUE Interpretation: The fraction of system N outputs that are captured as N yield rather than lost to the environment.
https://www.frontiersin.org/articles/10.3389/fpls.2021.637108/full

See note above on the rationale for NUE selection.

Method/SOP: Congreves et al. (2021) includes multiple references for different approaches to NUE and a discussion of the strengths and limitations of each.

d. Ratio of non-synthetic inputs to synthetic inputs (can be applied to either nutrient sources or pest control methods)

Unit: Ratio or percentage. This general indicator could be used to assess the proportion of N applied though farmyard manure, compost, or other natural sources compared to purchased synthetic N fertilizer, or it could be used to assess the application of natural pest control products and methods compared to synthetic pesticides.

Reference: Reviewer suggestions

Notes: As discussed in the socioeconomic Indicator 3.1.5.d. above, reduction in average input costs, it is important to ensure that an increase in on-farm inputs does not result in labor costs or opportunity costs for other income-generating or well-being activities.[116]

For example, if production of sufficient compost to increase on-farm fertility requires that crop residues previously fed to animals—such as goats or pigs—are redirected to composting, overall farm income from the sale of such animals, or food security benefits from these animals as livestock, may decline as a result.

Further work will be needed during the pilot phase, and in future versions of this Framework, to develop this as an indicator of positive progress in regenerative systems.

Ecological Health

3.2.6. Greenhouse gas emissions are reduced

The recent Food and Land Use Coalition (FOLU) report provides a clear overview of the issues with measuring greenhouse gas emissions as a farm-level indicator. As the FOLU Report notes: "There are ongoing debates about the technical and practical climate mitigation potential of regenerative agricultural practices. The carbon sequestration potential of soil on working agricultural lands, and the extent to which it can realistically be scaled up to tackle climate change, is a topic of intense debate amongst scientists … That said, it is important to focus on climate change mitigation more broadly, rather than carbon sequestration alone, given the role of other GHG emissions such as methane (CH_4)

and nitrous oxide (N_2O) in agriculture. In order to understand how carbon sequestration leads to climate change mitigation, it is important to understand if the CO_2 captured exceeds the CO_2e lost."[117] The indicators below, with the latter still actively in development, will hopefully provide a farm-level method for assessing this key question over time.

a. Greenhouse gas emissions [per unit of production]

Unit: Kg CO_2e per kg of production (can be calculated for a focus crop, such as cotton in the Delta Framework, or for full marketable biomass produced, as defined below).

References: Better Cotton / Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators." https://www.deltaframework.org/wp-content/uploads/2022/08/Delta-Framework-Sustainability-Indicators-3.pdf

General reference: Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance, Draft for Pilot Testing and Review, Part 1."
https://ghgprotocol.org/sites/default/files/standards_supporting/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-1.pdf

Notes: In the Delta Framework, this indicator is defined as "the ratio between CO_2 equivalent (CO_2e) emissions from agricultural activities and the marketable biomass produced: e.g., cotton lint … The scope of this indicator includes direct and indirect emissions (1, 2 and 3) including all emissions occurring upstream and at the farm from cotton … production."[118]

Assessing this indicator at the farm level requires the use of a calculation tool such as the Cool Farm Tool. This indicator is thus more suitable for larger farms or cases where project developers can support smallholders in greenhouse gas emissions calculations.

b. Carbon dioxide removals

As noted above in the brand expectations section, the GHG Protocol is currently developing additional guidance on Land Sector and Removals that will be highly relevant to regenerative agriculture.

Unit: tCO_2e

Reference: Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance, Draft for Pilot Testing and Review, Part 1." https://ghgprotocol.org/sites/default/files/standards_supporting/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-1.pdf

Notes: The emerging GHG Protocol Land Sector and Removals Guidance includes many elements that are relevant for removals targets at the farm level, including details on target boundary-setting and requirements for ongoing storage monitoring, traceability, reversals accounting, and other elements that are relevant for farm-level indicators. In particular, the draft LSR guidance states that "[c]ompanies shall account for and report removals **only if there is ongoing storage monitoring of the relevant carbon pool(s), as specified through a monitoring plan, to demonstrate that the carbon remains stored or to detect losses of the stored carbon**" [emphasis added].[119] Guidance for the assessment of CO_2 removal outcomes at farm level will continue to emerge and should only be included along with a direct greenhouse gas reduction measure.

3.3. Animal Welfare Outcomes

The integration of livestock is one of the key elements of regenerative systems, as discussed in the review of definitions and terms in the Regenerative Agriculture Landscape Analysis. This emphasis reflects the important synergies that are possible between soil health, animal health, and human health in fully regenerative systems. Accordingly, animal health and welfare outcomes are a key element of this Framework. While this area of the Framework is designed to apply to systems where animal fiber or leather production is a key focus, all cropping and grazing systems that integrate livestock can benefit from consideration of these important outcomes.

In keeping with the first report's conclusion that outcome indicators should be developed to complement existing rigorous standards, the animal welfare outcomes in this Framework are designed to be an add-on module to the existing Textile Exchange Responsible Animal Fiber standards. In all cases, with some exceptions for their welfare, grazing animals must spend their lives on pasture.

Summary table: Animal welfare indicators

Outcome	Expectation	Ref #	Indicator	Unit	Stage	Application
Sufficient and varied nutrition		3.3.1.	Body Condition Score	1-5 on the BCS scale	Outcome	Farm Level
Comfort and expression of normal behavior		3.3.2.	Thermal comfort: Access to shade and shelter	Presence or absence	Input	Farm Level
Good health and welfare	Basket of Metrics: If applicable, select 1 or more from each Animal Welfare outcome	3.3.3.a.	Mortality rate	Reduction in % over time	Outcome	Farm Level
		3.3.3.b.	Lameness	Reduction in % over time	Outcome	Farm Level
		3.3.3.c.	Reduction in use of medications and antibiotics (while maintaining reductions in mortality rate and lameness)	Amount used per # of animals, and reduction over time as long as mortality does not increase	Outcome	Farm Level
Positive mental state		3.3.4.a.	Familiar human approach test	Closest human approach before flight response, in meters	Outcome	Farm Level
		3.3.4.b.	Measures of vocalization at time of handling	Duration, rate, frequency, or other characteristic of vocalization, depending on species	Outcome	Farm Level

Animal Welfare

3.3.1. Sufficient and varied nutrition

a. Body Condition Score

As described by the European Animal Welfare Indicators Project (AWIN), Body Condition Score (BCS) is "a standardized method to estimate the amount of fat on a sheep's body. The body condition score measures the balance between intake and expenditure of energy, and is known to be related to feeding motivation."[120] Because of its relationship to other animal health issues, BCS is considered to be an outcome indicator of animal health and welfare.

Unit: 0-5 on the BCS scale

References:

AWIN, 2015. "AWIN Welfare Assessment Protocol for Sheep."
https://dx.doi.org/10.13130/AWIN_sheep_2015

General reference: Mellor, D., 2016. "Moving beyond the 'Five Freedoms' by Updating the 'Five Provisions' and Introducing Aligned 'Animal Welfare Aims.'" *Animals* 6. 59.
https://doi.org/10.3390/ani6100059

Method/SOP: See AWIN guidance above

Animal Welfare

3.3.2. Comfort and expression of normal behavior

a. Thermal comfort: access to shade and shelter

Unit: Presence or absence

Reference: AWIN, 2015. "AWIN Welfare Assessment Protocol for Sheep."
https://dx.doi.org/10.13130/AWIN_sheep_2015

Notes: Access to shade and shelter can be considered an input measure rather than an outcome measure. However, because it is very challenging to measure heat stress or cold stress in animals unless it is extreme, access to shade and shelter is a humane indicator to determine whether animals are able to maintain thermal balance.

Method/SOP: See AWIN guidance above

Animal Welfare

3.3.3. Good health and welfare

a. Mortality rate

As AssureWel notes in its animal welfare guidelines for sheep, "High levels of mortality are not only often associated with suffering but also represent a significant economic loss to the farmer … It is possible to reduce deaths through good hygiene, nutrition, management, breed selection, vaccination, parasite monitoring etc."[121] Thus, mortality rate can be considered a general outcome of overall animal welfare practices on the farm.

Unit: Reduction in % mortality over time

Reference: AWIN, 2015. "AWIN Welfare Assessment Protocol for Sheep."
https://dx.doi.org/10.13130/AWIN_sheep_2015

Notes: Some Framework reviewers suggested developing a mortality indicator that is tied to regional norms. The data for such a comparison are not fully developed yet, but work is underway in this area and will be tracked for inclusion in future versions of the Framework.

Method/SOP: See AWIN guidance above

b. Lameness

Unit: Reduction in % lameness over time

Reference: AWIN, 2015. "AWIN Welfare Assessment Protocol for Sheep."
https://dx.doi.org/10.13130/AWIN_sheep_2015

Notes: As with mortality above, Framework reviewers suggested a lameness indicator pegged to industry norms. Full data for this benchmarking, however, are missing. The Textile Exchange Animal Fiber Round Table will be working on mapping the key regions and data needed during 2023.

Method/SOP: See AWIN guidance above

c. Reduction in use of medications and antibiotics

Unit: Amount used per # of animals, and reduction over time **so long as** mortality does not increase

Reference: AWIN, 2015. "AWIN Welfare Assessment Protocol for Sheep." https://dx.doi.org/10.13130/AWIN_sheep_2015

Method/SOP: See AWIN guidance above

Animal Welfare

3.3.4 Positive mental state

a. Familiar human approach test

As described by AWIN, "this test measures the ability of a stockworker to properly examine the animals by measuring the response of animals to the normal method of approach." This can be seen as an outcome indicator reflecting the quality of the trust and relationship between animal and human.

Unit: Closest possible distance of approach before a flight response is triggered, measured in meters. If animals remain motionless at approach, record as 0 meters. If animals move towards the human and interact with them voluntarily, this should be noted.

Reference: AWIN, 2015. "AWIN Welfare Assessment Protocol for Sheep." https://dx.doi.org/10.13130/AWIN_sheep_2015

Method/SOP: See AWIN guidance above

b. Measures of vocalization at time of handling

Laurijs et al. (2021) assessed vocalizations in farm animals as a tool for welfare and assessment and concluded that "[o]verall, a combination of vocalisations and other measures of emotions could be a promising on-farm tool to monitor positive emotions."

Unit: Duration, rate, frequency, or other characteristic of vocalization, depending on species (see reference for species-specific notes).

Reference: Laurijs, K.A. et al., 2021. "Vocalisations in farm animals: A step towards positive welfare assessment." *Applied Animal Behaviour Science*, Volume 236. https://doi.org/10.1016/j.applanim.2021.105264.

Notes: The useful reference above assesses two questions: 1) What aspects of animal vocalizations can be measured? and 2) Which types of vocalizations may be linked to positive emotions, within and across farm animal species? The review also includes details on the practical implementation of vocalizations as an on-farm outcome indicator for positive animal emotions.

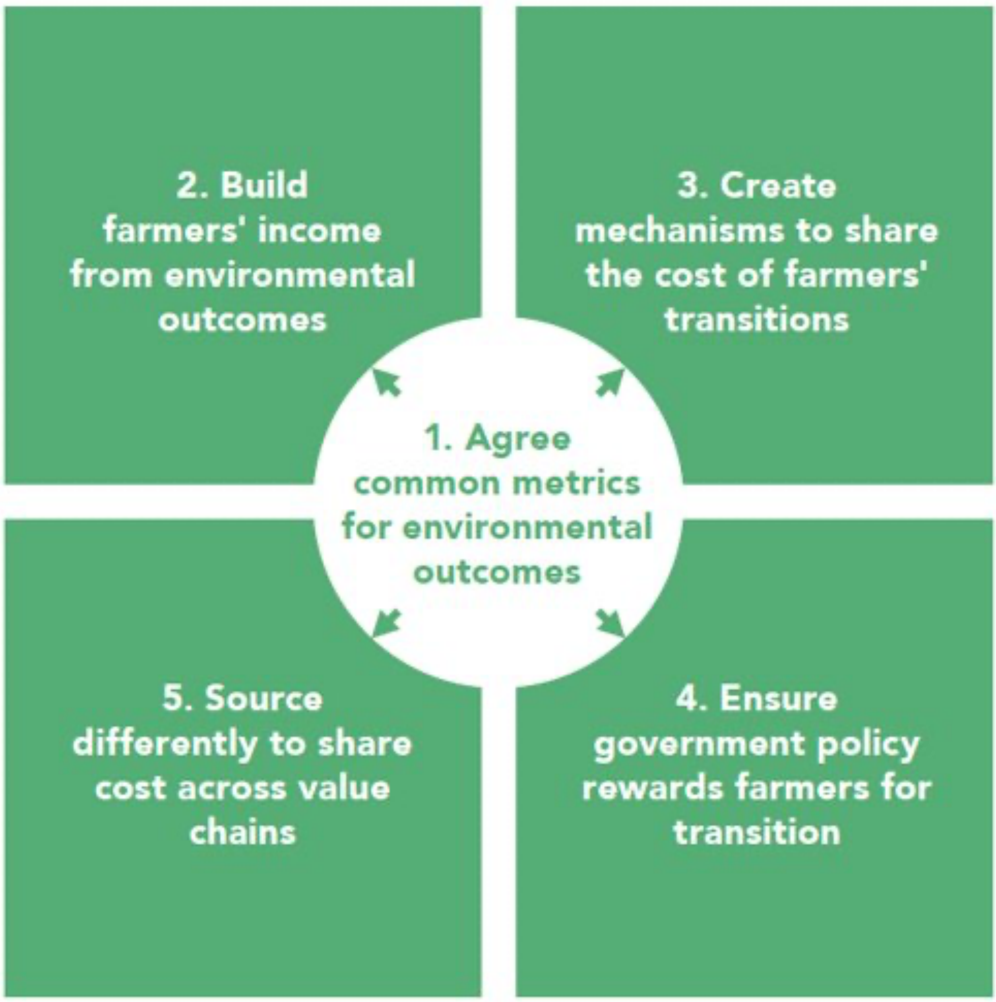
Method/SOP: See reference above.

4. Conclusions and Next Steps

The Textile Exchange Regenerative Agriculture Outcome Framework is a starting place for much-needed alignment on the indicators used by the fashion, textile, and apparel industry, as well as the food industry, to assess progress towards regenerative outcomes.

As the Sustainable Markets Initiative clearly illustrates in the figure below, this work is not about identifying indicators for their own sake. Instead, aligned outcome indicators are a tool to unlock much broader changes and benefits. Aligned indicators will also support the emerging area of farmer-centric data governance, allowing farmers to benefit from farm-level data that is essential for setting and meeting brand- and landscape-level targets.

These developments will in turn set the stage for the critical expansion of holistic regenerative systems in the short window remaining to meet interconnected climate and biodiversity targets and preserve safe and just Earth systems for all species.



122

Next steps

As the Food and Land Use Coalition (FOLU) report notes, "[f]armer experiences are often missing from the discussion and the development of metrics for reporting. Without building on practitioner experiences and needs, contextually relevant solutions may be missed—resulting in unintended consequences."[123]

In recognition of this fact, this Regenerative Agriculture Outcome Framework is being released in "Version One" form to reflect our ongoing commitment to piloting and refinement in partnership with the Textile Exchange Regenerative Agriculture Community of Practice and broader community. The Framework will be tested through the Textile Exchange Round Table Working Groups, commencing in summer 2023.

Additional companies, project developers, and farm groups are welcome to test the Framework and help us refine it in future versions. For more details and to get involved, visit: https://textileexchange.org/knowledge-center/reports/regenerative-agriculture-outcome-framework/

The testing process will further help identify tools, resources, on-the-ground partners, and emerging technologies that will be essential to scaling the co-benefits of regenerative agriculture within the critical window for industry progress on our Climate+ goals.

Outcome Framework future development timeline

Task	Q2 2023	Q3 2023	Q4 2023	Q1 2024	Q2 2024
Outcome Framework V1 release					
Round Table Working Groups call opens					
Testing: Round Table Working Groups					
Pilot testing: Public pilots by interested parties					
Review testing results by Impact Measurement and Regenerative Agriculture CoP					
Draft Outcome Framework V2					
Stakeholder feedback period					
Release of Outcome Framework V2 (and reporting mechanism)					

Appendices

Appendix 1: Development process and stakeholder consultation detail

A1.1. Inventory of outcome frameworks

The research process began with an inventory of existing outcome-based frameworks and indicators for regenerative agriculture and closely related fields such as agroecology. Emphasis was placed on frameworks that were developed to be used by multiple brands or projects and are open source, to the greatest extent possible. These included:

- ISEAL / 3Keel: Performance metrics for key sustainability issues
- Delta Framework
- OP2B / WBCSD Regenerative Agriculture Framework
- VF Corporation Regenerative Partner Guidelines
- Terra Genesis Regenerative Outcome Verification™
- Regenerative Fund for Nature (Kering and Conservation International)
- Science Based Targets for Nature guidance
- FSC Ecosystem Services Procedure
- REEL Regenerative Code
- FAO Tool for Agroecology Performance Evaluation (TAPE)
- Soil Health Institute North American Project to Evaluate Soil Health Measurements (NAPESHM)
- Sustainable Development Performance Indicators (UNRISD)

Many of these frameworks themselves included the assessment of dozens—or even hundreds—of potential indicators to arrive at their final selections.

Additional sources consulted included:

- Soil Science literature as referenced in indicators above
- Biodiversity literature as referenced in indicators above
- Food and Land Use Coalition report
- Sustainable Markets Initiative report
- Metrics research from other sectors, e.g. MSCI climate metrics
- Database for global soil health assessment
- Living Income and living wage research / Anker Methodology
- OEDC Due Diligence guidance
- Global Soil Laboratory Network (GLOSOLAN)—including current and forthcoming SOPs
- Ecological Health Index
- New Zealand Merino Company ZQ^{RX} Framework

This research was supplemented by specific calls with internal Textile Exchange experts and representatives from a limited set of other known multi-brand frameworks listed above.

A1.2. Textile Exchange Regenerative Community of Practice high-level review

Drawing on the sources above, the first draft of the Outcome Framework was developed and brought to the Textile Exchange Community of Practice (CoP) for initial review. In the Regenerative CoP meeting on February 16, 2023, participants were divided into six breakout groups and asked to consider the following questions and comment using a Jamboard tool.

1) How closely does the Framework match with the types of indicators you are already measuring?
2) How would you use this Framework in your organization or programs? Refer to "intended uses."
3) What do you think would be needed to help producers/programs you are working with use this Framework?

The breakout sessions generated a high level of response and individual "sticky note" comments in the Jamboard. Selected responses for each of the questions are included in Appendix 2.

A1.3. Expert review process

After revision based on initial CoP input, a survey was used to set up a detailed review process comprising expert/technical reviewers as well as selected members of the CoP. This list was combined with input from Textile Exchange's Fiber Leads and the project consultant on key categories of stakeholders and individual reviewers, to ensure a balance among perspectives and areas of expertise as follows:

- Aimed for balance between brands, NGOs, professional services, larger farms, and smallholder farms
- Aimed for geographic diversity and representation across crop and fiber types
- Included subject matter experts on human rights, livelihoods, fair financing, soil, water, biodiversity, and animal welfare

Based on the process above, we provided a total of 70 expert reviewers with the Framework to review in the week of March 6, 2023. Responses were requested on the following specific questions:

- What specific comments do you have on the indicators that are already included in the Framework baskets?
- Are there indicators you think should be added to a particular basket of metrics? Why?
- What comments do you have on the number of metrics currently recommended within each basket?
- Other comments or feedback.

Reviewers were notified that: "The project team will review all comments received, but due to constraints of project scope, space and usability of the Framework, and the definitions and guiding principles of the Textile Exchange Regenerative Landscape Analysis, we do not guarantee that all comments can be addressed in the Framework."

We received a total of 40 sets of responses from a set of stakeholders representing the key stakeholder categories and areas of expertise mentioned above. Responses were collated into one Excel spreadsheet so that patterns for responses could be observed across indicators—both those currently included and those that reviewers identified as missing.

A1.4. Framework revisions

After intensive review of the detailed Expert Review feedback, the following major adjustments and additions were made:

1) Clarify and reinforce message that producers are not expected to implement monitoring for regenerative outcomes alone. Include additional indicators suitable for assessment of change over time by producers who are, as one reviewer put it, “exceptionally experienced in reading the land.”

2) Move brand-level indicators to a separate “Brand Expectations” section. Reinforce message that companies must share cost and risk with growers and meet basic criteria before projects can be considered fully regenerative.

3) A total of 18 new indicators were added in key categories, as suggested by reviewers:

- Additional indicators appropriate for smallholder and resource-constrained growers;
- More "positive progress" indicators for areas including synthetic inputs and animal welfare;
- Additional biodiversity and water indicators, including alignment with the newly released Science Based Targets for Nature;
- Yield diversity and income diversity indicators to reflect integrated farming approaches; and,
- Additional farm-level well-being and opportunity indicators that go beyond income.

4) Point to additional guidance on how to measure:

- Include more references to specific sampling protocols;
- Include a section for “emerging measurement tools” in this Background document; and,
- Clarify the relationship with key industry processes like SBTN as they are refined.

Specific details on reviewer feedback and responses were recorded in an Excel tracking sheet.

Appendix 2: Selected comments from CoP High Level Review, 2.16.23

Comments have been lightly edited for clarity.

1) How closely does the Framework match with the types of indicators you are already measuring?

Room 1:
- These are all essential things [aspects] of what I view as regenerative agriculture. It more depends on which indicators there are within each of these baskets.
- "Brands and farmers share cost and risks" is a new one I'm seeing. Often talked about but not included as a standard metric.
- I also appreciate that many of these focus on generating positive outcomes instead of just reducing negative ones

Room 2:
- Ensuring alignment with SBTI and GHG Protocol, SBTN methodologies will be critical.
- Specify between farmer livelihoods and farm worker livelihoods
- Look at social/cultural regeneration and improvement metrics from TGI—beyond just risk management

Room 3:
- Getting primary data from the field for retailers can be challenging—so this needs to be considered in the methodology of what level of aggregation of data is acceptable.
- Close alignment with ecological outcomes—really value the inclusion of social indicators, however not clear what metrics would be identified for measurement
- Appreciate the holistic nature (inclusion of social indicators etc.)
- This is influencing what indicators we will track as our program matures

Room 4:
- Bolt on approach is positive!
- Important for TE to get alignment with the food sector
- Exciting development, perfect fit for current partnerships
- Refreshing to recognize existing standards and avoid audit fatigue

Room 5:
- Producer based framework. More direction is required for brands.
- How can we support as brands to support these outcomes?
- Feel that we are focusing on many of the ecological, animal welfare, and economic indicators; haven't been as focused on the social indicators in the regen space
- Very closely but I like the social equity pieces—agreed that they are more process-oriented than measurable but important to highlight

Room 6:
- Indicators from framework match [our] program measurements
- Ecological measurements are tracked, animal welfare is something not yet monitored but looking into it and economic viability is also measured

- Our KPIs are overall in line with the Framework. We are adjusting them depending on the project. Curious to know what would be the recommended indicators for the OECD Due Diligence.

Room 7 (post-meeting input):

- How is it taken into account when e.g., soil health improvement has "improved to the limit"/plateaued, and cannot be "improved" anymore?
- What happens if the farmer follows the practices but [the] outcome doesn't come [within]the expected timeline?

2) How would you use this Framework in your organization or programs? Refer to the 'intended uses'

Room 1:

- To learn about what works and how to measure and report results. We have been doing and learning along the way and that has been challenging.
- Select best reg ag practices for the local context; adapt based on outcomes
- Hotspot areas and better focus our work on the implementation side.
- "We can easily communicate if this outcome needs extra investment"
- To look at strengths/areas for improvement for various regen ag programs we are interested in pursuing
- To identify common desired outcomes across very varied regenerative programs (different agricultural systems, different regions, etc.)

Room 2:

- For brands—key use case is vetting and guiding project partners
- Consider how to strike the right balance between flexibility for producers and ability to roll up information into an aggregate
- Support brands in research related to measures that indicate improvement in these impact areas

Room 3:

- Defining a consistent and holistic framework/definition across different materials
- "North star" of measurement across different projects in different regions, among different crops/fibers
- Leverage this framework so that separate regenerative engagements can speak to a holistic intention—interested to understand how context-specific can be layered on
- Advise on SBTi alignment and carbon footprint, GHG inventory, and product footprint calcs and strategy
- Provide a list of questions for sourcing teams who are directly engaging with supply chain, a starting point for a vetting process in absence of a certification scheme

Room 4:

- Shows if we are actually trending forward / maintaining — how can we feed back to farmers and ranchers on the ground?
- Shared definition between brands and the supply chain—recognizing flexibility is required
- Improved consumer communications—to avoid confusion/greenwashing
- Align on the indicators we should be measuring and how to measure them—to avoid reoccurring need to go back to the producers (different stakeholders asking them)

Room 5:
- Top use would be that we would use the framework as an evaluation criteria for regen programs/standards/certifications
- Would primarily use this to benchmark programs, standards, or certification to assess their level of 'regeneration'
- Use it as common framework to follow when reporting on our own regenerative projects or program
- Can also use as a direction of travel for engaging producers that are just starting off on the journey, or use in smaller direct sourcing pilot programs

Room 6:
- currently testing regen frameworks and expecting to provide measurements on outcomes of regenerative practices and use this to scale
- Will use framework to inform the developing regen strategy
- Use framework to understand and tailor the specific aspects of regen to a given region
- As a checklist and guidance to make sure our own framework is aligned with industry needs. Will help for data sharing between different projects / organizations

Room 7:
- We are both a supplier and a brand. The intended uses for both are spot on.

3) What do you think would be needed to help producers / programs you are working with use this Framework?

Room 1:
- Farmers should own their data and be compensated for it
- Tech & data collection systems to ease the data collection process
- Defined data needed in order to create a common impact for regenerative practices
- Committed buyers to ensure data collection and practice adoption will be rewarded

Room 2:
- Always center in meeting farmers where they are—do not establish "minimum practices or standards"
- It is unclear how a producer would come across this guidance document. What does that process look like? Knowing this would be helpful to answering this question.
- Ensure producers have information on baselines—what good looks like in different regions/production systems
- Ensure clarity of modularity—measuring everything is super expensive and resource-consuming

Room 3:
- How can this framework be inclusive of separate geographic baselines? I.e., Success would look different across systems and contexts. Is that the purpose of Framework?
- How do you define an indicator for working with Indigenous communities? Does this speak to regen efforts at smallholder/mid/large scale

- A consideration of how the monitoring & audits will be carried out, and how to make it manageable for the producers
- Clarity on requirements at farm level, and scalability. Looks like big asks to growers, how do we share that burden?

Room 4:

- One size doesn't fit all—farmers, region, economic, social differences. Monitoring tool needs to be flexible to support this.
- Potential economic gain to farmers and ranchers —goal to have a measurement framework to have a new income stream
- Invest into a technology—remote sensing to gain data from soils and lands—without the farmer/rancher or company burden

Room 5:

- A standardized dashboard to track, etc.
- Also think some sense of the minimum outcomes that are needed to consider a program actually regenerative
- Making sure than brands come with the same (or similar) asks to the producers and growers should make the implementation of this framework easier
- Could be interesting (though tricky) to have threshold such as 'in transition to regenerative ag' in order to make sure that the framework also supports the transition

Room 6:

- Farmers are overwhelmed with new programs/certs, etc.—so need to have clear definitions of regen and measurements
- Traceability mechanisms throughout the supply chain
- Tools and resources to help implement the basket of indicators (on the ground partners that can help implement the framework)

Room 7:

- How would it make sure that farmers will choose to become regenerative and have the connections/means to do the extra work to measure the outcomes?

References

[1] The Food and Land Use Coalition, 2023. "Aligning regenerative agricultural practices with outcomes to deliver for people, nature and climate." https://www.foodandlandusecoalition.org/wp-content/uploads/2023/01/Aligning-regenerative-agricultural-practices-with-outcomes-to-deliver-for-people-nature-climate-Jan-2023.pdf, pg. 14.

[2] The Food and Land Use Coalition, 2023. "Aligning regenerative agricultural practices with outcomes to deliver for people, nature and climate," pg. 15.

[3] Simister, N., 2010. "Outputs, Outcomes and Impact." INTRAC, 2017. https://www.intrac.org/wpcms/wp-content/uploads/2017/01/outputs-outcomes-and-impact.pdf. Reference: OECD, "Glossary of Key Terms in Evaluation and Results Based Management." https://www.oecd.org/dac/evaluation/2754804.pdf.

[4] ISEAL Alliance, 2019. "Aligning and Combining: What we've learned about metrics and data sharing." https://www.isealalliance.org/get-involved/resources/aligning-and-combining-what-weve-learned-about-metrics-and-data-sharing, pg. 3.

[5] OECD, 2010. "Glossary of Key Terms in Evaluation and Results Based Management," pg. 25.

[6] City of Portland, Oregon, 2005. "Framework for Integrated Management of Watershed Health." APPENDIX G Selecting Indicators of Watershed Health, https://www.portlandoregon.gov/bes/article/108302.

[7] Food and Agriculture Organization of the United Nations, 2019. "TAPE: Tool for Agroecology Performance Evaluation 2019 – Process of development and guidelines for application. Test version." https://www.fao.org/documents/card/en/c/ca7407en/, pg. 13.

[7] Food and Agriculture Organization of the United Nations Agroecology Knowledge Hub, "Piloting the Tool for Agroecology Performance Evaluation (TAPE) in Mali and China." https://www.fao.org/agroecology/database/detail/en/c/1320371/.

[8] The Food and Land Use Coalition, 2023. "Aligning regenerative agricultural practices with outcomes to deliver for people, nature and climate," pg. 16.

[9] Kestel, J.H. et al., 2022. "Applications of environmental DNA (eDNA) in agricultural systems: Current uses, limitations and future prospects." Science of The Total Environment, Volume 847. https://doi.org/10.1016/j.scitotenv.2022.157556.

[10] The Biodiversity Consultancy and NatureMetric, 2021. "Using Environmental DNA to manage biodiversity risks." Briefing Note of The Biodiversity Consultancy, Cambridge, UK. https://www.thebiodiversityconsultancy.com/fileadmin/uploads/tbc/Documents/Resources/eDNA-and-biodiversity-risk-briefing-note.pdf

[11] Segarra, J. et al., 2020. "Remote Sensing for Precision Agriculture: Sentinel-2 Improved Features and Applications." *Agronomy* 10(5):641. https://doi.org/10.3390/agronomy10050641.

[12] Segarra, J. et al., 2020. "Remote Sensing for Precision Agriculture."

[13] Segarra, J. et al., 2020. "Remote Sensing for Precision Agriculture."

[14] Ogungbuyi, M.G. et al., 2023. "Enabling Regenerative Agriculture Using Remote Sensing and Machine Learning." *Land* 12, 1142. https://doi.org/10.3390/land12061142.

[15] See for example: https://agfundernews.com/remote-sensing-market-map; https://agfundernews.com/agri-carbon-market-map-companies-helping-harness-benefits-regen-ag

[16] Weiss, M. et al., 2019. "Remote sensing for agricultural applications: A meta-review." Remote Sensing of Environment. 236. https://doi.org/10.1016/j.rse.2019.111402.

[17] https://www.useyardstick.com/

[18] ARPA-E Technologies, Individual Projects, "A Rapid In-Field System to Measure Deep Soil C Stock," https://arpa-e.energy.gov/technologies/projects/rapid-field-system-measure-deep-soil-c-stock.

[19] https://arpa-e.energy.gov/technologies/projects/soil-organic-carbon-networked-measurement-system-socnet

[20] University of Illinois, 2020. "News Release: University of Illinois awarded $4.5 million to develop commercial carbon credit tools." https://www.eurekalert.org/news-releases/796910.

[21] Sworder, C. 2021. "Soil Mapping Technologies: Regenerative Agriculture, Soil Carbon Sequestration and Ecosystem Service Payments." Cleantech Group. https://www.cleantech.com/soil-mapping-technologies-regenerative-agriculture-soil-carbon-sequestration-and-ecosystem-service-payments/

[22] https://birdnet.cornell.edu/

[23] See for example: Kahl, S. et al., 2021. "BirdNET: A deep learning solution for avian diversity monitoring." Ecological Informatics, Volume 61. https://doi.org/10.1016/j.ecoinf.2021.101236.

[24] https://www.wildlifeacoustics.com/

[25] https://carbonrewild.com/services/

[26] https://faunaphotonics.com/

[27] https://faunaphotonics.com/faunaphotonics/in-the-cloud/#product-range

[28] Klein, J., "5 cool measurement tools attempting to quantify regenerative agriculture." GreenBiz, Feb. 11, 2021. https://www.greenbiz.com/article/5-cool-measurement-tools-attempting-quantify-regenerative-agriculture

[29] Three-step process developed by VF Corporation and gifted to Textile Exchange for use in conjunction with the Regenerative Outcome Framework.

[30] Accountability Framework Initiative, 2019. "Operational Guidance on Free, Prior and Informed Consent." https://accountability-framework.org/fileadmin/uploads/afi/Documents/Operational_Guidance/OG_FPIC-2020-5.pdf, pg. 2.

[31] Accountability Framework Initiative, 2019. "Operational Guidance on Free, Prior and Informed Consent," pg. 2.

[32] Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis." https://textileexchange.org/app/uploads/2022/01/Regenerative-Agriculture-Landscape-Analysis.pdf, pg. 49.

[33] Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose." Available at: https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf, pg. 67. See also McDowell, R.W., et al., 2020. "Global mapping of freshwater nutrient enrichment and periphyton growth potential." Sci Rep 10, 3568. https://doi.org/10.1038/s41598-020-60279-w.

[34] Science Based Targets Network, 2023. "Step 3: Measure, Set, Disclose: LAND (Version 0.3)." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Land-v0.3.pdf, pg. 5 (Executive Summary).

[35] Science Based Targets Network, 2023. "Step 3: Measure, Set, Disclose: LAND (Version 0.3)," pg. 6.

[36] Science Based Targets Network, 2023. "Step 3: Measure, Set, Disclose: LAND (Version 0.3)," pg. 56.

[37] Huckins, S., 2023. "Land Sector and Removals Guidance: Topline Themes from Stakeholder Feedback," https://ghgprotocol.org/blog/land-sector-and-removals-guidance-topline-themes-stakeholder-feedback.

[38] Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis," pg. 25.

[39] Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis," pg. 37.

[40] See https://www.ethosrov.com/case-studies

[41] Accountability Framework Initiative, 2019. "Operational Guidance on Free, Prior and Informed Consent," pg. 2.

[42] Accountability Framework Initiative, 2019. "Operational Guidance on Free, Prior and Informed Consent," pg. 2.

[43] Better Cotton / Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators." https://www.deltaframework.org/wp-content/uploads/2022/08/Delta-Framework-Sustainability-Indicators-3.pdf. pg. 52.

[44] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)." Front. Sustain. Food Syst. 4:579154. https://doi.org/10.3389/fsufs.2020.579154, Supplementary Material, pg. 31-33.

[45] FAO, 2019. "TAPE: Tool for Agroecology Performance Evaluation," pg. 28-29.

[46] Calo, A., 2020. "Who Has the Power to Adapt?" Frameworks for Resilient Agriculture Must Contend with the Power Dynamics of Land Tenure. *Front. Sustain. Food Syst.* 4:555270. https://doi.org/10.3389/fsufs.2020.555270

[47] Calo, A., 2020. "Who Has the Power to Adapt?"

[48] Better Cotton/Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators," pg. 39.

[49] Better Cotton/Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators," pg. 38.

[50] FAO, 2019. "TAPE: Tool for Agroecology Performance Evaluation."

[51] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)," pg. 9.

[52] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)," pg. 9.

[53] The Food and Land Use Coalition, 2023. "Aligning regenerative agricultural practices with outcomes to deliver for people, nature and climate," pg. 18 and 31.

[54] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)."

[55] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)."

[56] Komives, K. et al., 2015. "Defining, Calculating and Using a Living Income Benchmark in the context of Agricultural Commodities." Discussion note, working version May 2015. https://sustainablefoodlab.org/wp-content/uploads/2016/04/Living-Income-Discussion-Note-May-13-2015.pdf

[57] Living Income Community of Practice (LICOP), www.living-income.com/

[58] Global Living Wage Coalition, "What is a Living Wage?" https://www.globallivingwage.org/about/what-is-a-living-wage/.

[59] Singh, S. et al., 2020. "The association between crop and income diversity and farmer intra-household dietary diversity in India." *Food Sec.* 12, 369–390. https://doi.org/10.1007/s12571-020-01012-3, pg. 373.

[60] Singh, S. et al., 2020. "The association between crop and income diversity and farmer intra-household dietary diversity in India."

[61] FAO Committee on World Food Security, 2022. "CFS Policy Recommendations on Promoting Youth Engagement And Employment In Agriculture And Food Systems: Zero Draft – January 2022." https://www.fao.org/fileadmin/templates/cfs/Docs2122/Youth/Zero_Draft/CFS_Policy_Recs_Youth_Zero_Draft.pdf

[62] Duval, J. et al., 2021. "Livestock farmers' working conditions in agroecological farming systems. A review." Agron. Sustain. Dev. 41, 22. https://doi.org/10.1007/s13593-021-00679-y

[63] Duval, J. et al., 2021. "Livestock farmers' working conditions in agroecological farming systems. A review."

[64] Action Against Hunger / Action Contre La Faim, 2021. "Agroecology Monitoring Indicators: Monitoring the economic, social and agro-environmental effects of agroecology." https://www.actioncontrelafaim.org/wp-content/uploads/2022/01/Indicateurs-Agroecologique-EN-VF.pdf

[65] Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis," pg. 17-20, 28.

[66] FAO, Global Soil Partnership, "Standard Operating Procedures, Volume 2.1, pH." https://www.fao.org/global-soil-partnership/glosolan-old/soil-analysis/sops/volume-2.1/en/

[67] Soil Health Institute, 2022. "NAPESHM Intro Interpretive Summary." https://soilhealthinstitute.org/news-events/napeshm-intro-interpretive-summary/?highlight=NAPESH

[68] Soil Health Institute, 2022. "NAPESHM Intro Interpretive Summary."

[69] Soil Health Institute, 2022. "Interpretive Summary of the Technical Paper: A minimum Suite of Soil Health Indicators for North American Agriculture." https://soilhealthinstitute.org/news-events/a-minimum-suite-of-soil-health-indicators-for-north-american-agriculture/.

[70] Bagnall, D. K. et al., 2023. "A minimum Suite of Soil Health Indicators for North American Agriculture."

Soil Security, Volume 10. https://doi.org/10.1016/j.soisec.2023.100084.

[71] Tracy, P., 2020. "The North American Project to Evaluate Soil Health Indicators (NAPESHM) Indian Head

Agricultural Research Foundation – Soil and Crop Management Seminar & AGM." https://iharf.ca/wp-content/uploads/2020/02/The-North-American-project-to-evaluate-soil-health-indicators-Paul-Tracy.pdf.

[72] Cornell University, Comprehensive Assessment of Soil Health – The Cornell Framework (Version 3.2). https://soilhealth.cals.cornell.edu/manual/.

[73] Ward Laboratories Inc., 2019. "Haney Test Interpretation Guide v1.0." https://www.wardlab.com/wp-content/uploads/2019/09/Haney-Rev-1.0-Interpretation-Guide.pdf.

[74] Andrews, S.S. et al., 2004. "The Soil Management Assessment Framework." Soil Sci. Soc. Am. J., 68: 1945-1962. https://doi.org/10.2136/sssaj2004.1945.

[75] Stott, D.E. 2019. "Recommended Soil Health Indicators and Associated Laboratory Procedures." Soil Health Technical Note No. 450-03. U.S. Department of Agriculture, Natural Resources Conservation Service. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=44475.wba.

[76] See table at: https://www.fao.org/global-soil-partnership/glosolan-old/soil-analysis/sops/volume-2-2/en/

[77] Soil Health Institute, "Microbial Community Structure and Cmin Interpretive Summary," https://soilhealthinstitute.org/news-events/microbial-community-structure-and-cmin-interpretive-summary/

[78] Morgan, C.L.S. et al., 2020. "Assessing Soil Health: Soil Carbon Cycling and Storage." Crops & Soils Mag., 53: 43 - 47. https://doi.org/10.1002/crso.20076, pg. 46.

[79] Liptzin, D. et al., 2022. "An evaluation of carbon indicators of soil health in long-term agricultural experiments," Soil Biology and Biochemistry, Volume 172. https://doi.org/10.1016/j.soilbio.2022.108708.

[80] Medina-Sauza, R. M. et al., 2019. "Earthworms Building Up Soil Microbiota, a Review." Frontiers in Environmental Science, Vol. 7. https://doi.org/10.3389/fenvs.2019.00081.

[81] Soil Health Institute, 2022. "Comparing Aggregate Stability Methods." https://soilhealthinstitute.org/news-events/comparing-aggregate-stability-methods/

[82] Morgan, C.L.S., 2020. "Assessing Soil Health: Soil Water Cycling." Crops & Soils Mag., 53: 35-41. https://doi.org/10.1002/crso.20064

[83] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)."

[84] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE)."

[85] FAO, 2019. "TAPE: Tool for Agroecology Performance Evaluation."

[86] FAO Agroecology Knowledge Hub, "Piloting the Tool for Agroecology Performance Evaluation (TAPE) in Mali and China." https://www.fao.org/agroecology/database/detail/en/c/1320371/.

[87] Medina-Sauza, R. M. et al., 2019. "Earthworms Building Up Soil Microbiota, a Review."

[88] Walter, K. et al., 2016. "Determining Soil Bulk Density for Carbon Stock Calculations: A Systematic Method Comparison." Soil Science Society of America Journal 80(3). https://doi.org/10.2136/sssaj2015.11.0407, pg. 2.

[89] Walter, K. et al., 2016. "Determining Soil Bulk Density for Carbon Stock Calculations: A Systematic Method Comparison," pg. 12.

[90] Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance: Draft for Pilot Testing and Review, September 2022." https://ghgprotocol.org/sites/default/files/standards_supporting/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-1.pdf, pg. 45.

[91] Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance: Draft for Pilot Testing and Review, September 2022," pg. 4.

[92] Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance: Draft for Pilot Testing and Review, September 2022," pg. 85-91.

[93] Lankford, B. and Orr, S., 2022. "Exploring the Critical Role of Water in Regenerative Agriculture; Building Promises and Avoiding Pitfalls." Frontiers in Sustainable Food Systems, Vol. 6. https://doi.org/10.3389/fsufs.2022.891709.

[94] Morgan, C.L.S., 2020. "Assessing Soil Health: Soil Water Cycling."

[95] Lankford, B. and Orr, S., 2022. "Exploring the Critical Role of Water in Regenerative Agriculture; Building Promises and Avoiding Pitfalls."

[96] Morgan, C.L.S., 2020. "Assessing Soil Health: Soil Water Cycling."

[97] Lankford, B. and Orr, S., 2022. "Exploring the Critical Role of Water in Regenerative Agriculture; Building Promises and Avoiding Pitfalls."

[98] Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis," pg. 49.

[99] Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose," pg. 67.

[100] Science Based Targets Network, 2023. "Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose," pg. 18.

[101] Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis," pg. 88.

[102] ISEAL and 3Keel, 2020, "Performance Metrics for Key Sustainability Issues." https://www.isealalliance.org/get-involved/resources/performance-metrics-key-sustainability-issues; see Excel table accompanying report.

[103] Xu, S. et al., 2019. "Ecological Health Index: A Short Term Monitoring Method for Land Managers to Assess Grazing Lands Ecological Health." Environments, 6, 67. https://doi.org/10.3390/environments6060067.

[104] For the original source of the EHI Indicators, see Tongway, D. and Hindley, N.L., 2004. "Landscape Function Analysis: Procedures for Monitoring and Assessing Landscapes - with Special Reference to Minesites and Rangelands." CSIRO Australia. https://www.researchgate.net/publication/238748160.

[105] Xu, S. et al., 2019. "Ecological Health Index: A Short Term Monitoring Method for Land Managers to Assess Grazing Lands Ecological Health," pg. 1.

[106] Xu, S. et al., 2019. "Ecological Health Index: A Short Term Monitoring Method for Land Managers to Assess Grazing Lands Ecological Health," pg. 4.

[107] Gill, B. "Ecological Health Index Study Published by MSU & Ovis 21," July 3, 2019. https://savory.global/ecological-health-index-study-published-by-msu-ovis-21/

[108] Roswell, M. et al., 2021. "A conceptual guide to measuring species diversity." Oikos, 130: 321-338. https://doi.org/10.1111/oik.07202, pg. 1. See also: Valdez, J.W. et al., 2023. "The undetectability of global biodiversity trends using local species richness." Ecography, e06604. https://doi.org/10.1111/ecog.06604.

[109] Roswell, M. et al., 2021. "A conceptual guide to measuring species diversity," pg. 324.

[110] Roswell, M. et al., 2021. "A conceptual guide to measuring species diversity," pg. 327.

[111] Mazur, E. et al., 2023. "Science Based Targets for Land Version 0.3 – Supplementary Material. SBTN Natural Lands Map: Technical Documentation." https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Land-v0.3-Natural-Lands-Map.pdf

[112] Science Based Targets Network, 2023. "Step 3: Measure, Set, Disclose: LAND (Version 0.3)."

[113] The Food and Land Use Coalition, 2023. "Aligning regenerative agricultural practices with outcomes to deliver for people, nature and climate," pg. 21.

[114] Díaz, M. et al., 2021. "Long-Term Tree Regeneration of Fragmented Agroforestry Systems Under Varying Climatic Conditions." *Frontiers in Ecology and Evolution*, Volume 9, https://doi.org/10.3389/fevo.2021.640143.

[115] Textile Exchange, 2022. "Regenerative Agriculture Landscape Analysis,"pg. 25.

[116] Mottet, A. et al., 2020. "Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE).".

[117] The Food and Land Use Coalition, 2023. "Aligning regenerative agricultural practices with outcomes to deliver for people, nature and climate," pg. 17.

[118] Better Cotton / Delta Framework Team, 2022. "Delta Framework: Sustainability Indicators." Greenhouse Gas Emissions, pg. 34.

[119] Greenhouse Gas Protocol, 2022. "Land Sector and Removals Guidance, Draft for Pilot Testing and Review, Part 1," pg. 22.

[120] AWIN, 2015. "AWIN Welfare Assessment Protocol for Sheep." https://dx.doi.org/10.13130/AWIN_sheep_2015 pg. 21.

[121] AssureWel, "Mortality: Why is it measured?" http://www.assurewel.org/sheep/mortality.html

[122] Sustainable Markets Initiative, 2022. "The Sustainable Markets Initiative Agribusiness Task Force—Scaling Regenerative Farming: An Action Plan." https://a.storyblok.com/f/109506/x/7b102e6831/agribusiness-task-force-white-paper.pdf

[123] The Food and Land Use Coalition, 2023. "Aligning regenerative agricultural practices with outcomes to deliver for people, nature and climate," pg. 5.