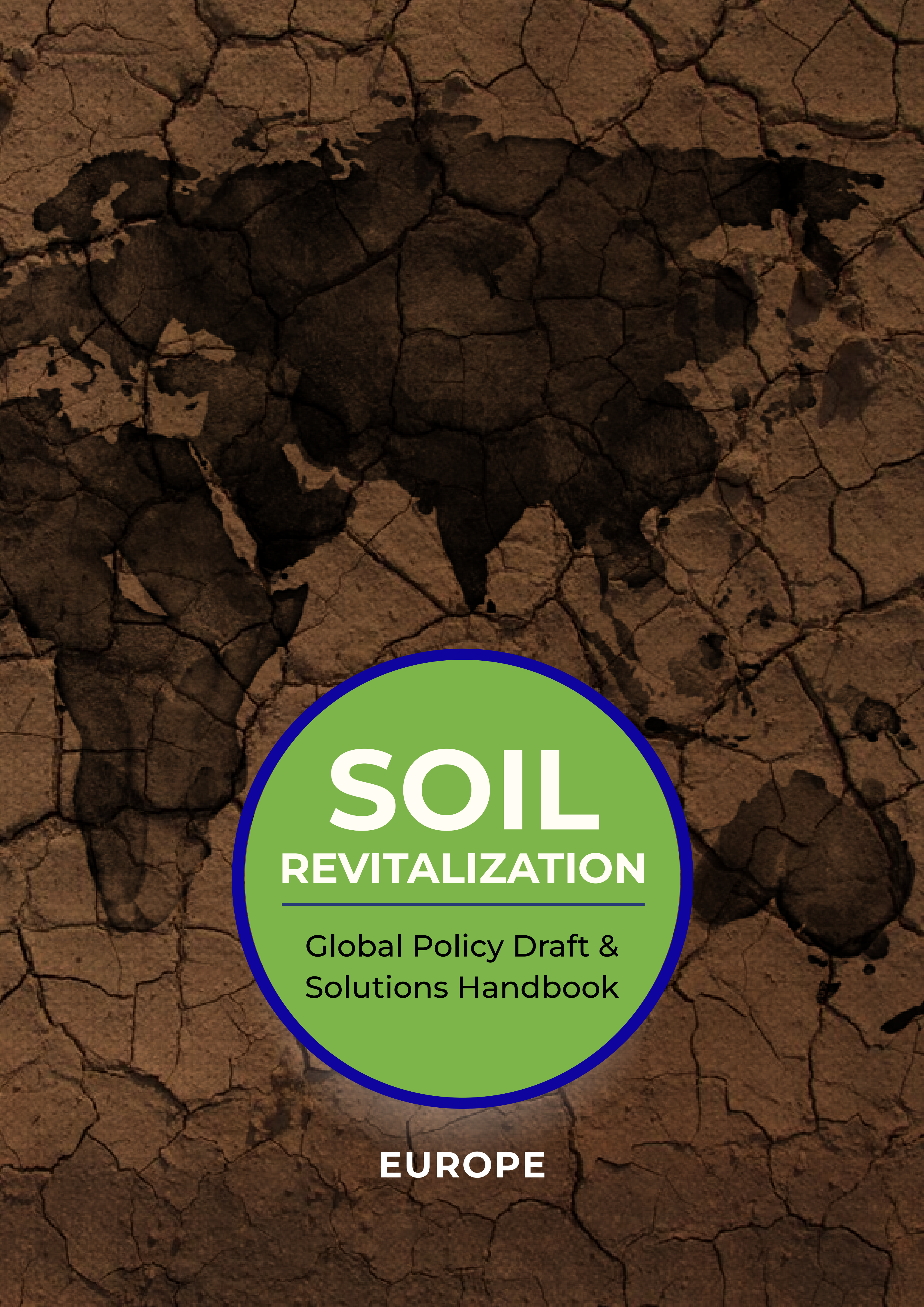


SOIL REVITALIZATION

Global Policy Draft & Solutions Handbook

EUROPE

SOIL REVITALIZATION

Global Policy Draft & Solutions Handbook

EUROPE

Cover design, typesetting, book layout, compilation,
and chapter illustrations done by Conscious Planet Inc.

Published by:
Conscious Planet Inc.
725 Cool Springs Blvd, Suite 245
Nashville, TN 37067

info@consciousplanet.org
consciousplanet.org

Table of Contents

Introduction

Global warming, pollution, deforestation – these are all well-known aspects of the environmental crisis that we face right now. Yet, very few have noticed the elephant in the room: soil degradation. This is the most immediate challenge before us. All terrestrial life, including ours, is sustained by just a few inches of topsoil. For the extremely fragile life that we are, our actions have been too reckless and whimsical, raining unprecedented damage upon this precious resource.

According to the United Nations (UN), we may have only 60 years of cultivable soil left. We are losing one acre of fertile soil every second. This means in the near future, agriculture will not yield sufficient food for human populations. We are quietly but surely speeding towards disastrous famines on a global scale.

The good news is that we can reverse this catastrophe if we act now. Conscious Planet's Save Soil Movement is an effort to awaken citizens around the world to the state of soil, and urge their governments to frame and execute the necessary policies to regenerate soil.

This book seeks to offer practical, scientific solutions that governments can put into action to revitalize the soil in their nation. Please note, this is a sincere effort to develop a policy for soil regeneration on the planet, based on soil types, latitudinal positions, and agricultural traditions of a given nation. It is a draft soil policy document which is subject to various inputs from scientists. Anyone who is knowledgeable in this field is most welcome to send any contributions they may have to enrich the soil policy. All such inputs will definitely be considered. Please feel free to email your contributions to info@consciousplanet.org.

In Chapter 1, we delve into how soil degradation has happened and the ramifications for ecology and human society. Chapter 2 briefly covers the components of soil biology and explains how the fundamental solution to revitalizing soil is to bring back its organic content. We also look at the principles of sustainable soil management practices. In Chapter 3, we assess current policy ecosystems and provide policy recommendations to revitalize soil. Lastly, Chapter 4 details Conscious Planet's approach to sustainable soil management solutions based on agroecological zones and soil types for various regions of the world.

Healthy soil is the right of our future generations. A global concerted effort is the need of the hour to save soil. Let us make it happen.

CHAPTER 1: Why Soil and Why Now?

It is common knowledge today that human behavior has altered the environment on a planetary scale. In the pursuit of making our lives easier through technological advancements, we began obliterating the very basis of all our comforts: nature itself. We are pushing the limits of our natural resources and systems – soil, water, and air; we are living in opposition to the natural systems that provide for our existence. It is time to wake up to the fact that we are axing the tree branch on which we are precariously seated.

To reverse this ecological degradation that we have unleashed, and restore the planet for future generations, we must turn to the soil.

Soil is at the center of the natural systems and cycles of our planet. Unfortunately, this critical resource is undergoing tremendous damage across the world. According to the most recent Food and Agriculture Organization (FAO) report, "The State of the World's Land and Water Resources for Food and Agriculture (SOLAW)", 2021, there has been an alarming trend of land resource exploitation.[1] Fifty-two percent of the world's agricultural land is already degraded.[2] If current trends are not arrested, 90% of the Earth's land surface could be degraded by 2050.[3] Considering that 95% of the food we eat comes from land,[4] and that 87% of the planet's biomass is land-based,[5] the ongoing destruction of soil holds truly terrifying implications for life on Earth.

1.1 Agriculture – The Problem and Solution for Soil

One does not have to look far to find the primary driver of global land degradation. It is on our plates!

---

1. *The State of the World's Land and Water Resources for Food and Agriculture (SOLAW).* (2021). Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/land-water/solaw2021/en/

2. Stewart, N., & Etter, H. (eds.). (2015). Report for policy and decision makers: Reaping economic and environmental benefits from sustainable land management. *Economics of Land Degradation (ELD) Initiative.* http://www.eld-initiative.org/fileadmin/pdf/ELD-pm-report_08_web_72dpi.pdf

3. *World Soil Day 2020: Keep soil alive, protect biodiversity.* United Nations Convention to Combat Desertification (UNCCD). https://www.unccd.int/news-events/world-soil-day-2020-keep-soil-alive-protect-biodiversity

4. *Global Symposium on Soil Erosion: Key Messages.* Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/about/meetings/soil-erosion-symposium/key-messages/en/

5. Bar-On, Y. M., Phillips, R., & Milo, R. (2018). The biomass distribution on Earth. *PNAS, 115*(25). https://www.pnas.org/content/115/25/6506

Half of the world's soil can be found in agricultural lands, and the rest is in uncultivable lands in mountains, deserts, etc. By and large, the deteriorating state of soil that we see today is a result of the conventional agriculture that is prevalent throughout the world. The present systems of farming and food systems often treat soil as an inert material upon which agricultural activity – growing crops and fodder, and animal rearing – is practiced. This system of farming refuses to recognize the living ecosystems that inhabit soil in the form of microbes, bacteria, fungi, nematodes, vertebrates, mites, earthworms, arthropods, birds, etc. and which interact symbiotically with plant life that grows on the soil.

This failure to acknowledge soil ecosystems has exacerbated the condition of soils across the world. While there are many facets to soil degradation, one of the most important ones is the measure of Soil Organic Matter (SOM).[6]

1.2 Soil Organic Matter

Soil Organic Matter can be defined as "any material produced originally by living organisms (plant or animal) that is returned to the soil and goes through the decomposition process."[7] The signs of declining SOM and strain on the soil ecosystems include: reduction or stagnation of crop yields, desertification of lands, reduced water holding capacity, reduced nutritive value of produce grown on these soils, and increased contribution of these lands to global warming through accelerated carbon dioxide release.

Sufficient SOM is key to ensuring healthy soil as it preserves the soil's life-sustaining physicochemical properties and structure. Healthy soil, in turn, is central to correcting ecological damage which is a consequence of human activity. In the following sections, we look deeper into the ramifications of soil degradation, both in terms of ecology and humanitarian crises, and how increasing SOM can counter them. These ramifications include: hunger, nutritional poverty, water scarcity, climate change, biodiversity loss and unrest in society.

---

6. Obalum, S. E., Chibuike, G. U., Peth, S., & Ouyang, Y. (2017). Soil organic matter as sole indicator of soil degradation. *Environmental Monitoring and Assessment, 189*, 176. https://doi.org/10.1007/s10661-017-5881-y

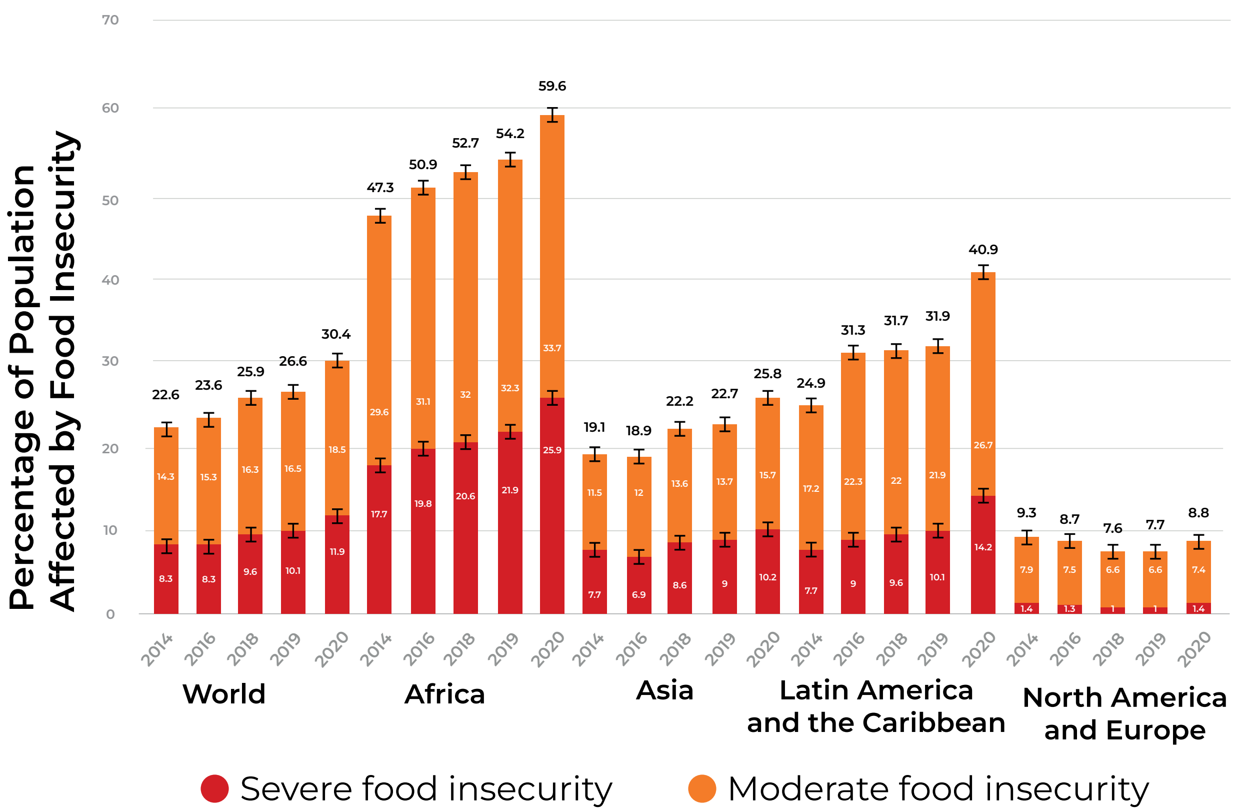
7. Bot, A., & Benites, J. (2005). The importance of soil organic matter: Key to drought-resistant soil and sustained food production. *Food and Agriculture Organization of the United Nations (FAO).* https://www.fao.org/3/a0100e/a0100e04.htm

1.3 Hunger

According to the HungerMapLIVE, the World Food Programme's Hunger monitoring platform, as of January 27, 2022, there are 826 million people across 92 countries who do not have access to sufficient food.[8] The future continues to look bleak. According to the FAO's "The State of Food Security and Nutrition in the World (SOFI)", 2021, there will be 660 million people hungry in 2030, falling woefully short of the goal to eliminate world hunger by 2030.

Moderate or severe food insecurity at the global level has gradually risen between 2014 and 2020, and affects more than 30% of humanity. Figure 1 shows the rise in food insecurity in various regions of the world.

Figure 1: Food Insecurity Index[9]

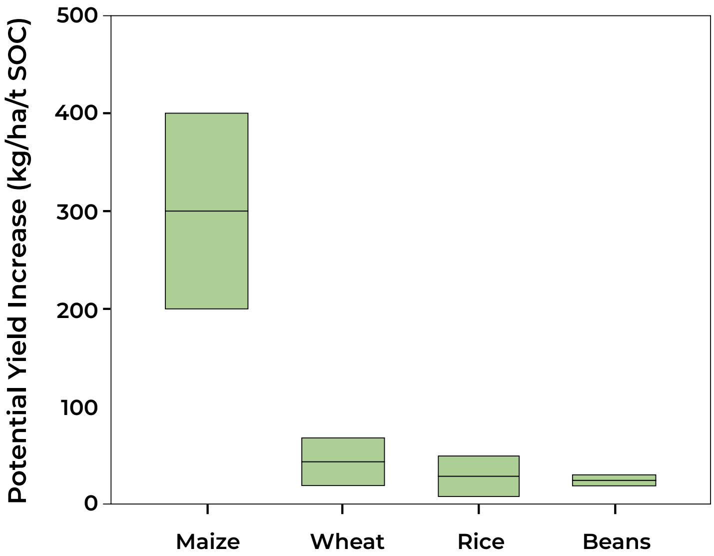


8. *HUNGERMAP: Global insights and key trends.* (2022). https://static.hungermapdata.org/insight-reports/latest/global-summary.pdf

9. *The State of Food Security and Nutrition in the World (SOFI)*. Food and Agriculture Organization of the United Nations (FAO). (2021). https://www.fao.org/state-of-food-security-nutrition

If soils are healthy, with a good amount of SOM, it not only increases soil fertility and therefore crop yields (Figure 2), but also makes crops more resilient to climate shocks. This can, in turn, play a huge role in tackling world hunger. The positive correlation between SOM and crop yields and the health of the farm has been well established by experts. In fact, at the Conference of the Parties (COP) held in 2019, the United Nations Convention to Combat Desertification (UNCCD) urged that soil organic carbon (SOC) be conserved to combat desertification.[10]

Figure 2: Potential yield increase per tonne SOC for each crop species (maize, wheat, rice and beans).[11]



1.4 Nutritional Poverty – Malnourishment

Malnutrition, in all its forms, includes undernutrition (wasting, stunting, underweight), inadequate vitamins or minerals, overweight, obesity, and resulting diet-related noncommunicable diseases. According to the World Health Organization (WHO), almost one in three people in the world suffered malnutrition in 2017.[12]

10. *UN urges soil organic carbon conservation to fight desertification*. Sci Dev Net. (2019). scidev.net/asia-pacific/news/un-urges-soil-organic-carbon-conservation-to-fight-desertification/

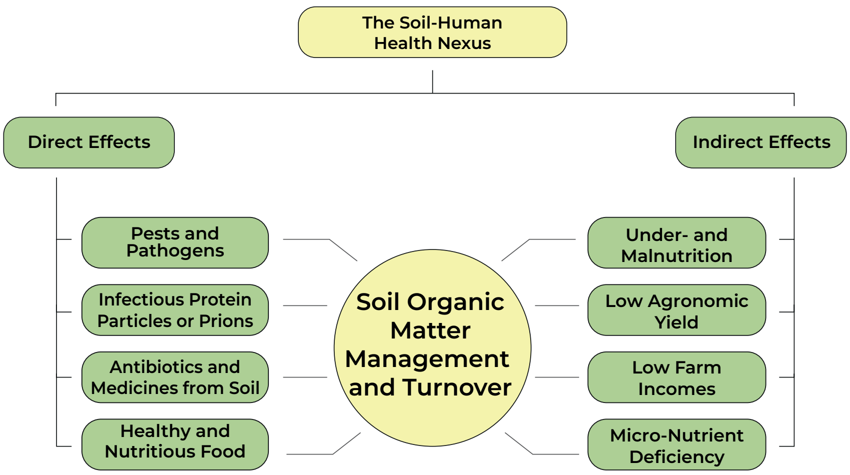
11. Lal, R. (2011). Sequestering carbon in soils of agro-ecosystems. *Food Policy, 36*(1), S33–S39. https://doi.org/10.1016/j.foodpol.2010.12.001

12. *The double burden of malnutrition: Policy brief.* World Health Organization (WHO). (2017). https://www.who.int/publications/i/item/WHO-NMH-NHD-17.3

One significant reason for this malnourishment is that food itself lacks sufficient nutrients. Deficiency of micronutrients in degraded soil, which takes place due to the depletion of SOM, is an important factor impacting human health.[13] A study in the United States found that compared to the early 20th century, levels of calcium, magnesium and iron in vegetables like cabbage, lettuce, spinach and tomatoes have reduced by 80–90%.[14] A similar study that analyzed twenty vegetables in the United Kingdom found that on average, calcium levels had declined by 19%, iron by 22% and potassium by 14%.[15] There exist similar findings for India as well,[16] indicating that this is a global phenomenon.

According to numerous studies, there is a positive correlation between SOM and nutrient supply systems of soil. Even to ensure the effective uptake of fertilizers applied to the soil from outside, SOM plays a critical role. Thus, increase in SOM leads to reduction in risk of nutritional poverty (Figure 3).

Figure 3: Direct and indirect effects of soil health on human health through SOM management and turnover.[17]



13. Lal, R. (2009). Soil degradation as a reason for inadequate human nutrition. *Food Security, 1(1),* 45–57. https://doi.org/10.1007/s12571-009-0009-z

14. Workinger, J. L., Doyle, R. P., & Bortz, J. (2018). Challenges in the diagnosis of magnesium status. *Nutrients.* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6163803/

15. Mayer, A. M. (1997). Historical changes in the mineral content of fruits and vegetables. *British Food Journal, 99*(6), 207–211. https://www.emerald.com/insight/content/doi/10.1108/00070709710181540/full/html

16. Kukreti, I. (2017). Protein levels are rapidly declining in all foods in India. *Down To Earth.* www.downtoearth.org.in/news/food/protein-levels-are-rapidly-declining-in-all-foods-in-india-58121

17. Lal, R. (ed.). (2020). *The Soil-Human Health-Nexus.* CRC Press.

1.5 Water Scarcity

Global freshwater resources are under pressure. Water stress is high across all basins that are intensely irrigated and densely populated. While Europe faces low levels of water stress[18] at 8.3%, East Asia, Western Asia, Central & South Asia, and Northern Africa face stress levels of 45%, 70%, more than 70% and above 100%, respectively. The rate of withdrawal is greater than the rate of replenishment in many basins. If this continues, water scarcity in the world will become even more severe. This will multiply the pressure on existing resources.

It has been proven that an increase in SOM leads to increased porosity of soil. These pores act as storage space for water to be held in the soil. This water is then readily available to plants and microbes in the soil.[19] Although this sounds simple, to understand the enormity of this process, we must keep in mind that water stored in the soil meets about 90% of the water demand for global agricultural production.[20,21] According to Jehangir *et al.*, increasing SOM by just 1% can increase soil's water holding capacity by up to 20,000 gallons per acre.[22]

Adding to the stress of water scarcity is the pollution of freshwater bodies due to agricultural chemicals used by conventional practices – in the form of fertilizers, pesticides, livestock pharmaceuticals, plastics, etc. that run off from farms. Of the total pollution of water bodies, agricultural water pollution in the form of agricultural effluents contributes 56%, amounting to 1260 km^3 a year.

Soil can act as a significant filter of water-borne pollutants. The pores of the soil act like any other physical filtration material. Additionally, when soil is rich with organic matter, the soil biota decompose the chemicals and contaminants that enter the

---

18. Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use.

19. Rabot, E., Wiesmeier, M., Schlüter, S., & Vogel, H.-J. (2018). Soil structure as an indicator of soil functions: A Review. *Geoderma, 314*, 122–137. https://doi.org/10.1016/j.geoderma.2017.11.009

20. Sposito, G. (2013). Green Water and Global Food Security. *Vadose Zone Journal, 12*(4). https://doi.org/10.2136/vzj2013.02.0041

21. Kim, Y. J., Jung, J. Y., & Mishra, U. (2021). Managing soil organic carbon for climate change mitigation and food security. *Soil Organic Carbon and Feeding the Future*, 25–46. https://doi.org/10.1201/9781003243090-2

22. Bhadha, J. H., Capasso, J. M., Khatiwada, R., Swanson, S., & LaBorde, C. (2017). Raising soil organic matter content to improve water holding capacity. *EDIS*. https://doi.org/10.32473/edis-ss661-2017

soil through excessive use of fertilizers or other chemicals.[23] Therefore, the solution to address water pollution from agricultural sources lies in increasing SOM.

1.6 Climate Change

While fossil fuels are consistently blamed for climate change, very rarely is the role of agriculture acknowledged. Around a third of the greenhouse gas emissions since 1850 can be directly attributed to changes in land use on the planet.[24]

Around 133 gigatons of carbon (GtC) have been emitted into the atmosphere since the dawn of agriculture via loss of SOM and soil erosion,[25, 26, 27] and 379 GtC through forest clearing and burning.[28, 29] In general, 50–70% of soil carbon stocks in cultivated soil have been lost.[30] Agricultural fields today often contain less than 2% SOM,[31] whereas SOM in grasslands or forests usually amounts to 8–15% or even more. This reflects the potential of soils under agriculture. On the other hand, if the soils of the world are not revitalized, global warming could cause 230 billion tonnes of carbon

---

23. Day, M. (2015). Want clean water? Filter with soil. *Michigan State University Extension.* https://www.canr.msu.edu/news/want_clean_water_filter_with_soil

24. *Putting carbon back where it belongs – the potential of carbon sequestration in the soil.* Foresight. United Nations Environment Programme. (2019). https://wedocs.unep.org/bitstream/handle/20.500.11822/28453/Foresight013.pdf

25. Lal, R. (2018). Digging deeper: A holistic perspective of factors affecting soil organic carbon sequestration in Agroecosystems. *Global Change Biology, 24*(8), 3285–3301. https://doi.org/10.1111/gcb.14054

26. Sanderman, J., Hengl, T., & Fiske, G. J. (2018) Soil carbon debt of 12,000 years of human land use. *Proceedings of the National Academy of Sciences, 114*(36), 9575–9580. https://www.pnas.org/content/114/36/9575

27. Teague, W. R., Apfelbaum, S., Lal, R., Kreuter, U. P., Rowntree, J., Davies, C. A., Conser, R., Rasmussen, M., Hatfield, J., Wang, T., Wang, F., & Byck, P. (2016). The role of ruminants in reducing agriculture's carbon footprint in North America. *Journal of Soil and Water Conservation, 71*(2), 156–164. https://doi.org/10.2489/jswc.71.2.156

28. Zomer, R. J., Bossio, D. A., Sommer, R., & Verchot, L. V. (2017). Global sequestration potential of increased organic carbon in cropland soils. *Scientific Reports,* 7(1), 15554. https://doi.org/10.1038/s41598-017-15794-8

29. Machmuller, M. B., Kramer, M. G., Cyle, T. K., Hill, N., Hancock, D., & Thompson, A. (2015). Emerging land use practices rapidly increase soil organic matter. *Nature Communications,* 6(1), 6995. https://doi.org/10.1038/ncomms7995

30. Zomer, R. J., Bossio, D. A., Sommer, R., & Verchot, L. V. (2017). Global sequestration potential of increased organic carbon in cropland soils. *Scientific Reports,* 7(1), 15554. https://doi.org/10.1038/s41598-017-15794-8

31. Beste, A. (2018). What is Europe's agriculture doing to the soil. *Agricultural and Rural Convention.* https://www.arc2020.eu/andrea-beste-soil-matters/

dioxide to be released into the atmosphere due to carbon loss from heating of the soil. This is more than all of humanity's emissions in the last 30 years combined.[32]

1.7 Biodiversity

The larger ecosystems across water and land have been under threat for many generations now. In this context, how we treat agricultural soil is significant as 87% of biomass on the planet is terrestrial.[33] Alarmingly, every year we are losing 27,000 species from the soil habitat in the tropics alone.[34] It is well proven that the two major factors for the loss in biodiversity are loss of SOM and intensive exploitation by humans.[35]

1.8 Peaceful Society

There are over 688 million people who live in abject poverty, 75% of whom come from rural areas with agriculture as their occupation. Their livelihoods depend on the quality of soil. If soil continues to degrade, then the number of people in abject poverty will only rise.[36]

In an advanced and developed economy like the European Union, a farmer on an average earns only half of what can be earned through other jobs.[37] This is leading to fewer younger people taking up agriculture in Europe. Less than 15% of EU farmers fall into the bracket of 35–44 years of age and this percentage is only decreasing.[38] Similar trends can be observed in poor African, Asian and Middle-Eastern farming

32. *Warming of 2°C would release billions of tons of soil carbon*. Science Daily (2020). https://www.sciencedaily.com/releases/2020/11/201102072915.htm

33. Bar-On, Y. M., Phillips, R., & Milo, R. (2018). The biomass distribution on Earth. *PNAS*. https://www.pnas.org/content/115/25/6506

34. Wilson, E. O. (1999). *The Diversity of Life*. W.W. Norton & Company.

35. Larbodière, L., Davies, J., Schmidt, R., Magero, C., Vidal, A., Arroyo Schnell, A., Bucher, P., Maginnis, S., Cox, N., Hasinger, O., Abhilash, P. C., Conner, N., Westerburg, V., & Costa, L. (2020). Common ground: Restoring land health for sustainable agriculture. *IUCN*. https://doi.org/10.2305/iucn.ch.2020.10.en

36. Bourguignon, F., & Bussolo, M. (2013). Income distribution in computable general equilibrium modeling. *Handbook of Computable General Equilibrium Modeling, 1*, 1383–1437. https://doi.org/10.1016/b978-0-444-59568-3.00021-3

37. *CAP Specific Objectives – Ensuring viable farm income*. European Commission. (2018). https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/cap_specific_objectives_-_brief_1_-_ensuring_viable_farm_income.pdf

38. *CAP Specific Objectives – Structural change and generational renewal*. European Commission. (2019). https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/cap-briefs-7-structural-change_en.pdf

communities. In short, no farmer's child wants to be a farmer in much of the world. The present farming practices, the risks associated with agriculture, and the incomes do not present a sensible means of livelihood for anyone. If this continues, one has to wonder, who will feed the world a few decades from now?

Furthermore, degraded soils are forcing an exodus from rural areas to cities, putting higher pressure on urban areas. According to a report published by the Institute for Economics and Peace, 1 billion people living in vulnerable areas of sub-Saharan Africa, Central Asia and the Middle East may be forced to migrate by 2050.[39]

Improving SOM can provide an effective solution in securing the livelihoods of the vast majority of the world's poor, preventing mass migrations and the security repercussions that follow, and is key to establishing a peaceful and thriving human society.

1.9 SOM and Sustainable Development Goals

The areas of concern listed in this chapter are incorporated, along with other factors, into the seventeen UN Sustainable Development Goals (SDGs). The SDGs provide "a shared blueprint for peace and prosperity for people and the planet, now and into the future."[40] Increasing SOM and revitalizing soil will address four SDGs directly and eight indirectly. These are presented in Figure 4.

39. Baker, L. (2020). More than 1 billion people face displacement by 2050 – Report. *Reuters.* https://www.reuters.com/article/ecology-global-risks-idUSKBN2600K4

40. *Sustainable Development Goals.* Department of Economic and Social Affairs, Sustainable Development. United Nations. https://sdgs.un.org/goals

Figure 4: Increasing SOM and revitalizing soil addresses (a) four SDGs directly, and (b) eight SDGs indirectly.

(a) SDGs directly addressed

(b) SDGs indirectly addressed

CHAPTER 2: Revitalizing Soil – The Principal Solution

2.1 Soil Diversity

Soil is a naturally occurring three-dimensional body that has been formed due to the combined influence of climate and living organisms acting on parent rock material, as conditioned by the terrain over a period of time.

Just as the inception, development and adaptations of plants and animals are a product of the environment, similarly, a particular soil profile is a product of the climate, rock and vegetation. As there is considerable variety in climate, organisms, parent rock and terrain, their combinations number in the thousands. For example, in the United States alone, there are 14,000–15,000 different soils,[1] known technically as "soil series."

For ease of study, research and management, the thousands of different soils in the world are categorized in a soil taxonomy pyramid with the broadest level of categorization being "soil order." In the past, various systems of soil classification were followed across the world by organizations such as the USDA and FAO. In 2015, they were unified under one system of classification, the World Reference Base (WRB). In this publication we have adhered to the WRB's system of soil classification with 34 groupings of different soil types.

2.2 Agriculture Based on Soil Type

Any external intervention affects the equilibrium of the soil ecosystem. It is thus important that farmers understand the delicate balance of their soil ecosystem before they work with the soil. Soil cannot be viewed as just a mere medium that supports plants, and we cannot claim one common prescription for cultivating the numerous soil types. In fact, the rapid deterioration found in the world's soils today is a consequence of not taking into consideration the diversity and the unique equilibrium of each soil type.

The majority of current conventional agricultural practices do not produce optimal results because they are not calibrated for the specific soil profile of the land. Instead, blanket interventions are applied. For example, two farmers use the same nutritional supplements though their crops and soil types are very different; or some farmers

---

1. Smith, G., (2003) The Guy Smith Interviews: Rationale for concepts in Soil Taxonomy. *National Soil Survey Center, Natural Resources Conservation Service, U.S. Department of Agriculture*. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051535.pdf

overutilize fertilizers while others underutilize for a given soil type. These blanket approaches have contributed to the large-scale failure of agriculture that we are seeing today.

Calibrating agricultural practices for a specific soil type depends on various attributes of the soil. A detailed analysis of how each component of a soil type influences what agricultural practices are applicable to it would run into hundreds of pages. The Conscious Planet team has collated and cataloged successful country-specific Sustainable Soil Management (SSM) practices from around the world, which stem from an understanding of each country's specific soil types and its thermal climatic zone. These can be found on our website: savesoil.org.

However, regardless of the complexity of each soil type, when it comes to soil productivity, the answer largely boils down to SOM as a common factor. Therefore, in this publication, we will focus on how to increase SOM in agricultural lands. If we have to achieve this, we must first understand a little more about what SOM is.

2.3 Humus

One of the main components of SOM is humus. Humus is organic matter that is the result of a food chain, in which a series of organisms feed on dead plant and animal residue. Humus and weathered rock form the solid portion of the soil. Together they form a clay-humus complex, or a bond between clay particles and humus, which is not easily broken down, as it is not so reactive with other compounds. Therefore, humus is one of the most stable forms of organic matter.

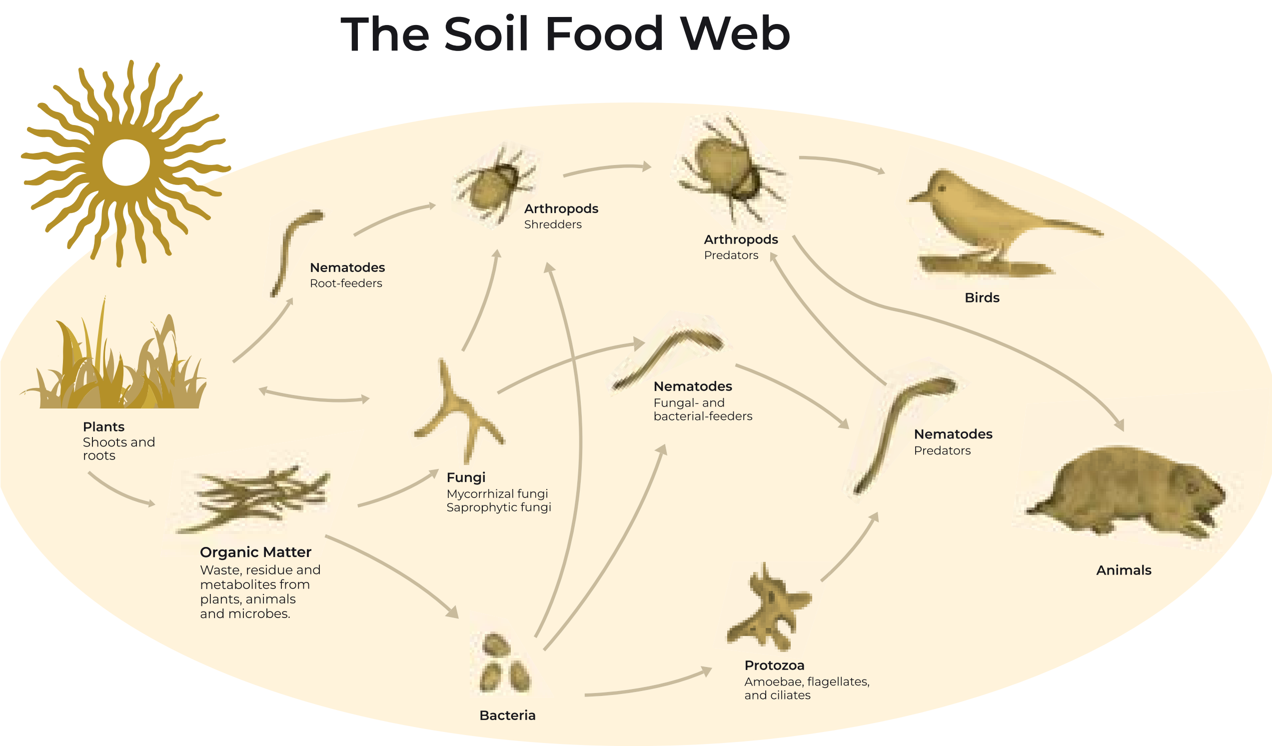
When there is sufficient humus, the soil will be porous in structure, which means there are numerous air pockets. These allow plant roots to easily grow. More humus also increases the soil's ability to absorb and retain water. Humus is also a vital source of nutrients for plants. Thus, increasing SOM is an integral part of soil health and sustainable agriculture.

2.4 The Soil Food Web

Soil organic matter is inextricably linked to the soil biome. Soil biology comprises macrofauna like moles, spiders and earthworms; plant roots; and microorganisms like bacteria, amoebae and fungi. These soil organisms are important not only as individual species but also in terms of how they interact with each other. As with any other food chain, these interactions are not linear. Rather, they are a complex web, which Dr. Elaine Ingham, a pioneer researcher in soil biodiversity, describes as "the soil food web". This is depicted in Figure 1.

When in balance, organisms interact with each other and create a thriving ecosystem. Before the advent of fertilizers, for millions of years, these organisms supplied the nutrients that plants needed.

Figure 1: Relationships between microbes, plants, organic matter, and birds and mammals. (Source: USDA Natural Resources Conservation Service[2])



First trophic level: Photosynthesizers	**Second trophic level:** Decomposers, Mutualists, Pathogens, parasites, Root-feeders	**Third trophic level:** Shredders, Predators, Grazers	**Fourth trophic level:** Higher level predators	**Fifth and higher trophic levels:** Higher level predators

2. Ingham, E. R. (n.d.) Soil Food Web. *Natural Resources Conservation Service. United States Department of Agriculture.* https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053868

Macrofauna, through their movement and the network of underground galleries, help aerate the soil, increase water percolation and recycling of insoluble and soluble chemicals. They also ensure that soil of various depths mixes well, thereby making mineral nutrients from deeper layers of soil accessible to plant roots. Their excrement is also an important source of nutrients for plants.

Plant roots penetrate the soil, open up its compact structure, and secrete exudates.[3] These exudates serve as food for microorganisms and are essential for healthy soil with a diverse microbial population. The plants produce these exudates through the process of photosynthesis.

Microorganisms in the soil are of various kinds. They receive food, directly or indirectly, from plant roots, and in turn make nutrients available to plants in a form that plants can consume. These microorganisms collectively self-regulate their populations based on the type of plant life growing in the soil. Together they form a dynamic soil biome.

Bacteria constitute the most varied and numerous group among the microorganisms. Some bacteria feed on mineral matter in the soil, while others feed on organic matter. In the process, they transform the chemistry of the soil, and make mineral nutrients available to plants. Without the bacteria, plants would not be able to absorb the minerals they need from the soil. Other types of bacteria feed on nitrogen in the atmosphere and fix it into nitrogen compounds in the soil (nitrates), which are then absorbed by plants. There are even bacteria that perform photosynthesis.

Bacteria are the first organisms to consume organic matter. For example, when a blade of grass falls on the ground, the bacteria break down the cellulose fiber of the grass. The cellulose gets converted into lignin fibers which remain within the bacterial cells. The bacteria are in turn eaten by amoebae, and the lignin fibers are set free.

3. Root exudates refer to a suite of substances in the rhizosphere that are secreted by the roots of living plants and microbially modified products of these substances. They consist of low-molecular-weight organic compounds that are freely and passively released root-cell material and mucilage associated with roots.

Fungi further break down the lignin fiber and form humus – an incredibly important constituent of fertile soil. Fungi also provide the physical support to hold soil particles together in their mycelium nets.[4] This ensures the structural stability of the soil.

Amoebae (protozoa) are the regulators of the microbial world, among the many other functions they perform. When there are too many bacteria in the soil, it becomes inhospitable for fungi. Amoebae keep the bacterial population in control and thus allow the fungi to function as well. A hectare of soil can contain around 100–300kg of protozoa.[5]

Actinomycetes are a specific category of bacteria which are intermediaries between fungi and other bacteria. They can secrete antibiotics like fungi and carry out biochemical reactions like other bacteria. They also contribute to the formation of humus, especially in the process of composting. The antibiotics they generate can pasteurize unwanted germs in the compost. They also mineralize organic matter, thus providing food for plants.

Algae live only on the surface of soil since they function through photosynthesis. They play the important role of fixing nitrogen into the soil.

2.5 Soil Organic Matter – A Single-Point Focus to Revive Soil

The present state of soil with its very poor SOM is the outcome of anthropogenic disturbance of the soil food web. The web is now broken and, as a consequence, there is large-scale soil degradation and erosion, and our food security and several other aspects are at stake.

The soil biome is sensitive to both heat and humidity. In conventional agriculture, the earth is opened wide with a plow, exposing the organisms. This leads to heating of the land and also loss of soil moisture through evaporation, which harms the soil food web. Additionally, the unbridled and injudicious use of fertilizers, herbicides and pesticides has destroyed some of the critical links in the soil food web.[6]

4. Mycelium is the vegetative part of a fungus or fungus-like bacterial colony, consisting of a mass of branching, thread-like hyphae.

5. Bourguignon, C. (2005). *Regenerating the Soil: From Agronomy to Agrology*. Other India Press.

6. Ingham, E. R., & Slaughter, M. D. (2004). The soil foodweb-soil and composts as living ecosystems. *First International Conference Soil and Compost Eco-Biology*. León, Spain.

There are many ways in which the soil biome can be restored. It may take a few months to a few years depending on the land management practices adopted, and how scientifically suitable it is to the crops being grown. As there are specific nutritional requirements for different crops, which are specified by a Package of Practices, there is also a specific soil biome composition for each crop. If one can catalyze the development of that specific soil biome, soil will be regenerated.

The Save Soil Movement of Conscious Planet is the culmination of 20 years of work with farmers, dealing with various levels of degraded lands. All of this experience points towards one thing: the only solution to address all the issues ailing agricultural soil in the world is to have a single point focus on increasing the Soil Organic Matter (SOM) to a minimum of 3–6%.

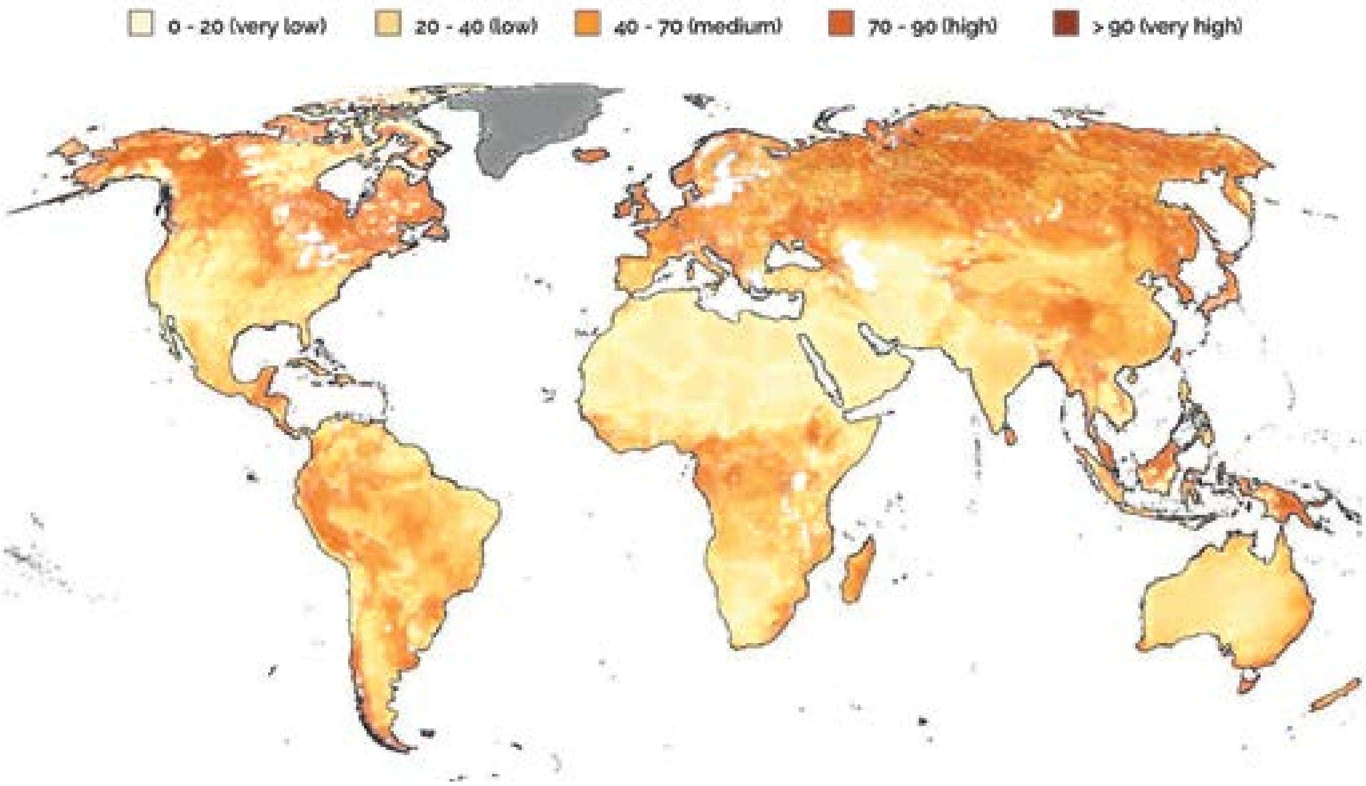
Although this solution may seem simplistic, increasing SOM will nourish soil biology and bring life back to the soil and, in the process, address soil degradation, soil erosion, water scarcity, climate change and the larger wellbeing of society. It is imperative that farmers are supported to adopt relevant sustainable soil management practices, like agroforestry and natural farming methods, that will improve SOM and soil fertility, as well as their own livelihood. Such practices will convert large swathes of degraded soil back into fertile soil by creating an environment for all soil life forms to thrive.

Soil testing labs are instrumental in helping farmers decide on the appropriate soil biology interventions in their lands. At present, soil testing predominantly tests the physical and chemical properties of the soil, not the soil biology. Soil testing labs run by governments across the world should also test for SOM, soil biological activity, the soil microbiome (bacteria, fungi, etc.). Farmers would need to test the biological parameters of their soil once every crop cycle to see the nutrient abstraction from crops grown and therefore assess the amount of organic matter and specific nutrients that need to be recycled back into the soil.

There are a few enterprises in the United States and India, which conduct soil biology tests for farmers. The testing can be conducted pre-harvest and post-harvest to assess the soil biology activity. These laboratory tests currently cost up to USD 200 per test. However, advances are being made with which field-testing kits in the market will be able to deliver results for less than USD 10 per test.

Map 1 shows the amount of Soil Organic Carbon (SOC)[7] across the globe. SOC and SOM are directly correlated, and it can be observed that most of the world's soil has less than 3% SOM.

Map 1: Global Soil Organic Carbon, 2019 (tonnes/ha)[8, 9]



2.6 Principles and Practices of Sustainable Soil Management

A number of agricultural practices have been found to be effective in improving SOM in farms across the world. Apart from the economic benefits that all these practices bring for farmers – better yields and higher incomes – the common fundamental

7. SOM = 1.7 x SOC

8. In the legend of the map, the conversion of SOC (tonnes/ha) to percentage SOC and percentage SOM is approximately as follows:
0–20 tonnes/ha SOC equals less than 0.5% SOC or less than 0.85% SOM
20–40 tonnes/ha SOC equals 0.5–1% SOC or 0.85–1.7%% SOM
40–70 tonnes/ha SOC equals 1–1.75% SOC or 1.7–2.98% SOM
70–90 tonnes/ha SOC equals 1.75–2.25% SOC or 2.98–3.83% SOM
> 90 tonnes/ha SOC equals more than 2.25% SOC or more than 3.83% SOM

9. *The State of the World's Land and Water Resources for Food and Agriculture (SOLAW)*. (2021). Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/land-water/solaw2021/en/

principle lies in Sustainable Soil Management (SSM) that is specific to crop types grown on particular soil types in particular agro-ecological land conditions. There are different SSM principles for land used for cropping and grazing.

General SSM Principles for Croplands

There are many systems of SSM for agricultural lands, such as Conservation Agriculture practices,[10] Climate Smart Agriculture,[11] and Integrated Soil Fertility Management,[12] which can be found in well curated databases such as that of the FAO and the World Overview of Conservation Approaches and Technologies (WOCAT), among others. We have cataloged some of these practices and details of country-specific case studies, the soil types and agroecological zone(s) in Chapter 4.

Some of the generic SSM practices for croplands that can be followed to regenerate soil are: no till or minimum till on land; ensure soil is always under shade and shielded from wind; growing leguminous cover crops; use of green manure for cover / mulch (summer and winter cover crops); increase the diversity of crops grown on soil; crop rotations; integration of animals; recycling green manure and animal waste; and scientific and judicious chemical usage.

Outcomes of SSM Practices for Croplands

Broadly, all SSM practices for agricultural land will have the following characteristics:[13]

- Minimal rates of soil erosion by water and wind.
- The soil structure is not degraded (e.g. soil compaction) and provides a stable physical context for movement of air, water, and heat, as well as root growth.
- Sufficient surface cover (e.g. from growing plants, plant residues, etc.) is present to protect the soil.

---

10. *The Three Principles of Conservation Agriculture*. Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/conservation-agriculture/en/

11. *Climate-Smart Agriculture*. Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/climate-smart-agriculture/en/

12. Fairhurst, T. (ed.). (2012). Africa Soil Health Consortium: *Handbook for Integrated Soil Fertility Management*. CABI Publishing.

13. Baritz, R., Wiese, L., Verbeke, I., & Vargas, R. (2017). Voluntary guidelines for sustainable soil management: Global action for healthy soils. *International Yearbook of Soil Law and Policy 2017,* 17–36. https://doi.org/10.1007/978-3-319-68885-5_3

- The store of SOM is stable or increasing and close to the optimal level.
- Availability and flow of nutrients are appropriate to maintain or improve soil fertility and productivity, and to reduce their losses to the environment.
- Soil salinization, sodification and alkalinization are minimal.
- Water (e.g. from precipitation and irrigation) is efficiently infiltrated and stored to meet the requirements of plants, and the drainage of any excess is ensured.
- Contaminants are below toxic levels.
- Soil biodiversity provides a full range of biological functions.
- The soil management systems for producing food, feed, fuel, timber, and fiber rely on optimized and safe use of inputs.
- Soil sealing is minimized through responsible land use planning.

SSM Principles for Grazing Lands

Managed Grazing[14] and Holistic Planned Grazing[15] are two examples of sustainable livestock rearing. An important part of the regenerative ranching process is regenerative grazing, where the use of livestock grazing is integrated into the ecological process to improve soil health and plant diversity. Regenerative grazing involves adaptive multi-paddock grazing (AMP or adaptive grazing) – moving cattle and other pastured animals (sheep, goats, turkeys, bison, pigs) cyclically through small sections of the overall land, and allowing grazed land adequate rest and recovery.

The common element across all sustainable agricultural and livestock rearing practices is that they lead to an increase in SOM, which facilitates regeneration of soils where degraded, and improvement of soils where the quality is good to begin with.

SSM practices need to be supported with the necessary policies for them to be implementable. In the next chapter, we detail our approach to assessing existing policy ecosystems and providing policy recommendations for various regions of the world.

---

14. *Managed Grazing*. Project Drawdown. https://drawdown.org/solutions/managed-grazing

15. *What is Holistic Planned Grazing?* Savory Institute. (2015). https://savory.global/wp-content/uploads/2017/02/about-holistic-planned-grazing.pdf

CHAPTER 3: Conscious Planet Policy Recommendations

At Conscious Planet, we have assessed the state of soils and present policy ecosystems in different regions across the globe, and have put forth policy recommendations to bring a minimum of 3–6% Soil Organic Matter in agricultural lands.

Just a millennium ago, agricultural land made up only 4% of the world's ice-free and non-barren land area.[1] But today, around half of the world's habitable land is used for agriculture. Therefore, addressing soil health requires us to consider agricultural practices.

The large-scale agriculture in the world today has massive implications for the planet. For example, livestock gas emissions on farmlands are the second major source of greenhouse gas emissions (after fossil fuels), and are responsible for an estimated 18–24% of annual greenhouse gases.[2, 3] The legacy emissions from agricultural land use change are 136 ± 55 petagrams of carbon (Pg C). From the start of the Industrial Revolution, carbon lost from soil degradation, through the depletion of Soil Organic Carbon (SOC), accounts for a further contribution of 78 ± 12 Pg C.[4] The total emissions thus come to 214 ± 67 Pg C. This is 80–90% of the emissions from fossil fuel, which is 270 ± 30 Pg C. As we saw in Chapter 1, this loss of Soil Organic Matter (SOM) has ramifications for food security, nutritional security, water scarcity, soil biodiversity, climate change and world peace. According to one estimate, global land degradation costs us USD 300 billion every year.[5]

Reversal of degradation by increasing SOM may generate up to €1.2 trillion per year of economic benefits globally.[6] For an individual farmer, increase in SOM builds resilience to climate risks, improves yield and income prospects. For anyone else who consumes

---

1. Ritchie, H. (2019). Half of the world's habitable land is used for Agriculture. *Our World in Data.* https://ourworldindata.org/global-land-for-agriculture

2. Hawken, P. (2017). *Drawdown: The most comprehensive plan ever proposed to reverse global warming.* Penguin Books.

3. *AR5 Synthesis Report: Climate Change 2014.* IPCC. https://www.ipcc.ch/report/ar5/syr/

4. Lal, R. (2004). Agricultural activities and the global carbon cycle. *Nutrient Cycling in Agroecosystems, 70, 103–116. https://doi.org/10.1023/b:fres.0000048480.24274.0f*

5. Nkonya, E., Mirzabaev, A., & von Braun, J. (2016). Economics of land degradation and improvement: an introduction and overview. In: Nkonya, E., Mirzabaev, A., & von Braun, J. (eds.). Economics of land degradation and improvement: A global assessment for sustainable development. *Springer Open*. https://doi.org/10.1007/978-3-319-19168-3_1

6. *Questions and Answers on the EU Soil Strategy.* European Commission. (2021). https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_5917

food, drinks water or breathes air, it improves the quality of all these resources and enhances our health and quality of life!

Hence, the policy recommendations from Conscious Planet's Save Soil Movement are focused towards agriculture and the food bowls of the world. We are aware that other kinds of land use (forests, urban areas, industry) also have a bearing on climate change, biodiversity and water scarcity. But interventions in agricultural land have manifold positive impacts on all these environmental aspects compared to interventions on other types of land.

The policy recommendations detailed in this publication strongly advocate for farmers to increase SOM in farmlands. This is a supply-side policy intervention. To ensure the interventions happen at an accelerated pace, we need the pull factors in play as well. For farmers, the pull factor will come from both backward and forward linkages and the end consumer – the citizens of a nation. These are the demand-side interventions. The Save Soil Movement will work towards building the demand from citizens by generating awareness. The goal is to touch over 3.5 billion citizens who will voice their intention to their governments to prioritize soil regeneration and a supportive policy ecosystem for food production on lands with higher SOM.

Forward linkage interventions can come from agricultural businesses, which can have differentiated procurement strategies for food grown on farms with regenerative practices. Additional costs can be passed on to the customer. FMCG companies can strive to mention what types of farms supplied their raw material on their labels. There can also be similar incentivization of farmers from backward linked entities who supply them with seeds, nutrients and other inputs. Backward linked agribusinesses can incentivize farmers for judicious and scientific use of the products they supply to farmers. The mechanisms to operationalize the demand-side interventions will vary with every country. Aspects of these mechanisms will be detailed in this publication only to a limited extent.

In 3.1, we articulate the high-level policy recommendations to help achieve the minimum 3–6% SOM across the world. In the following Section 3.2, we analyze the state of soils in the Europe, their existing policy ecosystems, and suggest specific policy interventions to increase SOM.

In order to put forth policy recommendations for countries around the world, we have grouped countries into different regions according to their present-day policy practices and geographical contiguity. For example, Europe is made up of European Union (EU) member nations and a few others. The policies of the EU and those of adjacent regions that trade with the EU are comparable. Therefore, policy recommendations pertaining to technical aspects for the EU are applicable for adjacent countries as well. For the remaining countries in the region, we address their distinct country-specific aspects and give specific recommendations where needed.

Every small area of farmland is unique in terms of soil type, and every farmer lives in unique technical, social and political contexts. Overall, however, geographical contiguity signifies similar conditions for farmland and farmers, in terms of creating policies. For example, in Caribbean nations, the common feature is that they are all small islands, and each of them face natural disasters in the form of hurricanes or volcanic eruptions year on year. Similarly, farmers in African nations have many commonalities, such as small landholdings (unlike their European and North American counterparts), poor access to nutritional inputs, and land tenure challenges. These are issues unique to the African region, but are common across countries within Africa. This is the rationale behind our approach to policy analysis and recommendation based on region.

We have looked into the policies of the following major regions of the world:

1. African Union

2. Asia

3. Europe

4. Latin America and the Caribbean (LAC)

5. Middle East and North Africa (MENA)

6. North America

7. Oceania

3.1 Policies for the World

In this section, we explain our approach to bringing a minimum of 3–6% SOM in agricultural lands across the world, through four pillars of intervention: Knowledge Systems; Farmer Support Ecosystem; Legal Provisions; and Monitoring and Learning Systems.

Soil Organic Matter (SOM) in agricultural lands is fundamental to the wellbeing of human beings and the terrestrial ecosystems of the world. A minimum of 3–6% of SOM is fundamental to ensuring food security and nutritional security, addressing water scarcity, improving soil biodiversity and mitigating climate change.

A substantial percentage of soil in agricultural lands is in critical condition. To rejuvenate these soils, governments of the world need to take urgent, concerted and timebound measures so that we do not endanger the very basis of life of present and future generations. The primary custodians of the world's agricultural lands are farmers, of whom 80% are small landholders. Thus, farmers are indispensable in increasing SOM in agricultural lands.

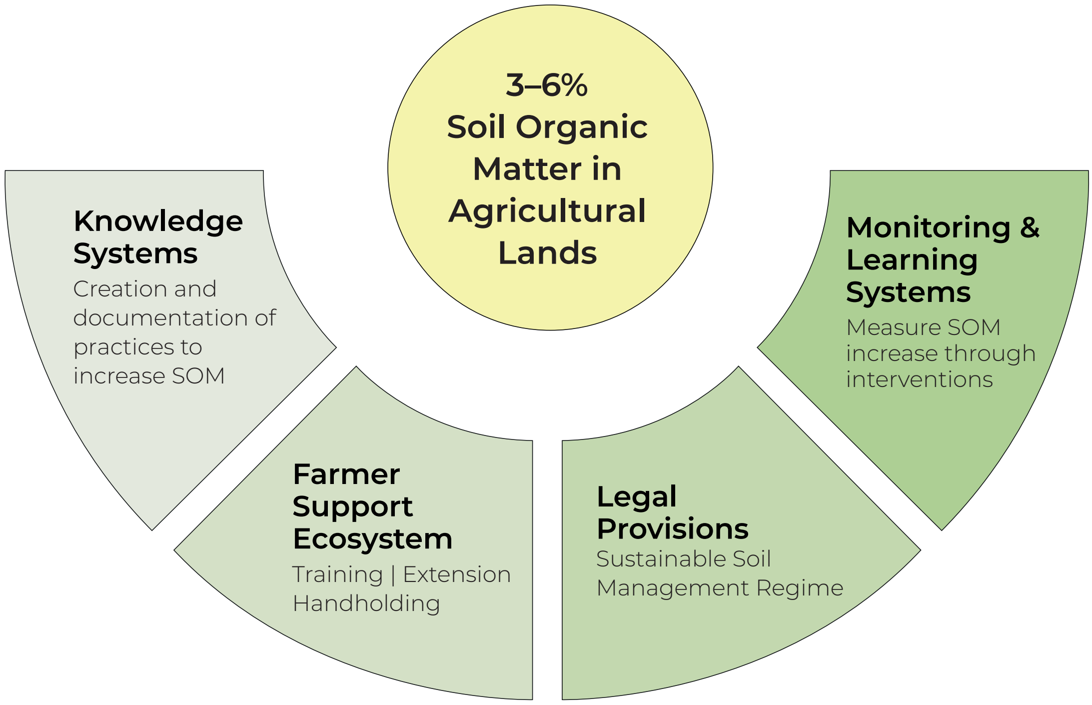
This overarching objective of ensuring a minimum 3—6% of organic content for agricultural soil can be achieved with a pragmatic three-pronged strategy:

1. Provide attractive incentives for farmers to strive to reach the minimum threshold of 3–6% organic content. Such incentives would create an aspirational race amongst farmers.
2. Facilitate and streamline carbon credit for farmers. The current processes for farmers to avail of carbon credit benefits are far too complex – and therefore need significant simplification.
3. Develop a mark of superior quality for food grown from soils that have the target 3–6% organic content level. Alongside this, we should also clearly articulate the various health, nutritional, and preventive health benefits of consuming such foods. As a result of this initiative, people would be more healthy, more productive, and more resilient – thereby leading to gains in man-days, and a lower stress on our health care systems. It is therefore evident that such a mark of superior quality food would have far more meaning than the current system of just trying to distinguish between so-called 'organic' and 'non-organic' produce.

Our approach to actioning the strategy for increasing SOM in farmers' lands is made up of establishing and executing four pillars of intervention:

- Knowledge Systems
- Farmer Support Ecosystem
- Legal Provisions
- Monitoring and Learning Systems

Figure 1: Conscious Planet's approach to facilitating increase in SOM in the world's agriculture lands.



Knowledge Systems

Cataloging and creation of Sustainable Soil Management (SSM) Package of Practices: For farmers to transition from their present agricultural practices to those that will increase SOM, there must be a database of clear Package of Practices (PoP) cataloged for various crop types and soil types. These PoPs are right now spread across research publications, institutional reports and specialized databases for sustainable land management or soil management practices. Dedicated national and subnational agricultural research institutions should host all this information in one place and make it easily accessible for farmers and farmer extension workers (i.e. soil doctors). Wherever there is no PoP for a particular cropping system, agricultural institutions should create a PoP. The PoPs in the databases should be specific to crop type based on its specific nutritional requirement and across various soil types of that nation or region. The nutritional requirements and means of production for these crops should be precise to avoid problems that arise due to excess usage of inputs or application of the wrong inputs – both organic and inorganic.

Farmer Support Ecosystem

Generate farmer-friendly information: Knowledge catalogued and produced in the knowledge systems pillar should be translated into "farmer-friendly information" and made available to farmers.

Trainings: Training sessions on SSM, regenerative agricultural practices, and PoPs for specific crops must be conducted for farmers. Agricultural research institutions should also arrange for model farm plots that demonstrate the benefits of such practices, such as improvement in crop yield. It should be noted that such training sessions have maximum impact when conducted by fellow progressive farmers whose livelihoods depend on agriculture.

Soil doctors: Investment in training and nurturing grassroots farmers who can address specific issues of other local farmers is a must. The concept of soil doctors was developed and adopted in certain countries of Africa. Also, there should be an optimal ratio of soil doctors to farmers in order to ensure effective outreach to farmers.

Legal Provisions

Most countries in the world have legislation to govern and manage natural resources like water and air. However, soil is often seen as an input commodity, an inert material for agriculture. Soil is usually only vaguely covered in environmental laws. Legal and policy frameworks that define what constitutes healthy soil, the responsibility of the custodians of soil, and the incentives and disincentives regarding agricultural practices should be articulated.

The European Union is one government which is in the process of formulating its Soil Health Law. The proposal, as it stands, focuses on clearly defining healthy soil and the mechanism to measure the outcome of any interventions on the quality of soil. Even within soil health, while there are a number of parameters, the single most important one is SOM. Countries should strategize on making significant headway on this parameter, as it has far-reaching impact on soil health, covering a wide scope of issues. Once there is sufficient understanding of the significance of SOM, and SSM farm practices become common knowledge, further interventions to improve other indicators of soil health can be introduced.

Monitoring and Learning Systems

Standardize indicators to assess soil health: There have been many grant programs in Africa and Asia towards SSM interventions. There have also been budgets allocated towards SSM practices under the European Commission. However, there is no stringent list of indicators, definitions of indicators, or measurement of these indicators to assess the effectiveness of interventions on soil health, specifically SOM. The FAO has suggested some of the indicators that can be measured to assess soil quality improvement through adaptation of SSM practices.[7] These indicators should be measured along with regular physical and chemical properties of soil.

Soil testing: Soil testing laboratories should also be equipped to conduct tests for biological properties of soil, along with the physical and chemical properties of soil. The testing facilities should be at nominal fee and accessible for farmers. For example, the French government has a free soil sampling scheme[8] to encourage farmers to test their soil and, accordingly, carry out interventions on their land. This will provide farmers with evidence of their soil's health and bring about a change in their behavior towards managing their soils sustainably. Farmers' decisions on use of nutrition (organic / inorganic) and its quantity, choice of sustainable soil management practice (cover crop species / intercrop mix, etc.) will be guided by their soil report and the nutritional needs of the crop(s) they intend to grow on their farm. This testing will also help soil doctors and farmers decide which type of SSM practice will increase productivity on their land and decrease input cost.

7. *Protocol for the assessment of Sustainable Soil Management.* Food and Agriculture Organization of the United Nations (FAO). (2020). https://www.fao.org/fileadmin/user_upload/GSP/SSM/SSM_Protocol_EN_006.pdf?fbclid=IwAR2Ob5F2SaNyA1d473bL7p_jC14YNMbujT9IgnC5C7lRqhLRq3QhhVEt7RY

8. *Gis Sol – Base de Données d'Analyses des Terres – BDAT.* https://www.gissol.fr/le-gis/programmes/base-de-donnees-danalyses-des-terres-bdat-62

Figure 2: Recommended indicators that can be monitored to assess Sustainable Soil Management (Source: FAO)9

Indicator	Parameter/ Metric	Measurement Methods	Sample Characteristics
Soil organic carbon	Organic carbon (%)	**Walkley-Black method** *http://www.fao.org/3/ca7471en/CA7471EN.pdf* **or Dumas method** *http://www.fao.org/3/ca7781en/ca7781en.pdf*	Representative soil sample
Soil biological activity	Soil respiration rate (gCO_2 m^{-2} d^{-1}) Ideally combined with at least one other biological indicator	Laboratory based soil respiration measurement (static or dynamic)	Representative soil sample to be analyzed within hours or refrigerated
Soil productivity	Agricultural productivity or biomass in dry matter (t ha^{-1} $year^{-1}$)	Dry weight of vegetation quadrats, or yield measurements	Quadrat method or yield measurement
Soil physical properties	Bulk density (kg dm^{-3}) In some cases, bulk density can be complemented by available water capacity, or other relevant soil physical properties	The Core Method	Undisturbed representative sample with known volume

Actioning Policy to Save Soils

To ensure our suggested approach is rolled out such that there is marked change in the condition of SOM within a decade, we suggest the SSM policies be phased as "Recommendations Phase", "Incentivization Phase" and "Phase to Wind Down Incentives". In other words, there should be a phased program of implementation over a number of years – with the first phase being that of providing inspiration, followed by a second phase of providing incentives, and eventually having a third phase with some appropriate disincentives.

Actioning recommendations: Large countries with federal governance structures like Brazil, Australia, India and political/economic unions like the European Union and African Union have a 2-year window for member states to adopt any new policy or legislation. This window can be a learning period where abiding by policies can be voluntary, and governments work to understand the challenges farmers face in making the transition, while fine-tuning the implementation of the policy.

Actioning incentivization: In this second phase of the policy rollout (the 2-year period after the learning period) governments can incentivize farmers and other

9. *Protocol for the assessment of Sustainable Soil Management*. Food and Agriculture Organization of the United Nations (FAO). (2020). https://www.fao.org/fileadmin/user_upload/GSP/SSM/SSM_Protocol_EN_006.pdf?fbclid=IwAR2Ob5F2SaNyA1d473bL7p_jC14YNMbujT9IgnC5C7lRqhLRq3QhhVEt7RY

stakeholders – like soil doctors, soil testing laboratories, research institutes – to facilitate large-scale implementation of SSM practices. For example, Uzbekistan's food production which grew by 7.2% from 2016–2020,[10] is attributed to the attention given to multipurpose farms. These farms were exempted from paying any tax on all types of activities related to crop growing. In India, the 2022 central budget announced a plan to incentivize farmers to bring land under shade through agroforestry, to grow more legume species and to follow natural farming practices.[11]

Actioning wind-down incentives: Once a critical mass of farmers have taken up SSM practices to improve their SOM and have benefited from it personally, the SSM policies need not be bolstered by heavy incentives. The knowledge of beneficial farm economics will spread among farmers naturally. The incentive structure for SSM practices can be modified as deemed necessary by governments. In this phase, governments can explore how to rope in carbon credit markets to pay for the carbon sequestered by farmers. Payments can be based on changes in select indicators such as SOC, the soil's water retention capacity, soil biodiversity, concentration of fertilizers in runoff from farmlands, etc. If environmental accounting systems are in place, governments and private entities can also compensate farmers for the ecosystem services they deliver.

10. *Uzbekistan is taking efforts to make its economy sustainable and green.* WION. (2021). https://www.wionews.com/world/uzbekistan-is-taking-efforts-to-make-its-economy-sustainable-and-green-375475

11. *Union Budget 2022: Govt to promote Kisan drones, chemical-free natural farming in 2022–23, Sitharaman says.* The Times of India. (2022). https://timesofindia.indiatimes.com/business/india-business/govt-to-promote-kisan-drones-chemical-free-natural-farming-in-2022-23-nirmala-sitharaman/articleshow/89268246.cms

3.2 Policies for Europe

European countries can be broadly classified as European Union (EU) countries and EU partner countries[1] whose policies mirror EU policies (like Switzerland and Norway), and countries with their own specific policies. There are two parts to this section. In the first part, we will look in depth at the EU policy ecosystem. This analysis will also largely apply to EU partner countries. The second analysis looks at a few major non-EU countries with a large area under agriculture: Russia, the United Kingdom and Ukraine.

3.2.1 European Union

1. EU partner countries are either European Economic Area (EEA) countries or European Free Trade Association (EFTA) countries. EEA member countries that are not in EU are Iceland, Liechtenstein and Norway. EFTA countries are Iceland, Liechtenstein, Norway And Switzerland.

Member Nations of the European Union (EU): Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

European Union Statistics

Total Population: 447.7 million

GDP: USD 15.3 trillion (Dec 2020)

GDP Per Capita: USD 34,149.3 (2020)[2]

Total Landmass Area: 3,999,622.5 km^2

Landmass under Agriculture: 1,637,507.3 km^2 (2018)[3]

Population Dependent on Agriculture as a Percentage of Total Employment: 17% (40 million people)[4]

Average Farm Size: 11 ha

Executive Summary

At the outset, we find that there is substantial progress that has happened in setting up knowledge systems to support farmers to transition to sustainable soil management practices. These policies are in line with Conscious Planet's recommendations on soil health. With the recent proposal from the European Commission to its MEPs and Parliament to have a Soil Health Law legislation, we think the legal provision to manage soil sustainably will be in place. Even without the Soil Health Law, the present EU Green Deal and its strong effect on the reformed CAP presents a strong case for increasing Soil Organic Matter (SOM). However, there are specific areas where we think the EU can strengthen its intervention to achieve its aspirations for healthy soil. These areas are the Farmer Support Ecosystem and the Monitoring and Learning Systems.

Before we articulate the recommendations, in this policy brief we outline the current state of soil in the EU, existing policies or policies being proposed that affect soil

---

2. Based on World Bank data. IMF figure is USD 42,120.998 (2020)

3. *Agricultural land (sq. km) – European Union*. The World Bank. https://data.worldbank.org/indicator/AG.LND.AGRI.K2?locations=EU

4. *The common agricultural policy at a glance*. European Commission. https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en

health, and provide recommendations to strengthen the policy ecosystem to help revitalize soil health. Our recommendation to the EU is to implement interventions in a timely manner through focused and clear policies to achieve a goal of increasing SOM to a minimum of 3–6%. The following is a summary of the specific recommendations under the four pillars of Conscious Planet's recommendations for soil health:

- *Under knowledge systems, establish knowledge systems with last-mile connectivity to farmers.*
- *Under Farmer Support Ecosystems, the EU can provide free access to education and the knowledge systems to help farmers adopt SSM practices. The EU can also provide assistance for equipment specific to regenerative agriculture practices.*
- *Legally, the EU can add the requirement of a minimum SOM of 3–6% to the definition of healthy agricultural soils in the new Soil Health Law.*
- *Under Monitoring and Learning Systems, soil health measurements should involve testing of biological properties along with chemical and physical properties of the soil.*

By working on improvement of SOM in agricultural lands, the EU will be able to see increased productivity from the agriculture sector and also reduction in expenditure for fertilizers. Land and soil degradation costs the EU an enormous sum of €50 billion per year.[5] Furthermore, soil erosion reduces annual agricultural productivity by €1.25 billion. Bringing back SOM to 3–6% will help cut down on these costs, and current trends can be reversed.

The State of Agricultural Soil in the European Union

The technical report on Soil Threats to Europe[6] by the Joint Research Centre (JRC) of the European Union very clearly articulates the problems faced by the soils of Europe. The list includes: deterioration of SOM, soil erosion, soil biodiversity loss, soil compaction, soil contamination, salinization, sealed soils and desertification. The following sections quantify the gravity of some of the fundamental issues.

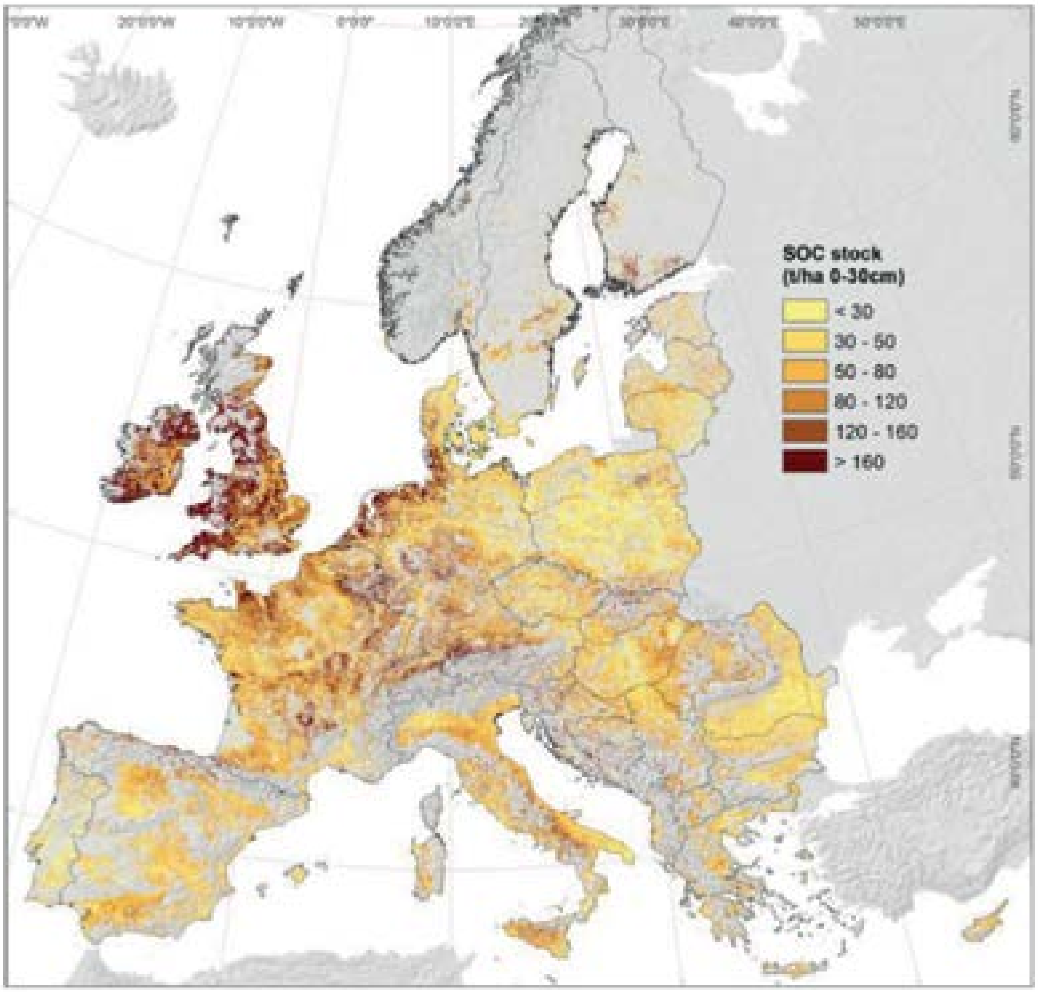
5. *Questions and Answers on the EU Soil Strategy.* European Commission. (2021). https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_5917

6. Stolte, J., Tesfai, M., Oygarden, L., Kvaerno, S., Keizer, J., Verheijen, F., Panagos, P., Ballabio, C., & Hessel, R. (2016). Soil threats in Europe: status, methods, drivers and effects on ecosystem services: deliverable 2.1 RECARE project. *JRC Technical Reports, European Commission.*

Declining Soil Organic Carbon

In a working paper that details the rationale and reasons for the key areas of focus for soil threats, it is estimated that around 75% of all EU croplands are below 2% Soil Organic Carbon (SOC).[7] This approximately translates into Soil Organic Matter (SOM) being less than 3%.

Map 1: Soil Organic Carbon stock in agricultural topsoils of the EU.[8]



7. Stolte, J., Tesfai, M., Oygarden, L., Kvaerno, S., Keizer, J., Verheijen, F., Panagos, P., Ballabio, C., & Hessel, R. (2016). Soil threats in Europe: status, methods, drivers and effects on ecosystem services: deliverable 2.1 RECARE project. *JRC Technical Reports, European Commission.*

8. Lugato, E., Panagos, P., Bampa, F., Jones, A., & Montanarella, L. (2013) A new baseline of organic carbon stock in European agricultural soils using a modelling approach. *Global Change Biology.* doi.org/10.1111/gcb.12292. In *CAP Specific Objectives – Efficient Soil Management.* European Commission. (2018). https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/cap-specific-objectives-brief-5-soil_en.pdf

Soil Erosion

Erosion affects three regions within the EU with different intensities: a southern zone with severe risk, a loess zone with moderate risk, and an eastern zone comprising areas with both moderate and severe erosion.

Approximately 11.4% of the EU's territory is estimated to be affected by moderate (up to 5 tonnes per hectare per year) to severe water erosion (more than 5 tonnes per hectare per year).[9] Over 24% of EU lands and almost a third of agricultural areas have erosion higher than sustainable rates (2 tonnes per hectare per year). Thus, 35% of EU lands are losing soil to erosion. Moreover, 24% of EU lands and almost a third of agricultural areas have erosion higher than sustainable rates (2 tonnes per hectare per year). Erosion rates today have reduced compared to what was observed between 2000–2010. For example, erosion has decreased by 20% in arable lands in Western and Central Europe because of erosion control activities.[10, 11]

A recent quantitative estimate of wind erosion shows that around 7% of the EU's arable lands have rates higher than 2 tonnes per hectare per year. The regions most affected by wind erosion are large parts of arable land in Denmark, Netherlands, the northern part of Germany and the Iberian Peninsula.[12]

---

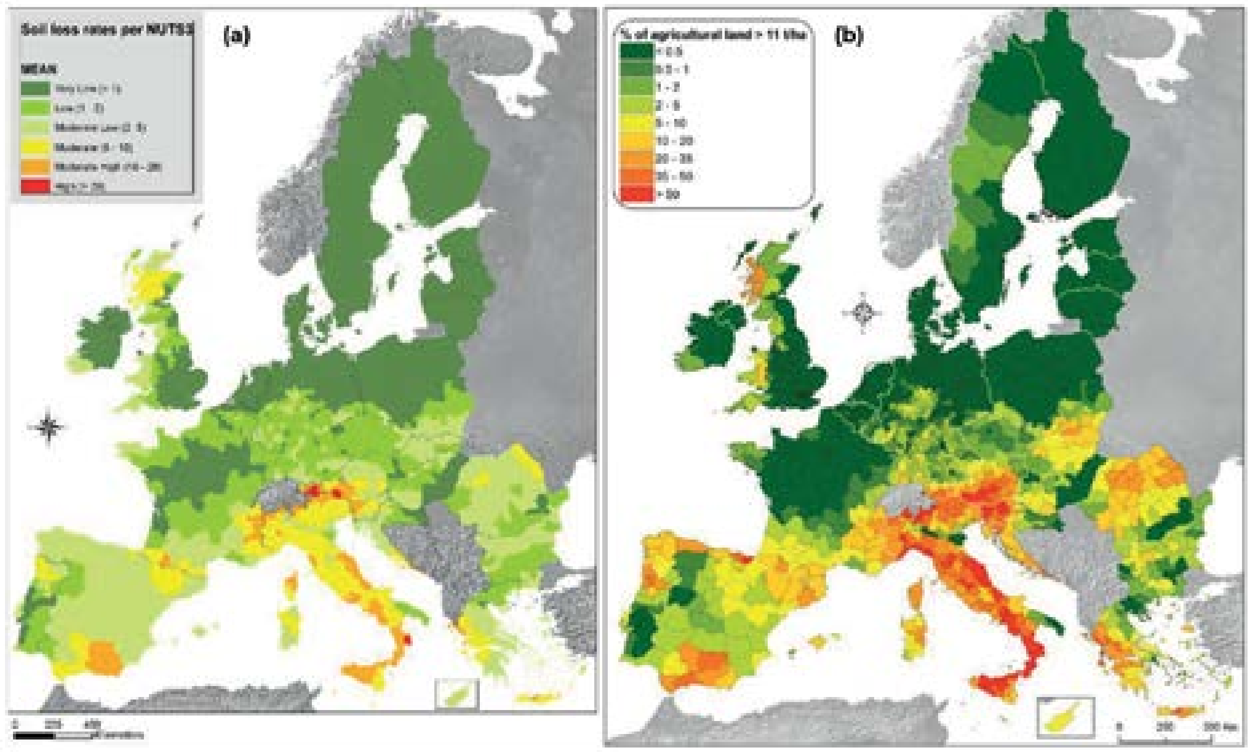
9. Panagos, P., Borrelli, P., Poesen, J., Meusburger, K., Lugato, E., Montanarella, L., & Alewell, C. (2015). The new assessment of soil loss by water erosion in Europe. *Environmental Science & Policy, 54*, 438–447.

10. *Summary for Policymakers of the Regional Assessment Report on Biodiversity and Ecosystem Services for Europe and Central Asia*. IPBES. (2018).

11. Panagos, P., Borrelli, P., Meusburger, K., Alewell, C., Lugato, E., & Montanarella, L. (2015). Estimating the soil erosion cover-management factor at the European scale. *Land Use Policy, 48*, 38–50.

12. Borrelli, P., Lugato, E., Montanarella, L., & Panagos, P. (2017). A New Assessment of Soil Loss Due to Wind Erosion in European Agricultural Soils Using a Quantitative Spatially Distributed Modelling Approach. *Land Degradation & Development, 28*, 335–344. https://doi.org/10.1002/ldr.2588

Map 2: (a) Soil erosion by water (tonnes per ha per year), 2010, EU-28, NUTS 3 (left) and (b) Severe soil erosion in agricultural lands (right) - % of agricultural land with >11t/annually.[13]



Soil Biodiversity Loss

The problem with quantification of soil biodiversity is that there is no comprehensive knowledge of what existed in the soil in the first place. This has been overcome by the European Atlas of Soil Biodiversity.[14] Based on various factors that lead to reduction in soil biodiversity – soil sealing, erosion, loss of soil organic matter, salinity, compaction etc.[15] – and according to the Land Use / Land Cover survey of 2018 and DNA extraction techniques, the potential risk to soil biodiversity is mapped and shown in Map 3 for

---

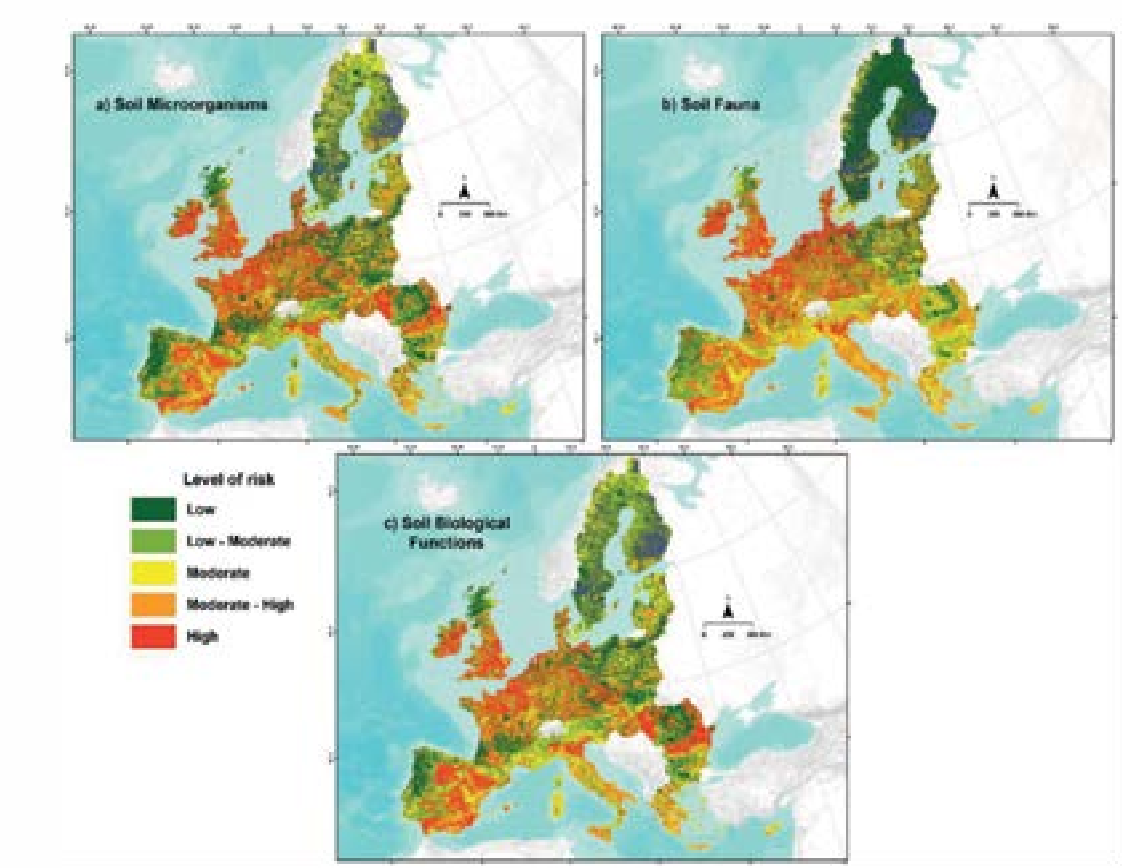
13. *CAP Specific Objectives – Efficient Soil Management*. European Commission. (2018). https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/cap-specific-objectives-brief-5-soil_en.pdf

14. Jeffery, S., Gardi, C., Jones, A., Montanarella, L., Marmo, L., Miko, L., Ritz, K., Peres, G., Römbke, J., van der Putten, W. H. (eds.). (2010). European Atlas of Soil Biodiversity. *Publications Office of the European Union.* https://doi.org/10.2788/94222

15. Stolte, J., Tesfai, M., Oygarden, L., Kvaerno, S., Keizer, J., Verheijen, F., Panagos, P., Ballabio, C., & Hessel, R. (2016). Soil threats in Europe: status, methods, drivers and effects on ecosystem services: deliverable 2.1 RECARE project. *JRC Technical Reports, European Commission.*

microorganisms, flora, and soil biological functions. The maps showcase the intensity of biodiversity loss across microorganisms, soil fauna and soil biological function. The color spectrum denotes green regions having low loss of diversity, and red regions at the other extreme with high loss of biodiversity.

Map 3: Distribution of the potential threats to (a) soil microorganisms, (b) soil fauna and (c) soil biological functions predicted for 27 European countries (spatial resolution 500 m).[16]

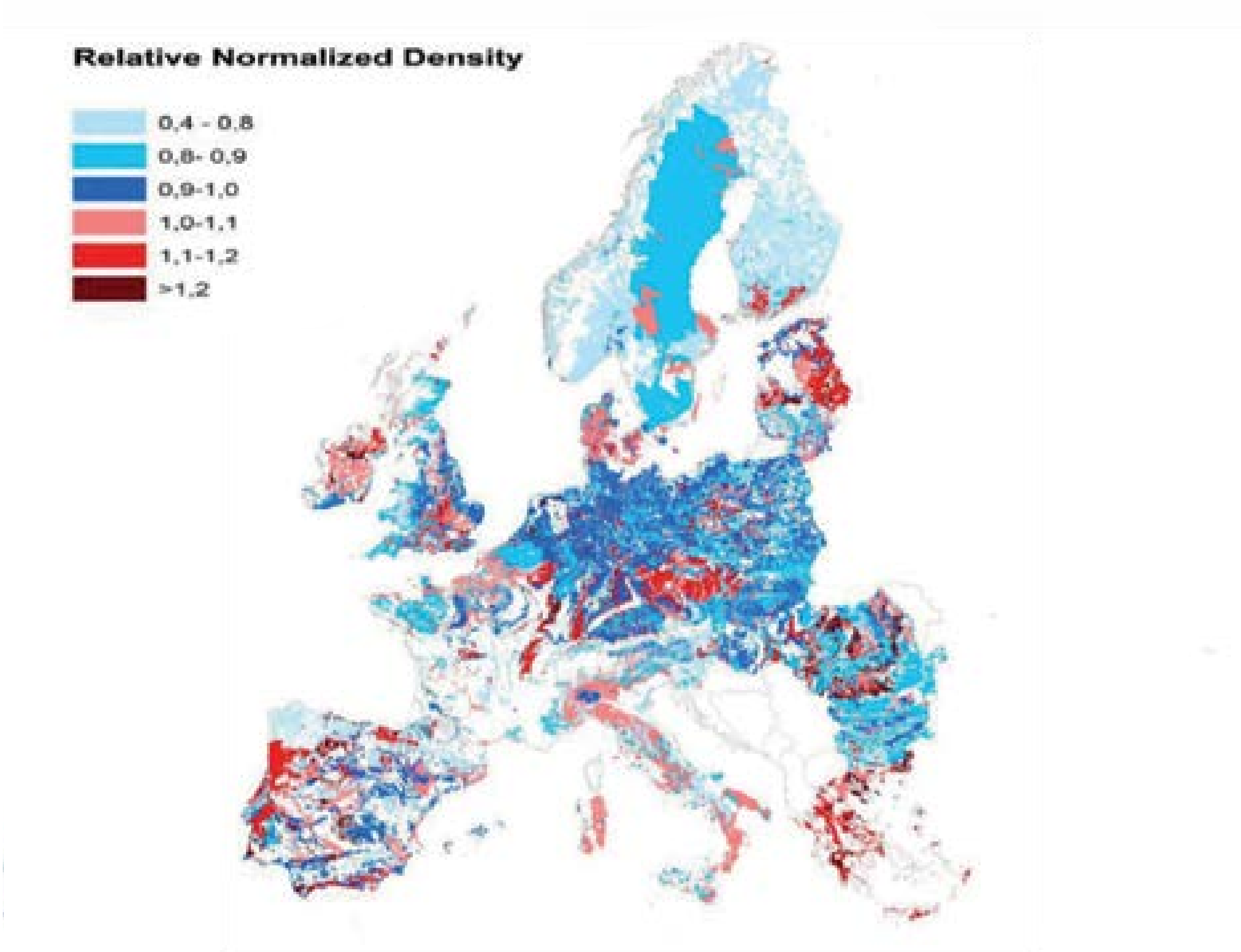


Soil Compaction

Based on a study conducted across various soils, it was found that around 23% of soils are at critical high densities, densities (i.e., they are heavily compacted) (Map 4). This status of soils can be partly explained by the increased use of heavy machinery since the 1960s, resulting in high stress on soils, in particular in the subsoil below the plough layer.

16. *CAP Specific Objectives – Efficient Soil Management*. European Commission. (2018). https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/cap-specific-objectives-brief-5-soil_en.pdf

Map 4: Relative normalized density (RND) for European subsoil horizons covering the depth of 0.25–0.7 m as calculated by Eqs. 3ab based on the SPADE8 database. RND>1 may be considered a dense soil.[17]



Present Policy Ecosystem in the European Union

Soil has become part of the larger sustainable initiatives of the EU. Research on the state of soil has been conducted in the EU since the early 2000s. The policy ecosystem largely comprises three main policies: The EU Soil Strategy for 2030; Common Agriculture Policy (CAP); and the European Green Deal. The first is primarily focused towards strategy; the second is a program under which budgets are allocated for soil regeneration activities; and the third is an aspirational document listing green targets. In this section, we read all three of these policies together to understand the overall policy ecosystem in the EU.

17. *CAP Specific Objectives – Efficient Soil Management*. European Commission. (2018). https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/cap-specific-objectives-brief-5-soil_en.pdf

The EU Soil Strategy for 2030

The EU Soil Strategy document for 2030 sets up a collective goal to make the soils of the EU healthy. It also acknowledges the significance of decisions to be made in this decade and their ramifications for the soils of Europe.

The Vision Statement

By 2050, all EU soil ecosystems are in healthy condition and are thus more resilient, which will require very decisive changes in this decade.

By then, protection, sustainable use and restoration of soil has become the norm. As a key solution, healthy soils contribute to addressing our big challenges of achieving climate neutrality and becoming resilient to climate change, developing a clean and circular (bio)economy, reversing biodiversity loss, safeguarding human health, halting desertification and reversing land degradation.

The medium-term goals and long-term goals are also outlined in this document.

Medium-term Objectives by 2030

1. Combat desertification, restore degraded land and soil (including land affected by desertification, drought and floods), and strive to achieve a land degradation-neutral world (Sustainable Development Goal 15.3).
2. Significant areas of degraded and carbon-rich ecosystems, including soils, are restored.
3. Achieve an EU net greenhouse gas removal of 310 million tonnes CO_2 equivalent per year for the land use, land use change and forestry (LULUCF) sector.
4. Reach good ecological and chemical status in surface waters and good chemical and quantitative status in groundwater by 2027 as defined by the EU's Water Framework Directive 2000/60/EC.
5. Reduce nutrient losses by at least 50%, the overall use and risk of chemical pesticides by 50% and the use of more hazardous pesticides by 50% by 2030.
6. Make significant progress in the remediation of contaminated sites.

Long-term Objectives by 2050:

1. Reach no net land take.[18, 19]
2. Soil pollution should be reduced to levels no longer considered harmful to human health and natural ecosystems, and should respect the boundaries our planet can cope with, thus creating a toxic-free environment.
3. Achieve a climate-neutral Europe and, as the first step, aim to achieve land-based climate neutrality in the EU by 2035.
4. Achieve a climate-resilient society for EU, fully adapted to the unavoidable impacts of climate change by 2050.

The strategy goes into detailing actions needed for these medium-term and long-term goals to be reached.

Common Agricultural Policy (2021–27)

The Common Agricultural Policy (CAP) is a policy that all EU nations must implement with regards to agricultural activity. Every few years, the CAP is reformed after consultation with member states, to ensure it stays relevant to the needs of farmers and society in a changing world. The objectives of the CAP (2021–27) are:

1. **To ensure a fair income to farmers:** Support viable farm income and resilience across the EU to enhance food security.
2. **To increase competitiveness of EU farmers:** Increase competitiveness and agricultural productivity in a sustainable way to meet the challenges of higher demand in a resource-constrained and climate uncertain world.
3. **To rebalance the power in the food chain:** Improve farmers' position in the value chain.
4. **Climate change action:** Contribute to climate change mitigation and adaptation, as well as sustainable energy.
5. **Environmental care / Efficient soil management:** Foster sustainable development and efficient management of natural resources such as water, soil and air; with special focus on soil.

---

18. Land take is the loss of agricultural, forest and other semi-natural and natural land to urban and other artificial land development.

19. Geneletti, D., Biasiolli, A., & Morrison-Saunders, A. (2017). Land take and the effectiveness of project screening in Environmental Impact Assessment: Findings from an empirical study. *Environmental Impact Assessment Review* 67, 117–123. https://doi.org/10.1016/j.eiar.2017.08.008

6. **To preserve landscapes and biodiversity:** Contribute to the protection of biodiversity, enhance ecosystem services and preserve habitats and landscapes.
7. **To support generational renewal:** Modernize the agricultural sector by attracting young people and improving their business development.
8. **Vibrant rural areas:** Promote employment, growth, social inclusion and local development in rural areas, including bio-economy and sustainable forestry
9. **To protect food and health quality:** Improve the response of EU agriculture to societal demands on food and health, including safe, nutritious and sustainable food, reducing food waste, and enhancing animal welfare.
10. **To foster knowledge and innovation:** Modernize agriculture by increasing cooperation and knowledge sharing, and improving agricultural training.

A thorough reading of all the working papers on the key objectives reflects a very strong intent to make agriculture in the EU nations sustainable and green. Analysis of the budgets under the two major pillars of the CAP only makes the intent firmer.

Figure 1: 10 Key Objectives of the CAP (2021–27)[20]

20. *Key policy objectives of the new CAP*. European Commission. https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27/key-policy-objectives-new-cap_en

CAP has two major verticals through which it ensures farmer welfare:

Pillar I:[21] direct payments and market measures

Pillar II:[22] focuses on well-rounded rural development

The overall budget for CAP for the period of 2021–27 is €387 billion. Compared to previous iterations of the CAP, the current policy is better equipped to ensure on-ground implementation of policy objectives. Several mechanisms have been incorporated into CAP for this purpose, including environment and climate action targets that increase with each programming period, prevention of backsliding by nations on these targets, and stronger mandatory requirements for beneficiaries to receive payments.

There are also enhanced minimum budget allocations towards climate, biodiversity and environment-related aspects. For example, 40% of the CAP (2021–27) budget will have to be climate relevant; in the fruits and vegetables sector, operational programs will allocate at least 15% of their expenditure towards environment; at least 25% of the budget for direct payments will be allocated for eco-schemes.

European Green Deal (2021)

The European Green Deal is a set of policies aimed at making the EU's economy circular, carbon neutral and sustainable by 2050. Agriculture has been rightfully recognized as an important component in fulfilling the European Green Deal. The European Green Deal will transform the EU into a modern, resource-efficient and competitive economy, ensuring:

- No net emissions of greenhouse gases by 2050
- Economic growth decoupled from resource use
- No person and no place left behind

21. Pillar 1: Direct payments are made annually to farmers to help stabilize their farm revenue and face risks associated with market volatility and market measures to tackle specific market situations and to support trade promotion.

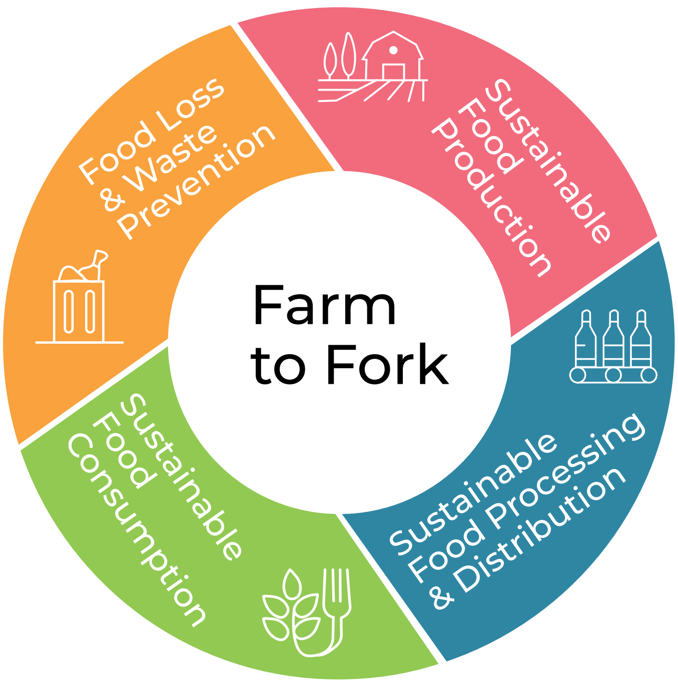
22. Pillar 2: Rural development – Objective of this pillar is to have balanced development in rural areas like provision of access to internet, sustaining a farming sector that is environmentally sound, as well as promoting competitiveness and innovation

The Green Deal aspires to reduce the greenhouse gas (GHG) emissions of Europe by at least 55% by 2030, compared to 1990 levels. The various areas of action under the Green Deal are: Climate, Energy, Agriculture, Industry, Environment and Oceans, Transport, Finance & Regional Development and, last but not least, Research & Innovation. By acting on these areas, the Green Deal intends to provide for and improve the wellbeing of citizens now and in the future through seven objectives. The two that are directly related to soil are: fresh air, clean water, healthy soil and biodiversity; and healthy and affordable food. The other five objectives will be affected positively by working on soil health.

As a part of the Green Deal, there are two major strategy documents to guide the interventions. The one specific to agriculture (the entire supply chain from production to processing to the dining table) is the Farm to Fork strategy document. The second one pertaining to biodiversity is called the Biodiversity Strategy for 2030.

The strategies listed under the Farm to Fork strategy document, especially pertaining to the production aspect of it, go in depth into SSM.

Figure 2: EU Farm to Fork Strategy[23]



23. *Farm to Fork Strategy*. European Commission. https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en

The strategy seeks to have a legislative framework for sustainable food systems, through which the EU wants to support and lead the world into sustainable agri-food systems through its trade policies and international cooperation instruments.

The overall budget for the Green Deal amounts to €1.8 trillion, part of which comes from CAP (2021–27) funding. CAP receives exceptional budgetary support – one-third of the EU's budget goes towards CAP[24] – and CAP will therefore play a major part in ensuring the Green Deal is fulfilled.

CAP Tied Tightly to the European Green Deal

The reformed CAP (2021–27) will have the payments to farmers tied to a set of mandatory environment conditionalities (rules).

Strong and Well-defined Conditionalities for Spending (Pillar I) – Direct Payments

All beneficiaries of the new CAP (2021–27) will continue to have their payments linked to a set of mandatory rules (known as "conditionality" in the new CAP), comprising of statutory management requirements (SMRs)[25] and good agricultural and environment conditions (GAECs).[26, 27] In the new CAP, the most effective aspects of these practices will be incorporated into new conditionality rules. For example:

- ***GAEC on soil protection and quality**: Crop rotation will be required on all farms of at least 10 hectares. Crop diversification (the current obligation) will only be permitted when this practice contributes to the objective of preserving the soil potential. There are exemptions for farms with a lot of grassland, and organic farms are considered as fulfilling the obligation.*

---

24. *The common agricultural policy at a glance*. European Commission. vvhttps://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en

25. SMRs include rules on public, animal and plant health and animal welfare and the environment

26. GAEC standards are designed to:
    - prevent soil erosion by defining minimum soil cover and minimum land management practices;
    - maintain soil organic matter and soil structures;
    - maintain permanent grasslands;
    - protect biodiversity and ensure the retention of landscape features through, for example, a ban on cutting hedges and trees during the bird breeding and rearing season;
    - protect and manage water through the establishment of buffer strips along water courses, authorization on water for irrigation and protection of groundwater from pollution.

27. *Cross-compliance: Good agricultural and environmental conditions*. European Commission. https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/income-support/cross-compliance_en#gaec

- ***GAEC on biodiversity and landscape:*** *Four percent of land will be devoted to non-productive elements and areas, including fallow land, on all farms of at least 10 hectares. This is more than under the current "greening" system. The obligatory minimum for such non-productive features will be 3% where farmers "top up" that total to 7% through an eco-scheme, or where farmers devote significant additional land to catch crops or nitrogen-fixing crops (cultivated without plant protection products in each case).*

Eco-schemes (Pillar I)

Twenty-five percent of payments made from CAP (2021–27) Pillar I (direct farmer payments) will be allocated for eco-schemes mandatorily, thus incentivizing climate- and environment-friendly farming practices, and tying together CAP and Green Deal objectives. These practices/actions will be listed and defined by the European Commission. These funds can also be used to support organic farming, agro-ecological practices, precision farming, agro-forestry or carbon farming, as well as animal welfare improvements.

Eco-schemes will be mandatory for EU countries to include in their plans, but voluntary for farmers. There is a 2-year learning period for countries to get on the eco-scheme bandwagon by 2023. In this period, countries may spend less than 25% of the budget. But by 2027 the average spending of 25% should be towards these eco-schemes.

Rural Development (Pillar II)

Rural development, the so-called "second pillar" of the CAP (2021–27), also ties into Green Deal objectives by dedicating a higher share ("**ring-fence**") of its resources to interventions relating to climate and the environment. In this "ring-fenced" fund, at least 35% of the rural development budget (earlier it was 30%) will be allocated to support environment, climate and animal welfare. Natura2000 (network of core breeding and resting sites for rare and threatened species) and Water Framework Directive payments, environmental and climate investments, and animal welfare are some of the schemes which are eligible under the ring-fenced budget. In areas with constraints, the mandatory ring-fenced expenditure on specific items will be 50% of the total allocation. Whereas in areas without constraints, it is mandatory to spend all the ring-fenced allocations for activities allowed under that category.

Higher Green Ambitions in Some Sector-Specific Interventions

Expenditures for specific sectoral interventions that are targeted towards production of fruits and vegetables will also have to go towards meeting specific objectives of environment / efficient soil management and climate / carbon sequestration efforts on agricultural lands. Moreover, the reform introduces several new types of intervention serving the same environmental and climate objectives (e.g. EU countries will have to dedicate at least 5% of financial allocations for the wine sector to meet these objectives).

Climate Tracking

What gets measured gets done. Following this principle, the new CAP (2021–27) will incorporate climate tracking to ensure that contribution to climate change mitigation from agricultural interventions is counted. The European Commission will propose an improved methodology through which climate tracking will be done with rigorous collection of data on specific indicators after 2025.

Policy Recommendations for the European Union

Soil degradation or soil extinction (the extreme form of degradation) has ramifications on food security, production of nutritious food that affects human and animal health, water scarcity, biodiversity, climate change and, therefore, the overall harmony of society. Also, soil degradation, like water scarcity, has transboundary effects outside of the states where degradation happens.

There is a clear awareness on the state of soil and what needs to be done on the soil, so that it is no longer a problem, but a solution for various developmental aspirations of the Union, like food security, food safety, climate mitigation, water, and biodiversity. The EU Soil Strategy for 2030 document, the CAP (2021–27), the European Green Deal, and the Farm to Fork strategy documentations cover various bases of what is needed to sustainably manage soil. CAP, the primary policy framework through which agricultural soils will be regenerated in this edition, has moved from a social policy to one that intends to deliver results for the environment as well as for human beings. But it will be good to make some adjustments to ensure this policy is rolled out effectively.

Ensuring soil health is an urgent need of the hour: The timelines set for CAP (2021–27) and the European Green Deal are of the order of 4–5 years. This duration may be too long for the agenda of soil regeneration and SSM, due to the urgency of the situation. There is a 2-year adaptation window given to all EU nations for new policies. It may be worthwhile to think of reducing these adaptation timelines to shorten the roll out.

After the analysis of the present policy ecosystem, Conscious Planet's Save Soil Movement gives policy recommendations under the four pillars of:

- Knowledge Systems
- Farmer Support Ecosystem
- Legal Provisions
- Monitoring and Learning Systems

Knowledge Systems

- **Simplified soil mandate for agricultural lands:** The present agriculture knowledge systems can be focused towards soil regeneration when catering to farmers. The existing system is quite nuanced and substantial studies have been conducted to develop a PoP for various agroecological conditions of the EU. All of this can be organized with a focused outcome to help achieve a minimum of 3–6% SOM in agricultural lands.

  All recommendations from soil scientists and practitioners of regenerative/conservation and smart agriculture to regenerate soil, amount to increasing SOM. The practices mentioned are crop rotation, no or reduced till farming, having leguminous crops in rotation to fix nitrogen naturally, cover crops for summer, cover crops for winter, managed grazing, composting, green manure, introducing animal waste back into land, silvo-pasture, and a few other practices. If knowledge generation and cataloging specific to agricultural lands were focused on a single mandate of increasing SOM to a minimum range of 3–6% soil management mandate, the communication and training of farmers will yield better results.

Farmer Support Ecosystem

- **Easy and free access to education and knowledge systems to facilitate transition:** The role of advisory services in the form of training, exposure visits, and engagement with progressive farmers are essential in assisting land users in transitioning from conventional farming practices to regenerative practices. This is crucial as there is a possibility of reduction in yields, and crop failures during the transition period. For agricultural soils, local action must be closely nurtured and fostered with sufficient support from the farm advisory services and the **Agricultural Knowledge and Innovation Systems (AKIS)** of the CAP (2021–27) strategic plans. The Farm to Fork strategy document again talks about research, innovation, technology and investments. Access to fast broadband internet will also enable data driven advisory and decision-making for farmers.
- **Assistance for equipment specific to regenerative agriculture practices:** Eco-scheme (Pillar I) and/or ring-fenced rural development funds can be allowed to assist farmers in equipping themselves with machinery (e.g. seed drills used to lodge seeds into the soil on no-till farms), that will be needed to transition from conventional to regenerative farming practices.

Legal Provisions

- **Need for a simple and focused Soil Health Law:** The process to bring soil back to being "healthy soil" seems to be split across various strategies and policies. It has been consistently observed that when a particular natural resource base (like water or air) gets sharp, focused attention, there is a clear direction to improve the quality of this resource, and the targets for various programs that use this resource get aligned to that mandate.

  There is a clear Water Legislation for Europe that ensures all types of water use is regulated and monitored. There is an EU policy for coastal areas and oceans. There is an EU and international air pollution policy to ensure clean air. But there are no policies that underline the need for a legal framework that grants similar protection to soil as water, marine environment, and air. While the MEPs of all EU nations are debating a need for a specific Soil Health Law, we feel that there is no question that a dedicated Soil Health Law is the need of the hour. This is because of the multifaceted effect healthy soil has on food, nutrition, water, biodiversity and climate change. This need for a resource-specific policy for soil has been pointed out by the EU Soil Strategy for 2030 document too. A soil certificate for farmers has been proposed in the Soil Health Law. The soil certificate *"should ensure the soil's SOM is also measured alongside physical and chemical properties of the soil."*

- **Define healthy soil:** Similar to what is mentioned in the EU Soil Strategy document, it will bring clarity on what healthy soil is if the EU defines the threshold beyond which soil cannot be considered healthy. This will aid in designing country-specific CAP (2021–27) strategic plans. In this definition of healthy agricultural soil, one of the criteria should be that SOM should be at least 3–6%. These ranges set by the Commission should then be achieved at an accelerated pace by 2030.

Monitoring and Learning Systems

- **Digital systems for data collection and monitoring:** Provisions to measure indicators of progress on various aspects of the soil, especially the change in SOM and soil biology, should be in place. This can help remote monitoring, knowledge exchange among farmers and also between farmers, experts and other stakeholders.
- **Implementation framework:** We acknowledge that EU's new CAP (2021–27) policies and the Green Deal and Soil Strategy are only a few months old. So we suggest the 2-year period allocated for member states to learn be spent on building a clear implementation framework with definitions of clear Key Performance Indicators (KPIs) across various soil specific schemes for landowners. Some of the specific KPIs that can ensure nations stay on track are:
    - Change in SOM
    - Change in water holding capacity of lands
    - Change in quantum of fertilizer use
    - Change in yields
    - Change in LULUC (change in cropping patterns, etc.)

It is recommended to have regular, annual assessments on these KPIs at local and aggregate levels. The results should be made available to farmers, and AKIS should support in addressing any lack of progress within the member states.

Implementation of the above-mentioned recommendations will yield significant results towards the following CAP (2021–27) key objectives:

- **Increasing competitiveness of EU farmers:** It has been observed that regenerative farm practices have given rise to increased yields of produce in any type of soil. They also lead to reduced input needs of fertilizers, water, etc. as the soil's natural ability to provide nutrients gets established with improved soil microbial biodiversity. Thus, the cost of production also goes down. Also, the quality of the produce goes up, and with the new labelling protocols that the EU is taking up, this may fetch the farmers better prices for their produce as well.

- **Climate change action:** Regenerative practices lead to increase in SOM, which translates to an increase in SOC. It has been observed that in grasslands and forests of the EU, SOC is 10% and sometimes up to 20%. The EU's agricultural lands at present mostly have less than 2% SOC.[28] The difference between grasslands and agricultural lands is the carbon sequestration potential of soils.
- **Environmental care / efficient soil management:** Improving SOM was suggested in order to meet this key objective of CAP (2021–27). An increase in SOM will lead to reduction in unsustainable soil erosion found in 35% of Europe's lands, reduced fertilizer runoffs and improved carbon sequestration.
- **To preserve landscapes and biodiversity:** Regenerative farming principles lead to increase of SOM. This happens through the revival of all life in soil and the overall soil food web.
- **To support generational renewal:** The activities to bring back SOM will require a detailed implementation framework starting from a clear training ecosystem involving experts, scientists, progressive farmers, and last-mile outreach to the farmers in rural areas. This will also involve using digital technologies which is an area that the younger generation is comfortable with. While some of them can engage with farming directly, other rural youth can be engaged in facilitation of:
    - Farmer-to-Farmer network based learning
    - Handholding farmers through helplines: phone-based, computer-based and in-person assistance
    - Facilitating access to the expertise of various stakeholders for farmers
- **To protect food and health quality:** Adopting regenerative agricultural practices will lead to reduced need for fertilizers, pesticides and other chemical inputs, and better animal husbandry and animal feed management within the farm. This leads to less chemical residues in the produce and healthier food.

Increasing SOM will also contribute towards the European Green Deal's aspiration to provide its citizens with fresh air, clean water, healthy soil and biodiversity, healthy and affordable food, recycled and re-used crop residue, globally competitive and resilient industry, and future-proof jobs and skills training for the transition.

---

28. FAO. (2015). World fertilizer trends and outlook to 2018. *Food and Agriculture Organization of the United Nations.* https://pdf.usaid.gov/pdf_docs/PA00XT7Z.pdf

3.2.2 Russian Federation

Russian Federation Statistics

Total Population: 145,912,000

GDP: USD 1.69 trillion

GDP per Capita: USD 11,605.6

Total Landmass Area: 17,098,246 km^2

Landmass under Agriculture: 2,154,940 km^2

Population Dependent on Agriculture as a Percentage of Total Employment: 5.6%

Average Farm Size: 150 ha[29]

The State of Agricultural Soil in the Russian Federation

The state of Russian soils vary dramatically due to the vast expanse of area and the many agro-climatic conditions of the nation. Fourteen percent of agricultural land suffers water erosion, 24% is affected by wind erosion, 31% suffers from swamping, 14% suffers water logging and 1.41% is affected by desertification. Radioactive contamination, a problem unique to Russia, also affects around 8% of agricultural soil.[30] The cost of land degradation that led to low soil productivity alone was calculated to be around USD 189 billion for the period between 2001–2009. The total economic value of ecosystem goods and services is estimated to be around USD 3700 billion, which is three times the GDP.[31] Also, in Russia, the costs of action against land degradation are lower than the costs of inaction by 5–6 times over a 30-year horizon.

Present Policy Ecosystem in the Russian Federation

Land Tenure Change (1990s): Agriculture reforms in Russia in the 1990s saw land ownership of over 85% of lands move from the state to individuals. This led to

29. Qamar, M. K. (2014). Russia. *GFRAS*. https://www.g-fras.org/en/world-wide-extension-study/europe/eastern-europe/russia.html

30. Vandysheva, N. M., & Gurov, A. F. (2011). Predominant negative processes on agricultural lands. In S. A. Shoba (Ed.), *National Atlas of Soils in Russian Federation*, 266–267.

31. Bao Le, Q., Nkonya, E., & Mirzabaev, A. (2014). Biomass productivity-based mapping of global land degradation hotspots. *ZEF—Discussion Papers on Development Policy No. 193, 1-57. Report on the state and use of agricultural lands.* (2011). Ministry of Agriculture of the Russian Federation.

reduction of loss-making agriculture enterprises from 88% in 1998 to 28% in 2010.[32] This had an impact on land use efficiency and overall land productivity.

Environmental Quality Standards (2003): Soil quality is covered as one of the parameters of the environment under the environmental quality standards in Russia. By 2003, the maximum allowed concentrations (MAC) for various chemical elements in soil and food stuffs was clearly demarcated.

Soil Use License: Under the larger natural resource licensing / permit system, there is clear articulation of what entails "soil protection". This license, though, leans towards protection of soil from contamination and pollution and does not dwell much on the biological activity of soil. This license is as applicable to a farmer as industries which use the soil.

The Federal Service for Environmental Use: This is a regulatory body entrusted with monitoring, control and supervision of land use and protection of biodiversity and other natural resources.

Land Code of the Russian Federation of 2006:[33] According to this code, the land title holder is responsible to ensure the following:

- *to carry out production of agricultural products in ways that exclude or limit the adverse impact of such activities on the environment*
- *to comply with the norms and rules in the field of ensuring the fertility of agricultural land*
- *to submit information on the use of pesticides and agrochemicals to the relevant executive authorities in accordance with the established procedure*
- *to promote agrochemical, soil, phytosanitary and ecological-toxicological surveys of agricultural lands*
- *to inform the relevant executive authorities about the facts of degradation of agricultural land and soil pollution on land plots in their possession or use, among others.*

---

32. *Agriculture, hunting and forestry.* Entrepreneurship, Official Statistics, Federal State Statistics Service. (2014). http://www.gks.ru/. (in Russian).

33. Saenko, A., & Shiposha, S. (2022). The Environment and Climate Change Law Review: Russia. *The Law Reviews*. https://thelawreviews.co.uk/title/the-environment-and-climate-change-law-review/russia

State Program for Agriculture (SPA) (2019) 15th Edition:[34] The reformed state agriculture scheme, SPA, focused on farmer support with respect to pricing of farm produce, payment for outputs, access to credit, etc. The SPA document aims to also create favorable conditions for efficient land use. The Ministry of Agriculture also promotes climate smart practices for farming systems, which will encourage sustainable use of water, air and nutrition regime. SPA strongly focuses on digitalization of agricultural data.

Federal Law On Soil Protection (No. 83334-3) Bill (2002): This is the legal provision that was brought to protect soil as a resource like water and air. But it never gained a strong foothold due to its drafting not being "quite correct in its formulation" from a legal point of view.[35]

Policy Recommendations for the Russian Federation

The overall policy regime in Russia at present is focused largely on contamination of soil and other natural resources. There exist policies regarding climate adaptation but focused on the contribution of industries. Agriculture as a sector receives focus in terms of improving productivity and ensuring the land is not polluted from agricultural use. Given this situation, soil biology and SSM is yet to come into focus in Russia.

Knowledge Systems

Russian agriculture is diverse. Agriculture as a sector, in terms of sustainable agricultural practices, is spread across various departments. There are universities conducting research, government institutions rolling out government schemes, etc. To ensure that Russia's food security is not jeopardized by climate change, all these institutions should work in tandem rather than in silos. There has to be a concerted effort to build knowledge systems (by pooling together the work done by all the various institutions) in one place. These knowledge databases should be accessible to farmers with varied education backgrounds from across the country.

34. *Russian Federation*. Agricultural Policy Monitoring and Evaluation 2021: Addressing the Challenges Facing Food Systems. OECD. (2021). https://www.oecd-ilibrary.org/sites/ed982f42-en/index.html?itemId=/content/component/ed982f42-en

35. Chukov, S. N., & Yakovlev, A. S. (2019). Soil and land categories in the modern legislation of Russia. *Eurasian Soil Science, 52*(7), 865-870.

- **Create/collate agroecological zone based information:** To start with, clear SSM recommendations for various agroecological zones and soil types should be published and made available to farmers across the country.
- **Conduct farm equipment R&D domestically:** At present there is a heavy reliance on imported technology for agriculture equipment. If the R&D around SSM practices is done domestically, farmers may be able to access the equipment at affordable prices.[36]
- **Increase the number of agriculture experts/staff to handhold farmers:** There may be a lack of enough trained agriculture experts who can handhold farmers in transitioning to SSM practices.[37]

Farmer Support Ecosystem

SSM techniques in agriculture will involve change in cropping types, nutrient regimes, and agriculture techniques and equipment.

The bottleneck for farmers to adopt climate smart / precision farming in Russia[38] is the lack of regulatory support from the government. SSM practices also suffer from the same bottleneck.

The farmer support ecosystem should have last-mile access to assistance. A contextual farmer-to-farmer learning network, like that of soil doctors suggested by the Global Soil Partnership, will help farmer transition to be quick and effective.

- **Access carbon credit for farmers:** Russia is clearly on track to meet its commitments at Paris COP15. Agriculture in Russia can play a huge role in meeting the nationally declared commitment at COP. The carbon credit benefits from SSM can be a way to incentivize farmers to transition to SSM practices.
- **Access to SSM-specific farm equipment:** When farmers transition to SSM practices, there will be a change in the farm equipment used. This capital expenditure may not be possible for all farmers. Either incentives should be designed to pay for this equipment, or some form of low cost rental/leasing should be facilitated by the regional governments.

---

36. Kulyasov, N. S., Novik, N. N., Klyukin, N. D., & Charyyarova, G. D. (2020). Precision agriculture in the Russian Federation: Problems and directions in development. *IOP Conference Series: Earth and Environmental Science*, *548*(2), 022090.

37. *ibid.*

38. *ibid.*

Legal Provisions

The present legal definition of soil is vague and uncertain. The only federal law on soil protection that was drafted did not take off in Russia. There should be clear legal provision for soil to be treated as an independent natural resource just like air and water. Just like there is a federal law on the protection of atmospheric air, there should be one for soil protection, too. The law should delve into the details of the various functions of soil – physical, chemical and biological. Most importantly, the biological function of soil must incorporate the requirement that SOM should be at least 3–6%, along with definitions of soil bulk density and soil biological parameters as mentioned by the FAO, (in 3.1 Policies for the World).

Monitoring and Learning Systems

Soil quality is presently monitored by regional regulatory bodies. The aspects that are monitored should include biological parameters like soil biological activity, SOM, soil productivity, and physical properties like bulk density. This data should be ideally collected at the farm level.

The information gathered at the farm level can also be used to guide farmers through the soil doctor last-mile connectivity network. For larger regional level mapping, the Global Soil Partnership's GSOCmap mapping teams and their models can be adapted to Russia. Strategic and statistically relevant monitoring centers can be established to collect data on soil health.[39]

Consistently, if interventions are undertaken with a single point focus to improve SOM to a minimum of 3–6%, it will help improve the soil health in Russia in a time-bound manner.

39. *The GSOCmap, a stepping stone in our knowledge of soils.* Global Soil Partnership. Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/global-soil-partnership/pillars-action/4-information-and-data-new/global-soil-organic-carbon-gsoc-map/en/

3.2.3 United Kingdom

United Kingdom Statistics

Total Population: 68,207,000

GDP: USD 2.82 trillion

GDP per Capita: USD 41,854.5

Total Landmass Area: 242,495 km²

Landmass under Agriculture: 175,212.961 km²

Population Dependent on Agriculture as a Percentage of Total Employment: 1%

Average Farm Size: 87 hectares[40]

The State of Agricultural Soil in the United Kingdom

Over 70% of land in the United Kingdom (UK) is under agriculture, which contributed £10.4 billion to the UK economy in 2019. Fifty-five percent of the food produced was consumed domestically.[41]

As with many parts of Europe, UK's soils under agriculture are degraded. Over 2.9 million tonnes of topsoil in the UK (England and Wales) are eroded by wind and water.[42] About 3.9 million ha are under the risk of compaction.[43] Contamination of soil due to poor sewage sludge application, microfiber and micro-plastic is also a concern. Contamination of soil adversely affects beneficial soil organisms like earthworms.[44] Soil nutrient balance had reduced between 2000 and 2019. Nitrogen had reduced by 24%, and phosphate by 46%.[45]

---

40. Dodds, S. (2019) What size is the average farm? *MHA MacIntyre Hudson.* https://www.macintyrehudson.co.uk/insights/article/what-size-is-the-average-farm

41. *Agriculture in the United Kingdom.* DEFRA. (2020). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1056618/AUK2020_22feb22.pdf

42. Environment Agency. (2019). The State of the Environment: Soil. *GOV.UK.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805926/State_of_the_environment_soil_report.pdf

43. *Technical Report.* UK Climate Risk. https://www.ukclimaterisk.org/independent-assessment-ccra3/technical-report/

44. Prendergast-Miller, M. T., Katsiamides, A., Abbass, M., Sturzenbaum, S. R., Thorpe, K. L., & Hodson, M. E. (2019). Polyester-derived microfibre impacts on the soil-dwelling earthworm Lumbricus terrestris. *Environmental Pollution, 251,* 453-459.

45. *Agriculture in the United Kingdom.* DEFRA. (2020). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1056618/AUK2020_22feb22.pdf

Present Policy Ecosystem in the United Kingdom

The present policy ecosystem around soil is quite strong. Concerted efforts to save soils began in 2009. The timeline of policy interventions since 2009 is as follows:

Safeguarding Our Soils (2009): Countrywide strategy document[46]

Protecting Our Water, Soil and Air (2009): A good-practice guide for land management[47]

The Natural Choice – Securing the Value of Nature (2011): A white paper valuing nature and assisting the nation to make choices that are sustainable. This looked at the value of soil along with other ecosystem services provided by nature.

The Environmental Audit Committee (2016):[48] Articulates the state of soil degradation in the UK, and how soil health can potentially address various issues of climate change, water scarcity, farm yields, etc. It also mentions the lack of a monitoring system to measure trends in soil health. It recommends the following:

- *Establish a scheme to monitor the uptake of soil conservation measures, with enforcement where soils are not being appropriately managed; and Include specific proposals to reverse the ongoing loss of lowland peat soils*

The 25-Year Environment Plan (2018):[49] Reiterated all the previous soil management goals, and sought dedicated allocation of £200,000 for setting up monitoring systems at national and farm-scale levels and developing matrices for soil health.

46. *Safeguarding Our Soils – A Strategy for England.* DEFRA. (2009). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69261/pb13297-soil-strategy-090910.pdf

47. *Protecting Our Water, Soil and Air – A code of good agriculture practice for farmers, growers and land managers.* DEFRA. (2009). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/268691/pb13558-cogap-131223.pdf

48. *Environmental Audit Committee – Inquiry into Soil Health.* Committee on Climate Change. (2016). https://www.theccc.org.uk/wp-content/uploads/2016/01/CCC-Written-Submission-to-Environmental-Audit-Committee-Inquiry-into-Soil-Health.pdf

49. *A Green Future: Our 25 Year Plan to Improve the Environment.* DEFRA. (2018). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf

Agriculture Act 2020:[50] In this act, the incentives for the farmer to improve soil health are articulated. Farmers will be compensated for protecting and improving soil health through Environment Land Management (ELM) schemes. Under the ELM scheme, Sustainable Farming Incentive (SFI) will be specifically brought in to replace certain payments made to farmers under the CAP regime of the EU.

Environment Act 2021: Under this new strategy, the Soil Health Action Plan for England (SHAPE) was announced to restore soil health through SFI.

The 2022 Sustainable Farming Incentive: Through this scheme, the UK government will pay farmers to produce public goods such as water quality, biodiversity, animal health and welfare, and climate change mitigation, alongside food production.

SFI payments are designed around 4 principles[51] that are inclusive and encourage widespread participation of farmers. These are: fair and effective payments to farmers; allow delivery through a range of activities; allow for existing natural assets to be managed in continuity; and allow for farmers to also earn from private sector sources.

A payment regime is articulated under this scheme, with details of introductory, intermediate and advanced levels of intervention in farmlands, with the payments being commensurate to the level of intervention.[52] The scheme also elaborates on creating more detailed standards which will be implemented from 2023. The payment regime for sustainable animal rearing, in line with the Annual Health and Welfare Review, is also outlined in the scheme.[53]

Innovations in Soil Monitoring Technology:[54] Innovations could simplify national- and farm-scale soil monitoring, reporting and verification. In a recent publication

---

50. *Agriculture Act 2020.* UK Public General Acts. https://www.legislation.gov.uk/ukpga/2020/21/contents/enacted/data.htm

51. *Annex A: Early roll out of Sustainable Farming Incentive – coherence with payment principles.* DEFRA (2021). https://www.gov.uk/government/publications/sustainable-farming-incentive-how-the-scheme-will-work-in-2022/annex-a-early-roll-out-of-sustainable-farming-incentive-coherence-with-payment-principles

52. *Sustainable Farming Incentive: How the scheme will work in 2022.* DEFRA. (2021). https://www.gov.uk/government/publications/sustainable-farming-incentive-how-the-scheme-will-work-in-2022/sustainable-farming-incentive-how-the-scheme-will-work-in-2022

53. *Introducing the Annual Health and Welfare Review.* Future Farming. DEFRA. (2021). https://defrafarming.blog.gov.uk/2021/10/05/introducing-the-annual-health-and-welfare-review

54. *Restoring Agricultural Soils.* UK Parliament Post. Post Note. (2022). https://researchbriefings.files.parliament.uk/documents/POST-PN-0662/POST-PN-0662.pdf

on measurement/monitoring, reporting and verification (MRV) systems for SOC, a concerted effort to understand the challenges in measuring SOC and development of models to measure SOC has been made.[55]

Policy Recommendations for the United Kingdom

The policy ecosystem that is being crafted to improve soil health in the UK is in congruence with all the recommendations of Conscious Planet. The work that has happened over a decade in the UK accounts for strengthening all pillars of intervention needed to improve soil health, namely:

Knowledge Systems

The good-practice guide effort that started in 2009 has set a strong foundation for the knowledge systems that are needed to transition to sustainable agriculture.

Farmer Support Ecosystem

The Sustainable Farming Incentive policy of 2022 is a promising start to encourage farmers to transition to sustainable agricultural practices to improve soil health. The incentives are clear and measurable. The farmer support ecosystems present now can be bolstered with a farmer-to-farmer learning platform like the Global Soil Doctors Programme run by the FAO.[56]

Additionally, the carbon credit rates in the last year have tripled as the European Commission moved towards tighter targets.[57] After the COP26 at Glasgow, a global protocol for trading carbon credits and offsets was arrived at consensually. The carbon credits market is now more accessible to both farmers and corporates/industries and financial investors. These markets can also be leveraged to accelerate the process of transitioning farmers to SSM practices.

---

55. Smith, P., Soussana, J. F., Angers, D., Schipper, L., Chenu, C., Rasse, D. P., ... & Klumpp, K. (2020). How to measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal. *Global Change Biology, 26*(1), 219-241.

56. *Global Soil Partnership.* Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/global-soil-partnership/pillars-action/2-awareness-raising/soil-doctor/en/

57. Mellow, C. (2022) Carbon Trading 2.0: The effect of the Glasgow COP26 meeting continues to grow and is now propelling the carbon-trading market. *Global Finance Magazine.* https://www.gfmag.com/magazine/february-2022/carbon-trading-20

Farmers will also incur capital expenditure related to the change in farm equipment, when they move towards SSM practices. The farmer support ecosystem should have explicit assistance in the form of low interest loans or rentals to assist with these expenditures.

Legal Provisions

Under the Cross Compliance in England rules set up by DEFRA in 2015,[58] the process to be followed for soil standard enforcement and associated payments to farmers based on the results of soil inspection is clearly articulated. The definitions of soil health, soil quality, soil security and soil resilience have been covered under the recent UK Parliamentary Post of January 2022 – Restoring Agriculture Soils. It will be best if the definitions for all these aspects are further elaborated and enshrined in law. At present, these feature only in the strategy document for safeguarding the soils of England.[59] **The definition of healthy soil under agriculture should also mention the need for a minimum SOM of 3–6%.**

Monitoring and Learning Systems

A clear need for MRV has been mentioned in the Parliamentary Post of January 2022. The work has begun to arrive at methods and models based on which SOC can be measured across the country scientifically. There exist simple field level testing kits (mentioned in Chapter 2) that can help farmers assess the change in their soil biological parameters, including SOM. Although such testing kits may not be as accurate as spectrometry tests, they will provide farmers with the information they need to understand the trends of how their soil is changing.

---

58. *Cross compliance in England: Soil protection standards.* DEFRA. (2015). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/397046/CCSoilPS_2015_v1_WEB.pdf

59. *Safeguarding Our Soils – A Strategy for England.* DEFRA. (2009). https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69261/pb13297-soil-strategy-090910.pdf

3.2.4 Ukraine

Ukraine Statistics

Total Population: 43,467,000

GDP: USD 153 billion

GDP per Capita: USD 3,495.5

Total Landmass Area: 603,500 km²

Landmass under Agriculture: 413,110 km²

Population Dependent on Agriculture as a Percentage of Total Employment: 14.1%

Average Farm Size: 100 ha[60]

The State of Agricultural Soil in Ukraine

Ukraine, rightfully known as the breadbasket of Europe, has one of the largest areas of agricultural land in Europe – 41 million ha. Its geographic location also provides access to key agricultural markets in Europe, the Middle East, North Africa, and Asia.[61] Having exceptionally fertile soil and favorable weather conditions for crop production, Ukraine has enormous potential for sustainable agriculture development.

Ukraine has one-third of the world's endowment of black soil, which is among the most fertile soils in the world. This soil, under the right conditions, can produce high yields and incomes. However, it is estimated that Ukraine's arable land loses over 500 million tonnes of soil to erosion annually, resulting in loss of soil fertility across 32.5 million ha. The loss of nutrients has a financial impact of approximately USD 5 billion.[62]

Water logging amounts to 12% of land degradation, while acidification, salinization and alkalinization together affect over 18% of the soil.[63] However, the primary causes

---

60. Mark, O. (2014). What it's like to farm in the Ukraine. *Farmers Weekly.* https://www.fwi.co.uk/machinery/like-farm-ukraine

61. *Productivity of agricultural land in the context of state policy.* Food and Agriculture Organization of the United Nations (FAO). (2021). https://www.fao.org/fileadmin/user_upload/GSP/WSD21/Concept_note_for_WSD_event_2021.pdf

62. Fileccia, T., Guadagni, M., Hovhera, V., & Bernoux, M. (2014). Ukraine: Soil fertility to strengthen climate resilience. *FAO Investment Centre.* https://www.fao.org/3/i3905e/i3905e.pdf

63. *ibid.*

of soil degradation are wind and water erosion. Twenty million hectares are affected by dust storms and 19 million ha are exposed to the harmful effects of water and wind erosion.[64] The value of eroded soil each year is around a third of the agricultural GDP.

Present Policy Ecosystem in Ukraine

The following are some of the policies that are relevant to soil health in Ukraine.

On Land Protection (2003):[65] This statute directly pertains to soil health. The law mandates protection of soil as a national wealth, prioritization of environmental protection of soil as it is a basic means of food production, compensation for damages caused to land by infringing upon the land protection legislation, designing economic incentives and ensuring legal responsibility of stakeholders with respect to land protection; and finally, it details the role of public participation and mandates transparency in the sphere of land protection.

Ministry of Agrarian Policy and Food Validating the Regulation (Order No. 536) (2011):[66] This order mandates all state government hands to have an agrochemical certificate. The certificate captures characteristics of the soil, the level of contamination and toxic substances. Agrochemical certification of arable land is carried out once in 5 years, and for hayfields, pastures and perennial plantations once in 5–10 years, and it is mandatory for all landowners and land tenants.

National Action Plan (NAP) to Combat Land Degradation and Desertification (2014):[67] In 2014, the Cabinet of Ministers of Ukraine resolved and approved the concept to combat land degradation and desertification. This concept was then elaborated and adopted in a resolution in March 2016. Implementation of the respective programs will mainly be aimed at decreasing land degradation in agricultural areas and achieving Land Degradation Neutrality (LDN).

---

64. *Ukraine: Soil degradation.* Agroberichten Buitenland. (2021). https://www.agroberichtenbuitenland.nl/documenten/publicaties/2021/06/17/ukraine-soil-degradation

65. *Ukraine: Law No. 1877-IV on land* protection. FAOLEX Database. (2003). https://www.fao.org/faolex/results/details/en/c/LEX-FAOC045747/

66. *Ukraine: Order No. 536 of the Ministry of Agrarian Policy and Food validating the Regulation on the procedure for managing of agrochemical certificate of a field and a land plot*. FAOLEX Database. (2011). https://www.fao.org/faolex/results/details/en/c/LEX-FAOC171839/

67. *National Target Setting to Achieve Land Degradation* Neutrality *in Ukraine.* LDN TSP, The Global Mechanism of the UNCCD. (2018). https://knowledge.unccd.int/sites/default/files/ldn_targets/2019-06/Ukraine%20LDN%20TSP%20Country%20Report.pdf

Ukraine 2050 Low Emission Development Strategy (2017):[68] Low Emission Development Strategy (LEDS) has determined that economic and social growth does not necessitate an increase Greenhouse Gas emissions (GHG). One of the emission reduction goals is to use land as a carbon sink. It is articulated as the objective "Increase in the volumes of carbon absorption and uptake with the help of best climate change mitigation practices in agriculture and forestry."

A Formal Coordination Council Was Established for the NAP (2017): Two workshops with key stakeholders on LDN issues were held in Kyiv and the targets were further tied with the implementation of SDGs in Ukraine. The experts produced two publications for stakeholders including: "Combating Land Degradation and Desertification: Key Political Documents" and "Monitoring and Indicators of Land Degradation Neutrality in Ukraine (Collection of Articles)".

Main Principles (Strategy) of the State Environmental Policy of Ukraine for the Period upto 2030 (2019): A multisectoral policy document related to protection of natural resources – air, water, soil – from the impact of climate change. This strategy mandates bringing back ecological balance in ecosystems of Ukraine.

National Land Degradation Neutrality (LDN) Target Setting Programme (2018): National Scientific Center and the Institute of Water Problems and Land Reclamation of the National Academy of Agrarian Sciences established a baseline for soil organic carbon national data gathered by experts from across the country. Proposals for national LDN targets were discussed, and the agreed upon target included the stabilization of soil organic carbon in agricultural lands.

Ukrainian Soil Partnership (USP) (2019): Under the umbrella of the Global Soil Partnership the USP was established in May 2019. This collaboration is for a period of 4 years between the Ukraine government and FAO to guide the country in achieving the national LDN targets. The protection of fertile land and the integrated management of natural resources is a national priority and it will play a major role in advocating for and coordinating initiatives to LDN targets by 2030.[69]

---

68. *Ukraine 2050 Low Emission Development Strategy*. FAOLEX Database. (2017). https://www.fao.org/faolex/results/details/en/c/LEX-FAOC181201/

69. *Launch of the Ukrainian Soil Partnership*. Global Soil Partnership. Food and Agriculture Organization of the United Nations (FAO). (2019). https://www.fao.org/global-soil-partnership/resources/events/detail/es/c/1196362/

Table 1: SOM-specific LDN Target[70]

LDN Voluntary Target	Target Baselines	Time of Implementation	Indicators of Implementation
Stabilization of SOC content in agricultural lands	The content of soil organic carbon (humus) in agricultural lands as of 2010: 3.14% on average in Ukraine, including as it relates to these zones: Polissya – 2.24%; Forest Steppe – 3.19%; Steppe – 3.40%	**By 2030, increase the content of soil organic carbon (humus) in agricultural land by not less than 0.1%**, including as it relates to these zones: Polissya – by 0.10–0.16% Forest Steppe and Steppe – by 0.08–0.10%.	1. Percent humus content in agricultural soil 2. Percent soil organic carbon content (0–30 cm) 3. Remote sensing data on agricultural productivity

Policy Recommendations for Ukraine

The World Bank along with the FAO carried out a study to quantify the benefits of large-scale adoption of specific sustainable agriculture practices, such as Conservation Agriculture in Ukraine.[71] The study made an assessment of potential benefits at farm, national and global levels. The benefits that will accrue were assessed to be USD 136 per ha at the farm level and USD 4.4 billion nationally. Conservation Agriculture will also reduce the USD 5 billion loss due to soil erosion. There are other benefits from Conservation Agriculture for the nation and world which, when quantified, will exceed the above benefits. In our recommendations, we encourage SSM practices like Conservation Agriculture.

The Ukraine Soil Partnership initiative in collaboration with FAO has objectives for soil health which are in line with sustainable soil management, namely: Strengthen monitoring systems, build transparency in monitoring systems, and strengthen the country's capacity to generate public interest around soil issues. Much needed is a step towards accelerating policies for healthy soil in Ukraine. The USP plays a major role in

70. *National Target Setting to Achieve Land Degradation Neutrality in Ukraine.* LDN TSP, The Global Mechanism of the UNCCD. (2018). https://knowledge.unccd.int/sites/default/files/ldn_targets/2019-06/Ukraine%20LDN%20TSP%20Country%20Report.pdf

71. Fileccia, T., Guadagni, M., Hovhera, V., & Bernoux, M. (2014). Ukraine: Soil fertility to strengthen climate resilience. *FAO Investment Centre.* https://www.fao.org/3/i3905e/i3905e.pdf

the process to achieve the national target of neutral land degradation by 2030.[72] This is also in line with recommendations of Conscious Planet's Save Soil Movement.

The four-year partnership with Global Soil Partnership and FAO can be leveraged to set up all the four pillars required for soil health.

Knowledge Systems

Advancement in policies for soil health in Ukraine have been hindered by a lack of adequate institutional structures and updated research in the field of soil health.73 Given that Ukraine has been favorably endowed with one-third of the world's black soil, research in the country should be conducted in line with its natural endowments and challenges. The national and subregional agriculture research organizations can start by cataloging credible databases of FAO and WOCAT, etc.

There has to be a crop-specific sustainable soil package of practices (PoP), along with models of intercropping, cover crop, leguminous rotation crops, etc., developed specific to Ukrainian farmers. The PoP should cover specific nutritional application protocols for every crop.

The partnership will act as a united national platform to facilitate dialogue and cooperation among ministries, leading institutions, existing research schools and laboratories on land resources, and relevant stakeholders.[74]

- **Centralized and Customized Information Systems:** A knowledge exchange platform to monitor the soil has been launched in Ukraine – "Healthy Soil."75 All of the information gathered and new research generated should be cataloged and organized in a database. This information should be available to all in the entire chain starting from knowledge producers (researchers, academics, pioneer farmers) and knowledge users (farmers and last-mile extension officers who will handhold farmers).

---

72. *Launch of the Ukrainian Soil Partnership*. Global Soil Partnership. Food and Agriculture Organization of the United Nations (FAO). (2019). https://www.fao.org/global-soil-partnership/resources/events/detail/es/c/1196362/

73. *ibid.*

74. *Ukraine, FAO unit to save healthy soil*. Global Soil Partnership. Food and Agriculture Organization of the United Nations. https://www.fao.org/global-soil-partnership/resources/highlights/detail/fr/c/1195674/

75. A knowledge exchange platform to monitor the soil in Ukraine, "Healthy Soil" is being populated with articles on topics directly linked to the project operations and recent developments or events of the project. https://healthy-soils.org.ua

Farmer Support Ecosystem

- **Creation of Farmer-friendly Information:** The research work done under the knowledge systems have to be made available to farmers in a farmer-friendly format, through various mediums of print, video and other formats that farmers prefer.
- **Training:** Training sessions on sustainable soil management, regenerative agricultural practices, and PoPs for specific crops must be conducted for farmers. Agricultural research institutions should also arrange for model farm plots that demonstrate the benefits of such practices, such as improvement in crop yield. It should be noted that such training sessions have maximum impact when conducted by fellow progressive farmers whose livelihoods depend on agriculture. Under the USP partnership with FAO there are training programs for farmers of Ukraine for specific Steppe regions of the country.[76] The FAO team in Ukraine is working on developing an online course on conservation agriculture practices in collaboration with national and regional agriculture universities of Ukraine, based on the Farmer Field School program.[77]
- **Soil Doctors:** Farmers will need last-mile support, in the form of extension officers, or soil doctors. Soil doctors could be reputed farmers who are trusted amongst the farming community, and have implemented SSM practices. A high ratio of trained soil doctors to farmers will ensure they can do justice to the number of farmers allocated to them.
- **Incentives for Farmers:** Strengthen incentives for adopting technologies to maintain soil fertility and reduce the volatility of agricultural production, through practices like Conservation Agriculture with no-till. These incentives can be leveraged from international carbon credits and environmental protection budgets.
- **Transitional Budgets:** The country should invest in helping farmers transition to SSM practices by either subsidizing equipment or offering financial instruments (rents, leases).

76. *Healthy soils in Ukraine: Integrated Natural Resources Management in Degraded Landscapes in the Forest-Steppe and Steppe Zones of Ukraine.* Food and Agriculture Organization of the United Nations (FAO). (2019). http://old.belal.by/elib/fao/1178.pdf

77. *ibid.*

Legal Provisions

In order to optimize the legal support to the protection of land and soil, adopting the draft law "On Protection of Soil and Its Fertility" (drafted in 2013) would be important.[78] This proposed law should define healthy soil and its parameters. The parameters to measure healthy soil should include biological factors as mentioned in Conscious Planet's recommendations for the world's soil. The definition should include a minimum of 3–6% SOM. The law should provide for clear monitoring of soil biological parameters.

Monitoring and Learning Systems

Ukraine has recently begun to set up soil monitoring infrastructure as part of the USP in 2019.[79] In addition, soil monitoring indicators were formulated and implemented by the Ministry of Energy and Environmental Protection with technical assistance from the FAO through the USP program. The "Healthy Soil" platform of the Ukraine government can also host monitoring information along with information on good practices. The "Healthy Soil" platform will support the formation of a monitoring base of land cover, land productivity and carbon stocks.[80]

It will be best if this platform is used to collect and monitor information at the granularity of every farm. And this monitoring information can be used to assist and handhold farmers through the Farmer Support Ecosystem. As mentioned in the Legal Provisions, the information collected at farm level should mandatorily have biological parameters, SOM, bulk density, biological activity, soil respiratory rate, etc.

---

78. Khominets, S. (2021). Legal Support to the Protection of Land and Soil in Light of New Regulations of Ukraine. *Journal of Environmental Law & Policy, 1*, 35.

79. *Launch of the Ukrainian Soil Partnership.* Global Soil Partnership. Food and Agriculture Organization of the United Nations (FAO). (2019). https://www.fao.org/global-soil-partnership/resources/events/detail/es/c/1196362/

80. *"Healthy Soil" knowledge platform.* https://healthy-soils.org.ua

CHAPTER 4: Sustainable Soil Management Solutions – From Around the World

There are various Sustainable Soil Management (SSM) practices followed by farmers across the diverse geographies of the world. Although the principles of SSM are common, the specific solutions for each region are guided by two major factors – the agroecological zone and the soil type.

An agroecological zone is defined by the FAO as follows:
Agroecological zoning (AEZ), as applied in FAO studies, defines zones based on combinations of soil, landform, and climatic characteristics. The particular parameters used in the definition focus attention on the climatic and edaphic requirements of crops and on the management systems under which the crops are grown. Each zone has a similar combination of constraints and potentials for land use, and serves as a focus for the targeting of recommendations designed to improve the existing land-use situation, either through increasing production or by limiting land degradation.

The essential components of the core applications that map AEZ comprise:

- Land resource inventory
- Inventory of land utilization types and crop requirements
- Land suitability evaluation, including:
    - Potential maximum yield calculation
    - Matching of constraints and requirements

The solution matrix that we chose to catalog relevant SSM practices across the world is the superimposition of **agroecological zones** of the world over **the soil types present in a particular region.** This is to ensure that recommended regenerative agriculture practices are relevant to both the climatic conditions – temperature and rainfall specifically, and the parent material of the soil.

4.1 Agroecological Zone for SSM – Thermal Climatic Zones

There are 12 thermal climatic zones in the world as per the Global Agro Ecological Zones (GAEZ) modeling of the FAO,[1] described in Table 1. Map 1 shows the zonations across the world.

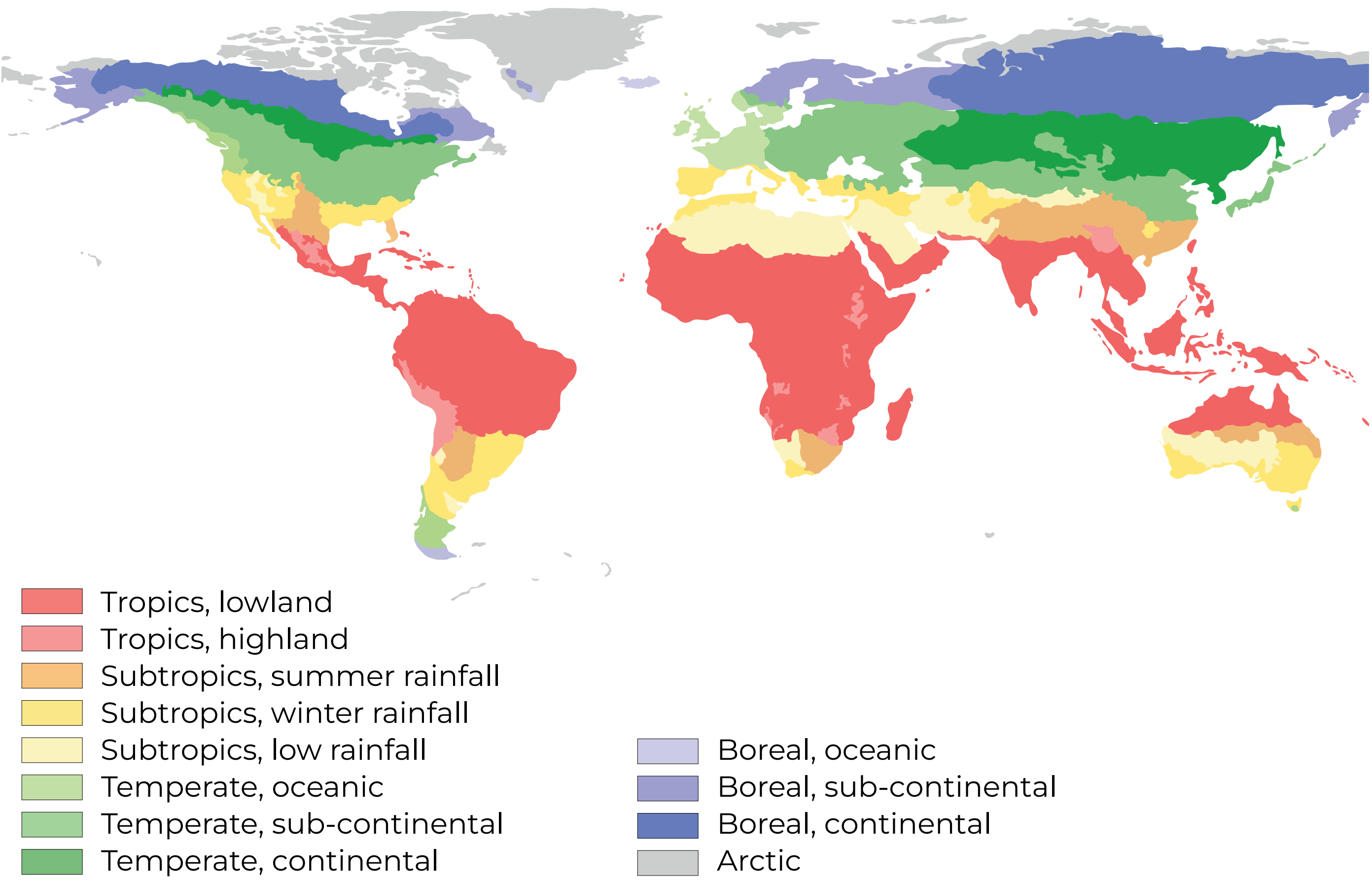
1. *Global Agro-ecological Zones (GAEZ v3.0)*. IIASA, Laxenburg, Austria and Food and Agriculture Organization of the United Nations (FAO). Rome, Italy. (2012). https://pure.iiasa.ac.at/id/eprint/13290/1/GAEZ_Model_Documentation.pdf

Table 1: Basis of Thermal Climatic Zonations of the World.[2]

Climate	Rainfall and Temperature Seasonality
Tropics All months with monthly mean temperatures, corrected to sea level, above 18°C	***Tropical lowland*** ***Tropics with actual mean temperatures above 20°C*** ***Tropical highland*** ***Tropics with actual mean temperature below 20°C***
Subtropics One or more months with monthly mean temperatures, corrected to sea level, below 18°C, but all above 5°C, and 8-12 months above 10°C	***Subtropics Summer Rainfall*** Northern hemisphere: P/Eto in April-September ≥ P/Eto in October-March Southern hemisphere: P/Eto in October-March ≥ P/Eto in April-September ***Subtropics Winter Rainfall*** Northern hemisphere: P/Eto in October-March ≥ P/Eto in April-September Southern hemisphere: P/ETo in April-September ≥ P/ETo in October-March ***Subtropics Low Rainfall*** Annual rainfall less than 250 mm
Temperate At least one month with monthly mean temperatures, corrected to sea level, below 5°C and four or more months above 10°C	***Oceanic Temperate*** Seasonality less than 20°C* ***Subcontinental Temperate*** Seasonality 20-35°C* ***Continental Temperate*** Seasonality more than 35°C*
Boreal At least one month with monthly mean temperatures, corrected to sea level, below 5°C and 1-3 months above 10°C	***Oceanic Boreal*** Seasonality less than 20°C* ***Subcontinental Boreal*** Seasonality 20-35°C* ***Continental Boreal*** Seasonality more than 35°C*
Arctic All months with monthly mean temperatures, corrected to sea level, below 10°C	***Arctic***
*Seasonality refers to the difference in mean temperature of the warmest and coldest month	

2. *Global Agro-ecological Zones (GAEZ v3.0)*. IIASA, Laxenburg, Austria and Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. (2012). https://pure.iiasa.ac.at/id/eprint/13290/1/GAEZ_Model_Documentation.pdf

Map 1: Thermal Climates of the World.[3]



4.2 Soil Classification

Soil classification as a process has evolved over decades. There were many soil classifications followed across the world. Two of the most prevalent ones even now are the USDA classification and the FAO classification (which has been reviewed and updated over years). But in 2014, the FAO, UNEP and the International Union for Social Science decided to adhere to the classification given by the World Reference Base for Soil Resources (WRB).[4] The WRB published its most recent soil map in 2015 (Map 2).

3. *Global Agro-ecological Zones (GAEZ v3.0)*. IIASA, Laxenburg, Austria and Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. (2012). https://pure.iiasa.ac.at/id/eprint/13290/1/GAEZ_Model_Documentation.pdf

4. *World Reference Base*. Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/soils-portal/data-hub/soil-classification/world-reference-base/en/?

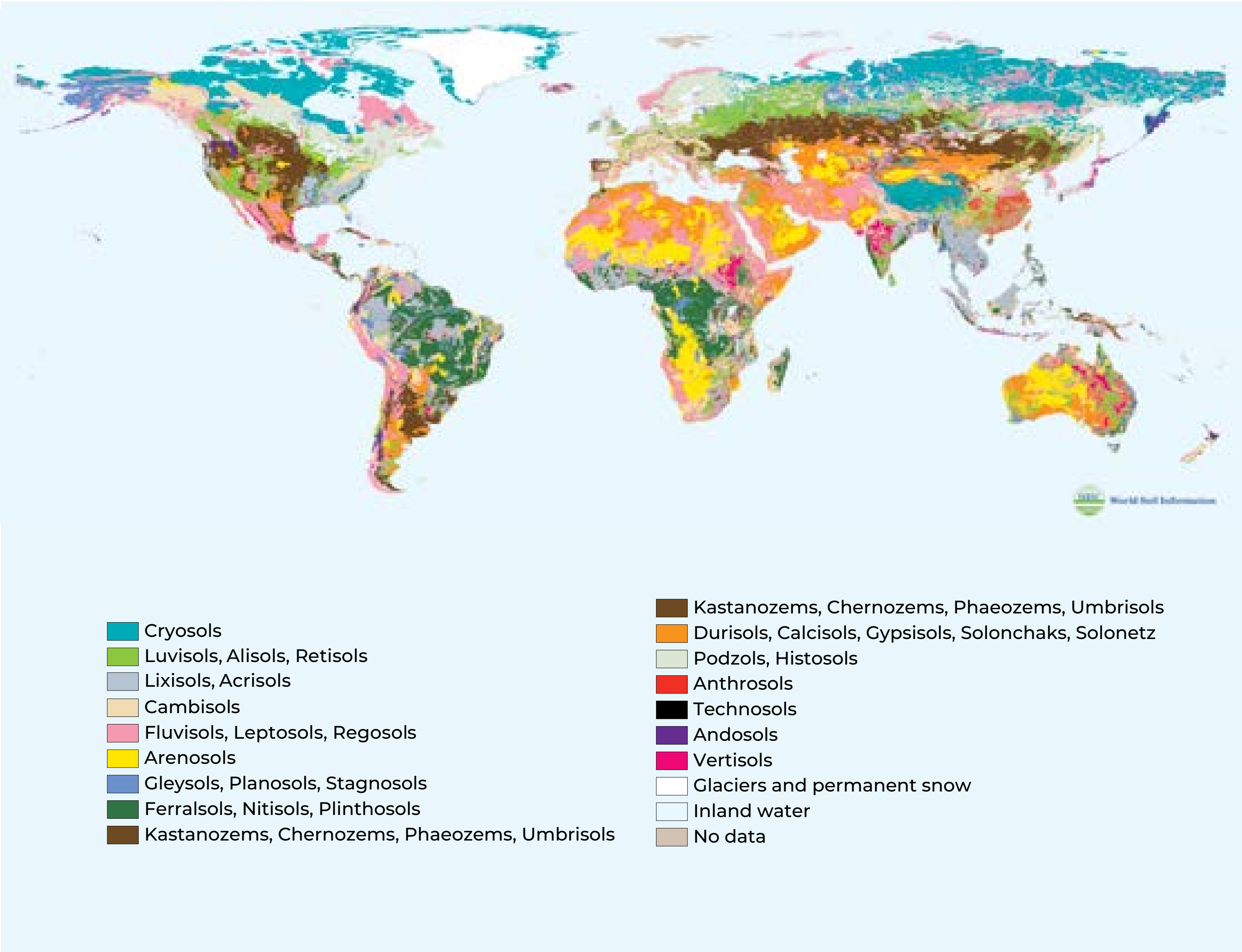
The WRB provides an opportunity to create and refine a common, global language for soil classification. The taxonomic units of the WRB are defined in terms of measurable and observable "diagnostic horizons", the basic identifiers in soil classification. Diagnostic horizons are defined by (combinations of) characteristic "soil properties" and/or "soil materials".

4.3 The Solution Matrix

Conscious Planet's Save Soil Movement has compiled SSM practices for individual countries by classifying each country as a combination of the GAEZ agroecological zones and WRB soil types present in the country.

As an example, the zonation for the SSM solution matrix for the United States of America is presented in Table 2. The USA falls under these thermal climatic zones: Tropical – Lowland, Subtropical – Low Rainfall, Subtropical – Summer Rainfall, Subtropical – Winter Rainfall, Temperate – Subcontinental and Boreal – Subcontinental. And each zone has several soil orders present in it. This is not an exhaustive zonation for the USA; rather it is presented as an example for many states and regions within the country.

Map 2: Soils of the World According to WRB[5]



5.*World Reference Base*. Food and Agriculture Organization of the United Nations (FAO). https://www.fao.org/soils-portal/data-hub/soil-classification/world-reference-base/en/?

Table 2: Zonation for the SSM Solution Matrix Based on Agroecological Zone and Soil Types in the United States.

Agroecological Zone	State(s) / Region	Soil Types
Tropical – Lowland	Florida Keys & Hawaii	Andisols, Entisols, Mollisols, Histosols, Inceptisols, Oxisols, Vertisols
Subtropical – Low Rainfall	New Mexico	Luvisols, Alisols, Retisols, Kastanozems, Chernozems, Phaeozems, Umbrisols
Subtropical – Low Rainfall	Colorado, Nevada, Utah, Arizona	Luvisols, Alisols, Retisols
Subtropical – Summer Rainfall	California, Arkansas, Louisiana, Alabama	Kastanozems, Chernozems, Phaeozems, Umbrisols
Subtropical – Summer Rainfall	Nevada, Arizona, New Mexico, Oklahoma	Luvisols, Alisols, Retisols
Subtropical – Summer Rainfall	Mississippi	Gleysols, Planosols, Stagnosols, Luvisols, Alisols, Retisols
Subtropical – Summer Rainfall	Georgia	Kastanozems, Chernozems, Phaeozems, Umbrisols, Luvisols, Alisols, Retisols
Subtropical – Summer Rainfall	South Carolina	Kastanozems, Chernozems, Phaeozems, Umbrisols, Lluvisols, Alisols, Retisols, Utisols
Subtropical – Winter Rainfall	Florida	Podzols, Histosols, Arenosols, Gleysols, Planosols, Stagnosols, Acrisols, Lixisols, sandy, low nutrient soils
Subtropical – Winter Rainfall	Texas, Colorado	Durisols, Calcisols, Gypsisols, Solonchaks, Solonetz, Fluvisols, Leptosols, Regosols, Kastanozems, Chernozems, Phaeozems, Umbrisols, Luvisols, Alisols, Retisols
Subtropical – Winter Rainfall	New Mexico	Kastanozems, Chernozems, Phaeozems, Umbrisols, Luvisols, Alisols, Retisols

Agroecological Zone	State(s) / Region	Soil Types
Temperate – Subcontinental	Southern Region	Kastanozems, Chernozems, Phaeozems, Umbrisols, Licisols, Acrisols
	Prairie Grasslands Region	Leptosol
	Ohio, Indiana, Illinois, Wisconsin, Missouri	Alfisols
	Kansas, Nebraska, Iowa, South Dakota, North Dakota, Minnesota, Texas, Oklahoma	Valent-Tassel, Wann Soils
	Wyoming (Western)	Arisols (sandy, desert), Andisols (volcanic)
	Maine	Cambisols
Boreal – Subcontinental	Alaska	Cryosol, Fluvisol, Leptosol, Regosol, Cambisol, Gleysol, Planosol, Stagnosol
	Clay County: Faceville, Marlboro, and Greenville	Fine, sandy loam

For every such unique zonation of a country, an SSM practice has been found to improve and accelerate the increase of Soil Organic Matter (SOM), for three types of **land use under agriculture**:

1. Land under croplands
2. Land allocated for feed production for animals
3. Land under animal rearing

So in the case of the USA, we would have solutions collated for all three land uses across the 5 zonations, producing 15 unique solutions for the nation to manage their soil sustainably for croplands, feedlands and animal rearing.

These practices are cataloged from studies conducted by FAO programs in the country, credible peer reviewed scientific publications, and Sustainable Land Management Databases like WOCAT.[6] Country-specific SSM practices can be found at our website: savesoil.org.

The solutions suggested are a mere subset of already existing SSM practices on farms of that particular region. They represent successful case studies, best practices (in conservation agriculture, climate smart agriculture and regenerative agriculture), and indigenous farming techniques. Also listed are the sources for detailed perusal by farmers, policy makers, farmer advisory service providers, or farmer networks. If a government or a farm owner chooses to adopt an SSM regime, then a detailed planning exercise along with specific studies of the farmland will need to be conducted.

Some of the SSM practices across various agroecological zones are shared in Table 3 for croplands, Table 4 for feedlands, and Table 5 for animal rearing. The practices involved in SSM related to fodder / feed production and animal rearing, in Tables 4 and 5, usually go hand in hand.

6. World Overview of Conservation Approaches and Technologies (WOCAT). https://qcat.wocat.net/en/wocat/

Table 3: SSM Agriculture Practices Documented Across Various Agroecological Zones for Croplands

Agroecological Zone	Country	Cropland SSM Practices
Tropical – Highland	Bolivia	Hedgerows of native grasses; Chinampas (water jacinth as green manure); Green mulching; Pest repellent plants like garlic; Raised fields (for soil drainage); Terraced hillsides
	Guatemala	Vegetal soil cover
	Peru	Fertilizing with alternative sources: 1) fish; 2) guano; 3) llama dung
	Uganda	Fertigation; Percolation pits; Mulching using banana leaves; Firelines for tree protection; Planting pits for soil fertilization and moisture improvement; Stone lines; Native trees as windbreaks; Underground water abstraction for crop and livestock production; Conservation farming basins in annual crops for water conservation
	USA (Hawaii)	Hillside ditch; Rock and vegetative barrier; Terrace hillsides
Tropical – Lowland	Zambia	Agroforestry of maize with *Faidherbia albida*
	Australia	Green cane trash blanket
	Bangladesh	Floating bed agriculture; Floating dhap cultivation; Embankment cropping; Saline tolerant rice and grass farming; Early crop harvesting
	Belize	Intercropping citrus with coconut, pineapple, soursop, plantain; Crop rotation – maize with beans
	Benin	Intercropping with mucuna; Zaï; System of Rice Intensification (SRI); Transform fallow land with mucuna
	Bolivia	Traditional farming with footplows
	Botswana	Pest management – mixture of tobacco garlic and onion and sunlight for aphid control; Predator repellent – python fat is mixed with seed before planting to protect the arable fields from predators

Agroecological Zone	Country	Cropland SSM Practices
Tropical – Lowland	Brazil	Kayapó Indians strategies; Green manuring; Agroforestry of cocoa and mahogany tree; Agroforestry of cocoa and rubber; Agroforestry of cowpea and maize; Bioengineered rehabilitation; Surface mulching; Agroecological transition systems; Mixed cropping
	Cambodia	Mulching with water hyacinth (*Eichhornia crassipes*) after monsoon floods
	Cameroon	Intercropping maize and sorghum with *Brachiaria ruziziensis* or *Crotalaria retusa*; Wood ash application as a local insecticide
	China	Integrated Nutrient Management (INM)
	Costa Rica	Intermixing legume trees (*Inga edulis* and *Gliricidia sepium*)
	Cuba	Multi-strata vegetation; Windbreaks; Agro-silvo-pastoralism
	Democratic Republic of Congo	Integrated Soil Fertility Management (ISFM)
	Ethiopia	Push-pull intercropping maize with Greenleaf desmodium, napier grass and Brachiaria grass
	Fiji	Fertilization with seaweed
	Ghana	Relay cropping; Crop rotation with legumes
	Honduras	Quesungual system; Milpas
	India	Rice-wheat (RW) system
	Indonesia	Embung; Integrated farming
	Ivory Coast	Combination of crops on mounds
	Jamaica	Live yam stick system; Mini-setts
	Jordan	Smother crop – alfalfa grown as a smother crop on corn and weeds; Raised bed farming
	Malawi	Agroforestry of maize with *Faidherbia albida*
	Mexico	Mixed cropping
	Namibia	Intercropping between pearl millet and cowpea

Agroecological Zone	Country	Cropland SSM Practices
Tropical – Lowland	Nicaragua	Level curves; Live barriers; Integrated Pest Management
	Niger	Multi-strata intercropping
	Nigeria	Alley cropping / farming
	Oman	Multi-strata intercropping
	Paraguay	Organic production
	Peru	Bench terracing; Contour hedgerow intercropping; Fertilization with dung, manure and ashes; Fertilizing with alternative sources: llakoshka; Agroforestry – The Tamshiyacu cyclic agroforestry system in the Amazon; Kayapó Indians strategies; Crop rotation with legumes
	Philippines	Rice-fish system
	Singapore	Vertical farming system
	Sri Lanka	Changing crop establishment techniques (dry sowing)
	Sudan	Bonds – cross slope tied bonding (CSTB), contour ridge with stone bonds (CRSB), cross slope bonding (CSB); Indigenous conservation tillage practices – chisel ploughing (CHP)
	Thailand	Khok-Nong-Na model; Crop-livestock systems
	Timor-Leste	Agroforestry – coffee with Albizia tree; Agroforestry – turmeric and bamboo; Agroforestry – vanilla with Gliricidia and cottonwood tree
	Uganda	Intercropping maize with watermelon; Drainage/ water harvesting – furrows act as drainage channels – into a pond below
	US (Hawaii)	Loʻi – flooded or irrigated agricultural terraces; Māla – dryland (rainfed) agricultural farming; Contour farming for cropland / orchids; Residue management; Tree / shrub management; Row arrangement; Alley cropping / farming
	Vietnam	Integrated farming
	Zimbabwe	Precision application of small doses of nitrogen-based fertilizer

Agroecological Zone	Country	Cropland SSM Practices
Subtropical	Australia	Pasture cropping (Canola–wheat–barley–5-year perennial pasture)
	China	Rice-fish farming
	India	Moringa cultivation
	Nepal	Panchagavya, ancient Vedic fertilizer
	Pakistan	Bioremediation of soils with plants, bacteria
	USA	Runoff agriculture
Temperate	Bulgaria	Minimal-till, no-till; Strip-till methods
	Chile	No-till / direct seeding; Conservative tillage; Continuous crop residue cover, Diverse crop rotations; Cover crops
	France	Permaculture; Biointensive micro-gardening; Calcareous liming; Preserving a permanent soil cover; Minimizing soil disturbance (going as far as NT); Diversifying crop species; No-till
	Ireland	Conservation tillage; eco-tillage; crop rotation
Boreal	Canada	Conservation tilling
	Greenland	Utilization of melted glacial land silt
	Japan	Satoyama landscapes
	Russia	Dacha plots maintenance
	USA	Biochar; Forward Osmosis (FO) technology for the recovery of water from sewage wastewater

Table 4: SSM Agriculture Practices Documented Across Various Agroecological Zones for Fodder Production in Feedlands

Agroecological Zone	Country	Feedland SSM Practices
Tropical – Highland	Bolivia	Monte diferido
	Uganda	Multi-purpose tree species for pasture supplementation
Tropical – Lowland	Brazil	Green manuring
	Cameroon	Grazing on leftover straw and harvest of animal droppings
	Colombia	Grass strips for cut and carry
	Eritrea	Planting fodder shrubs on the contour bunds
	Guinea	Integrated Taungya farming; Apisilviculture; Aquaforestry
	Honduras	Live Hedges Technology
	India	Integrated Farming Systems (IFS)
	Indonesia	Agrosilvopasture “Pagar Tejo” system
	Mali	Bourgou pastures
	Mexico	Silvopastoral
	Uganda	Napier grass intercropping for cut and carry
	Zimbabwe	Crop residue biomass as animal fodder
Subtropical	Afghanistan	Community fodder banks
	Australia	Bunds and rakes with calcrete, for regenerating dry, sandy rangelands; Rotational or cell grazing
	Pakistan	Halophytes (saltbushes) as fodder
	Saudi Arabia	Al-Hima Rangeland Protection and controlled grazing
	South Africa	Insect fodder trees
Temperate	Bulgaria	Intercropping; Restoration and maintenance of High Nature Value (HNV) grasslands; Traditional practices for seasonal grazing of animals (pastoralism); Conservation of endangered local breeds
	France	“Protein mixes”; “Green manure” cover crops; crop rotation feedstock
Boreal	Russia	Deep tillage
	Sweden	Semi-natural pastures
	USA	Multi-Species Pastured Livestock System

Table 5: SSM Agriculture Practices Documented Across Various Agroecological Zones for Animal Rearing

Agroecological Zone	Country	Animal Rearing SSM Practices
Tropical – Highland	Uganda	Bamboo-woven bee hives; Stall feeding of Friesian cow by cut and carry for livestock management; Indigenous Microorganism (IMO) use in natural pig farming; Groundwater fed fish ponds; Rotational grazing; Small-scale irrigation system for pasture production
Tropical – Lowland	Australia	Mini-livestock
	Bangladesh	Quesungual agroforestry system (QSMAS); Transhumant livestock rearing system
	Bolivia	Raising sheep in folds (RSF)
	Burundi	Nomadic herding
	Cambodia	Nomadic pastoralism
	China	Animal trails / walkways
	Congo	Insects as a source of protein and nutrients for the livestock in the form of feed
	Democratic Republic of Congo	Net fish, cage fish, crab farming
	Equatorial Guinea	Silage production technology
	Eritrea	Semi-scavenger housing for livestock
	Ethiopia	Making feed blocks from crop residues
	Ghana	Crop–fodder–tree–livestock systems
	Guinea	Rice-duck system; Ranching
	Honduras	Capture of out-migrating fishes and establishment of fish farming
	Indonesia	Freshwater acquaculture
	Israel	Intensive silvopastoral system

Agroecological Zone	Country	Animal Rearing SSM Practices
Tropical – Lowland	Jordan	Acquaculture
	Nigeria	Holistic planned grazing
	Qatar	Grazing leftover straw after harvest of rice grains
	Senegal	Range planting such as grasses, forbs, legumes, shrubs & trees; Mixed farming; Rearing and conservation of indigenous cattle; Small livestock – native chickens; Restricted grazing on crop residues; Integrated plant-animal production operations such as weeder animals and animal-drawn equipment; Agro-silvo-pastoralism
	Somalia	Seasonal grazing areas management
	South Sudan	Indigenous (ethno-veterinary) practices; Heavy-use area protection by vegetative cover
	UAE	Construction of fodder store houses; Integrated aquaculture and agriculture systems
	Uganda	Intensification and diversification
	USA	Reintroduction of fodder species suitable for improving pastures / grazing land; Introduction of fodder crops into the rotation system for cropland; Straw gathering and processing
	Venezuela	Technique of total or partial stabling
	Vietnam	Supplementary feeding in dry season; Good water management improves water availability and the distribution of cattle in grazing areas
	Zimbabwe	Rehabilitation of communal grazing land
Subtropical	India	Pigeon pea – lac system
	Pakistan	Ethnoveterinary plants for disease treatment and prevention (indigenous knowledge)
	Tunisia	Short duration high stocking rate opportunistic grazing
Temperate	Bulgaria	High Nature Value (HNV) farming / low intensity farming
	France	Integrated Crop–Livestock Systems (ICLS)
	Ireland	Rotational grazing / Management intensive grazing
	Italy	Controlled grazing
Boreal	Kazakhstan	Pastoralism, creating a mosaic of different grazing intensities
	Sweden	Using by products from crops as additives
	USA	Adaptive Multi-paddock (AMP) grazing

Acknowledgements

The task of building policy recommendations for various regions of the world, and curating sustainable soil solutions for all countries requires passion and commitment towards the vision of the Save Soil Movement. We are fortunate to witness that passion and commitment from so many people. We would like to express our gratitude to all those who helped draft this publication.

We would like to acknowledge the soil scientists, agronomists, agriculture economists, plant nutrient specialists, soil biologists, climate experts, water experts and many others, who generously advised and reviewed our approach to compiling Sustainable Soil Management (SSM) solutions. They also shared their wealth of knowledge in devising policy recommendations to accelerate soil revitalization.

We must also make a special mention of the organizations who have dedicated decades to establishing and understanding the importance of soil to life on the planet. These organizations have contributed to documenting and creating many of the SSM practices listed in this publication. The organisations include the United Nation's Food and Agriculture Organization (FAO), the FAO's agricultural science and technology information platform – AGRIS, the World Overview of Conservation Approaches and Technologies (WOCAT), Soil Explorer, FAOSTAT, the World Bank's Open Data platform, databases of various individual nations, think-tanks such as 4p1000, scientific journals on soil and agricultural practices, and many other organizations.

Last but not least, we wish to acknowledge our growing network of volunteers who collated the SSM solutions.


PLANET
CONSCIOUS
.ORG
SAVE SOIL