A Solution to the Crises of Soil, Water, and Climate in Plant Production

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Edited by

Imran

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TABLE OF CONTENTS

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CHAPTER ONE

SOIL, WATER AND ENVIRONMENTAL CRISES: A PRIME FACTOR FOR HUNGER, CONFLICT AND FOOD INSECURITY

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Abstract

The production of more food and agricultural goods are closely connected with world peace. In a world where everyone has access to enough food and is satisfied, there will be peace and a positive outlook on life. In contrast, when food is scarce, prices are high, and agricultural products are in low, people will snip food and commit robberies, murders, and kidnappings in order to feed themselves and their children. Peace is thus closely tied to having access to more food. Climate change is exacerbating agriculture productivity by various ways including soil, water and environmental crises. Water scarcity and water-related hazards (such as floods and droughts), as rising temperatures disrupt precipitation patterns and the entire water cycle. Water and climate change are inextricably linked. Climate change affects the world's water in complex ways. From unpredictable rainfall patterns to shrinking ice sheets, rising sea levels, floods and droughts most impacts of climate change come down to water. Global warming impacts everyone's food and water security. Climate change is a direct cause of soil degradation, which limits the amount of carbon the earth is able to contain. Some 500 million people

today live in areas affected by erosion, while up to 30% of food is lost or wasted as a result. Meanwhile, climate change limits the availability and quality of water for drinking and agriculture. In many regions, crops that have thrived for centuries are struggling to survive, making food security more precarious. Such impacts tend to fall primarily on the poor and vulnerable. Global warming is likely to make economic output between the world's richest and poorest countries grow wider. Disasters linked to climate and weather extremes have always been part of our Earth's system. But they are becoming more frequent and intense as the world warms. No continent is left untouched by the climate change (heat waves, droughts, typhoons, and hurricanes) causing mass destruction around the world. About 90% disasters are now classed as weather- and climate-related, costing the world economy 520 billion USD each year, while 26 million people are pushed into poverty as a result.

Keywords: Climate change, soil degradation, Nutrients depletion, precipitation, rainfall, crop yield, plant biomass, food security

Introduction

The production of more food and agricultural goods is closely correlated with world peace. In a world where everyone has access to enough food and is satisfied, there will be peace and a positive outlook on life (Imran and amanullah 2022a). In contrast, when food is scarce, prices are high, and agricultural products are in short supply, people will steal food and commit robberies, murders, and kidnappings in order to feed themselves and their children. Peace is thus closely tied to having access to more food. Years of intensive agriculture have damaged our resources (soil, water and the environment) for more food production through compaction, erosion and overuse of fertilisers and pesticides. It's estimated that one third of our agricultural soils have been lost over the past 40 years. It might be easy to dismiss the ground beneath our feet as just dirt. But without it humankind would not exist. Former US president Franklin D Roosevelt was right when he said: *"The nation that destroys its soil destroys itself."* He was speaking in the 1930s after years of severe drought and relentless winds turned states across America into dust bowls. The disaster wiped out crops and livestock and forced countless families across America to abandon their farms (Imran et al., 2022a). Today, our soils are facing chronic issues all over the world. Climate change, food insecurity, and degradation of natural resources such as water and soil are the major challenges the world is facing in the 21st century (Hall et al., 2017). Climate change causes the rainfall amount to decrease and become more erratic. Fresh water (< 500 ppm dissolved salt) is

the critical resource for the survival of many lives and the most limiting factor for crop production (Albert et al., 2021). About 72% of the world's freshwater resources are utilized for agriculture production, of which irrigation takes the highest share (FAO, 2021). Irrigation is essential for sustaining crop production and achieving food security in a changing climate. According to Hoogeveen et al. (2015) the world's average irrigation efficiency is 55%, and this indicate that almost half of the water withdrawn for irrigation is lost. However, under limited moisture supply conditions, since water resources are declining, water saving through an efficient irrigation practice is required to achieve optimal crop yield (Fischer et al., 2019). Efficient and water-saving irrigation can also reduce the carbon and energy footprint of irrigation practices and help in mitigating climate change (Zou et al., 2012). As a result, water availability is a critical problem affecting many countries and is expected to be scarcer in the future (Vogelmann et al., 2013). The problems we are facing are inter-related, therefore, multi-benefit (win-win) solutions are needed. It is less likely to achieve food and water security while putting less emphasis on climate change mitigation and environmental protection, and vice versa (Mbow et al., 2019).

Food Production and Soil Crises

Soil is a mix of mineral and organic matter jumbled up with air, water, and microbes. It provides a medium in which plants grow, and a habitat for animals and microscopic life. Soils don't just help us grow food. They absorb, filter and purify our water, helping to protect against flash flooding. They also store carbon, helping to mitigate the effects of climate change. There is an estimated three times more carbon in our soils than in Earth's atmosphere. One problem facing farmers is hard or compacted soil, usually caused by heavy farm machinery. Hard soils are difficult for roots to penetrate, giving plants limited access to water and nutrients. As a result, hard soils can reduce crop yields by over 50%, causing significant losses to farmers and growers. They also become less effective at taking up water, contributing to floods. Scientists recently discovered the chemical signal that causes roots to stop growing in hard soils. Amazingly, this can be 'switched off' to allow plants to punch through compacted soil. The international research team used X-ray Computed Tomography scanners to visualise in situ how plant roots responded to compacted soil. They discovered that plants release a chemical signal when they encounter hard soils, causing roots to stop growing. If this signal is switched off, roots are able to push through compacted soil. The research could lead the way to breeding new crops that can thrive in even the most compacted soils.

Signals in the Soil

There's still a great deal we don't understand about soils, and the invisible ecosystems that are vital to their function. Nowhere is this truer than in the Arctic, where melting ice sheets and glaciers are exposing vast regions of virgin soils to the outside air. These soils haven't seen daylight in thousands of years (Imran and amanullah 2022b). But they are quickly colonised by a whole range of microbes, lichens and plants that are adapted to extreme environments. These microbes have a significant role in the carbon cycle, emitting greenhouse gases such as carbon dioxide and methane. Yet amazingly, we know almost nothing about them. One reason for this knowledge vacuum is that scientist's usually only travel to the Arctic in the summer months: when there is enough light to see by and temperatures aren't too cold. As a consequence, we don't know how these extreme ecosystems behave in the prolonged cold, dark Arctic winters. This is set to change though. Dr James Bradley, a senior lecturer in environmental science at Queen Mary, University of London is leading a project that has installed sensors in soils near a retreating glacier in Svalbard, Norway (Imran et al., 2022b). The sensors will take continuous long-term measurements of biological and chemical activity under the snow. The project is part of a wider joint initiative between UK and US scientists called Signals in the Soil (SITS), which aims to unlock the mysteries of soils using pioneering new sensor technology.

Soil Compaction, May Depleted Food Production

Numerous factors are involved depleting soil health, nutrients status, organic matter and ultimately food production. Primary factor that contributes to the degradation of soils is over ploughing. In soils, particles of clay and sand bind together with lumps of organic matter. This matter can include dead roots, fungi and secretions from earthworms. These clumps are vital for soil structure. Without them, soils can become waterlogged and wash away. Unfortunately, when farmers plough and till soil it breaks down these clumps, putting them at risk of erosion. Researchers at the universities of Sheffield, York and Leeds have found that reviving an old farming practice could help restore damage to the soil. The researchers took soil from four arable fields and three pastures at The University of Leeds farm, a commercial mixed farm in northern England. Previously the land had been used to grow cereal crops and had been subjected to decades of tillage. They looked at what impact crop rotation would have on the health of the soils. This is when fields are allowed to 'rest' by growing different plants for a

season or more before replanting with the original crop. In the past, farmers commonly used crop rotation to let soils recover their nutrients. However the practice largely fell out of fashion when industrial fertilisers allowed the same crops to be grown year on year. The scientists planted a mixture of grasses and clovers in the soil. After just 19 months they found that the topsoil had recovered considerably, the soil was less compacted, earthworm numbers had increased, and the soils were much more resilient to drought and flood conditions. The research suggests that using less intensive ploughing methods, rotating crops, and allowing soils time to rest and recover could be key to improving yields.

Figure 1. Soil compaction from farm machinery is a serious soil health issue.

More People, More Food and Less Land

Climate change and growing populations mean that our soils are under more pressure than ever before. We need to feed more people using less land, and less good quality land. The truth is, our soils are degrading. Years of intensive agriculture have damaged them through compaction, erosion and overuse of fertilisers and pesticides. It's estimated that one third of our agricultural soils have been lost over the past 40 years (Imran et al., 2022c). These sick soils can lose their incredible ability to take carbon out of the atmosphere and instead become net emitters of CO2. Ironically, crops growing in degraded

soils require more intensive management and fertiliser, leading to a spiral of increasing greenhouse gas emissions and soil degradation.

Restoring Peat lands

As well as providing the nourishment for plants to grow, soils play a vital role in storing carbon. Peat, which consists of partially decayed vegetation or organic matter, is especially good at this. UK peat lands currently lock away more than three billion tonnes of carbon. That's more carbon than is stored in all the world's oceans combined. However peat lands only store carbon if they are healthy. If damaged, they can release CO2 into the atmosphere. In Wales, experts at the Centre for Ecology & Hydrology (CEH) have spent nearly 20 years studying the impacts of climate change on upland heath and peat land traditionally used for hill farming. They've found that dry soils lose up to 10% more carbon. The results suggest that climate change can be a vicious circle. As global warming causes more extreme dry spells, the soil's ability to store carbon gets reduced. That in turn leads to even more carbon being released into the atmosphere. The reason is all down to the activity of bacteria and fungi breaking down the peat. When soils are water-logged, microbes and fungi are less active. This means they break down the peat more slowly and release less carbon in the form of carbon dioxide and other greenhouse gases. But when they dry out, the microbe's ramp up their activity and start to undo the centuries of carbon storage provided by peat. This research shows that by seeking out a deeper understanding of the world beneath our feet and applying it in the right ways there's hope yet for a future where we can all benefit from healthy soil.

Figure 2. Peat bogs can be a great asset in fighting climate change but it all depends on their health.

Food Security in Relation to Water Security

Food and Water Insecurity: A Catalyst for Conflict

Climate change is a major threat to international peace and security. The effects of climate change heighten competition for resources such as land, food, and water, fuelling socioeconomic tensions and, increasingly often, leading to mass displacement. Climate is a risk multiplier that makes worse already existing challenges. Droughts in Africa and Latin America directly feed into political unrest and violence. The World Bank estimates that, in the absence of action, more than 140 million people in Sub-Saharan Africa, Latin America, and South Asia will be forced to migrate within their regions by 2050 (Imran et al., 2022d). Global warming impacts everyone's food and water security. Climate change is a direct cause of soil degradation, which limits the amount of carbon the earth is able to contain. Some 500 million people today live in areas affected by erosion, while up to 30% of food is lost or wasted as a result. Meanwhile, climate change limits the availability and quality of water for drinking and agriculture. In many regions, crops that have thrived for centuries are struggling to survive, making

food security more precarious. Such impacts tend to fall primarily on the poor and vulnerable. Global warming is likely to make economic output between the world's richest and poorest countries grow wider. While science tells us that climate change is irrefutable, it also tells us that it is not too late to stem the tide. This will require fundamental transformations in all aspects of society; how we grow food, use land, transport goods, and power our economies. While technology has contributed to climate change, new and efficient technologies can help us reduce net emissions and create a cleaner world (Imran et al., 2022d). Readily-available technological solutions already exist for more than 70% of today's emissions. In many places renewable energy is now the cheapest energy source and electric cars are poised to become mainstream. In the meantime, nature-based solutions provide 'breathing room' while we tackle the decarbonisation of our economy. These solutions allow us to mitigate a portion of our carbon footprint while also supporting vital ecosystem services, biodiversity, and access to fresh water, improved livelihoods, healthy diets, and food security. Nature-based solutions include improved agricultural practices, land restoration, conservation, and the greening of food supply chains.

Water Scarcity

About two billion people worldwide don't have access to safe drinking water today (SDG Report 2022), and roughly half of the world's population is experiencing severe water scarcity for at least part of the year (IPCC). These numbers are expected to increase, exacerbated by climate change and population growth. Only 0.5 per cent of water on Earth is useable and available freshwater and climate change is dangerously affecting that supply (Imran 2022b). Over the past twenty years, terrestrial water storage including soil moisture, snow and ice has dropped at a rate of 1 cm per year, with major ramifications for water security (WMO). Water supplies stored in glaciers and snow cover are projected to further decline over the course of the century, thus reducing water availability during warm and dry periods in regions supplied by melt water from major mountain ranges, where more than one-sixth of the world's population currently live. Sea-level rise is projected to extend salinization of groundwater, decreasing freshwater availability for humans and ecosystems in coastal areas. Limiting global warming to 1.5°C compared to 2°C would approximately halve the proportion of the world population expected to suffer water scarcity, although there is considerable variability between regions (Imran 2022c). Water quality is also affected by climate change, as higher water temperatures and more frequent floods and droughts are projected to exacerbate many forms of water pollution – from sediments to pathogens

and pesticides. Climate change, population growth and increasing water scarcity will put pressure on food supply as most of the freshwater used, about 70 per cent on average, is used for agriculture (it takes between 2000 and 5000 litters of water to produce a person's daily food) (FAO).

Water-Related Hazards

Climate change has made extreme weather events such as floods and droughts more likely and more severe. Rising global temperatures increase the moisture the atmosphere can hold, resulting in more storms and heavy rains, but paradoxically also more intense dry spells as more water evaporates from the land and global weather patterns change. Drought and flood risks, and associated societal damages, are projected to further increase with every degree of global warming. The frequency of heavy precipitation events will very likely increase over most areas during the 21st century, with more rain-generated floods. At the same time, the proportion of land in extreme drought at any one time is also projected to increase. Water-related disasters have dominated the list of disasters over the past 50 years and account for 70 per cent of all deaths related to natural disasters. Since 2000, flood-related disasters have risen by 134 per cent compared with the two previous decades. Most of the flood-related deaths and economic losses were recorded in Asia. The number and duration of droughts also increased by 29 per cent over this same period. Most drought-related deaths occurred in Africa.

Saving Precious Water

Another SITS project is led by Paul Hallett, a researcher at the University of Aberdeen. Hallett and his team are developing a network of underground sensors that can determine the health of soils by measuring soil moisture, temperature and salinity. Amazingly, the sensors don't contain batteries or have any direct source of power. Instead, they 'download' energy from autonomous robots and drones above ground. At first the team aim to use the network of sensors to investigate one of biggest problems facing the food industry: how to feed over 9 billion people by 2050 without outstripping our soil's capabilities (Imran 2021). To boost productivity, farmers use irrigation: the process of applying controlled amounts of water to land to assist in the production of crops. However irrigation consumes over 70% of freshwater reserves in many regions of the world. Alternative sources that could be used include water reclaimed from waste sources, or even seawater. But these can contain contaminants or excess nutrients and salt that are

harmful to the environment. Hallett's team will use the network of sensors to see what impact water from different sources has on soil health.

Figure 3. Glacial melt is exposing soils that have been trapped under ice for thousands of years.

Solution of Soil, Water and Climate Crises

Healthy aquatic ecosystems and improved water management can lower greenhouse gas emissions and provide protection against climate hazards (Water and Climate Coalition). Wetlands such as mangroves, sea grasses, marshes and swamps are highly effective carbon sinks that absorb and store CO2, helping to reduce greenhouse gas emissions. Wetlands also serve as a buffer against extreme weather events. They provide a natural shield against storm surges and absorb excess water and precipitation. Through the plants and microorganisms that they house, wetlands also provide water storage and purification. Early warning systems for floods, droughts and other water-related hazards provide a more than tenfold return on investment and can significantly reduce disaster risk: a 24-hour warning of a coming storm can cut the ensuing damage by 30%. Water supply and sanitation systems that can withstand climate change could save the lives of more than 360,000 infants every year (New Climate Economy report). Climate-smart agriculture using drip irrigation and other means of using water more

efficiently can help reduce demand on freshwater supplies (Imran and Amanullah 2021a).

A Climate Crisis Solution: A Race We Can Win

Climate change is the defining crisis of our time and it is happening even more quickly than we feared. But we are far from powerless in the face of this global threat. As Secretary-General Antonio Gutierrez pointed out in September, "the climate emergency is a race we are losing, but it is a race we can win". No corner of the globe is immune from the devastating consequences of climate change. Rising temperatures are fuelling environmental degradation, natural disasters, weather extremes, food and water insecurity, economic disruption, conflict, and terrorism. Sea levels are rising, the Arctic is melting, coral reefs are dying, oceans are acidifying, and forests are burning. It is clear that business as usual is not good enough. As the infinite cost of climate change reaches irreversible highs, now is the time for bold collective action. Billions of tons of CO2 are released into the atmosphere every year as a result of coal, oil, and gas production. Human activity is producing greenhouse gas emissions at a record high, with no signs of slowing down (Imran and Amanullah 2021b). According to a ten-year summary of UNEP Emission Gap reports, we are on track to maintain a "business as usual" trajectory. The last four years were the four hottest on record. According to a September 2019 World Meteorological Organization (WMO) report, we are at least one degree Celsius above preindustrial levels and close to what scientists warn would be "an unacceptable risk". The 2015 Paris Agreement on climate change calls for holding eventual warming "well below" two degrees Celsius, and for the pursuit of efforts to limit the increase even further, to 1.5 degrees. But if we don't slow global emissions, temperatures could rise to above three degrees Celsius by 2100, causing further irreversible damage to our ecosystems. Glaciers and ice sheets in polar and mountain regions are already melting faster than ever, causing sea levels to rise. Almost two-thirds of the world's cities with populations of over five million are located in areas at risk of sea level rise and almost 40 per cent of the world's population live within 100 km of a coast. If no action is taken, entire districts of New York, Shanghai, Abu Dhabi, Osaka, Rio de Janeiro, and many other cities could find themselves underwater within our lifetimes, displacing millions of people (Imran and Amanullah 2021c).

Scalable new technologies and nature-based solutions will enable us all to leapfrog to a cleaner, more resilient world. If governments, businesses, civil society, youth, and academia work together, we can create a green future where suffering is diminished, justice is upheld, and harmony is restored between people and planet. Climate change is a global challenge and a threat to food

security. Agriculture is expected to produce food for the world's population, estimated to reach 9.1 billion in 2050 and more than 10bn by the end of the century. Weather patterns/climate is one of the main factors influencing the productivity of agriculture. According to researchers, to improve the productivity and stability of smallholder agricultural production in the wake of climate change, agricultural systems must be transformed. Significant effects of this change have already been seen on water resources, human health, and food security. Rising temperatures, changes in precipitation, floods and famines affect crop production and negatively affect land and water resources. Fluctuations in climatic factors such as rainfall and temperature and elevated level of carbon dioxide have increased the frequencies of climatic disasters like floods, droughts and cyclones all over the Indian subcontinent. Improved irrigation facilities, highly genetically modified seeds, and increased usage of fertilisers and pesticides have restricted negative trends. But, the imbalance in the use of fertilisers and pesticides is also responsible for declining soil fertility. Climate-smart agriculture (CSA) refers to farming methods that tackle both the problems of climate change and global food security. It is becoming an increasingly crucial concept to ensure future food security and sustainability as the global climate becomes more hostile to conventional agricultural practices. The Food and Agriculture Organisation (FAO) has encouraged a sustainable agricultural production system due to the social, environmental, and economic issues caused by climate change and traditional agriculture. According to FAO, CSA practises are viewed as a way to improve resilience while slowing down environmental degradation. Consequently, its adoption will boost yield, enhance resource use efficiency, increase agricultural income, and mitigate the adverse effects of climate change on its production. CSA includes cutting back on chemical inputs, improving soil fertility, and managing water resources better. Crop diversification, changes in the cropping pattern and planting dates are other farming techniques that can lower the risk of crop loss due to climate change. The National Agriculture Extension Policy encourages farmers to adopt CSA practices such as water harvesting, efficient irrigation systems, improved crop varieties, and agroforestry. It also promotes the use of climate-smart farm inputs such as organic fertilisers and soil amendments.

Additionally, CSA focuses on enhancing the resistance of crops to extreme weather events. This includes the use of drought-resistant varieties, mulch or cover crops to prevent soil erosion, terracing and other soil conservation techniques. Farmers can also practise conservation agriculture, which reduces the amount of tilling and maintains a biological mulch cover on the soil. Precision farming and remote sensing are two examples of cutting-edge

technologies that climate-smart agriculture encourages farmers to adopt. While remote sensing can be used to monitor crop health and lower the risk of crop losses because of changes in weather patterns, precision farming helps farmers apply inputs like fertiliser and irrigation water more efficiently. The policy implication is that promoting and scaling up the adoption of CSA practices can help farmers raise their incomes by improving agricultural productivity and profitability. The Pakistan Agricultural Research Council studied farmers' knowledge and the intensity of their adoption of CSA practices. According to this research, most farmers were only moderately knowledgeable about the various indicators of climate-smart agriculture. The overall knowledge level showed that the sampled farmers knew more about crop rotation and varieties but less about pesticide application precautionary measures, crops recommended fertiliser application per acre and laser leveller. The sampled farmers had the lowest knowledge level in early maturity (short duration) crop varieties, integrated pest management techniques, wheat on ridges/seed beds, heat and drought tolerant varieties, and organic farming. These results indicate a significant knowledge gap and low practice of CSA, in spite of the positive outlook to climate-smart practices attributed to the collapse of extension services over the years. Insufficient understanding of climate-smart practices, limited access to weather and climate information, low financial capacity, and a lacklustre policy framework were the main barriers to adopting these practices. In general, the government is moving in the right direction to support CSA in the country. Nevertheless, there is still a need to raise knowledge among farmers. Using modern technology to connect with farmers and conduct targeted communication efforts can accomplish this. The government should also focus on providing technical assistance and access to finance to farmers so they can adopt CSA practices. This could include providing financial incentives to farmers to purchase climate-smart inputs and equipment and providing training and capacity-building programmes. By promoting CSA in Pakistan, farmers can improve their productivity and profitability while adapting to the effects of climate change. This will be essential for ensuring food security in the country and for building the resilience of its agricultural sector.

Conclusion

Peace can be ensure around the globe with food security. If everyone has access to enough food and to quality produce, will have smooth life while in contrast, when food is scarce, the life will be hard and full of conflicts. Peace is thus closely tied to having access to more food. Global peace can be

ensure to produce more food with the objectives to protect the soil, water and environment. Crops and animals should be raised not on the cost of future generation but by owing the principles of climate, soil and water smart farming to survive with peace and health.

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CHAPTER TWO

A SOLUTION TO SOIL, WATER AND ENVIRONMENTAL CRISES

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Abstract

The loss of soil quality and fertility, which is a global concern, is referred to as the "soil crisis." Soil quality degradation has a substantial economic impact, as it lowers crop production and raises the cost of food production. Soil crises is caused by several factors, including intensive agriculture, deforestation, and urbanization, overuse of fertilizer and pesticides, and climate change. As a results of these factors, soil erosion, desertification, salinization, and nutrients depletion have become major issues, which threaten food security, biodiversity, and environmental sustainability. The soil crisis requires a range of intervention, including the adoption of sustainable land use practice, conservation of soil resources, and promotion of soil restoration techniques such as agroforestry, conservation agriculture and composting. It also requires the cooperation and coordination of stakeholder at all levels, form farmers to policymakers, to ensure the long-term sustainability of our soil resources. The lack of freshwater resources to meet environmental and human demands is what is known as the water crisis. The first issue for global growth is the lack of clean drinking water, hence the water crisis is closely tied to human rights. Some of the major

causes of the water crisis include population growth, climate change, overconsumption, and pollution. As the world's population continues to grow, demand for water also increases, and many regions are already struggling to meet the water needs of their populations. Climate change is also exacerbating the water crisis, as it alters weather patterns and causes more extreme weather events such as droughts and floods. The environmental crisis has significant impacts on human health, well-being, and the economy, and it threatens the sustainability of the planet. Rising temperatures are fuelling environmental degradation, natural disasters, weather extremes, food and water insecurity, economic disruption, conflict, and terrorism. Sea levels are rising, the Arctic is melting, coral reefs are dying, oceans are acidifying, and forests are burning.

Keywords: Soil contamination, Nutrients depletion, Food shortage, water shortage, land degradation, pollution, crises.

Introduction

1. Soil Crises

Planet Earth is currently going through an unparalleled crisis of soil deterioration, desertification, and erosive loss that is adversely affecting the services it offers as a result of anthropogenic abuses, natural disasters, and extreme weather events encouraged by global warming (Imran and amanullah 2022a). The soil crisis refers to the degradation of soil quality and fertility, which is a global concern and the degradation of soil; quality also has significant economic impact, as it reduces crop yield and increase the cost of food production. The problem is caused by several factors, including intensive agriculture, deforestation, and urbanization, overuse of fertilizer and pesticides, and climate change. As a results of these factors, soil erosion, desertification, salinization, and nutrients depletion have become major issues, which threaten food security, biodiversity, and environmental sustainability (Imran et al., 2022a). The soil crisis requires a range of intervention, including the adoption of sustainable land use practice, conservation of soil resources, and promotion of soil restoration techniques such as agroforestry, conservation agriculture and composting. It also requires the cooperation and coordination of stakeholder at all levels, form farmers to policymakers, to ensure the long-term sustainability of our soil resources (Imran and amanullah 2022b).

A mix of intensive farming methods and natural processes is causing serious soil degradation. It becomes more challenging to raise food crops as the

topsoil layer that is fertile becomes thinner. The global food supply begins to appear vulnerable if farming methods are not changed and urgent measures are not taken to keep soil. Most natural resource commodities are currently undergoing increased demand in the twenty-first century. Natural resource governance is becoming increasingly complex, especially as the interdependence and linkages between different resources are becoming more apparent are considered when making decisions (Andrews-Speed et al. 2012). Erosion, soil fertility decline, and other factors frequently limit the productivity of available land. Pollution, salinization, and flooding (Gupta et al. 2009). Loessy soil substrates have a favourable root structure, but they are prone to hydro collapse and water erosion (Smalley et al. 2006). Cropland degradation in rainfed agriculture is primarily caused by soil erosion caused by both wind and water (Suleimenov et al. 2012). Water erosion caused by furrow irrigation is also a significant issue (Saparov et al. 2013).

According to Vazhenin (1987), the following levels of heavy metal contamination were assessed: weak, moderate, medium, increased, high, and very high. The research findings revealed that phosphorus fertilizers had the greatest amount of heavy metals penetrating the soil in terms of both accumulation and concentration of the impurity. Potash fertilizer figures are slightly lower, and nitrogen fertilizer penetration of heavy metals in the soil is negligible. The calculation confirms that using scientifically justified fertilizer quantities does not result in heavy metal contamination of soil (Imran et al., 2022b). There are numerous solutions to these issues. A unique approach must be developed for each region, taking into account the natural climatic and ecological conditions. To halt and reduce land degradation and desertification, salinization, and pollution, scientifically justified land cultivation systems, as well as complex organizational, economic, agro technical, and hydro-technical activities, forest reclamation schemes, and so on, must be implemented (Imran et al., 2022c).

- A thorough inventory of arable lands, taking into account their existing level of degradation and desertification, as well as their vulnerability to erosion, salinization, pollution, and other adverse conditions;
- land cultivation systems, industrial and creative technologies, pasture rotation, surface and radical improvement of soil reclamation and environmental conditions on unproductive degraded agricultural lands, rangelands and their irrigation; integrated soil resource management and their protection;

- Efficient use of water resources; stepping up efforts to stop water loss; implementing contemporary irrigation techniques;
- Establishing environmental monitoring programs and enhancing ecological conditions through the application of environmental certification and standards in agriculture;
- Creation of incredibly efficient hydrocarbon extraction technology.
- Preserving inundated oil wells

One of the most important goals of our day is to create fresh, highly applicable approaches to managing soil resources. Other major tasks include the rational use of the soil landscape, enhancement of soil reclamation, and environmental status of land resources. In this sense, the importance and relevance of the problem are clear, and it calls for quick action and a solution (Imran et al., 2022d). It is required to create specific programs for researching contaminated and disturbed lands, create legislation, and provide pertinent advice for re-cultivation and land restoration in order to address these issues (Imran 2022b; Imran 2022c). The agreed measures, which are intended to implement a single development policy in the agricultural sector, will form the framework for the sustainable and intense growth of agro-industrial complexes in the Republic and guarantee food security for the nation.

Soil or land Contamination

Soil or land contamination refers to the presence of harmful substances or pollutants in the soil, which can affect the quality of the soil and have adverse effects on human health and the environment. The contaminants can come from a variety of source, including industrial activities, agriculture, mining, and improper disposal of waste. Common example of soil contamination include heavy metal such as lead, mercury, and cadmium; pesticide and herbicides; petroleum product; and industrial chemical. These contaminants can enter the soil through direct application, leaching from contaminated ground water or surface water, atmospheric deposition, or through spills and leaks. Soil contamination can significant impact on the environment, including the loss of biodiversity, soil degradation, and water pollution. It can also pose health risks to humans, especially those who work or live in contaminated areas, and can lead to respiratory problems, skin irritation, and even cancer. To address soil contamination, various measure can be taken, including site assessments in the soil. Prevention measures, such as proper waste management and the use of environmentally friendly farming practices, can be also help reduce the risks soil contamination. Health hazards, direct contact with contaminated soil, vapour from toxins,

or secondary pollution of water supplies inside and beneath the soil are the main causes of worry with soil contamination. (US EPA) Environmental contamination mapping and clean-ups are time-consuming and expensive processes that call for knowledge of geology, hydrology, chemistry, computer modelling, and GIS, as well as an understanding of the development of industrial chemistry. (George et al., 2016)

A few factors can destroy the soil:

- Fertilizers, pesticides, and weed killers.
- Mining
- Fuel and oil spills
- Coal ash disposal
- Landfills' leaching
- Surface water contamination that seeps into the ground
- Excreting excrement and urine in the open
- Electronic garbage

Contaminants' potential influence on soil functions

The activity, species composition, and abundance of soil microorganisms can be negatively impacted by heavy metals and other soil pollutants, endangering soil functions such the biogeochemical cycling of carbon and nitrogen. (Rijk et al., 2020) Yet, with time, soil pollutants may become less bioavailable, and ecosystems and microbes may adapt to new environmental conditions. In polluted soils, soil characteristics including pH, organic matter concentration, and texture affect the mobility, bioavailability, and toxicity of contaminants. (Alloway 2012) The same quantity of a pollutant may be completely safe in one soil and harmful in another. This highlights the requirement for risk assessment and mitigation particular to soil.

Nutrients Depletion

Nutrient depletion refers to a condition in which the body lacks essential nutrients due to inadequate intake or poor absorption. Nutrient depletion can result from a variety of factors such as poor diet, mal-absorption, medication use, and certain medical conditions. Inadequate intake of essential nutrients such as vitamins, minerals, and protein can lead to nutrient depletion. Poor absorption can occur due to conditions such as celiac disease, inflammatory bowel disease, and certain medications that interfere with nutrient absorption. Nutrient depletion can lead to a variety of health problems, including fatigue, weakness, impaired immune function, and increased risk