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Appraisal of Stakeholders Perception of Soil Restoration Amid The UN Decade for Ecosystems Restoration (Under 2021-2030).

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Abstract

The recent surge of interest in soil restoration is not unconnected with the increasing impacts of soil degradation. This study purposed to appraise stakeholders' perception of soil restoration; it adopted the descriptive survey design and followed the stratified sampling technique to sample 260 members of the Soil Science Association of Nigeria and 240 farmers in Nigeria. A 35-item structured closed-ended questionnaire was used to obtain data. Data analyses were done using simple percentages, independent t-tests and visualized using bar charts. Results show that stakeholders agreed that some indices for measuring soil degradation are erosion and soil acidity; reforestation and agroforestry are soil restoration strategies, while technology and inappropriate ecosystems education are setbacks to soil restoration. However, soil restoration

	could reduce conflicts and poverty. Results of the t-test analysis show that stakeholders' profession has no significant influence on their perception of indices for measuring soil degradation. Stakeholders" location has no significant influence on their perception of strategies for soil restoration. Stakeholders' gender has no significant influence on their perception of the benefits of soil restoration. It is concluded that more funds should be voted for soil restoration programs, and nations should adopt innovative and best-fit strategies to combat soil degradation.

Introduction and background

Soil is the microbiome of mother earth. Most ecosystems subsist on the soil. In the same vein, a more significant percentage of the activities embarked upon by humans take place or emanate from the soil. Any harm or degradation coming to the ecosystems affects the soil. Sanz, de Vente, Chotte, Bernoux, Kust, Ruiz, Almagro, Alloza, Vallejo, Castillo, Hebel, and Akhtar-Schuster (2017); Ambe and Onnoghen (2019) opined that land provides several functions including ecosystem services. Ambe and Udumo (2020) noted that habitat changes have severely affected wildlife populations and altered land use and cover. Ambe, Eja, and Agbor (2014) decried the long-term effect of bush burning and noted that when the bush is burnt, the soil receives the heat and all the essential microbes that should nourish the soil all burn with the vegetation cover and the soil is further exposed to leaching, direct sunlight, and erosion.

Chapman, Gray, Murphy, Atkinson, Leys, Muller, and Yang (2011) observed that soil degradation is of significant environmental, economic, and social concern. environment.nsw.gov.au (2022) defines "soil degradation as the decline in soil condition caused by its improper use or poor management," which diminishes food production. Soil degradation is more severe in marginal climates such as those of Africa bordering deserts, especially the Sahel and the Sahara, where droughts have led to poor crop yields, which has resulted in poverty, drying of water bodies, hunger, starvation as well as the increase in occasions of war and disputes over land. Critchley, Harari, and Mekdaschi-Studer, (2021) lamented that "mankind is exhausting the land and soil vitality." Intensive plowing and cultivation practices, large monocultures, over-grazing, and the removal of hedges and trees let rain and wind erode precious soil. At the same time, excessive use of fertilizer lowers soil quality.

Center for International Forestry Research (CIFOR). (2021); Zanella, Bolzonella, Lowenfels, Ponge, Bouché, Saha, ... and Fukuoka (2018); Crump (2017) and United Nations Organisation (2015) decried that the world loses about 12 billion hectares of land each year to degradation and desertification which results to over 10 percent depreciation in global GDP in lost

ecosystem services. Critchley and others (2021) reported that "The UN Decade on Ecosystem Restoration (UNDER 2021-2030) is a rallying call for the protection and revival of ecosystems all around the world, for the benefit of people and nature". It aims to halt the degradation of ecosystems and restore them to achieve global goals through Sustainable Land Management (SLM). Given the rising cases of soil degradation and the seeming lack of efforts from stakeholders to curb this menace, this study attempts to gauge the soil stakeholders' perception of soil restoration measures as a contribution to the sector on UN Decade on farmland restoration, within the United Nations decade on ecosystems restoration (UNDER 2021-2030).

Literature Review

Indices to evaluate soil degradation, causes, and effects of soil degradation are reviewed as follows:

Soil condition is challenging to measure directly, as it is a product of numerous physical and chemical attributes and processes (Chapman and others, 2011). Turley, Bell-Dereske, Evans, and Brudvig (2020) found that soil restoration may be affected by several factors, such as regional soil texture and structure, past land use, soil type, and vegetation. This study will follow the soil conditions and pressure indicators to evaluate for soil degradation as proposed by Chapman and others (2011). These indicators are Sheet and rill erosion, gully erosion, wind erosion, soil acidification, soil carbon destabilization, soil structure sensitivity, and soil salinity. Authors such as Zakerinejad and Maerker (2015), Chapman and others (2011), and Zhu and Xu (2021) agreed that sheet and rill erosion occurs when raindrop impact removes topsoil and low stream power washes soils particles relatively uniformly. They noted further that in rill erosion, tiny channels are created on the soil, which can be removed by little tillage, and that sheet and rill erosion can reduce soil quality and the capacity of soil to hold water and nutrients to grow plants.

On the other hand, Gully erosion, according to Chapman and others (2011), Abbas (2020) and Poesen (2011), Jahantigh and Pessarakli (2011), and Igwe (2012) is the removal of soil by concentrated water flows, resulting in channels greater than 0.3 m deep which cannot be cleared during tillage argued that gully erosion can be caused by inadequate groundcover and concentration of water flows. Scholars such as Wang, Wang, Dong, Liu, and Qia (2006), Sterk (2003), Al-Kaisi, Yin, and Licht (2005), and Al-Kaisi, (2000) noted that soil degradation results from Wind erosion because it erodes soil when the wind in an area is strong enough to remove and carry soil particles from one place to another. Goulding (2016) argued that soil degradation is also caused by Soil acidification which results from several factors, including acidic precipitation and deposition from the atmosphere of acidifying gases, removal of bases leading to poor plant growth, stunted roots, and metal toxicities.

Soil carbon destabilization leads to reduced plant growth, and soil disturbance observed that Soil carbon is typically concentrated in the surface soil layers where organic inputs and biological activity is most remarkable. This argument is evidenced in the writings of Dijkstra, Zhu, Cheng (2021), Buck, and Palumbo-Compton, (2022). Another soil degradation indicator is Soil structure sensitivity which, according to De Ploey, Imeson, and Oldeman (1991), Reichert, Amado, Reinert, Rodrigues, and Suzuki (2016), Chenu and Cosentino (2011),

Chapman et al. (2011) can also be caused by improper land management on fragile soils. The authors noted that Soil structure is the architectural arrangement of soil particles and the voids between them. It defines the physical component of soil conditions as it governs water and gas exchange between the atmosphere and the soil. It is sensitive to biological activity, ground cover, management actions, and, in some soils, changes in moisture content or salinity. Soil salinity refers to salt infestation. High soluble salts are stored in the soil and groundwater because the landscape salinizes and degrades the soil (Munns & Gilliham, 2015; Shahid, Zaman, and Heng, 2018; Ali, 2010).

What is soil/ecosystems restoration?

Soil restoration refers to the attempt by man to return soil or any ecosystem to its previous ecological status either naturally or through other biogeochemical and mechanical means. Critchley, Harari, and Mekdaschi-Studer, (2021) said ecosystem restoration means assisting in the recovery of ecosystems that have been degraded as well as conserving the ecosystems that are still intact. In the same vein, Veblen, Young, Truman, and Porensky (2019) agreed that **ecological restoration** is repairing sites in nature whose biological communities and ecosystems have been degraded or destroyed. Callaham Jr and Stanturf (2021) observed that restoration ecologists have long appreciated soils as necessary for restoring ecosystems. Namubiru-Mwaura, (2021) and Kristjanson (2020) observed that gender-responsive actions are central to sustainable land-restoration projects and that gender neutrality should not be assumed while restoring soils.

Strategies for soil restoration

Sustainable Land Management (SLM) practices which strategies are proposed by United Nations Convention to combat desertification (UNCCD), may increase and stabilize crop productivity and restore soils (Sanz et al., 2017). In this study, the following strategies for soil restoration are proposed- Soil restoration, reclamation, and rehabilitation, Soil erosion control, Integrated nutrient management (INM), Reducing deforestation, increasing afforestation/reforestation, Minimum soil disturbance, Vegetation management, Agroforestry, Attainment of Land Degradation Neutrality (LDN), and halting the population growth.

Authors such as Sanz et al. (2017) believe that soil restoration is required for situations where the intent is to bring an ecosystem as close as possible back to its original state. Similarly, Ambe and Udumo (2020) noted that restoration activities enhance ecosystem conservation, recovery, and sustainable management, including facilitating landscape connectivity. Furthermore, the activities necessary for land and soil restoration are planting trees, crop rotation, and constructing cut-off drains and ditches to hold back running water. Other researchers such as Liu, Wang, and Yue (2020), Lin and Yu (2018), Khan (2012), Zengcui and Zeheng (2002), Kuter (2013), and Hayes (2022) reported that Land reclamation is the restoration of land to its natural ecological state, it is common in coastal areas. In this process, derelict land from the sea, wetlands, and other water bodies are sand-filled, polder, hydraulically filled, and reclaimed for anthropogenic purposes.

Many other authors, such as Sanz et al. (2017), Gao, Wu, Ma, Gong, and Zhang (2023), and Rakhmonov and Muradov (2022), proposed soil erosion control as a strategy for soil restoration. Soil erosion control is the process of preventing erosion due to wind power and rainwater. Activities in this strategy can be streamlined into vegetative measures (where vegetation is planted to control erosion), structural measures (where terraces and contours are created on hillsides), and integrated measures like SLM technologies, mulching at the early stages, zero or minimum tillage, rotational grazing are used to control soil erosion. Das and Avasthe (2018) and Selim (2020) advocated for the integrated nutrient management (INM) strategy for soil restoration. This strategy refers to maintaining soil fertility and plant nutrient supply at an optimum level for sustaining the desired productivity. INM will help reduce acidification and soil salinity by optimizing the benefits from all nutrient sources (organic, inorganic, or biological components) in an integrated manner.

On reducing deforestation and increasing afforestation/reforestation, researchers advised that cutting forest trees for timber, logs, firewood, farming, or other development purposes should be reduced or stopped outrightly. Afforestation and reforestation programs should be encouraged, so Kaushal, Mandal, Panwar, Kumar, Tomar, and Mehta (2021) advocated for tree planting on erosion control structures to stabilize the land. In the strategy for afforestation, trees should be planted in grassland regions, and farm drainage systems should be improved, avoid soil compaction, and use matting. Mühlbachová, Kusá, Růžek, Vavera (2022), Fatimah, Tilahun, and Mohammed (2020) advocated for Minimum soil disturbance as a soil restoration strategy. The authors said this strategy could be achieved by using the method of minimum tillage (in which case crops are planted with little tillage of the soil), zero tillage, no-till farming, no-tillage, and direct drilling (where the soil is not tilled at all before planting), and stubble mulch tillage practices. In this case, stubble or crop is left in place on the land as cover during a fallow period. Dey, Patel, and Singh (2022) and Reicosky and Allmaras (2003) are other authors who advocated this strategy.

Vegetation management as a soil management strategy is advocated by authors such as Weber (2017), Zuazo, and Pleguezuelo (2009), who observed that vegetation management controls unwanted vegetation in a farm or an ecosystem. They further describe it as the targeted control and elimination of unwanted vegetation—from weeds and bushes to branches and trees**.** This strategy requires that practitioners adopt cautious methods in vegetation management to avoid undue pressure on soils. The Agroforestry method of soil restoration is advocated by Jose (2009) and Brown, Miller, Ordonez, and Baylis (2018); the authors believe that in agroforestry land-use systems, woody perennials are deliberately integrated with crops within the same land. Agroforestry can restore soil carbon, reduce erosion, regenerate soil, improve crop yield, mitigate climate impacts, and reduce climate disorders. In tropical areas, plantations of cocoa, rubber, timber trees, oranges, kola nuts, and bush mango could be interspaced with seasonal crops like cassava, yams, vegetables, and potatoes. Another soil restoration strategy advocated here is the attainment of Land Degradation Neutrality (LDN). As part of the 2030 agenda for SDGs, nations have agreed to integrate LDN into the SDGs. To this end, all nations should, as a matter of urgency, set up and begin the implementation of LDN strategies where they have yet to begin.

According to UNCCD decision 3/COP.12, land degradation neutrality is "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (United Nations Convention to Combat Desertification (UNCCD), 2015). Montanarella (2016), Bhunia, Chatterjee, and Shit (2021) advocated that Controlling population growth will help reduce soil degradation and achieve restoration. Halting the population growth is a strong strategy for soil restoration; increasing the number of people will increase the pressure on the land. As a first approach, world nations should get serious with population control measures to balance the world population.

Benefits of proposed strategies for soil restoration:

Jobs, improved nutrition, and incomes are the immediate benefits of land and soil restoration. The results from adopting the strategies proposed here will manifest in the importance of soil restoration (Tepper, 2022; Robinson, 2020). Firstly, the world will gain more land for anthropogenic uses. Land restoration brings back into use previously degraded soils and enables expansion and recreation of the productive area with no impacts on natural ecosystems (Lomax, 2016; Smith & Seyfang, 2013). Soil restoration will increase the rate of soil water intake and underground water storage. Stokes, Douglas, Fourcaud, Giadrossich, Gillies, Hubble, and Walker (2014); Zuazo and Pleguezuelo (2009) noted that "restoring soils raises their infiltration capacity, which recharges aquifers and increases water availability." On a third note, poverty resulting from poor harvest or reduced yield, migration from ancestral homes due to soil infertility, wars, and conflicts would reduce significantly in Africa if soils were restored. Raven and Wagner (2021); Scarano (2017) echoed that "ecosystems support all life on Earth." If ecosystems are restored, poverty, climate crisis, and mass extinction of species can be combated.

Healthy soils will sustain life on earth longer and help restore humans' strained relationship with natural ecosystems. Van Mansvelt, Struik, Bos, Daub, Sprangers, Van Den Berg, ... and Zoeteman, K. (2021); Stirling, Hayden, Pattison, and Stirling (2016) noted that the revival of plants, crops, and forests depends on the revival of soils. Another benefit of land and soil restoration is the Sustenance of Indigenous culture. Ogar, Adie, Obeten, Kori, Abunimye, Essien, & Ikutal (2022) observed that human livelihood activities stem from a culture intricately connected to the land. Over the years, the erosion of ecosystems has led to the erosion of culture and indigenous knowledge base.

It is common knowledge that soils being part of the ecosystems, provide both medicines, recreation, and health values to humanity. The restoration of ecosystems is linked to the enhancement of human health. (Cross, Nevill, Dixon, & Aronson, 2019; Ambe & Onnoghen, 2019; Kimmerer, 2011; Kelly & Harwell, 1990). We expect a reduction in wars, farmers'/herders' conflicts in Africa, a slowdown of eco-migrants, and a restoration of endangered and threatened species of plants and animals that require a balance between soil and vegetation.

Summarily, according to the Food and Agriculture Organisation (FAO) (2021), "healthy soils are a prerequisite to achieve the SDGs." Healthy soils will lead to flood regulation and climate regulation, and they are a foundation for human infrastructure; they provide construction materials, food, fiber, and fuel. They serve as a habitat for organisms, sequester carbon, cycle nutrients, purify water and reduce soil contaminants, are a source of pharmaceuticals and genetic resources, and contribute to the preservation of cultural heritage.

Challenges to soil restoration

Strauss, Paul, Dönmez, Löbmann, and Helming (2023). Zhou, Wang, Wang, Zhang, Chen, and Liu (2020) analyzed some challenges to soil restoration, including technology: the authors noted that most approaches and techniques to soil restoration require training and equipment to execute them appropriately. People in regions where soils are being degraded the most and require urgent restoration are either unaware of these technologies or unable to afford the machinery involved. Another challenge is variable local environmental characteristics like climate, topography, and soil: plans for most ecosystem restoration programs are usually countrywide. Nevertheless, the characteristics of various soils are localized, which makes it difficult for a one-plan-fits-all strategy to be successful.

Land tenure systems are another challenge to soil restoration. Various land tenure systems exist within communities in some African and developing countries. Individuals manage their lands for profit maximization and high crop yields as much as they can. With centrally positioned policies for land restoration, it is easier to get individuals to embrace soil restoration practices. Authors and scholars have also identified problems of financing/funding gaps as another challenge of soil restoration. Statistics from World Resource Institute show that globally, only about 51 billion dollars is expended on land restoration, about 300 billion US dollars less than the required/proposed amount. Despite the efforts by various UN agencies and some private individuals and NGOs, funding soil restoration programs still needs improvement.

The problem of policy, policy acceptability, and practices by the government constitutes another problem of soil restoration. UN Agencies and national governments attempting soil restoration utilize the top-bottom approach to achieving their objectives. This approach has yet to give the locals who host the lands to be restored enough opportunities to be part of the restoration projects and hence lukewarm attitudes to the programs or outright rejection. In another vein, most governments have yet to ratify to domesticate UN agreements reached at various fora willingly. These non-binding agreements can only take force in those countries with ratification. Inadequate Ecosystems Education equally challenges soil restoration efforts. Despite the enormity of indigenous agricultural knowledge available to locals, comprehensive, universally accepted, and workable Ecosystems Education is still in short supply in most developing countries. This gap has caused locals to continually do the same old things while expecting different soil restoration results. These old practices have yielded fewer results and a consequent increase in land degradation.

Purpose of the study

The primary purpose of this study is to appraise stakeholders' perception of soil restoration amid the United Nations' decade for ecosystem restoration (UNDER 2021-2030). Specifically, the study seeks to:

1. Identify stakeholders' perceptions of what indices determine soil degradation in the study area.
2. Determine stakeholders' perceptions of strategies for soil restoration in the study area.
3. Examine stakeholders' perception of challenges to soil restoration.
4. Evaluate stakeholders' perception of the benefits of soil restoration to ecosystems.
5. Find out whether Stakeholders' profession influences their perception of indices for measuring soil degradation.
6. Find out if stakeholders' location has any influence on their perception of strategies for soil restoration.
7. Examine if stakeholders' gender influences their perception of the benefits of soil restoration.

Research questions

The following research questions will be answered in the study.

1. What do stakeholders perceive as the indices that determine soil degradation?
2. What do stakeholders perceive as the study area's soil restoration strategies?
3. What do stakeholders perceive as the challenges of soil restoration in the study area?
4. What do stakeholders perceive as the benefits of soil restoration to ecosystems?

Research hypotheses

1. Stakeholders' profession does not significantly influence their perception of indices for measuring soil degradation.
2. Stakeholders' location has no significant influence on their perception of strategies for soil restoration.
3. Stakeholders' gender has no significant influence on their perception of the benefits of soil restoration.

Research Methodology

The descriptive survey research design was adopted for this study because the researchers could only collect and analyze valid responses, and the variables could not be manipulated. The descriptive research design may also be used for quantitative research. Loeb, Dynarski, McFarland, Morris, Reardon, and Reber (2017) argued that "Part of the researcher's job and expertise is to use appropriate analytical, data visualization methods to translate raw data into reported findings in a format that is useful for each intended audience" (p. 2). Researchers could use descriptive design alone in exceptional circumstances; our unique situation here is

an appraisal of stakeholders' perception of soil restoration. Two hundred and sixty out of the 1200 registered soil scientists from the Soil Science Society of Nigeria and 240 out of the 22,500 registered farmers from the Farmers Association of Nigeria were sampled using purposive, stratified, and simple random sampling techniques.

The register of the Soil Science Society of Nigeria and that of the Farmers Association of Nigeria were obtained from the Society's Secretariats. The membership lists were stratified into the 36 states and further into North and South Zones. Two states from each zone were selected using the purposive sampling technique. Furthermore, from each of these four states, the serial numbers of all members of the two Associations were written on small pieces of paper, rolled into balls, and placed in four separate baskets. Two colleagues were blindfolded and requested to pick out 240 (60 per state) Farmers and 260 (65 per state) Soil Scientists, one after the other, with replacements to give all the respondents an equal opportunity to be selected, making a total sample size of 500 stakeholders.

A 35-item five-point Likert-type closed-ended structured questionnaire was used to obtain data on Stakeholders' perception of soil restoration. Part one sought Stakeholders' socio-demographic data like gender, Location, and Profession. Part two had five sections. The respondents were expected to indicate whether they Strongly Agreed (SA) 5-points, agreed (A) 4-points, were Undecided (U) 3-points, disagreed (D) 2-points, or strongly disagreed (SD) 1-point to the questionnaire items. Section A obtained data on stakeholders' perceptions of indices of soil degradation, section B obtained data on strategies for soil restoration, section C on challenges for soil restoration, and section D on the benefits of soil restoration.

The instrument was validated by three experts in test construction and measurement from the University of Uyo, Nigeria. Using the table of specifications and Pearson's product-moment correlation, and corrected using the Spearman Browns Proficiency formula, the instrument achieved a reliability coefficient of .85. These experts did both content and face validity. The table of specifications provided a clear indication of the instrument as being valid to be used for data collection. Based on the experts' analysis, we concluded that the instrument was valid and reliable for data collection for this study.

The questionnaire was mailed to the email addresses provided by the stakeholders in their register with an appealing message for them to respond candidly to the questionnaire items and return same by mail. After two weeks, a reminder was sent to those who still needed to respond. At the expiration of four weeks, 478 correctly filled questionnaires were returned. Twenty-two questionnaires either needed to be returned or adequately filled. After collation and coding, data obtained were analyzed using percentages, independent t-test analysis, and visualized using bar charts.

Presentation of results

Research question 1: What do stakeholders perceive as the indices determining soil degradation?

Table1: Stakeholders perception of indices for measuring soil degradation.

Indices for measuring soil degradation.	SD (%)	D (%)	U (%)	A (%)	SA (%)	Decision
Occurrence of sheet/rill erosion.	0(0.0)	12(2.5)	0(0.00)	335(70.1)	131(27.4)	Agreed
Occurrence of wind erosion.	0(0.0)	0(0.00)	106(22.2)	134(28.0)	238(49.8)	Agreed
Occurrence of gully erosion.	0(0.0)	0(0.00)	0(0.00)	236(49.)	242(50.)	Strongly agreed
Presence of acidic soils.	0(0.0)	0(0.00)	201(42.1)	265(55.4)	12(2.)	Agreed.
Soil carbon destabilization	0(0.0)	106(22.2)	0(0.00)	33(6.9)	339(70.9)	Agreed
Soil structure sensitivity	0(0.0)	0(0.00)	0(0.00)	370(77.4)	108(22.6)	Agreed
Soil salinity	0(0.0)	0(0.00)	12(2.5)	203(42.5)	263(55.0)	Strongly agreed

Results in Table 1 show responses of stakeholders' perception of indices for measuring soil degradation. No stakeholder strongly disagreed on sheet/reel erosion as indices for measuring soil degradation, but 12 persons, which is 2.5 percent, disagreed. None was undecided, whereas 335 (70.1%) and 131 that is 27.4 percent agreed and strongly disagreed with the item. On the item on the occurrence of wind erosion, none strongly disagreed, and none disagreed either. However, 106(22.2%), 136(28.0%), and 238(49.8%) were undecided, agreed, and strongly agreed, respectively. None strongly disagreed, disagreed, or were undecided on the item seeking to determine stakeholders' perception of whether gully erosion is an index for measuring soil degradation. On the contrary, 236, 49.4 percent, agreed, while 242 totaling 50.6 percent, strongly agreed.

On the presence of acidic soils, no respondent strongly disagreed nor disagreed, but 201(42.1%) were undecided, 265(55.4%) agreed, and 12(2.5%) strongly agreed. On soil carbon destabilization, none strongly disagreed, although 106(22.2%) disagreed, none was undecided, whereas, 370(77.4%) agreed and 208(22.6%) strongly agreed. None strongly agreed, none disagreed, and none was undecided, but 370(77.4%) agreed, and 108(22.6%) strongly agreed to soil structure sensitivity as an index of soil degradation. In the same vein, none strongly disagreed, none disagreed, while 12(2.5%) were undecided, but 203(42.5%) agreed, and 263(55.0%) strongly agreed. On the whole, the majority of the stakeholders perceived that the indices listed were used in measuring soil degradation. This result is visualized in figure 1, where a Bar Chart on the frequency of Stakeholders' perception of indices for measuring soil degradation is presented.

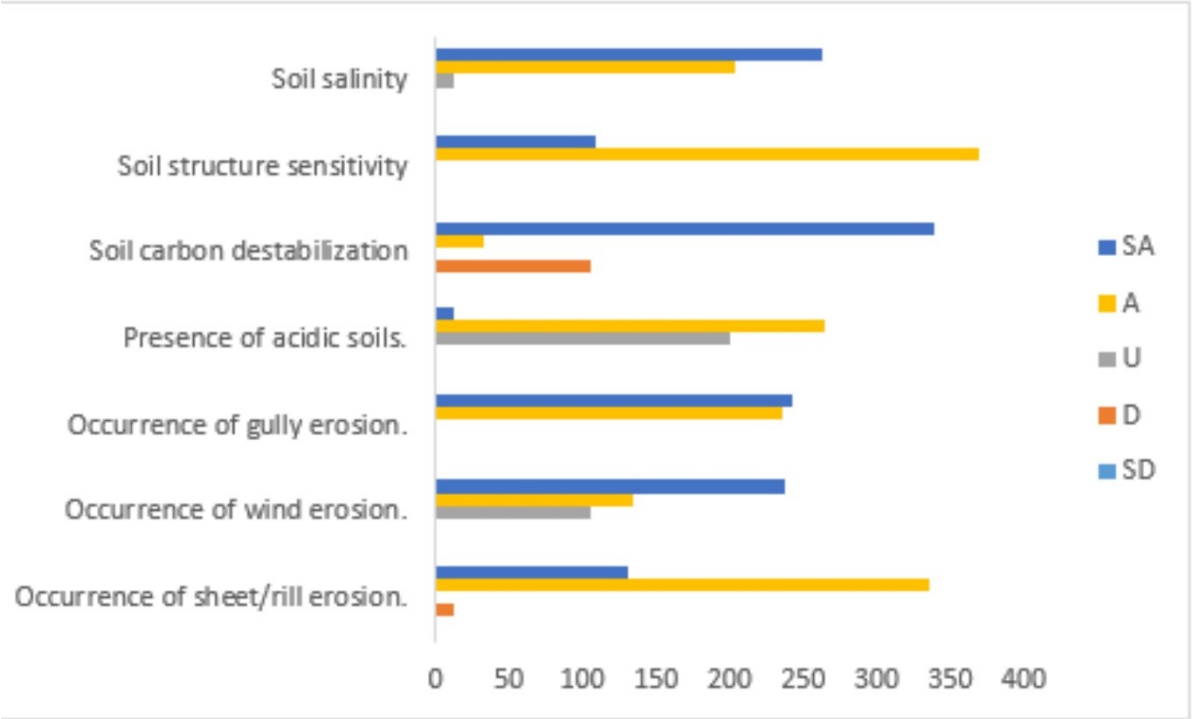

Figure 1: Bar Chart on the frequency of Stakeholders perception of indices for measuring soil degradation.

The bar graphs in figure 1 point clearly to the fact that stakeholders perceive that the presence of soil structure sensitivity, sheet/rill erosion, acidic soils, and gully erosions are the highest indices for measuring soil degradation.

Research question 2: What do stakeholders perceive as the strategies for soil restoration in the study area?

Analysis of results in the table2 shows stakeholders' perception of strategies for soil restoration. Out of 478 stakeholders, none strongly disagreed nor disagreed on the item that soil restoration is an effective strategy, but 228(47.7%) were undecided, while 238(49.8%) and 12(2.5) agreed and strongly agreed, respectively. On soil reclamation, none strongly disagreed, but 17(3.6%) disagreed, and none was undecided, but 30(6.3%) agreed, while 431(90.2%) strongly agreed that the item was a strategy for soil restoration.

Table2: Stakeholders perception of strategies for soil restoration. N=478

Strategies for soil restoration	SD %	D %	U %	A %	SA %	Decision
Soil restoration.	0(0.0)	0(0.0)0	228(47.7)	238(49.8)	12(2.5)	Agreed
Soil reclamation.	0(0.0)	17(3.6)	0(0.0)	30(6.3)	431(90.2)	Agreed
Soil rehabilitation.	0(0.0)	0(0.0)	0(0.0)	197(41.2)	281(58.8)	Agreed
Integrated nutrient management (INM).	0(0.0)	0(0.0)	12(2.5)	36(7.5)	430(90.0)	Agreed

Erosion control.	106(22.2)	0(0.0)	0(0.0)	354(74.1)	18(3.8)	Agreed
Vegetation management.	0(0.0)	0(0.0)	21(4.4)	133(27.8)	324(67.8)	Agreed
Agroforestry.	0(0.0)	12(2.5)	0(0.0)	430(90.0)	36(7.5)	Agreed
Attainment of Land Degradation Neutrality (LDN).	0(0.0)	106(22.2)	0(0.0)	39(8.2)	333(69.7)	Agreed
Reducing deforestation.	0(0.0)	0(0.0)	0(0.0)	353(73.8)	125(26.2)	Agreed
Increasing afforestation.	12(2.5)	0(0.0)	0(0.0)	36(7.5)	430(90.0)	Agreed
Increasing reforestation.	0(0.0)	0(0.0)	0(0.0)	336(70.3)	142(29.7)	Agreed
Minimum soil disturbance.	0(0.0)	0(0.0)	0(0.0)	348(72.8)	130(27.2)	Agreed

Whether soil reclamation was a strategy, no stakeholder strongly disagreed, none disagreed, and none was undecided, but 197(41.2%) agreed, and 281(58.8%) strongly agreed. None strongly disagreed nor disagreed that integrated nutrient management is another strategy for soil restoration, although 12(2.5%) were undecided, 36(7.5%) agreed, and 430(90.0%) strongly agreed with the item.

On soil erosion control, 106(22%) strongly disagreed, but none disagreed, and none was undecided; 354 (74.1%) and 18(3.8%) agreed and strongly agreed, respectively. On vegetation management, no respondent strongly disagreed, and none disagreed; 21 (4.4%) were undecided. However, 133(27.8%) agreed, while 324 (67.8%) strongly agreed. No respondent strongly disagreed that agroforestry is a strategy, although 12(2.5%) disagreed, while none was undecided, 430(90.0%) agreed, and 36(7.5%) strongly agreed.

On the attainment of Land Degradation Neutrality, no respondent strongly disagreed as none was undecided, although 106(22.2%) were undecided, 39(8.2%) agreed, and 333(69.7%) strongly agreed to the item. No respondent strongly disagreed, disagreed, or was undecided about reducing deforestation. A total of 353(73.8%), agreed and 125(26.2%) strongly agreed. On increasing afforestation, 12(2.5%) strongly disagreed, none disagreed, and none was undecided. Expectedly, 36(7.5%) agreed, and 430(90.0%) strongly agreed that the item is a strategy for soil restoration.

No stakeholder strongly disagreed, disagreed, or was undecided on increasing reforestation. A considerable number of 336(70.3%) agreed with the strategy, while 142(29.7%) strongly agreed. On engaging in minimum soil disturbance, none strongly disagreed, disagreed, nor was neutral, but 348(72.8%) and 130(27.2%) agreed and strongly agreed, respectively. Overall, the respondents agreed with the strategies proposed for soil restoration.

Figure 2 is a clustered bar showing frequency counts of Stakeholders' perception of strategies for soil restoration. The stakeholders indicated that increasing afforestation, integrated nutrient management, and soil reclamation are the most effective strategies for soil restoration, followed by agroforestry, minimum soil disturbance, increasing reforestation, and erosion control.

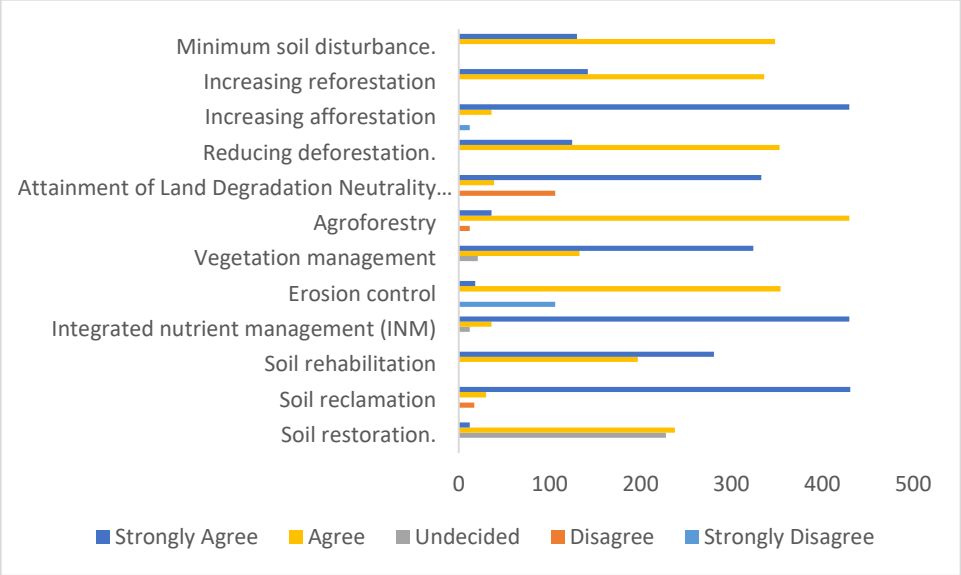

Figure 2: Clustered Bar showing frequency counts of Stakeholders perception of strategies for soil restoration.

Research question 3: What do stakeholders perceive as the challenges of soil restoration in the study area?

Table3: Stakeholders perception of challenges to soil restoration.

Perception of challenges of soil restoration	SD %	D %	U %	A %	SA%	Decision
Challenge of technology.	12(2.5)	0(0.0)	0(0.0)	203(42.5)	263(55.0)	Agreed
Variable local environmental characteristics like weather.	0(0.0)	167(34.9)	200(41.8)	58(12.1)	53(11.1)	Undecided
Variable land tenure systems.	0(0.0)	0(0.0)	0(0.0)	181(37.9)	297(62.1)	Agreed
Problems of financing/funding gaps.	0(0.0)	101(21.1)	111(23.2)	135(28.2)	131(27.4)	Agreed
Problem of policy, policy acceptability and practices by government.	89(18.6)	84(17.6)	100(20.9)	50(10.5)	155(32.4)	Agreed
Inadequate Ecosystems education.	195(40.8)	83(17.4)	0(0.0)	36(7.5)	164(34.3)	Disagreed

Table 3 presents responses to stakeholders' perceptions of challenges to soil restoration. A few stakeholders, 12(2.5%), strongly disagreed that technology is a challenge, but none disagreed,

and none was undecided. On whether variable local environmental characteristics like weather constitute a challenge, no respondent strongly disagreed, but 167(34.9%) disagreed, 200(41.8%) respondents were undecided, 58(12.1%), and 53(11.1%) agreed and strongly agreed respectively, this means stakeholders were undecided on the item. On the issue of variable land tenure systems, aside from 181(37.9%) respondents who agreed and 297(62.1%) who strongly agreed, no stakeholder strongly disagreed, none disagreed, and none was neutral on the issue.

No respondent strongly agreed that the problems of financing/funding gaps constitute a challenge. But 101(21.1%) persons disagreed and 111(23.2) were undecided, leaving 135(28.2%), 131(27.4%) who agreed and strongly agreed respectively. This result means funding is a major challenge to soil restoration. Eighty-nine subjects that is 18.6percent strongly disagreed that the problem of policy, policy acceptability, and practices by the government is a challenge to soil restoration, 84(17.6%) disagreed, and 100(20.9%) were undecided, but 50(10.5%) agreed, and 155(32.4%) strongly agreed. One hundred and ninety-five respondents (40.8%) strongly disagreed that inadequate ecosystems education is a challenge, and 83(17.4%) disagreed. None was undecided 36(7.5%) respondents agreed while 164(34.3%) strongly agreed.

Figure 3, a clustered bar showing the frequency of stakeholders' perception of challenges to soil restoration, reveals that many respondents strongly agree that variable land tenure systems challenge soil restoration, followed by technology and policy practices.

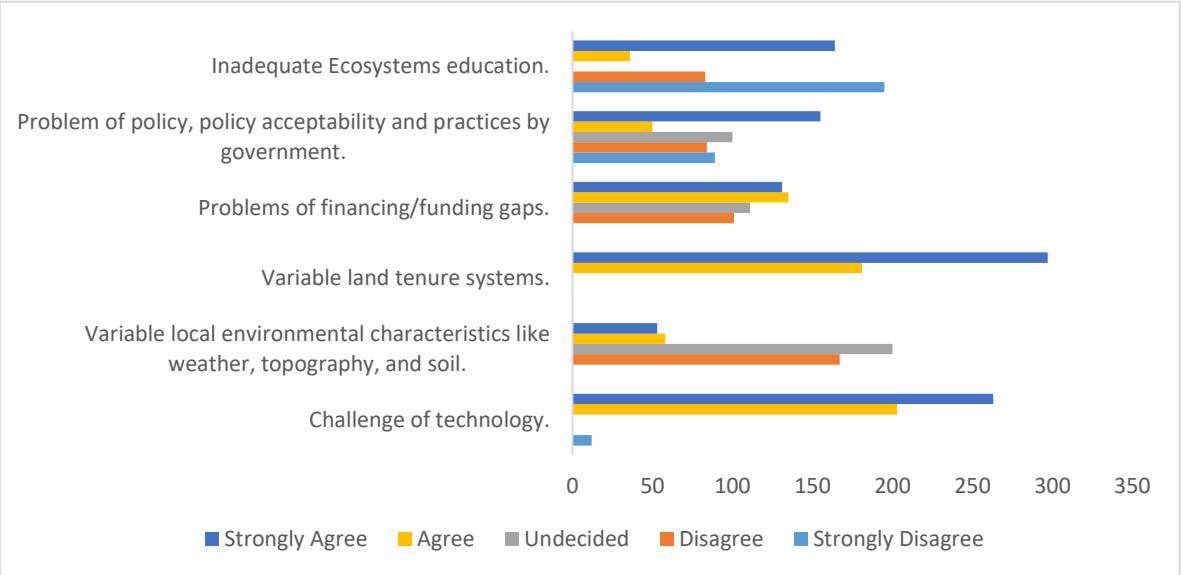

Figure 3: Clustered bar showing frequency of Stakeholders perception of challenges to soil restoration.

Research question 4: What do stakeholders perceive as the benefits of soil restoration to ecosystems?

Table 4 analyses stakeholders' perceptions of the benefits of soil restoration. No respondent strongly disagreed, and none disagreed with the item that soil restoration might lead to a reduction in poverty resulting from poor harvest, but 15(3.1%) were undecided, 301(63.0%) respondents agreed, and 162(33.9%) strongly agreed to the item. On the sustenance of life on earth for a longer time, 89(18.6%) strongly disagreed, none disagreed, 28(5.9%) were undecided, 176(36.8%) agreed, and 185(38.7%) strongly agreed.

On the restoration of humans' strained relationship with natural ecosystems, no respondent strongly disagreed, 17(3.6%) disagreed, 111(23.2%) were undecided, but 202(42.3%) and 148(31.0%) agreed and strongly agreed. On restoring medicinal and recreational properties of ecosystems, no respondent strongly disagreed, none disagreed, and none was undecided. Three hundred seventy (77.4%) respondents agreed, and 108(22.6%) strongly agreed. On the sustenance of Indigenous culture, none strongly disagreed, none disagreed, but 12(2.5%) were undecided, 120(25.1%) agreed, and 346(72.4%) strongly agreed. On reduction in wars, farmers'/herders' conflicts, 17(3.6%) strongly disagreed, 89(18.6%) disagreed, 111(23.2%) were undecided, but 243(50.8%) agreed, and 18(3.8%) strongly agreed.

On a slowdown of eco-migrants, no respondents strongly disagreed, and none disagreed, but 21(4.4%) were undecided.

Table4: Stakeholders perception of benefits of soil restoration.

Perception of benefits of soil restoration	SD %	D %	U %	A %	SA %	Decision
Reduction in poverty resulting from poor harvest.	0(0.0)	0(0.0)	15(3.1)	301(63.0)	162(33.9)	Agreed
Sustenance of life on earth for a longer time.	89(18.6)	0(0.0)	28(5.9)	176(36.8)	185(38.7)	Agreed
Restoration of humans strained relationship with natural ecosystems.	0(0.0)	17(3.6)	111(23.2)	202(42.3)	148(31.0)	Agreed
Restoration of medicinal and recreational properties of ecosystems.	0(0.0)	0(0.0)	0(0.0)	370(77.4)	108(22.6)	Agreed
Sustenance of Indigenous culture.	0(0.0)	0(0.0)	12(2.5)	120(25.1)	346(72.4)	Agreed
Reduction in wars, farmers/herders' conflicts.	17(3.6)	89(18.6)	111(23.2)	243(50.8)	18(3.8)	Agreed
A Slowdown of eco-migrants.	0(0.0)	0(0.0)	21(4.4)	328(68.6)	129(27.0)	Agreed
Restoration of endangered and threatened species of plants and animals.	0(0.0)	12(2.5)	89(18.6)	257(53.8)	120(25.1)	Agreed

Achievement of more lands for anthropogenic uses.	89(18.6)	100(20.9)	111(23.2)	39(8.2)	139(29.1)	Agreed
Increase in the rate of soil water intake and underground water storage.	0(0.0)	83(17.4)	0(0.0)	181(37.9)	214(44.8)	Agreed

A greater majority 328(68.6%) agreed and 129(27.0%) strongly agreed. On the item of restoration of endangered and threatened species of plants and animals, no respondent strongly disagreed; only 12(2.5%) disagreed, but 89(18.6%) were undecided, while 257(53.8%) and 120(25.1%) agreed and strongly agreed respectively. Eighty-nine (18.6%) respondents strongly disagreed that soil restoration might lead to the achievement of more lands for anthropogenic uses, while 100(20.9%) disagreed and 111(23.2%) were undecided, but 39(8.2%) agreed while 139(29.1%) strongly agreed.

No respondent strongly disagreed that soil restoration might lead to an increase in the rate of soil water intake and underground water storage, but 83(17.4%) disagreed, none was undecided, 181(37.9%) agreed, 214(44.8%) strongly agreed to the statement. Overall, stakeholders in this study perceive that soil restoration will benefit the communities enormously. The Clustered Bar in Figure 4 shows stakeholders' perception of the benefits of soil restoration. More stakeholders believe that soil restoration will restore indigenous culture, followed by increased water intake and restoration of medicinal and recreational properties of ecosystems, among others.

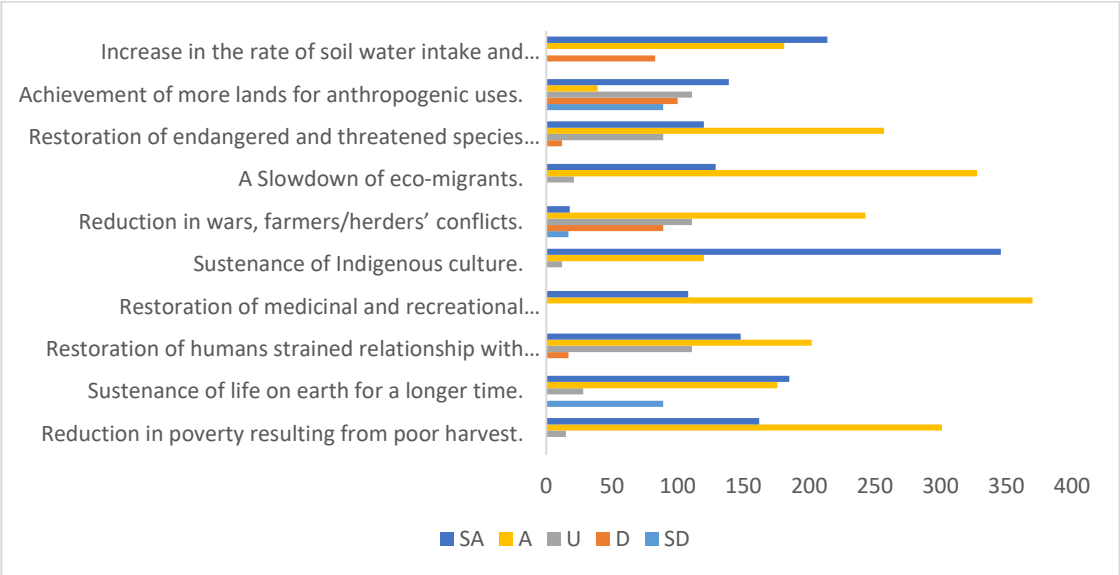

Figure 4: Clustered Bar showing Stakeholders perception of benefits of soil restoration.

HO:1

States that Stakeholders' profession has no significant influence on their perception of indices for measuring soil degradation.

The independent variable, the stakeholders' profession, was dichotomized into two nominal levels: farmers and Soil scientists. In contrast, the continuous dependent variable was the perception of indices for measuring soil degradation. This assertion made it suitable to adopt the independent t-test statistical technique as an appropriate form of data analysis. Table 5 indicates that soil scientists recorded a higher mean ($\bar{x}$ = 29.631) for the perception of indices for measuring soil degradation than farmers ($\bar{x}$ = 29.623), with a mean difference of .008. The p-value in table 5 was more significant than the alpha level of .05 at 476 degrees of freedom. We fail to reject the null hypothesis. This result means that stakeholders' profession does not significantly influence their perception of indices for measuring soil degradation.

Table 5: Independent t- test analysis of influence of stakeholders' profession on their perception of indices for measuring soil degradation.

Variables	Profession	N	$\bar{x}$	SD	t-cal.	p
Perception of indices for measuring soil degradation.	Farmer	226	29.623	2.65	-.029	.794
	Soil Scientist	252	29.631	2.63		

Not significant at .05, critical t = 1.960, df. = 476, Mean difference = .008.

Ho: 2

States that Stakeholders' Location has no significant influence on their perception of strategies for soil restoration.

The independent variable, stakeholders' location, was dichotomized into two nominal levels: North and South zone, while the continuous dependent variable was the perception of strategies for soil restoration. Table 6 indicates that stakeholders of the South zone recorded a higher mean ($\bar{x}$ = 51.90) for the perception of strategies for soil restoration when compared to the North zone ($\bar{x}$ = 51.64) with a mean difference of .26. The p-value in table 6 was more significant than the alpha level of .05 at 476 degrees of freedom. We fail to reject the null hypothesis. This result implies that stakeholders' location has no significant influence on their perception of strategies for soil restoration.

Table 6: Independent t- test analysis of influence of stakeholders' location on their perception of indices for measuring soil degradation.

Variables	Location	N	$\bar{x}$	SD	t-cal	P
Perception of strategies for soil restoration.	North	225	51.64	3.73	-.798	.425
	South	253	51.90	3.30		

Not significant at .05, critical t = 1.960, df. = 476, Mean difference = .26.

Ho:3
States that stakeholders' gender does not significantly influence their perception of the benefits of soil restoration.

The independent variable, stakeholders' gender, was naturally dichotomized into two nominal levels-male and female, while the continuous dependent variable was the perception of the benefits of soil restoration. Table 7 indicates that female stakeholders recorded a higher mean ($\bar{x}$ = 3.99) for the perception of benefits of soil restoration when compared to males ($\bar{x}$ = 3.96) with a mean difference of .03. The p-value in table 7 was more significant than the alpha level of .05 at 476 degrees of freedom. We fail to reject the null hypothesis. This result implies that stakeholders' gender t has no significant influence on their perception of the benefits of soil restoration.

Table 7: Independent t- test analysis of influence of stakeholders' gender on their perception of indices for measuring soil degradation.

Variables	Gender	N	$\bar{x}$	SD	t-Cal	P
Perception of benefits of soil restoration.	Male	241	3.96	.442	-.948	.887
	Female	237	3.99	.439		

Not significant at .05, critical t = 1.960, df. = 476, mean difference = .03.

Discussion of findings
This study set out to appraise stakeholders' perception of soil restoration within the United Nations decade on ecosystems restoration (UNDER 2021-2030). Results from research question one reveal that stakeholders perceived the occurrence of sheet/rill erosion, the occurrence of wind erosion, the occurrence of gully erosion, and the presence of acidic soils as indices for measuring soil degradation. This result agrees with the views of Chapman and others (2011), who noted that soil conditions and pressure indicators are used to evaluate soil degradation. The findings also agree with Zhu and Xu (2021), Zakerinejad, and Maerker (2015) noted that small channels are created on the soil in rill erosion. De Ploey, Imeson, and Oldeman (1991), Reichert, Amado, Reinert, Rodrigues, and Suzuki (2016) reported that soil structure sensitivity could be caused by "inappropriate land management on fragile soils.

Research question two reveals that most stakeholders perceive soil restoration, soil reclamation, soil rehabilitation, erosion control, and agroforestry as effective strategies for soil restoration. The result tallies with evidence earlier presented by Sanz and others (2017), Das and Avasthe (2018), Selim (2020), Kaushal, Mandal, Panwar, Kumar, Tomar, and Mehta (2021), and Bhunia Chatterjee, and Shit, (2021) whom all proffered various of these strategies for soil restoration.

Results of the third research question show that most stakeholders perceived that the challenges of technology, financing problems, and inadequate ecosystem education are challenges to soil restoration. This finding agrees with Strauss, Paul, Dönmez, Löbmann, and Helming (2023), Zhou, Wang, Wang, Zhang, Chen, and Liu (2020), who analyzed some challenges of soil restoration. Results answering research question 4 show that most stakeholders perceived that reduction in poverty resulting from poor harvest, restoration of medicinal and recreational properties of ecosystems, and achievement of more lands for anthropogenic uses are benefits of soil restoration. This finding agrees with Alam, Borthakur, Ravi, Gebremichael, and Mohanty (2021), Lomax (2016) Smith and Seyfang (2013), who advocated that restoring soils raises their infiltration capacity, and gaining more land for anthropogenic activities, among others.

Results of hypothesis one show that stakeholders' profession has no significant influence on their perception of indices for measuring soil degradation. This result is not a surprise because farmers and soil scientists are assumed to have both traditional and scientific knowledge of the determinants of soil degradation. This finding aligns with what Chapman and others (2011) noted: soil conditions and pressure indicators are used to evaluate soil degradation. The finding also agrees with Callaham Jr and Stanturf (2021), who observed that restoration ecologists have long appreciated soils as necessary for restoring ecosystems.

Results of hypothesis two show that stakeholders' location has no significant influence on their perception of strategies for soil restoration. The surprise in this finding is that the South of the study area enjoys more rainfall than the North, which significantly impacts soil degradation. Nevertheless, stakeholders' choices were not influenced by their location. This finding disagrees with Turley, Bell-Dereske, Evans, and Brudvig (2020), who found that soil restoration may be affected by factors such as regional soil texture and structure, past land use, soil type, and vegetation.

Results of hypothesis three show that stakeholders' gender has no significant influence on their perception of the benefits of soil restoration. This finding aligns with Namubiru-Mwaura, (2021) and Kristjanson (2020), who observed that gender-responsive actions are central to sustainable land restoration projects and that gender neutrality should not be assumed. This fact is more so because women especially in developing countries interact with the soil as much as their male counterparts. Their perception should, therefore, not differ.

Conclusion

Therefore, this research concluded that stakeholders perceived the occurrence of sheet/rill erosion and soil salinity, among others, as indices for measuring soil degradation. They equally perceived soil restoration and soil reclamation as effective strategies for soil restoration. Stakeholders also perceived the challenge of technology, and variable land tenure systems, as challenges to soil restoration. At the same time, they believed that reduction in poverty resulting from poor harvest, and restoration of humans' strained relationship with natural ecosystems, are benefits of soil restoration. Stakeholders also perceived that their profession does not significantly influence their perception of indices for measuring soil degradation. Stakeholders'

location has no significant influence on their perception of strategies for soil restoration, and gender has no significant influence on their perception of the benefits of soil restoration.

Recommendations

Following the findings of this research, we recommend that:

1. Bottom-up approach to planning for restoration should be pursued to make room for indigenous inputs.
2. Community-specific land restoration strategies, new methods for ecosystem restoration, Technology transfer, and adaptation should be taught to locals through Environmental Education and Agricultural extension services. Ecological issues will be made known to all citizens before they become disasters.
3. Improve Funding: Actionable (fundable) activities for soil restoration should be embarked upon.
4. All parties and member nations of the United Nations Organisations should fully embrace the UN Decade for ecosystem restoration, especially land and soil restoration programs.

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