Review on Rehabilitation of degraded dry land ecosystems

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ABSTRACT*: Land degradation is worldwide and a high thing that have an outcome on the livestock of 1.5 billion people whole of which one seventh or 250 million people live in dry lands. Globally, it is assumed that 10–20% of dry lands are already degraded and about 12 million ha are cleaned each year in a case of using treatment. Reached by on unstable ground land use practices, adverse air conditions and the increase of population, land degradation has led to beg to be excused in precondition of ecosystem services, insecurity of food, political and social unsteadiness and lessening in the ecosystem's resilience to natural climate unpredictability. All world studies have been launched to minimize land degradation, including rehabilitation of degraded dry lands. Restoration of agricultural land is important for sustainability of agriculture and environment. The basic factors causing soil erosion-induced degradation are wind and water erosion. The main causes of erosion on agricultural land are intensive cultivation, overgrazing, poor management of arable soils and deforestation. Restoration of eroded agricultural land is achieved through several agronomic and biological techniques. Biological measures such as buffers, conditioner application in direct contact with the soil surface, crop residues using manure protect the soil from erosion. This review aimed at collating the current state-of-knowledge about rehabilitation of degraded dry lands. Development of progression based models that forecast outcomes of the various treatment activities will be useful tools for researchers and practitioners. The concept of forest landscape re-establishment approach, which operates at landscape level, could also be adopted as the good framework for rehabilitation of degraded dry land ecosystems.*

KEYWORDS*;* land degradation; rehabilitation; degraded dry land; Agricultural, landscape

INTRODUCTION

Land degradation and deforestation has been seeing that a most important towards to human-wellbeing and environment due to the consequential of biodiversity loss, degradation of soil and important involvement to greenhouse gas emission and degradation Land in dry lands is a actuality touching millions of people, and marks in a grouping of local, national, and worldwide causes that the deteriorating ability of dry land systems the needs to support the other organisms and populations of humans that continue to exist there is common and established (Constantini E.A *et al*.,2016).

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Restoration of forests and agroforestry systems can improve small landowners' food security through crop diversification, reduced soil erosion, increased water availability and improved pollination. Therefore, land restoration contributes to poverty reduction and securing livelihoods. Restored ecosystems also increase pollinator diversity, which contributes to maintaining plant diversity at local and regional scales and improves the quality and stability of crop yields. Pollinators are required by a number of food crops, many of which have relatively high nutrient densities including numerous fruits and vegetables (Potts *et al*. 2016). To achieve SDG an integrated approach to land restoration is required that accounts for multiple goals related to food, air, water, and disease control, while prioritizing strategies that increase human health and well-being during the time the restoration process takes place. All are simultaneously dependent on healthy land, making a multiple benefit focus necessary to sustain soils, biodiversity and human health that address many of the SDGs (Wall et al. 2015) and Effective restoration depends on policies that support the development and implementation of practices adapted to local conditions and their economic and policy environments. This may include infrastructure investments, and incentives for better land management and regulation (Vlek *et al*., 2017).

Degraded soils straightly decrease vegetation envelop consequential in exposed land and for this reason risking a assortment of ecosystem services and livelihoods in the semi-arid and arid range lands and the consequential is windswept/eroded/ hillsides, denuded plains, huge erosion shelves and deep sheer sided gullies and Each year, 12 million hectares of land accomplished of producing 20 million tons of small piece are lost due to deficiency /drought/and desertification (Edrisi *et al*., 2016).

Organic farming has significantly increased during recent decades accounting for 37.5 million hectares of land in 2012 with the largest share in Australia (32 per cent), Europe (30 per cent), South America (18 per cent) and Asian countries such as India, China, Japan, and Indonesia (20 per cent) according to Willer *et al*., 2014 and Sustainable agricultural approaches have improved the average crop yields by 79 per cent on 3 per cent of farmland in developing countries (IPBES, 2018).

While co-benefits for the first four targets would be derived primarily from the rehabilitation of agricultural lands, target 2.5 could also benefit from the restoration of natural ecosystems, as the "genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species" is conserved and also the process of restoration also has a number of potential co-benefits, particularly for targets 2.3 to 2.5 in addation Cultivation of currently underutilized food crops can also be important for averting hunger and these crops include species rich in vitamins and other minerals such as pearl millet (Pennisetum glaucum), amaranth (apseudo cereal - Amaranth cruentus), winged bean (Psophocarpus tetragonolobus), sword bean (Canavalia gladiata), Indian spinach (Basella rubra), Amaranth leafy vegetable (Amaranthus viridis) and ground cherry (Physalis angulata) (Singh *et al*., 2018b).

Trees need a longer time to establish, ensuing in a longer period of time before tightly executing the role of controlling soil erosion. grasslands contain a shorter organization time and spread in addition to envelop the land inside a small time and in addation Earlier and sooner range

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rehabilitation can be achieved by grasses because they are easy to set up and grow fast and settle a great area due to their productive enlargement the environment furthermore, vegetative equipment contain be establish to enlarge the soil raw material carbonatautmostrateof1.06Mg/year(Garcia-Diazetal.,2018)

LITERATURE REVIEW

Dry Land Ecosystem

Dry lands means land areas, that are enclosed by comparatively short amounts of precipitation, and areas in which yearly indicate possible evapo transpiration is at least 1.5 times better than yearly mean precipitation while producing adequate biomass for cattle feed however, Erosion control using grass species and Successful range rehabilitation has been done in a lot of countries(Abhilash,P.C.(2017).while a number of output and rehabilitation appropriateness studies the species of grass for semi-arid and semi-arid environments are previously completed in Kenya and little concentration has been given to centre of population views on suitable species of grass that best fits of laughter their wants in addition, the communities variations " views survive with admiration to location, grass uses and preference and species performance. According to Kangalawe (Ricart *et al*., (2019)

The dominant land uses in dry lands are rangelands and croplands, jointly accounting for 90% of dry land areas; while forests and woodlands account for 10% of the dry lands and These land uses, in turn, support integrated agro-pastoral and silvo-pastoral livelihoods of more than 2 billion people, about one third of world population according to Millennium Ecosystem Assessment 2005a and apart from provisioning services (e.g. food, forage, fibre, biochemical), dry land ecosystems provide different regulatory services, including water, pollination and seed dispersal, and climate regulation by sequestering and storing vast amounts of carbon in the soil. Plant biomass per unit area of dry lands is lower than many terrestrial ecosystems, but total soil organic and inorganic carbon reserves in dry lands comprise 27% and 97%, respectively of the global soil organic and inorganic carbon reserves. Furthermore, dry land ecosystems play an important role in shaping cultural identity and diversity of their inhabitants as well as development of unique dry land farming systems (Djanibekov*etal*., 2016).

Restricted awareness, behaviour and knowing about same things have remote better implications to their surroundings including control of land degradation and resource management and Communities of restricted are identified what plants are accessible in the dry seasons and wet, variety that are additional continual and drought tolerant, and this in order to fulfilment the modern scientific information in selecting species for rehabilitation (IUCT.2017)

Dry land degradation: extent, drivers and impacts

degradation of Dry land is a uppermost and a grave danger to the millions of livelihoods and people mainly in global environment and developing countries and the United Nations Convention to Combat Desertification (UNCCD) defines degradation of land as a decrease semi-arid, sub-humid, dry area and in arid, of the organic or financial output and difficulty of

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rain-fed irrigated cropland, or range, pasture, forest, and woodlands consequential from land use of from a single process or mixture of processes including habitat patterns and processes arising from human conduct and By getting better "soil quality and land", restoration and rehabilitation can also increase resilience (Gessesse.B.,2016) .The integration of land restoration and rehabilitation in the implementation of existing policies, initiatives and projects may be particularly productive and these initiatives not only support landscape restoration, but they also yield multiple benefits, such as food security, climate change mitigation, ecosystem services and land quality improvement and sustainable housing.

Land restoration and rehabilitation in rural areas can also provide significant co-benefits for cities and human settlements. Direct benefits may include the provision of clean, reliable sources of water by restored watersheds (Santos*etal*., 2018)

As sited by global situation books;

Table 1. Degraded area and population distribution in dry land zones.

s/n	Dry land	Size of the area in KM	Share of global area in%	Degraded area in KM	Degraded area in %	Population	Population density
1	Dry sub humid	12.96	8.7	2.5	19.5	909,972,000	70
2	Semiarid	22.67	15.2	4.8	21.5	855,333,000	38
3	Arid	15.17	10.6	4.5	28.7	242,780,000	16
	Total dry land	50.80	34.5	11.8	69.7	200,808,5000	124

Sources: * UN 2011. Global dry lands: a UN system-wide response. Environment Management Group. 132 p.

The landscape strategy provides just one example of how an understanding of diversity can help target interventions where they are likely to yield the highest return on investment. The same logic can be applied to innovation. In the past, the contribution of biological research to restoration and rehabilitation has been primarily through breeding programs that resulted in plants that could simultaneously stabilize degraded soil while contributing nitrogen. New approaches now provide new opportunities to develop targeted solutions involving soil microbes. For example, microbes that are adapted to remediate contaminated soils in environments where pollutants might otherwise persist for decades (Tripathi *et al*. 2017).

There is a widespread use of the term desertification either interchangeably or in conjunction with land degradation; the definitions of land degradation in drylands and desertification are highly controversial. Desertification is defined by the UNCCD (1994) as "land degradation in the arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities". Desertification is also defined as the process of ecological degradation by which economically productive land becomes less productive and, in extreme cases, develops a desert-like landscape incapable of sustaining the communities that once depended on it and In addition to the areas and people directly affected, dryland degradation

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has adverse impacts on non-dryland areas, often many thousands of kilometers away. For instance, dust storms resulting from reduced vegetation cover may lead to air quality problems, both locally and far away and Land degradation which is a serious threat to dryland ecosystems is a complex environmental problem t hat combines a natural and social cause-effect cycle (Van der Esch *et al*.,2017).

Multiple opportunities exist for restored and rehabilitated land to be used for the production of traditional (wood fuel) and modern bioenergy (biofuels, combined heat and power) to generate renewable energy. Restoration can also restore productivity to areas such as coalfields, oilfields and gas fields degraded during fossil fuel extraction (Ahirwal *et al*., 2017).

Occasional droughts and long-term severe droughts can both be aggravated by the influence of humans on the environment. To better understand the drivers of land degradation, make a distinction between proximate and underlying causes. Proximate causes are those with a direct effect on terrestrial ecosystems and can be further divided into natural (biophysical) and anthropogenic (management) causes; underlying causes (e.g. policies, population density, markets, poverty) will be those directly affecting the proximate causes. However, there is disagreement on the role of underlying drivers of land degradation due to the complex interactions between them according to Nkonya *et al.* (2016), key environmental indicators of dryland degradation include net primary productivity, presence/absence of indicative plant species, soil organic matter, and several chemical and physical soil properties GOM. (2017).
In addition, the vegetation/bare soil pattern is an effective indicator of degradation/desertification that can be used to detect it, particularly at the early stages according to studing Wiesmeier, 2015, Climate change may exacerbate and itself is exacerbated by land degradation according to his study Cowie *et al*. 2011, climate change may aggravate dry land degradation through alteration of spatial and temporal patterns in temperature, rainfall, solar radiation and winds (Yan*etal*., 2017)

Closely causes are those with a direct effect on terrestrial ecosystems and can be additional alienated into natural (biophysical) and anthropogenic (management) causes; fundamental causes (e.g. markets, poverty, Policies, population density) will be those directly affecting the closely causes nevertheless, there is dissimilarity on the role of fundamental drivers of land degradation due to the intricate interactions among them (Haftu *et al*., (2019) Which in most cases are situation different even so, globally, water is the main agent of soil erosion, in a lot of arid and semi-arid areas, wind erosion can be considerable and even the main agent of soil erosion and The practices of SLM are the key factors to enhance, preserve, and sustain the productive capacity of land in agriculture (Stavi *et al*.,2015).

Dry land ecosystems that are most vulnerable to degradation are those that have low rainfall, extended dry seasons, repeated droughts, mobile surface deposits, very thin soils, and thin vegetation cover and also as to decrease the in progress degradation of land across watersheds thereby improving the ecosystem and livelihoods of farmers, the government of Ethiopia implemented the SLM program in six regions of the country since 2012 (Nidt and Tadesse, 2018).

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Reducing Drought the pay to mass, large quantity and ground cover of plants and hence minimizing the keeping of the soil against erosion ultimately, if all the top soil layers are separate, the condition becomes irretrievable to more implicit social contracts regarding the useoflargerareasofcommunalland(OudenhovenA.P.E*etal*.,2015).“Restoration seeks to re-establish the pre-existing biotic integrity, in terms of species composition and community structure, while rehabilitation aims to reinstate ecosystem functionality with a focus on provision of goods and services rather than restoration” and “The preferable option in each circumstance depends on the land potential, its land use history, its baseline condition, its potential uses and associated values, and likely impacts of climate change and other shocks and stressors” (Cowie *et al*. 2018).Change of Climate may exaggerate dry land degradation through alteration of spatial and temporal patterns in temperature, rainfall, solar radiation and winds In addition, dry land degradation is associated with biodiversity loss and contributes to global climate change through loss of carbon sequestration capacity(Huangetal.,2016)

In addition to the economic loss, land degradation is one of the main causes of human migration and can adversely affect local, regional, and even global political and economic stability Millennium Ecosystem Assessment Hence, the development and adoption of sustainable land management practices is one of the major solutions to combat the problem over the vast dry lands around the world and Integrated catchment management is most effective and efficient and is the advisable and desirable way to combat land degradation and other tropical mountains therefore, Soil and water conservation based integrated catchment management has shown promising results with regard to water resource availability (ELD Intitatives,2015).

Rehabilitation of degraded dry land ecosystems

Rehabilitation is defined as the reparation of ecosystem processes, productivity and services with on necessarily achieving a return to ’pre-disturbance’ conditions in addition rehabilitation is the process of repairing damaged agricultural land for food production or livestock grazing however, Poor soil management practices including incessant bush burning, continuous intensive cultivation and high intensity sunshine have been reported to cause diminishing and masking effect of SOC (weakening the potential of SOC as a cementing and binding agent) on soil aggregation and stabilization (Couix.N *et al*.,2015).

Humans are sustained by the flow of ecosystem goods and services. However, risks associated with restoration to support human health and well-being are related to many factors, including the effectiveness of restoration actions, which depends on how well they address the drivers (biophysical, social, economic, and political) that cause land degradation. Effective restoration can stabilize ecosystem functions, diversify livelihoods, raise incomes, and reduce gender inequities (Adams *et al*., 2016). Strategic land restoration of coastal ecosystems in urban environments can reduce risks from hazardous and extreme events. For example, damages from hurricane “Superstorm Sandy”, which hit the east coast of the US in 2012, were reduced by USD 625 million due to the presence of coastal wetlands. Shoreline management in the region

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now includes restoring salt marshes as an alternative or accompaniment to ‘hard’ infrastructure (Grimm *et al*., 2016).

The level of education of household has positively and significantly affected the likelihood of adoption of soil fertility management and soil erosion control methods (organic and inorganic fertilizer and soil-bund) of SLM practices at five and ten percent level of significance Although the terms' restoration and rehabilitation are used interchangeably in the literature, the term rehabilitation describes best by far most of the remedial activities that have been conducted in degraded dry land ecosystems and hence mainly the term rehabilitation is used in this article and Rehabilitation of degraded dry land ecosystems is quintessential for the conservation of the threatened and unique dry land biodiversity (Senbetie *et al*., 2017).

Livestock grazing is often perceived as the prime cause of rangeland degradation and having a critical impact on rangeland biodiversity and soil erosion soil nutrient cycling and hydrological processes and Others argue that livestock grazing coupled with rainfall variability, and soil and vegetation types have a long-term effect on productivity of rangeland vegetation and Available evidence also shows that it is the management of the grazing system, not grazing per se, which is the main cause of rangeland degradation in arid and semi-arid environments For instance, the traditional free-grazing system by pastoralists can lead to overgrazing, depending on livestock stocking density and frequency of grazing. Whereas improved grazing management system (e.g., cut and carry system, rotational grazing in alternating exclosures) enables better control of stock density and frequency of grazing; thereby minimizing the risk of overgrazing and rangeland degradation (Kgosikoma O.E *et al.*,2015)
The landscape rehabilitation efforts is simple to implement and This result might be due to the fact that farmers who own relatively more livestock size make use of animal manure as a source of inorganic fertilizer and Besides the income obtained from the sale of livestock could be used for organic fertilizer purchase and hiring of the labour force to undertake various activities of soil erosion control and degraded land rehabilitation (Tesfaye and Brouwer,(2016)
In general, the rehabilitation strategy for dry land ecosystems depends, among st other factors, on the intensity, duration, frequency, and scale of the perturbation and the availability of propagates And slower than ecosystem recovery in moist sites and Dry land rehabilitation activities have usually been focused on a specific site or on a plot scale However, environmental factors and processes which include soils, climate, topography, hydrology, land management, water management, and ecological systems operate at much larger scales andareinterlinked(CostAction,2016)

Range land rehabilitation

Range lands are the largest terrestrial ecosystems, comprised of natural grasslands, savannas, shrub lands, deserts, tundra, alpine communities, coastal marshes, and wet meadows they are estimated to cover around 40% of the Earth’s terrestrial surface, of which more than 80% are located in arid and semi-arid areas this implies that farmers who perceive soil erosion problem and its adverse effects on the productive capacity of farming land are more likely to adopt the soil fertility management and by use SLM practices improve dry degraded land rehabilitation(ManyekiJK*etal*.,2015).

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Degraded range lands are generally characterized by sustained reduction of biological and economic productivity and also the causes and drivers of range land degradation are spatially and temporally complex therefore, based on different studies on different range lands of Ethiopia, the possible causes of range land degradation are heavy grazing, recurrent drought, range land cultivation, bush encroachment, human population pressures, shortage of rainfall, inappropriate uses of land resources and soil erosion (Turner K.G.*et al*.,2016).

Available evidence also shows that it is the management of the grazing system, not grazing per se, which is the main cause of range land degradation in arid and semi-arid environments For instance, the traditional free-grazing system by pastoralists can lead to overgrazing, depending on livestock stocking density and frequency of grazing and the other problem of range lands is crop cultivation encroachment and communities were highly involved in crop cultivation as an alternative means of livelihood (Saguye TS. (2017). Rangeland degradation has a great impact in the pastoral communities and in the country level that resulted in substantial declines in rangeland condition, water potential, soil status, and animal performance, livestock holding at the household level, while communities in general have lost their livestock asset and become destitute. And this results food insecurity for the local community and become burden for the government due to the need for alternative livelihood income and diversification (Teshome, 2016).

This technique is highly applicable and very important for areas faced prolonged vegetation decline to successful rehabilitated in the short period by introduced native grasses are well adapted to the harsh environment of that area and become not only provide necessary habitat for many native animals, they also provide a suitable pasture base for animal production and Grass reseeding technology has been used successfully as a means of rehabilitating degraded range lands in East Africa TesfayeS,(2017). Range land degradation has a great impact in the pastoral communities and in the country level that resulted in substantial declines in range land condition, water potential, soil status, and animal performance, livestock holding at the household level, while communities in general have lost their livestock asset and become destitute and this results food insecurity for the local community and become burden for the government due to the need for alternative livelihood in come and diversification (Tesfaye *et al.*,2015).

Sustainable land management (SLM) is also known as multi-functional agriculture according to those studied said, eco-agriculture whole landscape management , multifunctional landscapes integrated landscape management and about eighty other lesser-known or lesser-used terms and the diverse terminology has arisen due to nuanced differences between approaches, but common across all SLM is the holistic and interconnected management of land for the multiple objectives of food production, biodiversity conservation, sustainable rural livelihoods, and other ecosystem service benefits derived from sustainable stewardship. SLM approaches applied in developing countries also have poverty alleviation and rural empowerment as prominent goals and Most recently, SLM has been broadened to incorporate climate change adaptation and resilience in particular, through the design of multi-use land systems providing diverse income sources, including biomass for alternative energy production Walie SD .(2015).

Integrated Water Resource Management (IWRM), also known as integrated catchment or watershed management as it eas studed by Cobourn, 1999, is the coordinated development and management of water, land, and related resources, in order to maximize economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems(Global Water Partnership,2016).Reseeding (introducing seeds) technique is highly applicable and very important for areas faced prolonged vegetation decline to successful rehabilitated in the short period by introduced native grasses are well adapted to the harsh environment of that area and become not only provide necessary habitat for many native animals, they also provide a suitable pasture base for animal production and Grass reseeding technology has been used successfully as a means of rehabilitating degraded range lands in East Africa (Tilahun *et al*., 2017).

Tree cutting and fire combined with grazing were also more effective in suppressing the regeneration of encroaching species In a similar area, while solely restoring degraded land can result in several improvements, further improvements can be made by introducing promising new crop species that are adapted to degraded land early in the restoration and rehabilitation process(Steiner *etal*.,(2018).The bush encroachment control techniques have also improved herbaceous biomass and plant biodiversity while reducing the population of tick and heavy infestation by ticks often damages and closes off cow teats; thereby reducing milk yield and suppression of shrub encroachment can be contentious in the face of climate change and recruitment of shrubs in range lands could be a natural secondary succession process (a form of passive restoration) restoration activities generate employments, thus improving the socioeconomic conditions of the poor (Mussa *et al*.,2016)

Perhaps the greatest challenge for targeting restoration and rehabilitation in a rapidly changing world is determining where these interventions are most likely to have persistent benefits and planners are beginning to understand the importance of taking climate change into consideration when deciding what types of agro ecological systems to promote however, there is often little consideration of how socioeconomic pressures may affect land use and management in the future and in addition identifying areas where interventions are most, and least, likely to have a long term impact is as, if not more, important as determining where the greatest short-term responses are likely to occur(Herrick*etal*.,2019)

Rehabilitation of degraded croplands

Rain feed and irrigated agriculture (which is the most intensive and productive form of cropland system in dry lands) are the main cropping systems practiced in dry lands all over the world and croplands are the second most extensive land use after range lands accounting for about 25% of the land use in dry lands and in the past, the contribution of biological research to restoration and rehabilitation has been primarily through breeding programs that resulted in plants that could simultaneously stabilize degraded soil while contributing nitrogen and new approaches now provide new opportunities to develop targeted solutions involving soil microbes and for example, microbes that are adapted to remediate contaminated soils in environments (Delgado., 2015) .

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Identifying, monitoring and mitigating threats and vulnerabilities to agricultural production will increase system resilience. Resilience can be enhanced by increasing the capacity of the landscape to avoid, deflect, absorb or recover from threats (Sayer et al., 2013). In the case of climate change resilience, landscape capacity is enhanced by implementing strategies which mitigate the impacts of increased climatic extremes and increase the system's ability to recover from disturbances (Shackelford et al., 2013). While each landscape and ecosystem is different, and the factors that enhance capacity are unique to each one, resilience can be improved by strengthening the capacity of local stakeholders to mitigate and/or adapt to climate change, and by learning from the experiences of others (Shames *et al.*,2016).

As sited by that of Nkonya, and Mirzabaev (2016) identified as significantly degraded and the most important food crops are wheat, rice, and maize and considered together, they represent approximately 42 percent of the cropland present in degraded areas and most of the crops are annual crops; tree crops are present in less than 4 percent of the area assessed as degraded and Some strategies requiring large-scale ecological restoration can be commonly adopted to increase ecological and socioeconomic resilience. An important goal as regards enhancing ecological resilience is to improve connectivity, and remove dispersal barriers, in production landscapes, so as to make it easier for species to migrate following rapidly shifting climatic niches. In heavily modified and degraded landscapes, where remnant habitat is highly

Table 4.1 The 20 most represented crops present in areas targeted for restoratio

Crops	Area (million hectares)	Percentage of degraded area
Wheat	213,571,606	17.6%
Rice	148,169,854	12.2%
Maize	144,332,370	11.9%
Soybeans	92,422,785	7.6%
Barley	55,522,753	4.6%
Vegetables	44,510,843	3.7%
Sorghum	43,220,795	3.6%
Cotton	34,516,615	2.8%
Millet	30,057,826	2.5%
Other cereals	29,864,369	2.5%
Rapeseed	27,272,391	2.2%
Beans	26,909,393	2.2%
Other minor crops	22,797,034	1.9%
Sunflower	22,694,767	1.9%
Tropical fruits	22,670,564	1.9%
Temperate fruits	22,630,977	1.9%
Groundnuts	22,555,812	1.9%
Sugarcane	19,499,447	1.6%
Potato	18,695,121	1.5%

Source: Bao, Nkonya, and Mirzabaev 2016.

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fragmented and extensive recreation of habitat is required so as to link remnant patches and create new habitat and Another goal is to incorporate functional redundancy into landscapes so that the supply of multiple ecosystem functions and services can be maintained despite the collapse of one, or a few, functions following major disturbances Restoration of forest habitat to connect remnant patches has been shown to improve functional diversity and redundancy (Craven *et al.*, 2016).

There are other values and benefits that arise from implementing climate-smart agriculture. One emerging concept is that of insurance value and viewed resilience's insurance value as its ability to reduce an ecosystem user's income risk in the event of changes in available ecosystem services due to unpredictable future disturbances. Implementing climate-smart agricultural practices, such as conservation agriculture and agroforestry – via the restoration of habitat connectivity and permeability, improvement of soil composition, structure and filtration capacity, reduced soils exposure, and crop diversification – potentially have high insurance value by reducing the risks to future extreme climatic events and disturbances. A recent example articulated by Pascual *et al*. (2015) is of the insurance value to a farmer of maintaining and restoring soil biodiversity. The authors describe how a high and diverse soil microbial biomass can reduce the likelihood and severity of crop losses caused by soil borne diseases and pathogens triggered by disturbances. Land management that restores soil microbial biomass mitigates the risk of crop failure under climate change, the economic value of which can be ascertained through measures of insurance value (Sustainable Agriculture Network, 2017a.)
Some caution, however, is needed. For example, from a review of 87 integrated landscape management programmes, across 33 African countries, are argued that long-term climate change adaptation benefits are unlikely to be realized via projects which are only funded on a short-term basis. Short-term sustainable development programmes, funded externally by donors and other groups, such as non-governmental organizations (NGOs), development banks and aid agencies, will need to be complemented or superseded by new policies, regulations and governance arrangements. The new arrangements must embed sustainable management and restoration within policy frameworks in order for benefits from climate change adaptation to be fully achieved over the long term. The integrated landscape management programmes will also need to be aligned with existing national and regional level development planning processes, preferably within a spatial land use planning framework (Metternicht, 2016).

Further barriers exist to the uptake of integrated land management and climate-smart technologies and practices that enhance resilience in production landscapes. Dissemination and communication of the advantages of new land management practices, tools and techniques for ecosystem restoration can be hampered by the excessive use of scientific jargon, and by a lack of understanding of farmers' specific circumstances (Wiens *et al*., 2015).The direct financial and economic benefits to landholders, which arise from the implementation of sustainable land management practices, are well established. For example, increased soil organic carbon in cropping systems consistently leads to increased yields, although the magnitude of the increase varies with specific practice and agro-climatic conditions. Yields tend to be higher in areas of low and variable rainfall, as demonstrated by Branca *et al*. (2013) in a global review of 160 studies reporting field data on the yield effects of sustainable land management. In livestock systems, high grazing pressure will have negative impacts on soil function – defined as the

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stability, nutrientcycling and infiltration-capacity of soils, and its ability to support pasture (Read *et al*., 2016)

Nevertheless, direct financial benefits are not the only motivators of ecological restoration and as studed by Gessesse *et al*. (2016) surveyed smallholder farmers in a degraded temperate/tropical highland catchment of central Ethiopia to determine what motivated them to plant trees for land restoration. The authors concluded that farmers were more likely to plant trees to restore farmland if they had larger households (i.e., more available labor), were more literate and aware of the longer-term benefits of reducing degradation, and had security over land tenure (Gessesse *et al*., 2016).

Urban and peri-urban landscapes suffer intensive and continuous pressure from rapid urbanization and infill; about 4 billion people were living in cities in 2014, with an additional 2.5 billion expected by 2050 as studed by (United Nations Department of Economic and Social Affairs: Population Division, 2014) and the pressure placed on land by rapidly expanding cities will typically target land in the peri-urban zone, currently used for agricultural or natural habitats. Existing open green spaces in developed urban areas are also under threat from densification and in fill (Matthews*etal*.,2015).Croplands have been extensively degraded in dry lands among others due to population pressure, policy and market failures, and inappropriate land use practices and farming techniques certification approaches are, however, limited by the temporal disconnections addressed above and that, “certification of farms in transition for technical support and supply-chain recognition can be a key aspect of encouraging increased domestic organic production”(Mekonnen M*etal*.,2016).

Dry land agro forestry system can be a valuable tool to replenish soil fertility; thereby enhancing land productivity and food security, particularly for smallholder farmers and also leguminous trees within dry land agro forestry systems contribute to soil fertility by fixing atmospheric nitrogen and inputting into the soil, retrieving of nutrients from below the rooting zone of crops, and reducing nutrient losses from leaching and erosion and the woody component can also provide possibilities for the use of green and animal manure for the amelioration of the soil Gashu MuchieY.(2018).In recent years,bio char,produced by hydrolysis of different organic wastes, has gained increasing attention as soil conditioner for improving soil quality,plant growth and yield reducing land degradation by increasing rehabilitationmethods(Laghari*etal*.,2016). Rehabilitationof degraded dry forest landscapes Dry forests are one of the major forest types and account for about 42% of the tropical and subtropical forests however, it is difficult to determine the original extent of dry forests because some present day savannas and woodlands may have been derived from dry forests and the largest areas of dry forests are found in South America, sub-Saharan Africa and northeast India in addation to the International Resource Panel’s GRO report provides a unique framework for focusing both local and global investments in the SDGs on those activities that promote “improved resource productivity and a relative decoupling of well-being from resource use” the “Sustainability Scenario” (IRP, 2019).

Tree planting is commonly the main intervention in landscape restoration, but in drylands there are significant challenges relating to poor seedling survival and growth. These challenges have been attributed to erratic rainfall, planting of ecologically unsuitable tree species, poor quality seedlings, and poor tree seedling management practices and innovative methods were co-designed and implemented with farmers as part of the co-learning and action research component of the programme (McWilliam *et al.*, 2015).The landscape-level sub-catchment management approach requires coordinated and integrated processes to simultaneously address rural economic development, poverty reduction and environmental sustainability goals (Reed *et al.*,2015).

This presupposes community involvement from the outset that upholds key principles of inclusiveness and bottom-up processes. The programme facilitated robust community-level visioning and action planning, involving various categories of farmers to identify options, interventions, learning and research priorities in 29 sites/sub-watersheds in Ethiopia and 28 in Kenya. A co-learning framework was used to select, refine and review the appropriateness and performance of various options. In addition, multi-stakeholder events facilitated sharing and learning at the community, sub-national and national Mutu PL .(2017).Dry land used the "options by context" approach to promote interventions that were prioritised by smallholder farmers and informed by local realities, and that integrated local and expert knowledge (M.,Metternich *et al*.,2018).

Drylands constitute 40% of the Earth's land surface, supporting the livelihoods of almost one-third of the global population (Reynolds *et al*. 2007). They are under severe pressure from human activities and climate change, with 25–35% now considered as degraded; this is expected to worsen (IUCN 2017) and As in other regions, drylands in the Sahel and Horn of Africa suffer from reduced agricultural productivity, food and nutrition insecurity, limited economic development, inadequate water management, declining resilience to climate variability, social and political instability, and human migration (Mganga KZ *et al*.,2015).

In this think piece, we recognize that land is one of Earth's most important and limiting resources, that its inefficient and inappropriate use continues to result in degradation, and that degradation does and will have dire consequences on human well-being and the earth systems we depend on and rather than dwelling on the problem, however,we explore solutions: opportunities to exponentially change the way we engage with this most fundamental resource and it is also consistent with and supports many of the messages included in the United Nations Convention to Combat Desertification (UNCCD) publication,"A natural fix: A joined-up approach delivering the global goals for sustainable development",which focus esexplicitly on land degradation neutrality.(Vanden Berg *et al*.,2017).We emphasize the importance of both restoration and rehabilitation, and where the term "restoration" is used alone, both are implied and restoring degraded land is often more of an inspirational or aspirations concept therefore, in many cases, reverting land to an absolute pristine state is not feasible due to the high diversity of species in nature (including plants, animals and microbes), some of which become extinct during the period of land degradation and in other cases, modification of one or more factors (e.g. climate, slope or soil depth) that determine the land's long-term potential may limit restoration (Sacande M *et al*., 2016).The rehabilitation of degraded dryland ecosystems also plays an important role in achieving several commitments, such as the Land Degradation Neutrality initiative by UNCCD, the Rome Promise for Drylands, the New York Declaration

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on Forest, the African Forest Landscape Restoration Initiative (AFR100), the African Resilient Landscapes Initiative (ARLI), and Reducing Emissions from Deforestation and Forest Degradation (REDD+) (MacDicken *et al*.,2015).

“Restoration seeks to re-establish the pre-existing biotic integrity, in terms of species composition and community structure, while rehabilitation aims to reinstate ecosystem functionality with a focus on provision of goods and services rather than restoration “the preferable option in each circumstance depends on the land potential, its land use history, its baseline condition, its potential uses and associated values, and likely impacts of climate changeandothershocksandstresses”(ManyekiJK*etal*.,2015)

“Land degradation and restoration” shows that at least two-fifths of humanity is impacted negatively by land degradation, and that it is both the driver for biodiversity loss and responsible for intensifying climate change and its impacts, contributing to mass human migration and increased conflict(IPBES,2018).The rehabilitation strategies developed for moister forests may not be the best suited for dry forests the high proportion of small-seeded wind dispersed species, the high sprouting ability and the relatively simple structure and low diversity of dry forests in comparison to moist forests should be taken into considerations in the selection of rehabilitation strategies (JandreauC*etal*.,2016).Rainfall intensities regularly exceed 50mm/hour in most areas of the world, and run-off and flooding are more likely to occur when rainfall intensity exceeds the infiltration rate so, this is particularly important as the frequency of intense storms is likely to increase with climate change(Garcra-Martin*etal*.,2016).

For highly degraded dry forests active restoration approaches, such as multi-species planting (a forestation and reforestation), framework species, maximum diversity, and nurse tree methods may be more appropriate than passive restoration methods (Torres L *et al*.,2015). Hence, the management of recurrent fires is essential in order to rehabilitate degraded dry forests, abandoned dry land farms and fire-maintained savannas and In general, the development of process-based models that allow manipulation of specific ecological processes and forecast rehabilitation outcomes and can be increased by the restoration process, as both students and adults learn new skills there fore, innovative management practices are often taught, and math and reading skills (target 4.6) can be promoted in a practical context and the technology is increasingly used to both plan and monitor restoration projects(Kimiti*etal*.,2017)

Economic costs of dry land rehabilitation

Despite having rough estimations about the economic losses associated To dry land degradation, either globally it is surprisingly difficult to obtain information about the potential cost of avoiding degradation or the cost of restoring degraded dry lands. UN sustainable development goals (SDGs) recognize the importance of large-scale restoration for achieving sustainable development goals and targets (AkhtarSchuster et al., 2016). Financing dryland restoration for impact at scale is critical. It requires large, integrated and longterm investments that are beyond the scope and duration of most projects. This calls for public-private partnerships that can catalyse technological innovations, leverage resources, help people learn and engage and scale up and out beyond a project’s target landscape and country. After all, the benefits of restoration far outweigh the costs of degradation and the losses that accrue from inaction (Mulinge W *et al*.2016) .

In the lack of accurate information about the cost of rehabilitation, a common argument in favour of action is to add together the so-called 'damaged costs' or forgone revenues, including losses of products and services due to degradation, and approximated cost of rehabilitating a particular area and it will generate a large monetary value and the argument that any rehabilitation effort (including transaction costs) with a price tag below the previous total is worth to implement (Diederichs-Mander *etal.*,2015).These estimations include agriculture, water and infrastructure losses and more complicated. most of the published research deals with the drivers (human induced and natural) behind dry land degradation, how dry land degradation affects local people, the role of communities as part of rehabilitation efforts, and climate change and the links from natural capital to human well being, and back at the same time ecological and socioeconomic sustainability is achieved through recognizing and accounting for the links in this method therefore, the restoration of natural capital generates many benefits to society. Source: (Admassu *et al*.,2016).The restoration of degraded land will also improve the flow of many other ecosystem services by conserving and improving the condition of natural capital and it will generate direct and indirect benefits to human well-being restoration improves a vast array of issues, which include: soil stability and condition; surface and groundwater water quality; habitat and biodiversity; micro and global climate stability; and amenity, cultural and recreational benefits to people (Alexander *et al*., 2016).In recognition of the wide extent of land degradation and the many demonstrated benefits of ecological restoration, there is a need for an orders of magnitude increase in ecological restoration activities, globally; by some accounts this ought to be a hundred-fold increase and major international conventions and programmes and platforms Sustainable Development Goals (SDGs) recognize the importance of large-scale restoration for achieving sustainable development goals and targets (Abhilash *et al.*,2017)

The UN SDGs include a target to achieve land degradation neutrality globally, by 2030, which will require extensive ecological restoration according to study of the (UNCCD/ Science-Policy Interface, 2016) and that many other targets of the SDGs are relevant to the sustainable management of land systems, which puts increased emphasis on the importance of ecological restoration in degraded production landscapes. The 2015 UNFCCC Paris Agreement recognizes the importance of enhancing forest and soil carbon stock to mitigate climate change. There are also a number of regional and national policies and programmes promoting large-scale ecological restoration (Abhilash *et al.*, 2016).

However, there are several implementation, financing and regulatory challenges to overcome before ecological restoration can be mainstreamed. Ecological restoration requires new capacity-building, knowledge-sharing and awareness-raising initiatives to become a largescale and widespread activity and Perverse incentives which encourage intensive and unsustainable agriculture need to be removed, and appropriate market signals to protect and restore natural capital need to be established. Regulatory and planning instruments need to be expanded so that restoration becomes a requirement within land and water management regimes and the links from natural capital to human wellbeing, and back. Ecological and socioeconomic

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sustainability is achieved through recognizing and accounting for the links in this pyramid and the res toration of natural capital generates many benefits to society. Source: (Nkonya E.*et al*.,2016).

The restoration of degraded land for productive use, especially abandoned cropland, is thought to be a key element in the global effort to halt the spread of agriculture into forested areas, and to meet the growing global demand for agricultural food and energy products and the restoration of degraded land will also improve the flow of many other ecosystem services by conserving and improving the condition of natural capital and This will generate direct and indirect benefits to human well-being and Restoration improves a vast array of issues, which include: soil stability and condition; surface and groundwater water quality; habitat and biodiversity; micro and global climate stability; and amenity, cultural and recreational benefitstopeople(Denier *et al*.,2015).These integrated approaches lead to more sustainable resource use; their implementation involves: planning and designing landscapes at multiple scales; identifying and respecting the needs and perspectives of multiple stakeholders; improving coordination between multiple sectors; enhancing human and institutional knowledge and capacity for decision making; and implementing policies and incentives that encourage sustainable outcomes (Mganga K. Z *et al*.,2015).

The diverse terminology has arisen due to nuanced differences between approaches, but common across all SLM is the holistic and interconnected management of land for the multiple objectives of food production, biodiversity conservation, sustainable rural livelihoods, and other ecosystem service benefits derived from sustainable stewardship therefore, SLM approaches applied in developing countries also have poverty alleviation and rural empowerment as prominent goals (Barral et al., 2015).

The out of control degradation of dry lands calls for concerted rehabilitation efforts, involving several stakeholders, both governmental and non-governmental and all stakeholders should have clear division of tasks, rights, costs and benefits in order to avoid confusion and replication of efforts and Particularly, local communities who are affected most by restoration projects should participate from project conceptualization to implementation and management (Turner K. G *et al*.,2016).

Land restoration may reduce soil borne pathogens that cause human diseases such as anthrax, parasitic helminths (worms), and vector-borne diseases. Intact ecosystems provide a dilution effect that may reduce the number of hosts for vector borne diseases (Aronson et al. 2016)

CONCLUSIONS AND RECOMMENDATIONS

Land degradation is rampant and a serious threat affecting the livelihoods of 1.5 billion people worldwide of which 250 million people reside in dry lands. The extent of degradation is estimated at 12 million ha each year, which is expected to increase with projected increasing in human population inhabiting the dry lands. Land degradation is driven by human activities, adverse climatic conditions (such as recurrent droughts) and population increase. Land degradation in dry lands has already taken its toll in reducing provision of environmental

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services, food insecurity, social and political instability and reduction in the ecosystem's resilience to natural climate variability. The review also identified the data gap in cost-benefit analysis following restoration intervention. However, there is a general understanding that the cost of rehabilitation and sustainable management of dry lands is lower than the losses that accrue from inaction, depending on the degree of degradation. Most restoration efforts in dry lands have concentrated on research scale, addressing the intricate issues pertaining to restoration separately and also thus, a landscape-level approach, which is an integrated and multidisciplinary approach, would be a promising tool to address the various and often contradictory environmental and societal needs. With respect to dry forest restoration, the forest landscape restoration approach, which operates at a landscape level, can be used as the overarching framework and The rehabilitation of degraded areas in Australia is a good example of an effort to incorporate different natural (e.g. hydrology, geomorphology, and weathering) and social (e.g. environmental change, agriculture, health, pollution) processes in order to understand and modify the drivers of degradation and Above all, local communities' participation, incorporation of traditional ecological knowledge and practices, consideration of local peoples' short and long-term needs and value systems, clear division of tasks and benefits, strengthening of local organizations are crucial not only for cost-sharing, but also for the long-term success of dry land rehabilitation endeavours.

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