Review paper
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LAND DEGRADATION, AGRICULTURE PRODUCTIVITY AND FOOD SECURITY

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Abstract

Land degradation can be defined as a change in one or more of lands properties that result in a decline in land quality The extent to which land degradation affect agricultural productivity and poses a threat to productivity growth and food security is fundamentally influenced by economic, environmental and institutional factors. Furthermore, the important role of the farmer responses to land degradation and its potential impacts on agriculture productivity and food security. Recent estimates suggest that 5 – 6 million hectares of arable land worldwide are irreversibly lost each year as a result of soil erosion, salinization and other degradation processes. Degradation induced yield losses may become more significant in relation to yield growth in the future, as yield growth rates are projected to fall below one percent per year over the next few decades. This is likely to be more sever in arid and semi arid regions due to a combination of resource ; economic factors and infrastructure lack.

The process of rehabilitation of degraded lands is essentially a long-term development that requires the enactment of appropriate policies and supporting institutions as well as enabling environment that ensure the farmers participation and other land users.

Technology development, acquisition and adaptation are central for combating land degradation. Various technologies can be employed to benefit and to have a positive influence on the lives of the people. New technologies innovations in fields such as land use and soil water conservations are needed most. Equally, research needs to move from research centres and stations to farmer’s lands, who are the target beneficiaries. The experiences gained and the know-how achieved in these centres need to be harnessed for the benefit of the land users.

In the Mediterranean where land degradation is widely increasing, priorities, should be directed for further progress in understanding and addressing the links between resource quality, agricultural productivity and food security including targeted improvements in data analysis, technology development and policy. Those issues will be discussed in this paper.

Keywords: *Soil, Degradation, salinization, land quality, land rehabilitation, food security*

Introduction

Land degradation will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment and its effect on food security and the quality of life. It is a massive, global environmental problem (FAO/UNAD/UNEP 1994; FAO/UNEP, 1995; Scerr, 1999). Overall degraded lands worldwide are about 18.1 million km^2 where 92% to mismanagement and 38% to overgrazing.

Land degradation, a decline in land quality caused by human activities has been a major global issue during the 20th century and will remain high on the international agenda in 21st century. The importance of degradation among global issues is enhanced because of its impact on world food security and quality of the environment. High population density is not necessarily related to land degradation that determines the extent of degradation. The Mediterranean, this degradation is manifested in general decline of soil fertility and soil structure, degradation of irrigated land, and erosion of biological diversity eventually leading

to the diminution of affected land's biological potential to sustain life. In the region, continued process of desertification has now far reaching sequences: it manifests itself as a problem of sustainable development, its sever negative impacts on the socio-economic conditions, its responsibility for reducing the regenerative capacity for affected ecosystem and its profound impacts to the wide spread poverty (Eswaran et al., 2001).
Land degradation can be considered in terms of loss of actual or potential productivity or utility as a result of natural or atrophic factors. In context of productivity, land degradation results from a mismatch between land quality and land use (Beinorth et al., 1991).
Land degradation indicates temporary or permanent long-term decline in ecosystem function and productive capacity. It may refer to the destruction or deterioration in health of terrestrial ecosystem, thus effecting the associated biodiversity, natural ecological processes and ecosystem resilience. It also considers the reduction and loss of biological / economic productivity and complexity of crop lands, pasture, woodland, forest, etc.
Across the world over 20% of cultivated areas, 30% of forests and 10% of grasslands are suffering from degradation, affecting about 1.5 billion people this degradation may be the result of numerous factors or combination thereof including anthropogenic activities such as unsustainable land management practices and climatic variations (Bai et al., 2008).
Land degradation occurs in the form of depletion or total loss vegetative cover, and loss of its biophysical and economic productivity through exposure of the soil surface to wind erosion and water erosion, and through salinization and water logging, leading to deterioration of the physical, chemical and biological properties of soil. The continued loss of vegetation through salinization and human activities also depletes the world's biodiversity, and it reduces the ability of natural environment for carbon sequestration, with the consequent long-term effects of global warming and climate; overgrazing in the case of rangelands in particularly serious in arid regions.
Such conditions surrounded with very complex arising problems hitting severely the human well being allow us to state plainly that we are in need to efficient programmes to be implemented in order to face the enormous challenges we are no facing to achieve our goal towards a sustainable use of the natural resources Land and Water.

Land Degradation: Meaning, Definitions, Causes and impacts.

Data on land degradation of global scale are scarce, but recent estimates suggest that 5-6 million hectares of arable land worldwide are irreversibly lost each year as a result of soil erosion, salinization and other degradation processes (Scherr, 1999b). If that degradation occurs in rough proportion to total arable land, then roughly half (about 2-3 million hectares per year) could be assumed to occur in developing regions.
Following FAO definition 1999, in the capacity of land to produce benefits from a particular land use under special form of land management, agricultural mismanagement and overgrazing are two major factors of human induced physical soil land degradation (FAO, 1999).
Agricultural mismanagement, deforestation excessive use of fertilizers, pesticides and other chemical are major causes of chemical soil degradation. Biological soil degradation is associated with lowering or depletion of soil organic matter, continuing negative soil nutrient balance, imbalance in fertilizer application.
Chemical soil degradation occurs due to loss of nutrients and / or organic matters, salinization, acidification or pollution from industrial activities such as mining. Degradation impacts of land degradation are due to decline in land quality on site where degradation occurs (erosion) and offsite where sediments are deposited. However, the onsite impacts of land degradation on productivity are easily masked due to use of additional inputs and adoption of improved technology. On the whole, the numerous studies carried out in different

parts around the world suggest that land degradation to date had had significant impacts on the productivity or quality of cropland in some areas, out not in others impacts are sensitive to location – specific biophysical and economic factors and thus remain unclear at regional and global scales. How much might continued degradation affect productivity in the future? Given that crop yields are projected to increase more slowly in percentage terms than food demand over the next several decades, even small degradation induced losses of productivity raise concerns ((UNEP, 1992).

Causative factors of land degradation, and environmental mismanagement in general are poverty and under evaluating of natural resources (Figure 1)

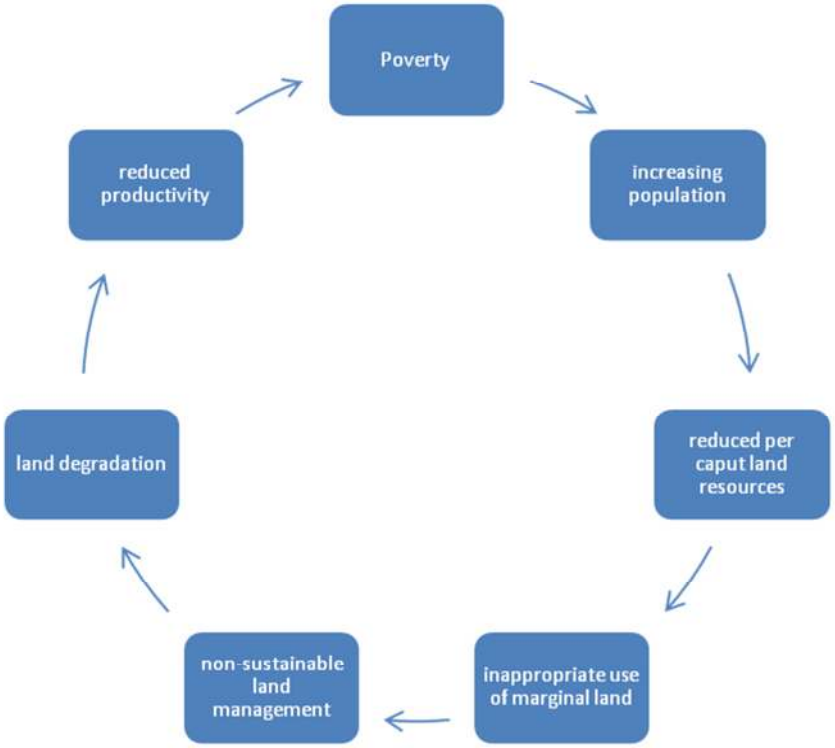

Figure 1: The vicious cycle of land degradation (UNCCD 2013)

Data on land degradation at a global scale are scarce, but recent estimates suggest that 5-6 million hectares of arable land worldwide are irreversibly lost each year as a result of soil erosion, salinization, and other degradation processes (Scherr 1999). If that degradation occurs in rough proportion to total arable area, then roughly half (about 2-3 million hectars per year) could be assumed to occur in developing regions.

Land degradation, desertification and drought: some facts and figures.

More than 50% of agricultural land are moderately to severely degraded.

Land degradation directly affects 1.5billion people globally.

15 billion tons of fertile soil disappears per year.

12 million ha/year lost due to drought and desertification.

Six million km2 of dry lands bear a legacy of desertification.

Biodiversity: 27000 species lost each year due to land degradation.

110 countries have dry lands that are potentially at risk, over 250 million people are directly affected and one billion under threat or risk.

Global desertification costs us$ 42 millions.

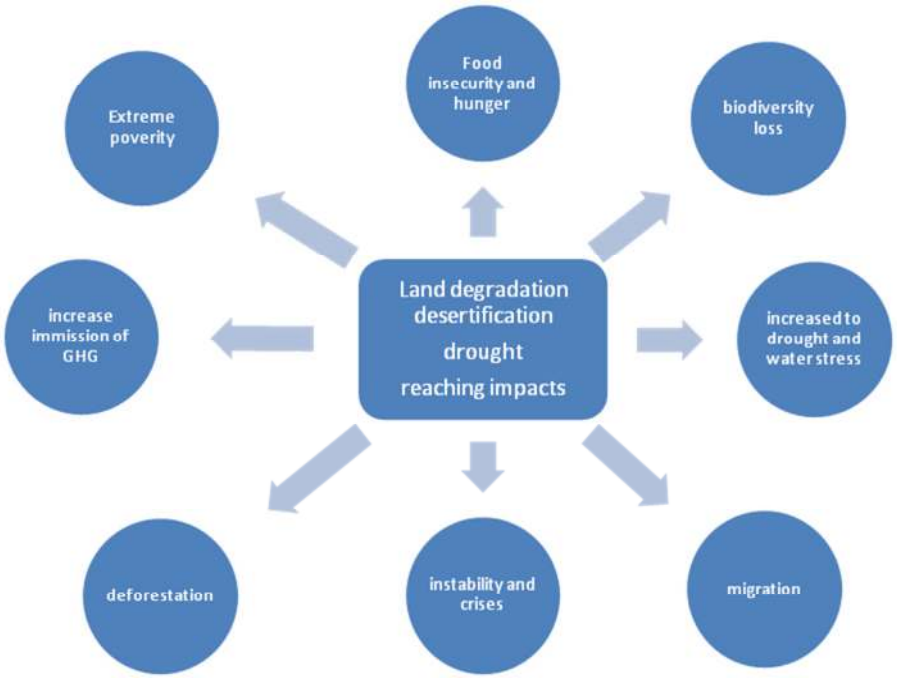

Figure 2. Land degradation: the surrounding question, issues and challenges

There are sufficient studies and reviews (Barro, 1991, Blaikie and BrookField 1987, Johnson and Lewis 1995) that clearly demonstrated that land degradation affects all facets of life, in the mean time it is evident that inspite of the new technologies to reduce degradation and also the techniques to access and monitor land degradation a number of questions are still remaining unanswered including:

Is land degradation inevitable?

Are there adequate early warning indicators of land degradation?

Who pays, who wins in the economics of land degradation?

How to create greater awareness on the perils of land degradation in society and political leadership?

How the absence of land tenure and the resulting lack of stewardship be resolved?

What is the societal in declining soil quality resulting largely from human-induced degradation?

How can soil scientists better participate in developing public policy and local action plans including the restorative inputs to enhance productivity?

What are the areas of collaboration and the tools to be provided by international organizations?

Land degradation, yield growth and food security

Degradation included yield losses may become more significant in relation to yield growth in the future, as yield growth rates are projected to fall below 1 percent per year over the next few decades. Land degradation's effects on more sever in some regions and local areas due to a combination of resource factors (soils and precipitation) and economic factors (poverty, insecurity and lack of infrastructure) (Wiebe K. 2003).

Model results suggest that number of people with nutritionally inadequate diets in low income developing countries would decline 5 percent if average annual yield losses to land degradation in those countries were reduced to 0.2 percent to 0.1 percent.

Reduced yield losses to land degradation is not an easy matter to achieve, hence actual interactions between land quality and productivity are shaped by technical, physical and biological processes many of which are complex, highly interdependent and dynamic.

Land degradation's impacts on productivity may affect food security in some areas both through losses in aggregate production and thus higher food prices for all consumers and through losses in income for those who derive their livelihoods from agricultural land or agricultural labor.

Food security is defined in terms of secure and sustainable access to sufficient food for active and healthy lives, whether access derives from production or exchange. Most studies of the effects of land degradation may also affect food security, through its impacts on food production as well as on incomes and food prices.

Giving the importance of yield growth as a source of production growth in most regions, and the regionally varied impacts of land degradation on productivity, the crucial issue is how food security might be affected by land degradation over time, even if cropland is not lost irreversibly to degradation (Scherr 1999b).

The potential impact of land degradation on food security at a global scale is difficult to quantify, given limited data and complex interlinkages, but, preliminary findings are provided by recent efforts using global simulation models of agricultural production and trade.

On the local, regional and international level, the emerging question which is under continuous debate is: how differences and changes in land quality affect agricultural productivity and food security?. Generally and for land degraded countries most studies of the effects of land degradation focus on selected measures of productivity, but, without carefully considering that land degradation may also affect food security through its impacts on food production as well as on incomes and food prices. Econometric analysis using new data on soil and climate and controlling for the effects of agricultural inputs and other measures of resources quality confirm that differences in land quality contribute to significant differences in agricultural productivity, and food security between countries.

Recent improvements in data and methods allow a new look at these interactions at a variety of scales. For example, existing data on soil properties and new data on climatic characteristics can now be overlaid with high resolution satellite data on land cover to create spatially referenced indicators of crop land quality. These indicators can be used to refine our understanding of the link is between land degradation and agricultural productivity and food security (Wiebe K. 2003).

For most arid and semi arid countries those suffering land degradation further progress is needed for understanding and addressing the links between resource quality, agricultural productivity and food security including targeted improvements in data analysis, technology development and policies that modify the incentives and decisions to mitigate land degradation adverse impacts.

Farmers response to land degradation

Farmers responses to land degradation affect how potential impacts on yields may translate into actual impacts on agricultural productivity. Econometric and simulation analysis show how differences in land tenure and other factors that combine with differences in land quality do influence decisions about practices that reduce erosion and nutrient depletion.

A variety of activities may be considered conservation practices because they maintain or improve soil fertility or reduce soil erosion and runoff and pesticides. These activities include management practices, such conservation tillage, soil-conserving crop rotations, and land improvement. These practices differ from one another and from conventional management practices in the expected magnitude and timing of their costs and returns to the farmer some practices such as conservation tillage may be profitable in the short term due to reduced labours and machinery costs (Rahm and Huffman 1984). Others may become profitable only over the medium term such as contour farming or the long term terracing as they control erosion and maintain and enhance soil fertility and thus improve productivity and land values.

The farmer problem is to choose production practices that maximize present and future net returns, it should be well recognized that impacts of land degradation depends critically on farmers choices, which change overtime in response to and in anticipation of changing economic and environmental conditions.

Indeed, degradation is a slow imperceptible process and so many people are not aware that their land is degrading, creating awareness and building up a sense of stewardship are important in the challenge of reducing degradation. Consequently, appropriate technology is only a partial answer. The main solution lies in the behaviour of the farmer who is subject to economic and social pressures of the community / country in which he/she lives.

Historical and socioeconomic evidence suggest that farmers often respond to degradation by modifying the farming system or practices, either through independent innovation or by adopting practices known elsewhere (Mermut and Eswaran, 1997).

Land degradation prevention and control measures:

The global extent, the significant negative on-and offsite impacts of land degradation on the atmosphere, terrestrial and aquatic ecosystems, food security, continuing degradation of ecosystems, and the high human toll due to land degradation require a concerted effort by the international community to prevent and control it. Well-meaning efforts in the past to address this issue were not very effective mainly because they were based on a sector-by-sector approach that had the unintended effect of fragmentation of policies, institutions, and sustainable land management measures. Therefore, a holistic and integrated approach to land degradation prevention and control, covering both ecosystem and socioeconomic dimensions, is needed.

The package of interventions, with both global environment and sustainable development benefits, -- policies, regulations, institutions, incentives, investments,-- to address land degradation prevention and control may include sustainable land use measures to:

(a) stabilize the global climate and regional system by reducing carbon emissions and increasing carbon sequestration;

(b) promote conservation and sustainable use of diverse ecosystem products (including biodiversity);

(c) maintain the stability of ecological processes such as the hydrological cycle and nutrient cycle; and

(d) improve the economic and social well being of people in areas experiencing land degradation or areas vulnerable to land degradation.

UNCCD united nations convention to combat desertification

Package intervention should include land management activities that can contribute positively to the ability of global and regional climate system and the maintenance or restoration of ecosystem structure and function:
(a) development of participatory sustainable land management planning processes;
(b) assessment of land resources and land use practices as the basis for management measures;
(c) development of information management systems for decision-making on sustainable land management as part of broader management activities;
(d) on-the-ground measures on land management activities to conserve and rehabilitate biological resources; and
(e) development of policies, regulations, incentives, institutions, and on-the-ground investments, to ensure that good practices in sustainable land management are viable and sustainable under local conditions.
Integrated soil fertility management (ISFM). It forms a part of prevention mitigation, and restoration of land from desertification and land degradation it is a set of agricultural practices adopted to maximize the efficiency of nutrient and water use and improve agricultural productivity. IFSM attempts to make the best use of inherent soil nutrient stocks, locally available soil amendments and mineral fertilizers to increase land productivity while maintaining or enhancing soil fertility. Farmers have adopted IFSM technologies have more than doubled their agricultural productivity and increased their farm level incomes by 20 to 50 percent and was the most effecting profitable method to improve degraded areas (Divyalakshne et al., 2013).
A critical factor to keep in mind when thinking about IFSM strategies is that it is very important to consider the socio economic aspects of technological interventions recommended.
Most countries of arid and semi arid regions are now facing important challenges to diminish the increasingly land degradation and to improve the land productivity. However to achieve such goal we are in need to the followings:
To mobilize the scientific community to mount an integrated programme for methods, standards, data collection and research networks for assessment and monitoring of soil and land degradation.
To develop land use models that incorporate both natural and human induced factors that contribute to land degradation and that could be used for land use planning and management.
To develop information systems that link environmental monitoring, accounting and impact assessment to land degradation.
To help develop policies that encourage sustainable land use and management and assist in the greater use of land resources information for sustainable agriculture.
To develop economic instruments for the assessment of land degradation of land resources.
To standardize methods of assessment of extent of land degradation.
To overcome the difficulty in evaluating the on farm economic impact of land degradation on productivity there is an urgent need to productivity, there is an urgent need to address these issues through a multi disciplinary approach, but the most urgent need is to develop an objective, quantifiable, and precise concept based on scientific principles.
Successful land degradation prevention implies the set up of driven training programmes to build local capacity on viable policies, regulations, institutions arrangements. Such training could include participatory workshops involving key government and governmental organizations on measures needed for sustainable land management programme that address in holistic and integrated manner, global environment and sustainable development issues.

Also an effective response to land degradation calls for improving the incentives for farmers to care for their land and improving their access to knowledge and inputs required for proper care. In this connection it is recommended (UNCED, 1992)

Concluding remarks and recommendations

- Steps to improve the enabling environment to combat land degradation involve overcoming institutional, financial legal and science policy challenges and finding solutions that cross multiple levels and sectors.
- A framework that outlines national priorities for sustainable dry land development is required to provide overall guidance to actors and groups across levels (Herz 2006). The national framework should be incorporated in the mandates of all relevant sectors, providing overall guidance for investment in sustainable land management SLM and promoting public awareness on land degradation and SLM. Furthermore, to prevent policy frameworks from quickly becoming absolute, policy formulation and supporting legislation need to be flexible (Porschè et al 2009), and forward looking to encourage the institutionalisation of planning and implementation measures (Jones et al 2009).
- There are many on- initiatives both at national and international levels to address land degradation problems. While appropriate technologies and information to avoid mismanagement of resources exist for many problems, they have not been sufficiently disseminated and implemented. Although many international, regional networks have been established and are in operation, many of them have not been sufficiently effective and efficient. What further measures should be taken, especially to facilitate dissemination of appropriate knowledge/information and technologies at grass-root levels? What should be done to reactivate existing networks to effectively and efficiently achieve their objectives?

Reasonable answers to the above raised questions could be found through considering the following suggestions.

Existing networks should be reviewed and reorganized, where necessary, to more effectively and efficiently achieve their objectives. Regional, sub-regional networks for specific topics, such as waterlogging and salinization, afforestation/reforestation to prevent sand dunes, may be considered useful.

Dissemination of appropriate information/knowledge and capacity building should have the highest priority for such networks; and

Community-based organizations may need to be established at local community level to bridge gabs between scientific information/knowledge and individual end-users, most likely farmers in dry areas. Education and awareness raising among such end-users and the general public is essential (Katsunori, 2003).

An effective response to land degradation calls for improving the incentives for farmers to care for their land and improving their access to the knowledge and inputs required for proper care. Based on lessons learned from past successes and failures in managing land degradation, the following policy actions should be considered:

Increase research and technology development for land management, and improve the spread of information, through widely linked, user-friendly information systems for farmers.

Promote land-improving investments (for example, building up soil organic matter, planting trees, and installing small-scale irrigation) through technical assistance and new financing arrangements suitable for low-income farmers.

Encourage long-term land improvements by securing property rights and rights of access to natural resources, particularly for the poor.

Develop planning systems for sustainable land use that involve key resource user groups.

Improve the economic environment for farmers by developing market infrastructure, correcting distorted price incentives, and encouraging rural income growth and diversification.

For marginal regions, encourage more public investment in infrastructure, social services, and agricultural support services.

A range of powerful scientific methodologies is available that could considerable improve the accuracy, precision and insightfulness of monitoring and assessment of dry land degradation and sustainable land management. However, their use is currently constrained by inadequate institutional protocols and formats within the global scientific community locks a mechanism for distilling and communicating its knowledge in ways that are relevant to and easily understood by non scientific communities such as decision makers and land users. Methods developed by local farmers as well as those developed through scientific research should receive greater recognition and dissemination.

Many types of land degradation can potentially be reserved, but the process requires long term commitment. Land improving investments and better land management can definitely be encouraged through appropriate policies, improved information systems and increased research and technology development.

And above all capacity development through effective training programmes those to cover and respond to the needs of all the stakeholders involved in land degradation management and maintaining land productivity at a relatively high rate.

A coordinated international effort is needed to prioritize research investments efficiently and effectively. Growing international investments in land resources provide potential for assess the global economics of land degradation and to implement recommended actions.

Food security, environmental balance, and land degradation are strongly inter-linked and each must be addressed in the context of the other to have measurable impact. This is the challenge of the 21st century for which we must be prepared.

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