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Sustainable Use of Land Resources for Agricultural Production: A Review

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ABSTRACT

As increasing population and food demand in the current era, we need to focus on new standards of an agricultural system for more production, which is only possible through proper land evaluation. Sustainability refers to the long-run food production system that contribute a welfare social life by providing sufficient food and services to mankind in a way that are socially responsible, environmentally sound and economically efficient and profitable. Sustainable food production systems and implement resilient agricultural practices increase productivity, maintain ecosystems and strengthen capacity for adaptation to climate change, extreme weather, drought and flooding, which progressively improve land and soil quality. Land resource inventory is needed to specify the proper agenda in agricultural system, which is very poorly understood. Land resources information can be helpful to agriculturists before taking up any farming activities in the areas with addressing the issues. The present review highlights the value of the land resources with its application in relation to conservation strategies, site specific crop selection, development of nutrient management system. The climate change mitigation and potential solutions for maximising land productivity with preserving environmental sustainability also highlighted.

1. Introduction

Food production is the basic need of human beings and even all living organisms depend upon nature for their food. Now a days increasing population creates a highfood demand. To that human beings are mostly dependent on the agricultural system for their survival. The COVID-19 during 2019-20, awaked the society that how importance of the livelihood for the life. Soil erosion, ground water pollution, depletion of natural resources, climate change and poor knowledge about the sustainability are the major cause for reducing the agricultural production. India is primarily based upon agriculture and faces a dilemma problem of population growth, poverty, food crisis and land degradation. To mitigate the poverty and environmental pollution, a sustainable agricultural system is required.

In the 21st century, land degradation is a global issue and by year 2050, it may create a serious threat to the environment, agronomic productivity, food security and quality of life (Bhilare, 2013). FAO (2014) identified five interlinked principles toward sustainable food and agriculture with relevance to land resource planning, such as 1) improving efficiency in the use of resources; 2) natural resource conservation; 3) improving rural livelihoods; 4) enhancing resilience and 5) governance.

The current review is highlighted from existing research on sustainable agriculture and land use in which a greater understanding is necessary in sustainable land management in addition to knowledge regarding this. The present research aims to examine the development of economic system in agricultural activity, perceptions and preferences of

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stakeholders, improvement irrigation water use efficiency, development of land and crop management practices that can adopt to the impact of climate change. The present article will be helpful to the researcher, stakeholder and farmers to aware about the sustainability.

Brundtland *et al*. (1987) defined sustainable development is a "Development which meets the need of the present without compromising the ability of future generations to meet their own needs". The Rio Declaration point out the treaties for the sustainable development, which protects and promotes the sustainable use of the planet's biological resources (UNESCO, 1992). In this regard, the Kyoto Protocol committed the nation of the world to reduces greenhouse gasses emission (UNFCCC, 2008). The main objective of the sustainable development is to balance the production of high yields while preserving the environment and wellbeing of local livelihoods (Godfray and Garnett, 2014; Pretty and Bharucha, 2014). Social concerns are required for agricultural production and land conservation by reducing food waste (Kummu *et al*., 2012; Tscharntke *et al*., 2012) and improving food accessibility (Borras and Franco, 2012). Paz *et al*. (2020) stated that the biodiversity and ecosystem services play an integral part for maintaining food supply. With this, it is mentioned that the natural and agricultural land are the key to achieve sustainability and avoid socio-ecological collapse. Mitchell *et al*. (2013) mentioned that the agricultural productivity is strongly dependent on ecosystem services like pollination, nutrient cycling and pest control. They reported about 60% of the population is lost due to the failed crops over time and the advanced technology adopted the intense form of agriculture, which increased food security and resource production. Kuijt and Goring-Morris (2002) described the agricultural production enabled the population growth and allowed the development of complex society with respect to social differentiation and territorial expansion. It also mentioned the agriculture is dependent on the natural environment, and the social life style is declined due to the over-exploitation of resources and poor agricultural land management. The agriculture is responsible for both the rise and fall of society. Barrett *et al*. (2020) interpreted the environmental conservation is caused to threat due to over population and over consumption. The same threat also has been described by Kentor (2001) and Ceballos *et al*. (2017) respectively, which contribute to social instability and environmental degradation. The impact of agricultural intensification on sustainability in the present scenario is an important issue in developing countries foreign demand and conversion of large areas of natural land into intensively cultivated monocultures (Fearnside, 2001; Pengue, 2005; Reboratti, 2010; Soares-Filho *et al*., 2006). They found that the landscape is highly vulnerable to environmental fluctuations, fragmentation, nutrient runoff, contamination of underground water sources and destruction of natural habitats, which practices are detrimental to the healthy environment. And in the other way the agriculture is necessary to feed the population and for which the balance needs to be achieved between the food production and natural land conservation, which can help the population viability in the long run. From this the future work may be derived a greater focus on the links between changes in technology with behavior and its impact on socio-economic dynamics with respect to local environment. By modelling the bi-directional feedbacks between human demography and land use, the misguided or uninformed agricultural land use planning can lead a socio-ecological system to collapse.

Saturday (2018) reviewed and clarified that the restoration of agricultural land is important for sustainability of agriculture and environment. Singh *et al.* (2016) reported that the investment of agriculture in India is grown at the rate of nine percent annually. Niranjana *et al.* (2021) studied on land resource inventory (LRI) for sustainable development in Bisarahalli-1 micro-watershed in the semiarid region of Koppal district, Karnataka and they found the areas suitable for agriculture, horticulture and forestry. It is concluded that the land resource inventory gives information on areas suitable for growing major annual and perennial crops with limitations, which helps in identifying areas that are deficient or sufficient in major and micronutrients. Many researchers have studied the strategies to improve soil quality in different regions (Khillar and Mallik, 2023), which are shownin Table 1.

Intensification and expansion of land use have been started from the beginning of Anthropocene (Ellis and Haff, 2009), which benefitted the livelihood demands for bioenergy, fibre and food (MEA, 2005). The intensification of agriculture is achieved via the application of unlimited high levels of input, such as fertilizers or herbicides, which pollute the environment and down the health of local livelihoods (Kirkhorn and Schenkar, 2001; Tillman, 1999). Kissinger *et al*. (2012) reported about three quarters of the world's forest has been disappeared due to agricultural expansion practices. It influences soil erosion and fertility due to the careless practices (Cunningham *et al*., 2013; Foucher *et al*., 2014). And it is also mentioned that the expansion of agriculture is the second largest global threat to biological diversity conservation (Maxwell *et al*., 2016) because of deforestation. Jose *et al*. (2019) reported about 42% of the world population depends on agriculture for its livelihood, which derives the economy of most developing countries. For the human and civilizational survival, agricultural production is an essential

because of the growing population and food requirement along with income and employment source (Bathaei and Streimikiene, 2023). In the international economy, agriculture plays a crucial part because of about 1.3 billion people (16%) of the global population are employed by which it contributes the global output of 24% (Elawara, 2016). Institutional support, policy changes and behavioral nature are necessary to integrate ecological and societal knowledge towards sustainable agriculture (Nightingale *et al*., 2020). Agricultural practices are incorporated based on the local ecosystem services, consumer needs and the impact of environmental factors (Lluis *et al*., 2020). An awareness of ecological sustainability on agricultural activities including topography, slopes and soil quality play a vital part to assign the value of environmental factors to the crop system, such as the area under cultivation, agricultural productivity, and income earned (Bathaei and Streimikiene, 2023). Sustainable agriculture determines whether farmers are fit or not with respect to technical knowledge and skills (Komlavi, 2019). Out of various perspectives, a farm's prime concerns are soil conditions, water availability, plant growth and nutrient levels (De Corato, 2020). From biophysical perspective, agricultural growth is influenced by soil fertility, climate and pests (Belay, 2022). Production of crops and livestock management practices, structure and viability are also main operation of a farm.

Sustainability is concerned the meeting of national and global food needs with the quality and securing of food supply, transforming technology and improving food distribution systems efficiency and fairness (Kumar *et al*., 2020). The most commonly used definition of sustainable development is "humanity has the power to create a development that meets the needs of the present without impairing the ability of future generation to meet their own needs" (Hansen, 1996). In the sustainable practices, improving soil management with soil quality, crop rotation and water availability benefitted more to the society with increasing yields and creating sustainable environment (Bhilare, 2013). Economic viability is achieved through sustainable agriculture in reducing machinery, chemical fertilizer and pesticide costs. Environment sustainability is achieved through protecting, replacing and maintaining the natural resources such as soil, water, biodiversity that attribute towards conservation aspects ensuring equitable agricultural products, increasing employment and availability of food products locally rather than distant market. Under this prospect, the increasing future demand of agricultural production with balancing nature preservation is a key challenge for future sustainability of land management (Alexandratos and Bruinsma, 2012; Grau *et al*., 2013; Chaplin-Kramer *et al*., 2015).

2. Methodology

Paramanik (2016) used a study for agricultural land use at Darjeeling district by A.H.P. and GIS methodologies (Kumar, 2016). Bozdag *et al*. (2016) conducted a land suitability analysis for Cihanbeyli (Turkey) country based on the methodologies A.H.P. and GIS (Gurkan *et al*., 2016) for sustainability. Bathaei and Streimikiene (2023) studied a systematic scientific review literature on the sustainable agriculture using the tools SALSA followed by PRISMA methodology. It is analyzed about 157 papers in their review study and noted about 101 indicators by analyzing three dimension, such as social, economic and environment. Out of which most recommended indicators for sustainable agriculture are economic (Technology, Market access and price), environment (Farm structure, Pollution and Soil) and Social (Quality of product and Farmers right). The same dimensions also mentioned by Bhilare (2013). In the sustainable practices, Bhilare (2013) mentioned the methodology for the conservation of soil called as till-age namely Strip-till, Ridge till and No till. In addition, it is mentioned that the Grassed waterway and Filter strip have many advantages to the farmers by conserving soil, nutrient and water.

3. Discussion

The world is towards wayward because of pollution, natural calamities, population growth, irregular of season due to the global warming and use of chemical fertilizer with toxic pesticide materials in agricultural system. The aim of future society is to have agriculture improve with social welfare. To achieve this in the current situation of land degradation, the use of advanced technology with pollution free materials is the major concern. In addition to this improving soil fertility, availability of water, drainage, irrigation and erosion control management should be applied for sustainable agriculture. The LRI database helps in preparing optimum land use plans for the micro-watersheds not only in restoring the ecological balance but also in improving the production on a sustainable basis.

The detail idea of sustainability is understanding the basics of agricultural system with attention to biological and physical world to know about the living earth system. For example, understanding of the conservation strategies, land resource management, nutrient cycling, environmental factors, disease and pest control, cropping system which means the selection of crop with respect to soil quality and local environment (Table 1). Agricultural productions contribute to the society's present and long-term food with maintaining ecosystem functions and human development in the society. Sustainable agriculture plays an important

role in the economic and social development along with creating an ecofriendly environment locally. This alternative agricultural system can solve many problems faced by below-poverty-line farmers with ensuring food supply. Sustainability system is a quality of life which provides a healthy, productive and meaningful life for all the communities present and future.

4. Conclusion

The agricultural system interlinks soil, crop and livestock production practices by creating a healthy environment in which life and livelihood depends on. The use of advance technique with organic farming and conservation management which are adopted to local communities using local resources should be followed in a systematic manner.

A proper management of the available land resources is necessary to ensuring food production, biological diversity conservation and quality of life Thus, limited scarce land resources must be used in a socially acceptable eco-friendly way for sustaining life on the earth.

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Table 1:

Different strategies used in different regions to improve agricultural soil quality. Source: Khillar and Mallik (2023).

Strategy	Region	Process	Reference
Litter turnover	Tropics	The rate of organic matter and C supply and nutrient cycling reactivation	Leon and Osorio, 2014
Forestry Plantations	Tropics	Silvo-pastoral system for nutrient cycling	Kohli *et al*. 2008
Woodlot Islets	Degraded drylands	Silvo-pastoral systems in drylands	Helman *et al.* 2014
Soil Carbon Sequestration	Agroecosystems	Optimal management strategies	Berazneva *et al.* 2014
Integrated Nutrient Management	Sub-Saharan Africa	Soil quality management	Diacono and Montemurro, 2010
Nutrient Management for SOC Sequestration	Sub-Tropical Red Soils (China)	Soil carbon buildup	Gong *et al*. 2013
Manuring	Indus Plains	Application of farm manure	Iqbal *et al*. 2014
Residue Retention as Mulch	Mexican Highlands	Improvement of soil structure	Govaerts*et al*. 2006
Regular Organic Inputs	Western Kenya	Nutrient retention and soil structure improvement	Kimetu *et al.* 2008; Moebius-Clune *et al*. 2011
Urban Waste	Mediterranean Europe	Enhancing soil fertility	Rajan *et al.* 2010; Sortino *et al*. 2014
Soil Biological Management	Global soils	Enhance ecosystem services provisioned by SOC pool	Manley *et al.* 2007
Environmental Awareness	U.S.	Promoting technology adoption	Baumgart-Getz *et al.* 2012

Reference

Alexandratos, N. and Bruinsma, J. (2012). World Agriculture towards 2030/2050: the 2012 Revision. FAO, ESA Working Paper 12-03. United Nations Food and Agriculture Organization, Rome.

Barrett, S., Dasgupta, A., Dasgupta, P., Adger, W. N., Anderies, J., van den Bergh, J., Bledsoe, C., Bongaarts, J., Carpenter, S., Chapin, F. S. and Crépin A. S. (2020). Social dimensions of fertility behavior and consumption patterns in the anthropocene. Proc Natl Acad Sci. 117(12): 6300–6307.

Bathaei, A. and Streimikiene, D. (2023). A Systematic Review of Agricultural Sustainability Indicators. Agriculture. 13: 241.

Belay, B.S. (2022). Climate Change Vulnerability and Adaptation of Crop Producers in Sub-Saharan Africa: A Review on Concepts, Approaches and Methods. Environ. Dev. Sustain. 14: 1–35.

Bhilare, A. (2013). Sustainable Agriculture and Land Management, International Journal of Agriculture and Food Science Technology. ISSN 2249-3050, Volume 4, Number 9 (2013). pp. 881-886

Borras Jr, S.M. and Franco, J.C. (2012). Global land grabbing and trajectories of agrarian change: a preliminary analysis. J. Agrar. Chang. 12: 34–59.

Brundtland, G., Khalid, M., Agnelli, S., Al-Athel, S., Chidzero, B., Fadika, L., Hauff, V., Lang, I. and Shijun, M. (1987). Our Common Future ('Brundtland report'). Oxford University Press, pp. 383.

Ceballos, G., Ehrlich, P. R. and Dirzo, R. (2017). Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. Proc Natl Acad Sci USA. 114(30): E6089–E6096.

Chaplin-Kramer, R., Sharp, R.P., Mandle, L., Sim, S., Johnson, J., Butnar, I., Milài Canals, L., Eichelberger, B.A., Ramler, I., Mueller, C., McLachlan, N., Yousefi, A., King, H. and Kareiva, P.M. (2015). Spatial patterns of agricultural expansion determine impacts on biodiversity and carbon storage. Proc. Natl. Acad. Sci. U. S. A. 112: 7402–7407.

Cunningham, S.A., Attwood, S.J., Bawa, K.S., Benton, T.G., Broadhurst, L.M., Didham, R.K., McIntyre, S., Perfecto, I., Samways, M.J., Tscharntke, T., Vandermeer, J., Villard, M.A., Young, A.G. and Lindenmayer, D.B. (2013). To close the yield-gap while saving biodiversity will require multiple locally relevant strategies. Agric. Ecosyst. Environ. 173: 20–27.

De Corato, U. (2020). Agricultural Waste Recycling in Horticultural Intensive Farming Systems by on-Farm Composting and Compost Based Tea Application Improves Soil Quality and Plant Health: A Review under the Perspective of a Circular Economy. Sci. Total Environ. 738: 139840.

Ellis, E.C., and Haff, P.K. (2009). Earth science in the anthropocene: new epoch, new paradigm, new responsibilities. EOS Trans. Am. Geophys. Union 90 (49): 473.

FAO, (2014). Building a common vision for sustainable food and agriculture, principles and approaches. Rome.

Fearnside, P. M. (2001). Soybean cultivation as a threat to the environment in Brazil. Environ Conserv. 28(1): 23–38.

Foucher, A., Salvador-Blanes, S., Evrard, O., Simonneau, A., Chapron, E., Courp, T., Cerdan, O., Lefèvre, I., Adriaensen, H., Lecompte, F. and Desmet, M. (2014). Increase in soil erosion after agricultural intensification: evidence from a lowland basin in France. Anthropocene 7: 30–41.

Godfray, H.C.J. and Garnett, T. (2014). Food security and sustainable intensification. Phil. Trans. R. Soc. B 369 (1639).

Grau, R., Kuemmerle, T. and Macchi, L. (2013). Beyond 'land sparing versus land sharing': environmental heterogeneity, globalization and the balance between agricultural production and nature conservation. Curr. Opin. Environ. Sustain. 5: 477–483.

Gurkan, B., Mumusoglu, S., Zengin, D., Karabulut, E. and Yildiz, B.O. (2016). The Prevalence and Phenotypic Features of Polycystic Ovary Syndrome: A Systematic Review and Meta-Analysis. Hum. Reprod. 31: 2841–2855.

Hansen, J.W. (1996). Is Agricultural Sustainability a Useful Concept? Agric. Syst. 50: 117–143.

Hasanshahi, H., Hooshang, I., Ameri, Z.D. and Kh, K. (2015). Measure and Comparison of Economic, Social and Ecological Sustainability of Farming Systems in the Marvdasht Plain. Desert. 20: 231–239.

Kentor, J. (2001). The long term effects of globalization on income inequality, population growth, and economic development. Soc Probl. 48(4): 435–455.

Khillar, A. K. and Mallik, K. (2023). A review study on Land Resource Utilization for Sustainable Agriculture. Multidisciplinary Approach in Arts, Science and Commerce. Published by Sankalp Publications, (2): 64-69.

Kirkhorn, S. and Schenker, M.B. (2001). Human Health Effects of Agriculture: Physical Diseases and Illnesses. National Agriculture Safety Database (NASD), pp. 18.

Kissinger, G., Herold, M., De, V., Angelsen, A., Bietta, F., Bodganski, A., Boucher, D., Boyle, T., Brickell, E., Defries, R., Dragisic, C., Elias, P., Enters, T. and

Kishwan, J. (2012). Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD + Policy Makers. Vancouver, Canada.

Komlavi, A., Kabo-bah, A. and Zwart, S. (2019). Agricultural Land Suitability Analysis: State-of-the-Art and Outlooks for Integration of Climate Change Analysis. Agric. Syst. 173: 172–208.

Kuijt, I. and Goring-Morris, N. (2002). Foraging, farming, and social complexity in the pre-pottery neolithic of the southern levant: a review and synthesis. J World Prehistory. 16(4): 361–440.

Kumar, M.R., Meena, R., Naik, B., Meena, B. and Meena, S. (2020). Organic Farming-Concept, Principles, Goals & as a Sustainable Agriculture: A Review. Int. J. Chem. Stud. 8: 24–32.

Kumar, P.M. (2016). Site Suitability Analysis for Agricultural Land Use of Darjeeling District Using Ahp and Gis Techniques. Model. Earth Syst. Environ. 2: 1–22.

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O. and Ward, P.J. (2012). Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. Sci. Total Environ. 438: 477–489.

Maxwell, S.L., Fuller, R.A., Brooks, T.M. and Watson, J.E.M. (2016). Biodiversity: the ravages of guns, nets and bulldozers. Nature. 536: 143–145.

MEA (2005). Ecosystems and Human Well-being: Current State and Trends. Island Press, Washington D.C, pp. 137.

Mitchell, M. G. E., Bennett, E. M. and Gonzalez, A. (2013). Linking landscape connectivity and ecosystem service provision: current knowledge and research gaps. Ecosystems. 16(5): 894–908.

Nightingale, J.A., Eriksen, S., Taylor, M., Forsyth, T., Pelling, M., Newsham, A., Boyd, E., Brown, K., Harvey, B. and Jones, L. (2020). Beyond Technical Fixes: Climate Solutions and the Great Derangement. Clim. Dev. 12: 343–352.

Niranjana, K. V., Mahendra Kumar, M. B., Rajendra, H. M., Seema, K. V., Dhanorkar, B. A., Srinivas, S. and Srinivasan, R. (2021). Land Resource Inventory (LRI) for Sustainable Watershed Development-A Case Study of Bisarahalli-1 Microwatershed of Semiarid Region of Koppal District, Karnataka, India, International Journal of Environment and Climate Change 11(6): 64-81.

Pengue, W. A. (2005). Transgenic crops in argentina: the ecological and social debt. Bull Sci Technol Soc. 25(4): 314–322.

Pretty, J. and Bharucha, Z.P. (2014). Sustainable intensification in agricultural systems. Ann. Bot. 114 (8): 1571–1596.

Reboratti, C. (2010). Un mar de soja: la nuevaagriculturaenargentina y sus con-secuencias. Revista de geografía Norte Grande. (45): 63–76.

Saturday, A. (2018). Restoration of Degraded Agricultural Land: A Review, J Environ Health Sci 4(2): 44- 51.

Soares-Filho, B. S., Nepstad, D. C., Curran, L. M., Cerqueira, G. C., Garcia, R. A., Ramos, C. A., Voll, E., McDonald, A., Lefebvre, P. and Schlesinger, P. (2006). Modelling conservation in the amazon basin. Nature. 440 (7083):520–523.

Tscharntke, T., Clough, Y., Wanger, T.C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J. and Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. Biol. Conserv. 151: 53–59.

United Nations Climate Change (UNFCCC), (2008). Kyoto Protocol – Targets for the First Commitment Period.

United Nations Educational, Scientific and Cultural Organization (UNESCO), (1992). The Rio Declaration on Environment and Development.