Journal of Global Agriculture and Ecology

Volume 17, Issue 1, Page 31-41, 2025; Article no.JOGAE.12709
ISSN: 2454-4205

Sustainable Land Use and Value Addition Practices to Combat Land Degradation and Enhance Food Security in Arid and Semi-Arids Regions

Edward Missanjo [a*], Elizabeth Mberema [a] and Oskar Mbango [b]

[a] Department of Environmental Sciences, University of Namibia, Ogongo Campus, Omusati Region, Namibia.
[b] Department of Animal Production, Agribusiness and Economics, University of Namibia, Ogongo Campus, Omusati Region, Namibia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/jogae/2025/v17i19063

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.ikprress.org/review-history/12709

Original Research Article

Received: 14/11/2024
Accepted: 17/01/2025
Published: 24/01/2025

ABSTRACT

Combatting land degradation and desertification is crucial for protecting biodiversity, mitigating climate change impacts, and improving climate adaptation capacity. A cross-sectional study was conducted at the University of Namibia (UNAM) Ogongo campus to explore land use and value

---

**Corresponding author: Email: emissanjo@unam.na, edward.em2@gmail.com;*

***Cite as:** Missanjo, Edward, Elizabeth Mberema, and Oskar Mbango. 2025. "Sustainable Land Use and Value Addition Practices to Combat Land Degradation and Enhance Food Security in Arid and Semi-Arids Regions". Journal of Global Agriculture and Ecology 17 (1):31-41. https://doi.org/10.56557/jogae/2025/v17i19063.*

addition practices aimed at combating land degradation, building resilience to climate change, and enhancing food security. Data was collected through digital photography and face-to-face interviews using a standardized questionnaire. The data was analysed using content analysis and the Chi-Square (X^2) test. Findings identified key land use practices, including the cultivation of drought-tolerant crops such as pearl millet and groundnuts, water management practices like rainwater harvesting using earth dams, and modern irrigation techniques such as drip irrigation and sprinklers for efficient water use. Soil management practices at the campus focus on enhancing fertility and conservation, with the use of organic matter from cattle and chicken manure to improve soil quality. Rice husk mulching reduces evaporation and maintains soil moisture during dry periods. Adaptive farming techniques, including agroforestry, crop rotation, and intercropping, were also employed to enhance biodiversity, improve soil quality, and increase resilience to climate change. The campus has installed solar panels to reduce reliance on non-renewable energy sources and reduce carbon emissions. Artificial waterholes in the Game Park provide water for wildlife during dry periods. Additionally, the campus adds value to agricultural products such as groundnuts, beans, rice, and fruits (e.g., guavas, lemons, mangoes) by processing them into flour, juices, dried snacks, omaere, fresh milk, butter, yogurt, and biltong. The findings suggest that campuses like UNAM Ogongo can serve as models for sustainable land management practices in arid and semi-arid regions, blending education, research, and practical implementation.

Keywords: Land use; additional value; land degradation; climate change, food security.

1. INTRODUCTION

Land degradation is a pervasive challenge in arid and semi-arid regions (ASARs), significantly undermining agricultural productivity, food security, and ecosystem stability (Lamb et al., 2005; Lal, 2009). Characterized by erratic rainfall, high evaporation rates, and fragile soils, these regions are particularly vulnerable to desertification and resource depletion (Vanlauwe et al., 2012). Sustainable land use and innovative value addition practices are therefore critical to addressing these challenges and improving livelihoods in ASARs (Dlamini et al., 2014).

Several researchers have investigated land degradation and its implications for food security in ASARs, highlighting a range of challenges and potential interventions. Studies by Lal (2015) and Eswaran et al. (2001) emphasize the role of soil conservation techniques, afforestation, and water management in mitigating land degradation. Research by World Overview of Conservation Approaches and Technologies (WOCAT) (Van Lynden et al., 2002) documents successful land management practices, including terracing, agroforestry, and integrated watershed management. Additionally, studies in Namibia have showcased the significance of community-driven approaches, such as those in the Kunene and Oshikoto regions, which combine indigenous knowledge with modern techniques to restore degraded landscapes (Lal, 2020; Olusola et al., 2020; Rathore et al., 2023; Dhyani et al., 2023). However, despite these advancements, there is limited focus on the role of academic institutions as hubs for innovation in sustainable land use and food security strategies.

A critical gap exists in the exploration of how university campuses, as localized ecosystems and knowledge centers, can spearhead sustainable land management practices and value addition to agricultural outputs. This gap reflects the need to understand the practical implementation of academic research in real-world settings, particularly in ASARs (Gupta et al., 2021). This study seeks to address this gap by focusing on the University of Namibia (UNAM) Ogongo Campus, which is uniquely positioned to combine its academic resources, experimental farms, and community partnerships to tackle land degradation and enhance food security.

Therefore, the main objective of the present study was to assess and evaluate land use and value addition practices that can combat land degradation and enhance food security in arid and semi-arid regions, using the Ogongo Campus as a case study. Specifically, the study aimed to: (1) identify current land use practices and their impacts on soil health, water resources, and food production, and (2) identify innovative value addition techniques for agricultural produce, suitable for ASARs. This study underscores the pivotal role of academic institutions in bridging the gap between research and implementation to address pressing environmental and food security challenges. By focusing on Ogongo Campus, this research seeks to generate actionable insights that align with Namibia's national development goals and global sustainable development targets. The findings will not only enhance the campus's role as a model for sustainable practices but also contribute to the broader understanding of combating land degradation and improving food security in ASARs. This philosophy aligns with the belief that empowering local solutions through education and innovation is key to sustainable development (Jinger et al., 2021).

2. MATERIALS AND METHODS

2.1 Study Area

The University of Namibia, Ogongo Campus, is in the Omusati Region of north-central Namibia within the so called Cuvelai-Etosha Basin (Fig. 1). The campus lies at approximately 17°40'42'' S latitude and 15°17'48'' E longitude. It is around 800 km north of Windhoek, the capital city, and is accessible via the C46 highway, located about 50 km from Oshakati. The climate of this area is classified as semi-arid, characterized by warm to hot temperatures averaging between 20°C and 30°C annually. Rainfall typically occurs between November and April, with annual precipitation ranging from 300 to 500 mm. The soil at Ogongo Campus is predominantly sandy, a typical characteristic of the Cuvelai Basin, and is interspersed with clay soils in some low-lying areas. The campus is situated at an altitude of approximately 1,100 meters above sea level. The university's 4,350-hectare farm, which includes a 1,000-hectare game park, offers unique opportunities for agricultural and environmental research, as well as biodiversity conservation efforts (Mendelsohn et al., 2009).

2.2 Study Design and Sample Size

Across-sectional study was employed. The target population were the UNAM Ogongo campus staff. The probability proportionate to the size sampling methodology was used to determine the sample size (Daniel & Cross 2013). The formula is:

$$n = \frac{N \times X}{X + N - 1} \quad \text{.............................(Equation 1)}$$

Where: n is the sample size, N is the population size, and X is defined as:

$$X = z^2 pq/e^2, \quad \text{.......................(Equation 2)}$$

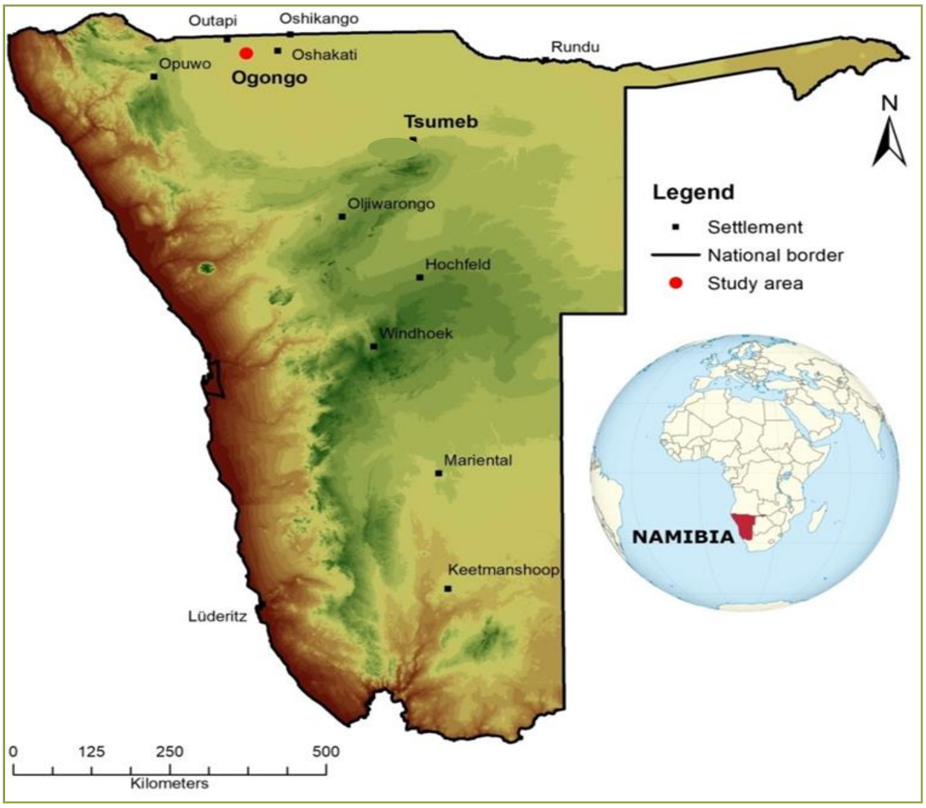

Fig. 1. Location of the Study Site in Namibia

p is the proportion of the population containing the major attribute of interest, q is (1-p), z is the standard variety at a given confidence level (α = 0.05), and e is the acceptable error (precision). A recommended allowable error ranges from 1% to 10% (Daniel & Cross 2013).

In this study, a 10% error rate, a standard proportion (p) of 0.5, and a z-score at a 95% confidence level (α = 0.05) of 1.96 was used. The population of UNAM Ogongo campus staff was 105. Therefore, a sample size of 50 UNAM Ogongo campus staff was used.

2.3 Data Collection and Analysis

The data for the study was collected using digital photography and a standard structured questionnaire administered through face-to-face interviews. The questionnaire was administered in the months of August and September 2024. The data obtained was subjected to content analysis and Chi-Square (X^2) test in SPSS version 25. The X^2 test was used because of its ability to analyse enumerative data (Daniel & Cross 2013). The analysis was tested at a 5% significance level.

3. RESULTS

3.1 Land Use Practices

A summary of the results on the land use practices to combat land degradation at UNAM Ogongo campus are presented in Fig. 2. There were no significant (X^2=10.64; P>0.05) differences in the identified land use practices. However, the land use practices were categorized into five (Climate change adaptation, water resources management, soil management, adaptative farming techniques, and Wildlife management).

3.1.1 Climate change adaption

Land use practices at UNAM Ogongo campus in the category of climate change adaptation are presented in Fig. 3. The land use practices include growing of drought resistant crops and habitat restoration and protection.

3.1.1.1 Growing of drought resistant crops

Growing of drought resistant crops plays a critical role in ensuring food security in Arid and Semi-Arid Lands (ASALs). At Ogongo Campus, drought-tolerant crops like Okashana (mahangu), beans, and mutete are chosen because of their resilience to water scarcity and their ability to mature quickly. Okashana, a variety of pearl millet, is particularly favoured because it is highly adapted to Namibia's harsh climatic conditions. These crops provide staple food supplies for local communities, ensuring agricultural productivity even in years of poor rainfall. In addition, the campus is researching other fast-growing, drought-resistant crops to diversify crop options.

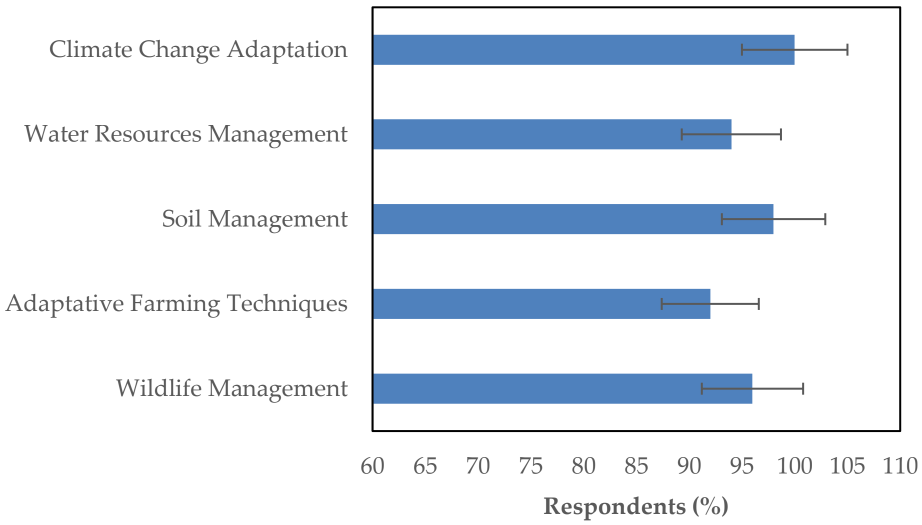

Fig. 2. Categories of Land use practices at UNAM Ogongo Campus (X^2=10.64; df=4; P>0.05)

3.1.1.2 Habitant restoration and protection

Reforestation is a key initiative at Ogongo Campus, where both replanting and planting of indigenous trees are ongoing (Fig. 3). Indigenous tree species such as Acacia and Mopane are dominant species and to restore degraded land, improve soil quality, and provide shade for livestock and people the campus is replanting other species that are less dominating. These trees also serve as windbreaks, reducing soil erosion caused by wind. Reforestation efforts are crucial in enhancing the region's capacity to sequester carbon and improve biodiversity.

3.1.2 Water resources management

Land use practices at UNAM Ogongo campus in the category of water resources management are presented in Fig. 4. The land use practices include establishment of earth dams, sprinkler irrigation, and drip irrigation. Water is a scarce and valuable resource in the ASALs, making effective water management crucial. At Ogongo Campus, various strategies are implemented to conserve and manage water, such as the construction of dams and the use of rainwater harvesting techniques. These methods store rainwater for use during the dry season. Rainwater is collected from rooftops and directed into underground storage tanks or reservoirs, which are then used to irrigate crops. Additionally, sprinkler and drip irrigations are applied to minimize water loss while maximizing crop yields. Water conservation ensures that the campus is resilient to droughts and can sustain agricultural production year-round.

3.1.3 Soil management

Land use practices at UNAM Ogongo campus in the category of soil management are presented in Fig. 5. The soil management techniques include mulching with rice husks, as well as use of cattle dung and chicken manure. Soil fertility and moisture retention are major challenges in ASALs. To address this, Ogongo Campus employs mulching, a technique that involves covering the soil with dead plant material, such as leaves, rice husks, or crop residues, to reduce water loss through evaporation. Mulching also helps in suppressing weed growth and improving soil fertility as the organic matter decomposes. Composting is another technique used, where organic waste from the campus is recycled into nutrient-rich compost that enhances soil health. These soil management practices are essential for maintaining productivity in degraded and nutrient-poor soils.

3.1.4 Adaptive farming techniques

Land use practices at UNAM Ogongo campus in the category of adaptive farming techniques are presented in Fig. 6. The adaptive farming techniques include rotational grazing, crop rotation, as well as agroforestry. In agroforestry, livestock such as cattle, sheep, and goats are integrated into orchards. This approach allows for efficient land use and promotes sustainable farming. Additionally, crop rotation and rotational grazing helps maintain and improve soil fertility by alternating crops, reducing soil depletion, and enhancing nutrient cycling. These practices support the resilience of farming systems in the semi-arid region.

Fig. 3. Land use practices at UNAM Ogongo Campus under the category of climate change adaptation

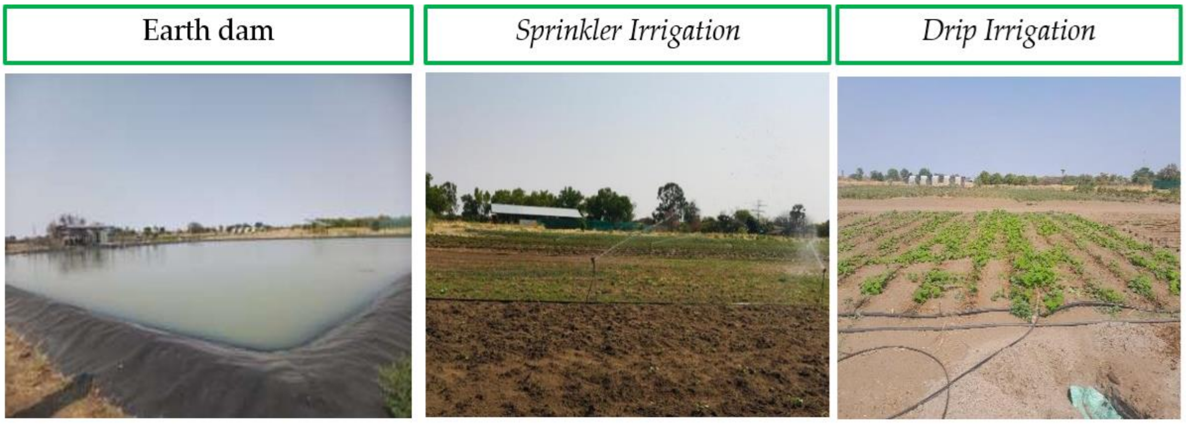

Fig. 4. Land Use Practices at UNAM Ogongo Campus under the category of Water Resources Management

Fig. 5. Land Use Practices at UNAM Ogongo Campus under the category of Soil Management

3.1.5 Wildlife management

Land use practices at UNAM Ogongo campus in the category of wildlife management are presented in Fig. 7. The wildlife management include protection of wild animals, establishment of water holes and troughs, and human wildlife conflict mitigation. Ogongo Campus is adjacent to a protected game park, where wildlife such as giraffe, springbok, gemsbok, zebras, antelopes, and various bird species roam freely. To prevent conflicts between wildlife and the surrounding farming communities, the game park is fenced off. This physical barrier prevents animals from entering farmlands, where they could damage field crops such as pearl millet (mahangu) or pose a threat to farmers' livestock. Additionally, the campus promotes community awareness programs to educate locals on the importance of wildlife conservation and the measures they can take to avoid conflicts. The campus also established artificial waterholes and water troughs within its game park, to make sure wildlife has access to water, especially during the dry season. This supports the animals and helps maintain the park's biodiversity.

3.2 Value Additions

The value additions practiced at UNAM Ogongo campus have been categorized into two. These are establishment of renewable energy and processed agricultural products (Fig. 8). With unreliable electricity supply and harsh climatic conditions, the campus employs solar panels for energy generation to power irrigation systems, lights, and water pumps. This not only reduces dependence on fossil fuels but also ensures that farming activities can continue even in remote areas without access to the national grid. Solar energy is a sustainable solution that aligns with the goal of reducing carbon emissions while enhancing agricultural productivity.

Fig. 6. Land Use Practices at UNAM Ogongo Campus under the category of adaptive farming techniques

Fig. 7. Land Use Practices at UNAM Ogongo Campus under the category of Wildlife Management

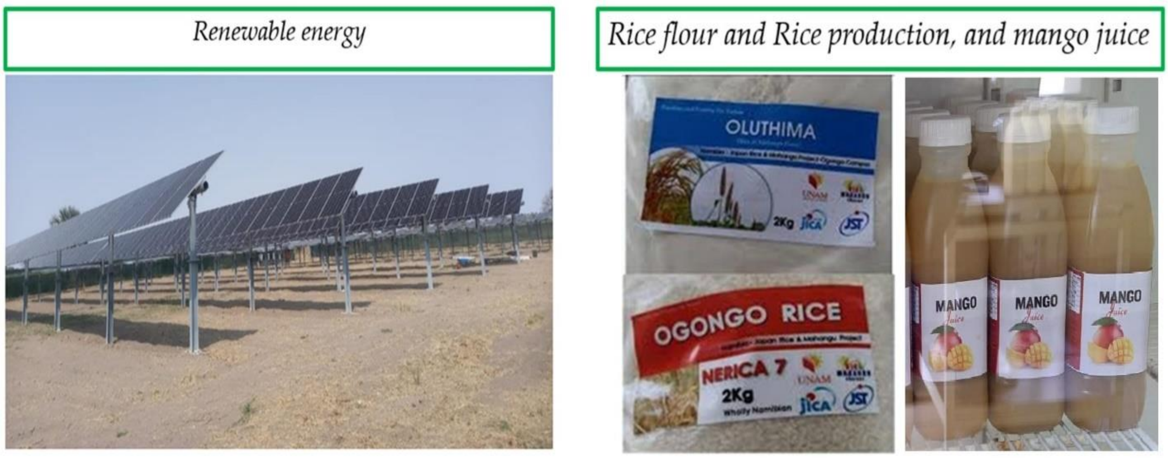

Fig. 8. Established Renewable energy and Processed Agricultural Products at UNAM Ogongo campus

Furthermore, UNAM Ogongo Campus adds value to its agricultural products by processing groundnuts, beans, rice, and fruits like guavas, lemons, and mangoes into flour and variety of juices. Other value-added farm products produced are dried mango snacks, omaere, fresh milks, butter, yoghurt, and biltong's.

4. DISCUSSION

The present study aligns with global and regional efforts to combat land degradation and desertification while enhancing food security and building resilience to climate change. The findings highlight innovative land use and value addition practices and their potential to address these interconnected challenges. Comparing these results to existing literature reveals both agreement with prior research and areas where the Ogongo Campus provides unique contributions. The present study's emphasis on cultivating drought-tolerant crops such as pearl millet and groundnuts is consistent with findings in arid and semi-arid regions. Research by Rockström et al. (2014) underscores that drought-tolerant crops are a critical strategy for food security under changing climatic conditions. Similarly, the use of water management techniques like rainwater harvesting and modern irrigation aligns with literature advocating efficient water use in ASARs. Lal (2015) emphasizes that water conservation methods, such as earth dams and drip irrigation, are vital in sustaining agricultural productivity in water-scarce environments.

The soil management practices described in the study, including the application of organic matter and mulching with rice husks, echo findings by Eswaran et al. (2001) and (World Overview of Conservation Approaches and Technologies (WOCAT) (Van Lynden et al., 2002). These studies confirm that organic amendments improve soil structure, fertility, and moisture retention, enhancing plant growth and reducing susceptibility to erosion. Hence, much emphasis on soil management practices that can increase crop nutrients such as soil organic matter, total nitrogen and soil available P should be encouraged for small scale crop growers. Furthermore, adaptive farming techniques such as agroforestry and intercropping also align with previous research. According to studies by Garrity et al. (2010) and Waldron et al. (2017), agroforestry systems not only increase biodiversity but also create microclimates that improve soil quality and reduce the impacts of extreme weather. The integration of biodiversity conservation measures, like artificial waterholes in game parks, resonates with findings that emphasize protecting wildlife habitats as an integral component of sustainable land management (UNCCD/Science-Policy Interface 2019; OECD 2020; Zhang et al., 2023; Zhu et al., 2023).

While the findings broadly agree with existing research, the integration of renewable energy solutions, such as solar panels, highlights an innovative approach not extensively covered in earlier studies on land management in ASARs. The campus's adoption of solar energy reflects a holistic understanding of sustainability that addresses both environmental and energy challenges. This aligns with global trends (Jinger et al., 2023; Cao, M., Tian et al., 2023; Ndirangu et al., 2017) but offers specific applicability to Namibia, where abundant sunlight provides significant renewable energy potential.

The study's emphasis on value addition to agricultural products, such as processing groundnuts, beans, and fruits, adds a dimension often underrepresented in traditional land degradation studies. This approach aligns with findings by (Tittonell, 2014), who notes that value addition increases market opportunities and household incomes, creating incentives for sustainable land management. However, the level of integration of value addition with land use practices, as seen at Ogongo Campus, represents a notable advancement in linking production with food security strategies.

The focus on local and campus-specific practices may limit the generalizability of the findings to broader regions. While previous studies advocate for scalable solutions, the present study at Ogongo Campus emphasizes location-specific interventions, which, though effective, might require adaptation before replication in other settings. This focus on a localized approach highlights the importance of integrating context-specific knowledge, as emphasized in community-based natural resource management studies (Fabricius et al., 2013; Chege et al., 2018; Scherzinger et al., 2024; Wang et al., 2024). The findings of the present study suggest that campuses like UNAM Ogongo can serve as models for sustainable practices in ASARs, blending education, research, and practical implementation. Therefore, there is a need for continued research and investment in the identified practices to strengthen the university's role on fostering sustainable land management and supporting regional food security initiatives.

5. CONCLUSIONS

The study has revealed a significant land use and value addition practices at UNAM Ogongo campus that can be scaled to similar environments. This aligns with calls for comprehensive approaches to sustainable land management, as outlined in the Land Degradation Neutrality framework that there is a need for integrated, locally tailored solutions to address land degradation and build resilience to climate change. However, the study offers a unique insight into the role of renewable energy and value addition. Therefore, the present study recommends a scaling of the findings to similar environments and a continued research and investment in the identified practices to strengthen the university's role on fostering sustainable land management and supporting regional food security initiatives.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study can be obtained from the corresponding author upon request.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Cao, M., Tian, Y., Wu, K., Chen, M., Chen, Y., Hu, X., ... Luo, L. (2023). Future land-use change and its impact on terrestrial ecosystem carbon pool evolution along the Silk Road under SDG scenarios. *Science Bulletin, 68*(8), 740–749.

Chege, J. M., Lemba, J. K., & Semenye, P. P. (2018). Influence of land tenure on food security status among smallholder farmers in Kilifi South Sub-County, Kenya. *Current Journal of Applied Science and Technology, 25*(3), 1–8. Available: https://doi.org/10.9734/CJAST/2017/32587

Daniel, W. W., & Cross, C. L. (2013). *Biostatistics: A foundation for analysis in the health sciences* (10th ed.). New York, NY: Wiley.

Dhyani, S., Santhanam, H., Dasgupta, R., Bhaskar, D., Murthy, I. K., & Singh, K. (2023). Exploring synergies between India's climate change and land degradation targets: Lessons from the Glasgow Climate COP. *Land Degradation & Development, 34*, 196–206. Available: https://doi.org/10.1002/ldr.4452

Dlamini, P., Chivenge, P., Manson, A., & Chaplot, V. (2014). Land degradation impact on soil organic carbon and nitrogen stocks of sub-tropical humid grasslands in South Africa. *Geoderma, 235–236*, 372–381. Available: https://doi.org/10.1016/j.geoderma.2014.07.016

Eswaran, H., Lal, R., & Reich, P. F. (2001). Land degradation: An overview. In *Responses to land degradation* (pp. 1–6). New Delhi, India: Oxford Press.

Fabricius, C., Koch, E., Turner, S., & Magome, H. (2013). *Rights resources and rural development: Community-based natural resource management in Southern Africa.* London, UK: Routledge.

Garrity, D. P., Akinnifesi, F. K., Ajayi, O. C., Weldesemayat, S. G., Mowo, J. G., & Kalinganire, A. (2010). Evergreen agriculture: A robust approach to sustainable food security in Africa. *Food Security, 2*, 197–214. Available: https://doi.org/10.1007/s12571-010-0070-7

Gupta, A. K., Kumar, P., Rathore, A. C., Kumar, P., Kaushal, R., & Islam, S. (2021). Soil and water conservation techniques-based land degradation neutrality: A need-based solution for degraded lands in Indian perspective. *Current Science, 121*, 1343–1347. Available: https://doi.org/10.18520/cs/v121/i10/1343-1347

Jinger, D., Kakade, V. D., Kaushal, R., Dinesh, D., & Bhatnagar, P. R. (2021). Rehabilitation of degraded lands through different planting techniques in *Melia dubia Cav. Food and Scientific Reports, 2*, 7–9.

Jinger, D., Kaushal, R., Kumar, R., Paramesh, V., Verma, A., & Shukla, M. (2023). Degraded land rehabilitation through agroforestry in India: Achievements, current understanding, and future prospects. *Frontiers in Ecology and Evolution, 11*, 1088796. Available: https://doi.org/10.3389/fevo.2023.1088796

Lal, R. (2009). Soil degradation as a reason for inadequate human nutrition. *Food Security, 1*, 45–57. Available: https://doi.org/10.1007/s12571-009-0009-z

Lal, R. (2015). Restoring soil quality to mitigate soil degradation. *Sustainability, 7*(5), 5875–5895. Available: https://doi.org/10.3390/su7055875

Lal, R. (2020). Regenerative agriculture for food and climate. *Journal of Soil and Water Conservation, 75*(5), 123A–124A. Available: https://doi.org/10.2489/jswc.2020.0620A

Lamb, D., Erskine, P., & Parrotta, J. (2005). Restoration of degraded tropical forest landscapes. *Science, 310*(5754), 1628–1632. Available: https://doi.org/10.1126/science.1111773

Mendelsohn, J., Jarvis, A., Robertson, T., & Roberts, C. (2009). *Atlas of Namibia: A portrait of the land and its people.* Cape Town, South Africa: David Philip Publishers.

Ndirangu, S. N., Mbogoh, S. G., & Mbatia, O. L. E. (2017). Effects of land fragmentation on food security in three agro-ecological zones of Embu County in Kenya. *Asian Journal of Agricultural Extension, Economics & Sociology, 18*(4), 1–9. Available:https://doi.org/10.9734/AJAEES/2017/34321

OECD. (2020). *Towards sustainable land use: Aligning biodiversity, climate, and food policies.* Paris, France: OECD Publishing. Available: https://doi.org/10.1787/3809b6a1-en

Olusola, A. T., Lawrence, B. O., Kayode, A., Timothy, A. O., & Ayodeji, A. T. (2020). Soil conservation techniques among arable crop farmers in Odo Otin local government area, Osun State: A multinomial logit approach. *Journal of Soil Science and Environmental Management, 11*(2), 50–56. Available: https://doi.org/10.5897/JSSEM2020.0806

Rathore, A. C., Singh, C., Jayaprakash, J., Gupta, A. K., Doharey, V. K., Jinger, D., ... Madhu, M. (2023). Impact of conservation practices on soil quality and ecosystem services under diverse horticulture land use system. *Frontiers in Forests and Global Change, 6*, 1289325. Available: https://doi.org/10.3389/ffgc.2023.1289325

Rockström, J., Falkenmark, M., Folke, C., Lannerstad, M., Barron, J., Enfors, E., ... Pahl-Wostl, C. (2014). *Water resilience for human prosperity.* Cambridge, UK: Cambridge University Press.

Scherzinger, F., Schädler, M., Reitz, T., ... et al. (2024). Sustainable land management enhances ecological and economic multifunctionality under ambient and future climate. *Nature Communications, 15*, 4930. Available: https://doi.org/10.1038/s41467-024-48830-z

Tittonell, P. (2014). Ecological intensification of agriculture—Sustainable by nature. *Current Opinion in Environmental Sustainability, 8*, 53–61.

UNCCD/Science-Policy Interface. (2019). *Land management and drought mitigation.* Science-Policy Brief No. 6. Bonn, Germany: United Nations Convention to Combat Desertification.

Van Lynden, G. W. J., Liniger, H. P., & Schwilch, G. (2002). The WOCAT map methodology: A standardized tool for mapping degradation and conservation. Proceedings of the ISCO Conference, Beijing.

Vanlauwe, B., Hester, R., & Harrison, R. (2012). Organic matter availability and management in the context of integrated soil fertility management in sub-Saharan Africa. In R. Hester & R. Harrison (Eds.), *Soils and Food Security* (pp. 135–157). Cambridge, UK: Royal Society of Chemistry. Available: https://doi.org/10.1039/9781849735431-00135

Waldron, A., Garrity, D., Malhi, Y., Girardin, C., Miller, D. C., & Seddon, N. (2017). Agroforestry can enhance food security while meeting other sustainable development goals. *Tropical Conservation Science, 10*, 1–6.

Wang, X., Zhao, H., Qian, J., Li, X., Cao, C., Feng, Z., ... Cui, Y. (2024). Sustainable land use diagnosis based on the perspective of coupling socioeconomy and ecology in the Xiongan New Area, China. *Land, 13*(1), 92. Available: https://doi.org/10.3390/land13010092

Zhang, L., Kuang, B., & Yang, B. (2023). Sustainable land use and management. *Sustainability, 15*(23), 16259. Available: https://doi.org/10.3390/su152316259

Zhu, Y., Wang, Z., & Zhu, X. (2023). New reflections on food security and land use strategies based on the evolution of Chinese dietary patterns. *Land Use Policy, 126*, 106520. Available:https://doi.org/10.1016/j.landusepol.2023.106520

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.ikprress.org/review-history/12709