INDONESIAN JOURNAL OF SOCIAL AND ENVIRONMENTAL ISSUES (IJSEI)
Journal Homepage: https://ojs.literacyinstitute.org/index.php/ijsei
ISSN: 2722-1369 (Online)
Research Article

Volume 5	Issue 2	August (2024)	DOI: 10.47540/ijsei.v5i2.1385	Page: 192 – 201

Impacts of Agrobiodiversity in Landscape Ecology

Fekadu Hailu
Forest and Nature Management, Ethiopian Forestry Development, Ethiopia
Corresponding Author: Fekadu Hailu; Email: hailufekadu22@gmail.com

ARTICLE INFO

Keywords: Agrobiodiversity; Environmental Sustainability; Landscape; Livelihood Security.

Received : 29 March 2024
Revised : 21 August 2024
Accepted : 27 August 2022

ABSTRACT

The agricultural landscape is very important for the production of goods and services, which are vital to human life. However, agricultural intensification affects the ecological interconnection, function, structure, and capability of landscape production and productivity. Therefore, this review aims to understand the role, diverse causes of biodiversity losses, and maintenance options of agrobiodiversity in landscape ecology. To achieve these objectives, different reputable journal articles that were published starting in 2013 until now were collected, organized, summarized, and compiled carefully. Agrobiodiversity includes all the components of biological diversity that are relevant to agricultural ecosystems. It has an essential role in the sustainable development of agricultural systems, which provide food, fiber, fuel, fodder, medicines, and other products for subsistence. Agricultural biodiversity has a great contribution to food security, production, environmental sustainability, diversifying rural livelihoods, and rural development. These essential agrobiodiversity are endangered due to the ignoring of native knowledge, the absence of local institutions and management systems, inequitable tenure, market pressures, and demographic factors. Thus, conserving agrobiodiversity and its multiple functions included awareness creation in ecosystem management, promoting local adaptive management, supporting local participation, strengthening local rights and tenure property, improving trade-related policies, and providing economic incentives.

INTRODUCTION

Agrobiodiversity is vital for producing commodities that are necessary for human survival and providing other benefits. It provides additional values such as biodiversity conservation, wildlife habitat, biological pest control, nutrient cycling, water quality regulation, cross-pollination, recreation, and the preservation of rural and cultural traditions (Corrado et al., 2019; Kahane et al., 2013). There are numerous agricultural landscapes in the world. Most agricultural landscapes vary, usually in terms of land use, field size and form, and the pattern of semi-natural components. Most of these landscapes, particularly those with low-intensity agriculture systems, were rich in biodiversity (Van der Zanden et al., 2016).

The main issue in tropical land management is meeting the increasing demand for agricultural goods, conserving biodiversity, providing ecosystem services, and sustaining rural communities. This problem is mainly severe in a biodiversity hotspot region for both wild and domesticated species that is experiencing human population expansion, ecological degradation, and the decline of traditional farming systems (Harvey et al., 2020). Agricultural intensification reduces biodiversity predominantly to a few genetically homogenous species. Many abundant species have become scarce or extinct as a result of increased agricultural intensification and a subsequent loss of natural landscape components. The loss of biodiversity in farming landscapes has been particularly prominent in many countries, highlighting the agriculture policy's considerable environmental impact. Agricultural intensification is currently considered the most prominent cause of biodiversity losses (Kehoe et al., 2017; Zabel et al., 2019).

Furthermore, agricultural magnification harms production sustainability and productivity through a

variety of mechanisms. Monotypic agricultural systems can achieve the same levels of production under relatively narrow environmental conditions. Nutrient cycles become more open in agricultural systems, with nutrient losses during harvest, increased volatilization due to surface environment change, and increased leaching due to decreased soil organic matter (Sanaullah et al., 2020). Soil organic matter is also damaged by soil erosion in intensive agriculture. The reduction of soils, particularly when the ground is bare, causes more run-off and less infiltration, as well as an increase in the danger of erosion. The conversion of agroecosystems to agriculture usually results in fewer species of both planned and related biota, with reduced genetic variation and fewer functional groups.

At the landscape level, it is critical to consider all ecosystem constituents rather than only plants and animals. Unchanging land use is an essential feature and the foundation for understanding biodiversity. The management of biophysical landscape variability becomes increasingly important in understanding the relationships between genetic resources, abiotic and biotic settings, and management approaches generally. The biophysical diversity and cattle grown on it are susceptible to different levels of control. Large farms in the northern countries and plantations in the south have typically identical management practices; however, small farms tolerate diverse management approaches in different micro-environments (Uphoff, 2013; Young, 2017). Therefore, the overall goal of this review paper is to explore the functions, diverse causes of biodiversity loss, and sustainability choices for agrobiodiversity in landscape ecology.

MATERIALS AND METHODS

This review activity entails investigating, reading, analyzing, assessing, and summarizing scholarly material, primarily journal articles and books related to the topic. To accomplish our review objective, we conducted a comprehensive literature search on agrobiodiversity, starting with 2013 published journal articles and books. Accordingly, reputable journal articles and books were used to examine the functions, causes of loss, and sustainable management of agrobiodiversity in landscape ecology. The Scopus, Google Scholar, and Web of Science citation databases were utilized to narrow down the pool of publications that fit the criteria.

RESULTS AND DISCUSSION

The Concept and Role of Agricultural Biodiversity

Biodiversity refers to the variety of life forms on Earth that contain plants, animals, and microorganisms, the genes they contain, and the ecosystems they create. It relates to genetic variance, environmental variation, and biological diversity within a biome (Rawat and Agarwal, 2015). Agrobiodiversity describes the variety of living organisms that support food and agriculture in a wide sense and are related to cultivating crops and breeding animals within ecological developments (Jackson et al., 2013; Nemogá, 2019). In some cases, it is extended to cover all creatures found in an agricultural landscape.

Farmers, pastoralists, forest dwellers, fishermen, and gardeners, as well as their individual descriptions of well-being, priorities, rights, capabilities, and knowledge, influence the functioning of the agroecosystem. Social goals such as economic, cultural, and aesthetic qualities, in addition to biological output depending on the conditions, refer to the temporary increase of specific output based on a particular crop (DeClerck et al., 2015). These have an impact on the biodiversity in the larger landscape, which is constantly changing due to the interface between human intervention and ecological processes. Natural events and human activities have perpetuated a wide range of ecological biodiversity. Agrobiodiversity serves a variety of socioeconomic and environmental functions that are inextricably linked, as detailed below.

Agricultural biodiversity for livelihood and food security

The livelihood systems in rural areas are diverse based on the various cultural groups (Van Ginkel et al., 2013). They typically rely on a combination of wild fruit, agriculture, and trade work. Particularly poor households engaged in diverse activities and increased their revenue collection. Contrary to popular belief, agriculture's importance for food security can be fairly modest and rapidly change poor communities. In Africa, non-farm income dependency ranges from 30% to

50%, but it can reach 80% to 90% in southern Africa (Davis et al., 2017). It is difficult to expect the interactions of agrobiodiversity and rural farmers, predominantly in scarce resource places with considerable biological and social diversity (Van Ginkel et al., 2013).

Diverse forms of agrobiodiversity are employed by people in various areas, hence sustaining livelihood strategies in a complex way (Mijatovic et al., 2013). Agrobiodiversity is varied among communities because there is a wide range of money and authority in human civilization. These typically have less access to land, labor, and capital, necessitating a greater reliance on existing natural diversity. Poor individuals in most developing countries receive around 20% of their income from their property, while wealthier households receive only 1% (Ravallion, 2015). Although wild fruit provides significant nutritional value to all diets, mostly carbohydrates, vitamins, and minerals, it is particularly useful for kids.

Some aspects of agricultural biodiversity's cultural and spiritual ideals can be valued more highly than their monetary value. Several rural groups regard specific biologically diverse sections of terrestrial and aquatic bodies as sacred. These sanctified areas are protected and used for spiritual purposes. Some derive their sacred character from the springs of water they protect, the medicinal and ritual items in their plants, or the wild animals they care for. Sacred groves can be found throughout southern and eastern Asia, Africa, the Pacific Islands, and Latin America (Arjjumend et al., 2018). Sacred sites or areas are frequently linked to the benefits of agrobiodiversity because they are rich in biodiversity.

There is also notable variation within species among plants and animals that are used for agricultural outputs. Farmers' crop variations, or landraces, are greatly diverse for cross-pollinated species like millet and maize (Shuro, 2017). Individual varieties of self-pollinated crops like rice and barley, as well as vegetative-propagated species, are less diverse. Every role of animals' diversity in livelihood activity is influenced and interconnected with institutional elements and social relations. A diversified examination of livelihoods is thus required for each economic and ecological situation to grasp what a certain livestock contribution is worth, to whom, when, and in what way. In general, animal diversity produces a variety of products, including food, clothing, cutlery, transportation, traction fuel, fertilizers, income, insurance, spiritual functions, and so on.

The role of agrobiodiversity for environmental sustainability and production

Every species in an ecosystem is part of a complex web that is connected with energy and material movements (Yousefi et al., 2020). Although those species may have distinct ecological niches and be used as producers, consumers, and decomposers, they contribute to other ecosystem activities and ecological processes, both directly and indirectly. The components of agrobiodiversity have multiple benefits for the resilience of production while also offering ecological benefits in the landscape. There is rising evidence that shows the complication of biodiversity and the functions of ecosystems at all levels may be due to a few essential structuring mechanisms (Oliver et al., 2015).

On the other hand, high-effort farming based on high-yielding varieties, as well as agricultural biodiversity, contributes to the maintenance of numerous ecosystem functions (Kumar et al., 2022). In the United States and Australia, farmers manage vegetation cover for soil and water conservation to increase production. Forests can supply food, increasing the internal link between ecosystems based on species. The following examples highlight and serve as a reminder of the various purposes of agricultural biodiversity.

1. Soil decay and nutrient cycling functions.
2. Both soil and water preservation functions
3. Pest resistance functions
4. Plant pollination and seed dispersion functions
5. Natural diversity preservation functions
6. Climate regulating functions
7. Functions in the water cycle

Agricultural biodiversity for rural development

Agricultural biodiversity can lead to rural improvement via ecotourism and increase employment activities for local communities. Various humanized lands in Australia, Europe, South America, and Asia are gaining popularity for their artistic and historic values. For instance, in Asia, steep slope areas were transformed into pond lands for the production of rice and other crops (Moreno et al., 2016).

These landscapes exist as both archaeological sites and living landscapes, which are still used and maintained by the communities. A rising number of stakeholders recognize the need to manage these cultural landscapes. For instance, the low-input agroecosystems are prized by urban residents who are willing to pay for the pleasure of a rural vacation in Europe. Globally, the essential value of these landscapes, what they can teach in the long term and their relations with humans have resulted in an approach for identifying, evaluating, and conserving specific regional landscapes within the framework of the World Heritage Convention (Cave and Negussie, 2017; Rössler and Lin, 2018).

Furthermore, native communities earn a small share of revenues created by the sale of products containing their expertise and resources (Herman, 2023). Several codes of conduct and recommendations have been produced to assure more justice, recompense, and fair profit sharing between bioprospecting businesses and local communities, although none are uniformly legally obligatory (Chennells, 2015). Such methods of native rural improvement aim to develop strong economic enterprises that depend on local knowledge and adapted agrobiodiversity, as well as corporations among civil society, government, and the private sector. In both developing and wealthy countries, efforts to recover biodiversity for rural improvement frequently focus on redeveloping native food systems and economic well-being and prosperity.

Diverse Causes of Agrobiodiversity Losses

The rate of biodiversity loss varies depending on the biological and economic contexts. The loss of genetic, species, and agroecological diversity is putting local livelihoods and environmental processes at risk. The primary causes of biodiversity loss include land use change and habitat conversion to other land uses, pollution, unsustainable natural resource use, climate change, and the introduction of invasive species (Singh et al., 2021). Consider the causes that overlooked and damaged the benefits of agrobiodiversity to identify the activities required to preserve these vital resources.

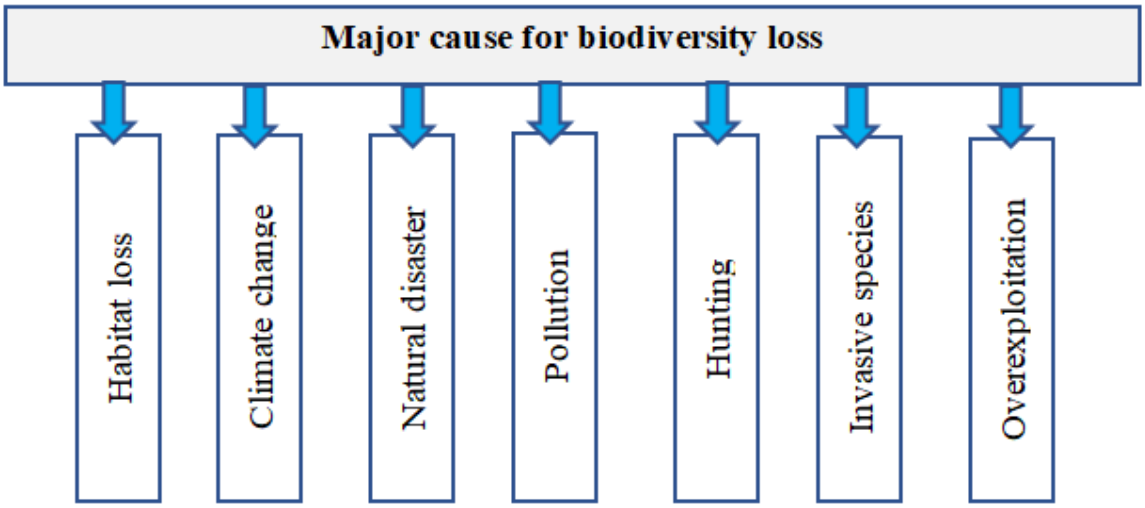

Figure 1. The main cause of biodiversity loss (Singh et al., 2021).

Ignoring local knowledge and management system

Native methods of identifying, esteeming, and organizing the biosphere are sometimes overshadowed by globalization. Indigenous knowledge is being lost as a result of modernization and ongoing transformation processes (Gadgil et al., 2021). The introduction of current commercial agriculture technology from the West removes traditional practices as well as indigenous knowledge. These types of techniques have an impact on the agrobiodiversity of natural landscapes.

Local organizations and indigenous institutions have played a vital role in promoting cooperative action and coordination of the management of agrobiodiversity across several scales. Using native knowledge in natural resource management is the best example of conservation and sustainable use. Rural people provide valuable information for managing and enhancing agrobiodiversity. Those good practices or actions are effective and

successful; environmentally, economically, and socially sustainable; technically promising; fundamentally participative; reproducible and adaptable; and have been demonstrated to function well and provide positive consequences for biodiversity management (Joshi et al., 2020). Over millennia, these structures evolved to meet local demands, and precise knowledge enabled humans to adapt to social and environmental change.

Unequal tenure and lack of control over resources

A primary driver of biodiversity loss is a lack of access rights and resource management problems, which reduces the motivation to protect resources and undermines livelihood security. Secure land tenure promotes food security, economic growth, and natural resource management while mitigating the effects of conflict and climate change (Hunsberger et al., 2017). Western notions of private property fail to appreciate indigenous rural peoples' intellectual contributions and informal innovations in modifying, conserving, and managing wild animals and environments.

Moreover, the aspiration of most countries is not to impair the intervention of an international access-rights and value-sharing system under the Convention of Biological Diversity, which may limit the application of 'commons' management principles to a broader scale (Mani et al., 2021). Lawful industrial rights and personal rights enable firms in northern institutions to retain unbalanced regulation over agricultural biodiversity, inherited resources, and advantages. However, native communities and farmers who first developed this inherited diversity have rarely been acknowledged or compensated for their innovations. Inadequate distribution of land and resources, insecure rights, and disregarding and restricting livelihood systems have continued, eroding human security and environmental integrity and resulting in increased conflict and instability.

Market pressures and undervaluation

Agricultural biodiversity has many values, which allows it to serve a variety of roles. However, it is underestimated or overlooked in economic estimations, owing in part to the difficulty of valuing many functions in economic terms. This has skewed conservative natural resource management planning in favor of key food crops with marketable relevance in urban areas. Global market development and trade liberalization have a normalizing effect on agrobiodiversity by standardizing food production practices and consumption (Borsellino et al., 2020). It frequently requires uniform foods, which are increasingly manufactured and distributed by large-scale firms and tailored to the nutrition preferences of fairly wealthy urban customers. These commercial forces frequently push farmers to comply with the need for regularity.

Conversely, the costs of agrobiodiversity loss, such as pest buildup, the elimination of beneficial insects, and the loss of ecosystem services, are difficult to assess. They are consistently overlooked in analyses of yields, productivity, and market value. Furthermore, the off-farm merits and public advantages of agricultural biodiversity are rarely reflected in economic analyses. Not only governments but also markets, fail to recognize the societal benefits of biodiversity on a large scale. These considerations and the extensive reliance on economic implements and decision-makers have little incentive to deliberate agrobiodiversity gains and losses (Kuchibhotla and Chakrabortty, 2022). Some studies suggest that biodiversity can be estimated based on non-use valuations of various threats (Nobel *et al.*, 2020). To avoid anthropogenic effects, the non-use values of biodiversity conservation studies that account for a diverse variety of biodiversity risks are important.

Sustaining Agrobiodiversity and Its Multiple Functions

Increase knowledge on agrobiodiversity conservation:

Agrobiodiversity refers to the diversity and variability of animals, plants, and microorganisms on the planet that are used directly or indirectly for food, fodder, building, fuel, and other goods and services. The interaction of the environment, genetic resources, and management systems used by culturally diverse peoples results in different ways of using natural resources for production as well as traditional benefits (Kantanen et al., 2015). Agrobiodiversity also includes non-harvested species that support the production of soil microorganisms, predators, and pollinators, and those in the larger environment that support agro-ecosystems such as agriculture, pastoral, forest, and aquatic diversity (Duruigbo et al., 2013).

Human activity has been causing the loss of plants and animals for many years; nevertheless, we

have only lately started to comprehend the effects of this loss on the composition and functionality of ecological systems at the biome scale (Murray et al., 2020). The importance of restoring and conserving entire systems was recognized by relevant biodiversity conservation factors, but their priorities and interventions are still centered on scales too small to address the functions of the biome as a whole. There is a persistent debate over the necessity of a fresh worldwide endeavor to tackle the historical and present-day depletion of plants, animals, and their functional units.

Increase the effective use of agrobiodiversity

Indigenous peoples create and maintain agricultural biodiversity, which is used in the food chain and contributes significantly to global food security. Despite the large population growth over the last 150 years, agrobiodiversity alteration has resulted in enormous nutritional and health benefits, notably through agricultural intensification. Healthy human nutrition is best achieved through an agrobiodiversity approach that ensures a diverse food supply while remaining environmentally sustainable. This technique is excellent in theory, but data availability is limited due to the multiple variables that contribute to the eco-nutrition model. Agrobiodiversity food-based approaches should have been used to boost agricultural production, produce disease- and stress-resistant crops, nutritionally enrich crops, and address other nutritional agriculture issues (Ayyam et al., 2019).

The comparatively modest number of successfully domesticated plant species was an important aspect of the agrobiodiversity movement. Even a smaller number of species were chosen over time due to their relative ease of cultivation, dependability, ability to grow in a variety of settings, and nutritional content. It arose as a result of the long-term utilization of natural capital, such as wild plant and animal biodiversity, crop breeding, and the development of agronomic skills. Our forefathers' hunter-gatherer diets depended on local wild plant and animal species for food, as well as resources for shelter, fiber, fire, and medicine all across the world. The transition from hunting and gathering to agriculture began many years ago when a small number of wild plant species were domesticated, resulting in an agricultural revolution that provided humans with a relatively secure source of food (Gowdy, 2020).

Support the local adaptive management systems

The variability within and between agroecosystems is tremendous. The structural changes in agro-biodiversity can be seen on a daily, monthly, and long-term basis, from the broad landscape level to individual farmed plots. Uncertainty, regional variability, non-equilibrium conditions, and nonlinear ecosystem changes highlight the importance of viable adaptive management of resources, with native agricultural biodiversity users playing major roles in analysis, planning, and negotiations. This necessitates a considerably higher appreciation for local farmers and the expertise employed by rural communities to manage agro-biodiversity. Improving agricultural biodiversity management requires close coordination among farmers, officials, conservation experts, and policymakers (Maas et al., 2021). Administrative activities, land use planning, and agricultural research and development operations carried out at the level of actual resource users or beneficiaries are compatible with efficiency and accountability. Agrobiodiversity management involves strengthening local communities and organizations by decentralizing resources and reducing legal barriers to local planning and management.

Increase the participation of the community in planning and management

Most experts are inclined to put their particular suggestions upon locals and landscape management approaches. In actuality, their perspectives on the poor's realities and what might be done have typically been formed from a distance. Adaptive management is an interdisciplinary and collaborative approach to ecosystem governance that tests and revises institutional arrangements and ecological knowledge through a dynamic, ongoing, and self-organized process of learning from experience (Mas-Tur et al., 2021). Family livelihood policies frequently include different members in a variety of activities and sources of assistance throughout the year.

Agrobiodiversity improvement and landscape planning and management should begin with empowering native residents, particularly farmers, to perform their analyses and priorities. Joint management approaches are the main long-term local involvement method that extends beyond the initial assessment and planning to monitoring and

evaluation. This entails using a learning process approach to manage agricultural biodiversity. It also advocates expertise that incorporates new ideas, participative procedures, and conduct (Hughes and Hughes, 2013). Ensure that farmers, herders, fishermen, and forest dwellers participate in the creation of land use and agricultural policies, as well as the generation of technology. Encourage the use of gender-disaggregated, socially differentiated local indicators for monitoring and assessment, which will guide further technical assistance and the distribution of limited resources for biodiversity conservation.

Strengthen local rights and tenure property

Landscapes are reinterpreted as the output of social, economic, and environmental histories, which highlights the legitimacy of rural people's claims to tenure and rights to agrobiodiversity. These findings support a rights-based approach to participatory biodiversity management, which is critical for food security, agriculture, and livelihoods. Furthermore, they have significant consequences for countrywide strategies governing the distribution of functions gained from the utilization of lands, agrobiodiversity, and products and services. In this regard, ensuring farmers' rights to conserve and use resources is critical (Tsioumani, 2014).

Modification of rules and regulations helps to govern the rights to use and manage natural resources like trees, water, and inherited resources to preserve farmers' rights as a foundation for fair benefit share agreements. Property rights over genetic resources are now being renegotiated under the World Trade Organization's agreement (Sundaram, 2015). However, it does not compromise the preservation and sustainability goals established by the Convention on Biological Diversity and the Food and Agricultural Organizations.

CONCLUSION

Agrobiodiversity refers to all aspects of biological diversity associated with food and agriculture, including agricultural landscapes. It contributes significantly to the long-term growth of agricultural systems that provide food, fiber, fuel, fodder, medicines, and other necessities. Watershed functions, nitrogen cycling, soil health, and pollination all rely on agricultural biodiversity management. Agricultural biodiversity helps to ensure food security and environmental sustainability while also diversifying rural livelihoods and improving them.

Communities have had a profound impact on the diversity and function of wildlife all across the planet. Plant and animal variety, both wild and domesticated, is often the foundation of flexible and dynamic rural livelihoods. These valuable agroecosystems are under threat and are losing function due to a range of factors, including land-use change and habitat conversion, pollution, unsustainable resource use, climate change, invasive alien species, and intensive agriculture. Some methods have been proposed to protect critical agrobiodiversity for human subsistence, such as effective resource utilization, increasing local participatory management, tightening regulations, and strong laws on access rights.

Traditionally, local knowledge and skills have been essential in promoting cooperative action and coordinated management of agrobiodiversity across various geographical ranges, but disregarding native knowledge has implications. Considering indigenous knowledge has major value in managing, protecting, and sustaining agricultural biodiversity, equitable tenure, control over resources, and access rights to resources are significant in increasing resource conservation and local livelihood security. Increasing awareness and understanding of the dynamics of agricultural biodiversity, as well as supporting local adaptive management of agrobiodiversity, is critical for agricultural biodiversity conservation.

REFERENCES

Arjjumend, H., Konstantia, K., Fagan, H. and Shibata, S. (2018). International Overview of Sacred Natural Sites and Indigenous and Community Conserved Areas (ICCAs) and the Need for Their Recognition. *Journal of Global Environmental Studies,* 13**,** 33-56.

Ayyam, V., Palanivel, S., Chandrakasan, S., Ayyam, V., Palanivel, S. and Chandrakasan, S. (2019). Alternative Farming Systems for Diversification and Conservation of Agro-biodiversity. *Coastal Ecosystems of the Tropics-Adaptive Management***,** 319-361.

Borsellino, V., Schimmenti, E. and El Bilali, H. (2020). Agri-food markets towards sustainable patterns. *Sustainability,* 12**,** 2193.

Cave, C. and Negussie, E. (2017). *World Heritage conservation: The World Heritage Convention, linking culture and nature for sustainable development*, Routledge.

Chennells, R. S. (2015). *Equitable access to human biological resources in developing countries: Benefit sharing without undue inducement*, Springer.

Corrado, C., Elena, T., Giancarlo, R. and Stefano, C. (2019). The role of agrobiodiversity in sustainable food systems design and management. *Genetic diversity in horticultural plants***,** 245-271.

Davis, B., Di Giuseppe, S. and Zezza, A. (2017). Are African households (not) leaving agriculture? Patterns of households' income sources in rural Sub-Saharan Africa. *Food policy,* 67**,** 153-174.

DeClerck, F., Estrada‐Carmona, N., Garbach, K. and Martinez‐Salinas, A. (2015). Biodiversity and Ecosystem Services of Agricultural Landscapes. *Agroecology for food security and Nutrition***,** 140.

Duruigbo, C., Okereke-Ejiogu, E., Nwokeji, E., Peter-Onoh, C., Ogwudire, V. and Onoh, P. (2013). Integrated remediation strategies for sustaining agrobiodiversity degradation in Africa. *IOSR Journal of Agriculture and Veterinary Science,* 3**,** 16-23.

Gadgil, M., Berkes, F. and Folke, C. (2021). Indigenous knowledge: From local to global: This article belongs to Ambio's 50th Anniversary Collection. Theme: Biodiversity Conservation. *Ambio,* 50**,** 967-969.

Gowdy, J. (2020). Our hunter-gatherer future: Climate change, agriculture and uncivilization. *Futures,* 115**,** 102488.

Harvey, M. G., Bravo, G. A., Claramunt, S., Cuervo, A. M., Derryberry, G. E., Battilana, J., Seeholzer, G. F., McKay, J. S., O'Meara, B. C. and Faircloth, B. C. (2020). The evolution of a tropical biodiversity hotspot. *Science,* 370**,** 1343-1348.

Herman, K. S. (2023). Green growth and innovation in the Global South: a systematic literature review. *Innovation and Development,* 13**,** 43-69.

Hughes, W. and Hughes, C. (2013). Professionalism and professional institutions in times of change. *Building Research & Information,* 41**,** 28-38.

Hunsberger, C., Corbera, E., Borras Jr, S. M., Franco, J. C., Woods, K., Work, C., de la Rosa, R., Eang, V., Herre, R. and Kham, S. S. (2017). Climate change mitigation, land grabbing and conflict: towards a landscape-based and collaborative action research agenda. *Canadian Journal of Development Studies/Revue canadienne d'études du développement,* 38**,** 305-324.

Jackson, L. E., Brussaard, L., de Ruiter, P., Pascual, U., Perrings, C. and Bawa, K. (2013). Agrobiodiversity. *Encyclopedia of Biodiversity,* 126**,** 135.

Joshi, B. K., Gauchan, D., Bhandari, B. and Jarvis, D. I. (2020). Good practices for agrobiodiversity management.

Kahane, R., Hodgkin, T., Jaenicke, H., Hoogendoorn, C., Hermann, M., Keatinge, J., d'Arros Hughes, J., Padulosi, S. and Looney, N. (2013). Agrobiodiversity for food security, health and income. *Agronomy for sustainable development,* 33**,** 671-693.

Kantanen, J., Løvendahl, P., Strandberg, E., Eythorsdottir, E., Li, M.-H., Kettunen-Præbel, A., Berg, P. and Meuwissen, T. (2015). Utilization of farm animal genetic resources in a changing agro-ecological environment in the Nordic countries. *Frontiers in Genetics,* 6**,** 52.

Kehoe, L., Romero-Muñoz, A., Polaina, E., Estes, L., Kreft, H. and Kuemmerle, T. (2017). Biodiversity at risk under future cropland expansion and intensification. *Nature ecology & evolution,* 1**,** 1129-1135.

Kuchibhotla, A. K. and Chakrabortty, A. (2022). Moving beyond sub-Gaussianity in high-dimensional statistics: Applications in covariance estimation and linear regression. *Information and Inference: A Journal of the IMA,* 11**,** 1389-1456.

Kumar, D., Sinha, N. K., Haokip, I. C., Kumar, J., Wanjari, R., Verma, S., Mohanty, M., Jayaraman, S., Elanchezhian, R. and Mishra, R. (2022). Impact of Fertilizer Consumption

on Soil Health and Environmental Quality in India. *Indian Journal of Fertilisers,* 18**,** 992-1005.

Maas, B., Fabian, Y., Kross, S. M. and Richter, A. (2021). Divergent farmer and scientist perceptions of agricultural biodiversity, ecosystem services and decision-making. *Biological Conservation,* 256**,** 109065.

Mani, S., Osborne, C. P. and Cleaver, F. (2021). Land degradation in South Africa: Justice and climate change in tension. *People and Nature,* 3**,** 978-989.

Mas-Tur, A., Roig-Tierno, N. and Ribeiro-Navarrete, B. (2021). Successful entrepreneurial learning: success factors of adaptive governance of the commons. *Knowledge Management Research & Practice,* 19**,** 291-302.

Mijatović, D., Van Oudenhoven, F., Eyzaguirre, P. and Hodgkin, T. (2013). The role of agricultural biodiversity in strengthening resilience to climate change: towards an analytical framework. *International journal of agricultural sustainability,* 11**,** 95-107.

Moreno, G., Gonzalez-Bornay, G., Pulido, F., Lopez-Diaz, M. L., Bertomeu, M., Juárez, E. and Diaz, M. (2016). Exploring the causes of high biodiversity of Iberian dehesas: the importance of wood pastures and marginal habitats. *Agroforestry Systems,* 90**,** 87-105.

Murray, N. J., Keith, D. A., Duncan, A., Tizard, R., Ferrer-Paris, J. R., Worthington, T. A., Armstrong, K., Hlaing, N., Htut, W. T. and Oo, A. H. (2020). Myanmar's terrestrial ecosystems: Status, threats and conservation opportunities. *Biological Conservation,* 252**,** 108834.

Nemogá, G. (2019). Indigenous agrobiodiversity. *Agrobiodiversity: integrating knowledge for a sustainable future,* 24**,** 241.

Nobel, A., Lizin, S., Brouwer, R., Bruns, S. B., Stern, D. I. and Malina, R. (2020). Are biodiversity losses valued differently when they are caused by human activities? A meta-analysis of the non-use valuation literature. *Environmental Research Letters,* 15**,** 073003.

Oliver, T. H., Heard, M. S., Isaac, N. J., Roy, D. B., Procter, D., Eigenbrod, F., Freckleton, R., Hector, A., Orme, C. D. L. and Petchey, O. L. (2015). Biodiversity and resilience of ecosystem functions. *Trends in ecology & evolution,* 30**,** 673-684.

Ravallion, M. (2015). The idea of antipoverty policy. *Handbook of income distribution.* Elsevier.

Rawat, U. and Agarwal, N. K. (2015). Biodiversity: Concept, threats and conservation. *Environment Conservation Journal,* 16**,** 19-28.

Rössler, M. and Lin, R. C.-H. (2018). Cultural landscape in world heritage conservation and cultural landscape conservation challenges in Asia. *Built Heritage,* 2**,** 3-26.

Sanaullah, M., Usman, M., Wakeel, A., Cheema, S. A., Ashraf, I. and Farooq, M. (2020). Terrestrial ecosystem functioning affected by agricultural management systems: A review. *Soil and Tillage Research,* 196**,** 104464.

Shuro, A. R. (2017). Review paper on approaches in developing inbred lines in cross-pollinated crops. *Biochemistry and Molecular Biology,* 2**,** 40-45.

Singh, V., Shukla, S. and Singh, A. (2021). The principal factors responsible for biodiversity loss. *Open Journal of Plant Science,* 6**,** 011-014.

Sundaram, J. (2015). Analysis of TRIPS Agreement and the justification of international IP rights protection in the WTO's multilateral trading system, with particular reference to pharmaceutical patents. *Information & Communications Technology Law,* 24**,** 121-163.

Tsioumani, E. (2014). Exploring Benefit-Sharing from the Lab to the Land (Part I): Agricultural Research and Development in the Context of Conservation and Sustainable Use. *Edinburgh School of Law Research Paper*.

Uphoff, N. (2013). *Agroecological innovations: increasing food production with participatory development*, Routledge.

Van der Zanden, E. H., Levers, C., Verburg, P. H. and Kuemmerle, T. (2016). Representing composition, spatial structure and management intensity of European agricultural landscapes: a new typology. *Landscape and Urban Planning,* 150**,** 36-49.

Van Ginkel, M., Sayer, J., Sinclair, F., Aw-Hassan, A., Bossio, D., Craufurd, P., El Mourid, M., Haddad, N., Hoisington, D. and Johnson, N. (2013). An integrated agro-ecosystem and livelihood systems approach for the poor and vulnerable in dry areas. *Food Security,* 5**,** 751-767.

Young, K. J. (2017). Mimicking nature: a review of successional agroforestry systems as an analogue to natural regeneration of secondary forest stands. *Integrating landscapes: Agroforestry for biodiversity conservation and food sovereignty***,** 179-209.

Yousefi, M., Darvishi, A., Padró, R., Barghjelveh, S., Dinan, N. M. and Marull, J. (2020). An energy-landscape integrated analysis to evaluate agroecological scarcity. *Science of the Total Environment,* 739**,** 139998.

Zabel, F., Delzeit, R., Schneider, J. M., Seppelt, R., Mauser, W. and Václavík, T. (2019). Global impacts of future cropland expansion and intensification on agricultural markets and biodiversity. *Nature Communications,* 10**,** 2844.