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11. Conservation of Biological Resources in the Changing World

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Abstract:

The critical role that biological resources play in sustaining human life has in the last two decades received considerable if belated attention. In 1992 a broad framework for the conservation and use of the world's biological resources the Convention on Biological Diversity (CBD) was agreed by the United Nations Conference on Environment and Development (the Earth Summit). Despite increasing recognition, however, the world's biological resources continue to be lost at an alarming rate, particularly in developing countries where many of the remaining resources are concentrated. There are two well-known approaches to biodiversity conservation: in-situ conservation, which focuses on protecting habitats, and ex-situ conservation, which involves safeguarding individual species outside their natural habitats. Conserving biodiversity is a complex process that requires not only habitat protection but also a thorough analysis of the available biological resources. Over time, the concept of conservation has evolved from a static state to a more dynamic one, influenced by changing policies.

Keywords:

In situ- Ex situ- Biological Resources- Biodiversity- Conservation

11.1 Introduction:

Bioresources are biologically generated materials that support life on Earth. They encompass plants, animals, microorganisms, and all biogenic products. The purposeful use of these resources involves preparing food, discovering value-added bio-products, and generating energy. Bioresources are broadly known as any resource obtained from biological origin or nature. In other words, bioresources are considered as life-generated materials and processes that are naturally and sustainably renewable and biodegradable (Narodoslawsky, 2014) Consequently, these resources play a significant role in agriculture, the pharmacological industry, and the production of bioactive molecules with pharmaceutical and industrial potential, contributing to the nation's overall economic development. Bioresources are generally diverse and abundant in nature. This rich diversity means that people rely on these resources to obtain sufficient goods and services to meet their needs. Microbial diversity is extensive and has many applications in agriculture, environmental management, and the pharmaceutical industry. Legumes also provide food security for millions, and practices such as climate-smart agriculture can enhance sustainable utilization. Medicinal plants contain bioactive molecules with potential benefits, including antimicrobial, anticancer, antidiabetic, and hepatoprotective properties. Validating the ethnomedicinal properties of these plants can lead to the identification of numerous drug leads that would benefit humanity. However, the excessive use of natural resources can result in socio-economic and environmental issues. Thus, the conservation and sustainable consumption of biological resources are crucial for maintaining the balance of our ecosystem. To prevent the overexploitation of these resources, various strategies should be implemented. A strong emphasis should be placed on improving the resource efficiency of available biomass to develop novel products at reduced costs. In this context, multidisciplinary research on the utilization of different resources would be advantageous for advancements in health systems and industrial sectors through scientific and technological innovation.

A central challenge for development agencies is finding effective ways to incorporate ecological concerns into rural development projects and programs that aim to reduce poverty and promote economic growth, particularly for improving the living standards of poor rural communities. This challenge is closely linked to the concept of sustainability, which emphasizes the importance of ensuring that future generations are not adversely affected by today's short-term decisions and actions. Development and conservation share many common goals, making it essential to seek opportunities for convergence wherever possible. However, there are times when these two objectives are not mutually supportive, leading to trade-offs between development and conservation. These trade-offs may become more frequent due to population growth and other changing pressures. Unfortunately, project and program preparations often overlook or minimize these trade-offs, and they are rarely integrated as a considered and budgeted aspect of development planning. Biological resources, their management, and people's livelihoods are complex and intricately interconnected.

The interventions aimed at rural development should begin with a clear understanding of how these resources benefit different groups of people, as well as the economic incentives and institutional factors that influence these processes. Additionally, it is crucial to analyze the costs and benefits of any proposed changes. Ignoring the micro-level economic-environmental interactions and the distribution of costs and benefits from a project or program can jeopardize its effectiveness, resulting in lower-than-expected economic gains and unnecessary degradation of biological resources. Bioresources are non-fossil biogenic resources that humans can utilize to meet their individual and social needs, such as food, materials, and energy. Key types of bioresources include crops and waste, timber from forestry, marine resources, common and aquatic weeds, organic residues from industries, and societal waste. These bioresources can be broadly classified into two categories: Primary Bioresources and Secondary Bioresources.

11.2 Primary Bioresources:

These bioresources are created for specific applications in forestry, agriculture, and aquaculture to facilitate the production of food, valuable products, and energy.

A. Crops:

Crops and plants are essential bioresources that fulfil many fundamental needs for both humans and animals. These plants can either be grown directly or their products harvested for profit or subsistence. Crops can be broadly categorized into six types:

1. Food Crops: These are primarily grown for human consumption and include wheat, rice, vegetables, potatoes, fruit-bearing plants, and various grains.
2. Feed Crops: These are cultivated specifically for livestock consumption, such as oats and alfalfa.
3. Fibre Crops: These are useful for producing cordage and textiles (e.g., Cotton, Hemp).
4. Oil Crops: These are grown for consumption or industrial uses (e.g., Cottonseed, Corn, sugarcane).
5. Ornamental Crops: These are used in landscape gardening (e.g., Dogwood, Azalea).
6. Industrial and Secondary Crops: These are used for various personal and industrial applications (e.g., Tobacco, Medicinal plants, Rubber).

These classifications highlight the diverse roles that crops play in supporting life and the economy.

Crop plants that are primarily cultivated for food or feed are typically not grown for their flavours, vitamins, or aesthetic appeal (Shapiro et al., 2017). Many types of crops, including vegetables, fruits, and grains, are grown worldwide by suitable climatic conditions and are consumed by people. According to the Food and Agriculture Organization (FAO), agriculture accounted for about one-third of the total land area in the world in 2016, with sugarcane, maize, wheat, rice, and potatoes being among the most widely cultivated plants (FAO, 2018). In addition to their use as food, some agricultural crop plants can be utilized for bioenergy production. For example, the residues of certain crop plants can serve as a direct energy source when burned, particularly in small villages. Furthermore, these residues can be commonly used to produce first-generation biofuels (Henry et al., 2017). Crop plants that are primarily cultivated for food or feed are typically not grown for their flavours, vitamins, or aesthetic appeal (Shapiro et al., 2017). Many types of crops, including vegetables, fruits, and grains, are grown worldwide by suitable climatic conditions and are consumed by people. According to the Food and Agriculture Organization (FAO), agriculture accounted for about one-third of the total land area in the world in 2016, with sugarcane, maize, wheat, rice, and potatoes being among the most widely cultivated plants (FAO, 2018).

B. Wood from forestry:

The forest plays a crucial role in the bioeconomy, offering significant potential through various sectors such as forestry, furniture manufacturing, wood processing, and a range of other high-value products (Gravelsins et al. 2017). The continued growth of the human population is leading to an increasing demand for wood. To address this demand, fast-growing tree species are being utilized as alternatives to wood sourced from natural forests (Adi et al. 2014). These fast-growing species outpace the growth of traditional trees found in natural forests and have shorter harvesting cycles, thereby helping to maintain a balance between wood demand and supply (Adi et al. 2014).

C. Marine bioresources:

Humans have explored marine bioresources over the years due to their immense potential for various applications. However, their uncontrolled exploitation has raised significant concerns worldwide (Fu et al., 2018). Human interaction with marine resources can be categorized into three main activities: fishing (extraction), aquaculture (farming), and tourism (contemplation) (Fabinyi et al., 2018). Marine biomass, which includes microorganisms, plants, and animals, has attracted considerable attention due to its diversity and unique biological activities (Qin et al., 2018). Seaweed, or macroalgae, stands out among marine bioresources as a valuable feedstock for biorefineries. This is due to its versatility and its ability to produce a variety of useful products, including oils, fatty acids, pigments, antioxidants, and other high-value biological components (Balina et al., 2017). The cultivation of seaweed has gained significant attention because it is considered eco-friendly compared to other agricultural practices, and it does not interfere with fish stocks (Fabinyi et al., 2018).

Currently, seaweeds are being explored for their potential in biorefineries to produce biofuels such as biohydrogen, methane, and bioethanol, as well as other bio-based products. This is advantageous since seaweeds do not compete with traditional food and feed crops (Balina et al., 2017; Sudhakar et al., 2018).

11.3 Secondary Bioresources:

One category of bioresources is secondary bioresources, which primarily consist of byproducts or waste generated from agricultural, industrial, or societal processes. Generally, utilizing these resources does not compete for land, allowing that land to be allocated for other purposes. Typically, secondary bioresources can be employed in two ways: in a cascade form, which extends the value chain of primary resources within society, or in parallel with valuable crops by using parts of plants that usually do not enter the market, such as straw and corn cobs (Narodoslawsky et al., 2014; Gwehenberger and Narodoslawsky, 2008). The following sections briefly discuss some important secondary bioresources.

A. Agricultural wastes:

Agricultural wastes or residues are primarily classified into two categories. The first category is "field residues," which typically includes the stems, stalks, leaves, and seed pods of plants. The second category is "process residues," which consists of materials such as husks, seeds, roots, bagasse, and molasses.

These residues are generated during the cultivation and processing of crops and can exist in solid, liquid, or slurry forms. Additionally, animal waste, including manure and carcasses, is also considered a type of agricultural waste (Obi et al., 2016; Singhania et al., 2018).

B. Industrial wastes:

Industrial waste is produced by various small and large-scale industries and typically includes a variety of residues. Common examples are slaughterhouse waste, flower waste from related industries, food waste from food processing, and black liquor from pulping. Additionally, significant amounts of waste are generated from agro-based food industries, such as peels from potatoes, oranges, cassava, and pineapples, as well as oil cakes from groundnuts, soybeans, and coconuts. These by-products arise from industries involved in juice production, chip manufacturing, meat processing, confectionery, and fruit processing. Generally, this type of waste is composed of various materials that are rich in sugars, minerals, moisture, and proteins (Sadh et al., 2018).

C. Municipal or urban wastes:

Municipal or urban waste mainly includes the waste generated by society and municipal corporations, like food waste, market waste, yard waste, plastic containers, etc. These wastes are also commonly known as trash or garbage (Gupta and Gupta, 2015). However, here, only biowastes like everyday household waste items like food and kitchen waste (i.e., vegetables, fruits, etc.), wastepaper, organic municipal waste, used vegetable oil, wastewater, etc., are discussed. Management of municipal solid waste (MSW) is a major concern around the globe (Mesjasz-Lec, 2014). However, various alternative waste management options are proposed to deal with MSW and limit the residual amount left for disposal to landfill. Among the various options, advanced biological treatment (ABT) like in-vessel composting and anaerobic digestion is most routinely used. Aerobic decomposition is considered a composting process, in which biodegradable material is decomposed into carbon dioxide, and water moreover, the heat generated through microbial respiration in the presence of oxygen converts this material into compost, which is a very beneficial fertilizer for plant growth. Similarly, in anaerobic digestion, biodegradable material is converted into methane, carbon dioxide (together known as biogas), and water. The biogas and methane, thus produced, can be used as important energy sources (Department for Environment, Food & Rural Affairs, 2013).

11.4 Wastes from The Fishing Industry:

Currently, the disposal of by-products from the fishing industry, such as crustacean residues is a major problem, which in many cases is responsible for silting rivers and mangroves and forming the slurry in soils causing severe ecological imbalances in these ecosystems. Carapaces of crayfish, shrimp, and crab, usually discarded, are quite significant because they contain 15%-20% chitin, 25%-40% protein, and 40%-55% calcium carbonate, as well as pigments and lipids in small amounts (Craveiro et al. 1999 and Campana-Filho et al. 2007). With the advancement of green technologies in search of a sustainable society, the by-products of the fishing industry, such as exoskeletons of crustaceans are also of great importance for biotechnology since they can be used to generate value-added products.

In 2017, the global market for crustaceans reached a value close to 147 billion dollars with a market growth perspective of 4.5% (FAO, 2014). This increase in the market is mainly due to population growth and consumer demand for healthier foods. Based on this growing market and the need for a correct destination for the by-products generated by the fishing industry, in recent years' biotechnology has focused on the use of exoskeletons of crustaceans to obtain chitin and chitosan, biopolymers of extreme importance for modern society.

11.4.1 Common Weeds:

Weeds are among the most harmful biotic factors in agricultural production, causing severe losses in crops, and their management is an integral part of agriculture (Gharde et al. 2018). These plants are ubiquitous and developed several mechanisms to compete with other species for nutrients, water, and light; some of the main characteristics of such weeds are listed below (Zimdahl 2018):

- Fast seedling growth and reproduction
- Capacity to grow and tolerate under a wide range of edaphoclimatic conditions
- Long-term resistance to detrimental environments several evolutionary mechanisms of dormancy and seed dispersal
- Do not require special conditions for germination
- Production of large quantities of seeds per plant

- Morphological and physiological adaptations against grazing
- Great ability to compete for nutrients, water and light
- Resistant to herbicides

Despite being invasive plants, some species of weed are used as food by people, Purslane (*Portulaca oleracea*), barnyard grass (*Echinochloa* sp.), dandelion (*Taraxacum* sp.), etc., are some weeds that can be consumed in raw, cooked or parched form (Zimdahl 2018). Apart from their use as food and feed, it is considered one of the most important noncompetitive renewable resources to produce biofuels and other bio-based products (Ciesielczuk et al. 2016). *Lantana camera*, a common weed spread worldwide, is generally used to treat some health problems due to its chemical constituents, such as ursolic acid, a pentacyclic triterpenoid present in plants that is responsible for various pharmacological activities (Verma 2018). In biofuel production, weeds can be used as promising feedstocks because they have high calorific values, and availability, and are less expensive than processed wood, such as briquettes and pellets (Ciesielczuk et al. 2016, Saikia et al. 2015). Besides biofuels, these plants can be used to produce bio-based products like biobutanol. After a pretreatment, generally, acid hydrolysis is followed by alkaline delignification and enzymatic hydrolysis to obtain a hydrolysate rich in both pentose and hexose sugars that can be fermented by specific microorganisms (Borah et al. 2019).

11.4.2 Aquatic Weeds:

Aquatic weeds or macrophytes occur naturally in all types of water, as an important part of the aquatic ecosystem, but their exacerbated growth causes serious negative ecological and anthropomorphic effects (Pompeo et al. 2017).

These are divided according to growth pattern into three types: (i) submerged: growth underwater, (ii) emergent: species rooted in the sediment, but presenting floating leaves, and (iii) floating: plants that are not attached to the sediment, being free-floating in, at least, one step of their lifecycle (Hussner et al. 2017).

Macrophytes are considered invasive plants, generally grow in water due to the availability of nutrients, such as phosphorus and nitrogen generated due to some human activities and their huge growth may cause serious ecological and economic damage (Kaur et al. 2018). These nonnative plants are distributed worldwide, with no natural enemies, and have fast propagation (Kaur et al. 2018 and Feng et al. 2017). Once introduced into an aquatic ecosystem, their accelerated growth can cause mainly, channel blocking and water quality deterioration with negative effects on biodiversity and extinction of aquatic organisms (Feng et al. 2017). Although aquatic weeds are considered a major concern due to their negative environmental effects, these plants are relevant for biotechnological applications. These plants are generally found to be rich in cellulose and hemicellulose, with very low lignin content (Kaur et al. 2018); therefore, they can be used as a potential renewable feedstock to produce biofuel and bio-based products. When compared to other lignocellulosic biomass, low lignin content in aquatic weeds and a few other advantages like the nonrequirement of land for cultivation and any inputs make them more suitable feedstocks (Kaur et al. 2018).

11.5 Bamboo and Grasses:

Bamboo and a variety of grasses are also important sources of biomass, which can be used as novel feedstocks to produce various biorefining products. In this section, bamboo and important grasses have been discussed.

Bamboo: Bamboo is a fast-growing species, which acts as an abundant source of biomass. It is widely distributed around the globe, especially in Asia, with India and China. The existence of the remarkable genetic diversity of bamboo can be assessed from the reported number of bamboo species, which is about 1200 (Saikia et al. 2007, Kapu et al. 2017). For thousands of years, bamboo has been a very popular feedstock for various commercial products like flooring, furniture, plywood, building materials, etc. In addition, over the past decades, bamboo has been used as prime feedstock in the paper and pulp industry for making paper and paper products (Alexopoulou 2018). Apart from these, it can be potentially used to produce cellulosic ethanol despite its high silica content, which is a major challenge for bamboo processing (Yuan et al. 2017). ***Switchgrass***: Switchgrass (*Panicum virgatum* L.) is a type of perennial (C4) grass and is also called an energy crop. It is commonly found in warm-weather regions, and it is native to the United States, particularly in North America (Lewandowski et al. 2003). It is considered one of the most promising feedstocks to produce ethanol because of its fast-growing nature, high yields, low inputs, remarkable adaptability to diverse conditions, and resistance toward many diseases and pests (Keshwani and Cheng 2009).

Miscanthus: Miscanthus is another low-input perennial (C4) grass, that originated from warm-season areas of Asia. Nowadays, it is cultivated over a wide geographic range in temperate regions; however, conditions in arid regions are not appropriate for its cultivation. Miscanthus can grow up to 13 feet even in poor soils, including marginal land and requiring very little or no fertilizer like switchgrass, it can be stored for longer periods. It is possible to use the same crop for about 15-20 years without reestablishment with proper management and weed control (Farm Energy 2019)

Giant reed (Arundo donax* L.*): It is another kind of perennial (C3) grass. It is an herbaceous, erect, fast-growing, low-input-high-yielding grass, which may grow up to 9 m. It is identified with several names around the globe, which mainly include Carrizo, Arundo, Spanish cane, Colorado River reed, wild cane, etc. The subtropical and warm temperate regions are the most suitable for the growth of this grass. Moreover, its presence was well documented in the Mediterranean basin for thousands of years. Various historical and archaeological reports available indicate that it may have originated from Asia, South Europe, North Africa, the Middle East, North and South America, and Australia. Although it is not a native plant of India, during the last few decades, it has spread rapidly and covered most of the wetlands in the North-Eastern region of India (Saikia et al. 2015). It is often categorized as an important aquatic plant due to its rapid growth in water.

Canary grass (Phalaris arundinacea): It is a perennial bunchgrass that commonly forms extensive single-species stands, which can reach up to 2 m in height, sometimes referred to as reed canary grass. It is commonly found along the margins of lakes and streams and in wet open areas and grows extremely well in poorly drained regions (Strasil 2012 and Rancane et al. 2017). As far as its distribution is concerned, it is widely distributed in Europe, Asia, northern Africa, and North America (U.S. Department of Agriculture, 2010). It is one of the highest-yielding cool-season grasses and is considered the most important renewable feedstock for biofuel production (Wrobel et al. 2009 and Rancane et al. 2016). Biomass from grasses like canary grass can be used for the generation of biogas and biomethane through its anaerobic digestion or for combustion in adapted heating plants (Thumm et al. 2014 and Rancane et al. 2015).

11.6 Biorefinery Technologies:

The biorefinery concept is not new. Biomass-converting technologies, such as sugar/ ethanol or pulp and paper industries exists since the 19th century. It is well known that energy is one of society's major pillars for the development of a new sustainability model. It can be useful to develop new circular economy policy models based on bioeconomy. However, for proper implementation of bioeconomy and biorefineries, it is necessary to understand the benefits and challenges of this model so that a large spectrum of products can be generated for societal needs.

11.6.1 Feedstock Utilization in Biorefineries:

The biorefinery is a facility that aims to integrate above mentioned bioresources and industrial processes to produce a variety of products, that may meet human needs. Bioresources from aquaculture (algae, seaweeds, etc.), lignocellulosic (sugarcane, rice straw, forest residues, etc.) starch crops (rice, maize, and soybean) or even human wastes (used industrial cooking oils, municipal waste) can be utilized. Their applications may vary according to different biorefinery models (Hingsamer & Jungmeier 2019). They are divided into two groups: energy (fuels, electricity, heat, and synthetic biofuels) and products (chemicals, food, and feed, as well as some other materials).

Similarly, biorefineries can be classified according to their main conversion processes: biochemical (fermentation or enzymatic fermentation); thermochemical (gasification, pyrolysis), chemical (synthesis and esterification), and mechanical processes (fractionation and pressing) (Hingsamer & Jungmeier 2019). Different platforms presented in a biorefinery must be connected to a specific feedstock and technologies and used according to each product generation. For that, biomass must be first fractionated in its composites (fibers, oils, proteins, and sugars) using biological or thermochemical processes for bio-based products and bioenergy generation (Sannigrahi & Ragauskas 2013).

Biorefineries can be classified into four different structures: platforms, products, feedstocks, and processes. These four elements are responsible for different biorefinery configurations (Hingsamer & Jungmeier 2013). A good example is the sugarcane industry in which various products like C5 and C6 sugars, ethanol, and various other valuable products can be produced from sugarcane bagasse. The generation of coproducts, such as biogas, fertilizer, and electricity may occur or not, according to the necessity and the demand for products and the physical limitations of the biorefinery.

11.6.2 Sustainability and Regulatory Applications:

Sustainability is the major pillar for the implementation of biorefineries, and all processes must be in synergy. The complete utilization of the biomass for optimized and maximized generation of products must be followed, promoting economic, environmental, and social benefits. The overall life cycle analysis (construction, operation, and dismantling) must follow the standard international methods, such as Life Cycle Assessment (environmental), Life Cycle Costing (economic), Social Life Cycle Assessment (social), and Greenhouse gases (GHG) emission (Benoît et al. 2010).

Regulatory commissions around the world have presented new proposals for the substitution of traditional chemicals and the utilization of bioproducts. The Renewable Energy Directive (RED) establishes an overall policy for the production and promotion of energy from renewable sources in the EU, proposing that until 2020, transport fuels must present at least 10% of renewable fuels. Until the same date, the substitution of 20% of energy needs for the renewable source is expected, to reach 32% by 2030 (European Union 2018).

11.6.3 Importance of Conservation:

The preservation of natural resources, encompassing ecosystems, species, and habitats, is crucial for the well-being of our planet. Human-induced environmental degradation, exemplified by deforestation, pollution, and resource overexploitation, underscores the urgent need for comprehensive conservation strategies. Maintaining biodiversity is a paramount conservation objective, as it ensures the integrity and resilience of ecosystems. The loss of biodiversity compromises ecosystem stability, rendering them increasingly susceptible to collapse. Effective conservation initiatives, including habitat preservation and species reintroduction programs, are vital for safeguarding biodiversity and guaranteeing the long-term sustainability of ecosystems (Pasko and Lebedeva 2024).

Conservation is instrumental in promoting human well-being by safeguarding the integrity of natural ecosystems. These ecosystems furnish an array of essential services, including the purification of air and water, soil generation, and climate modulation. For instance, forests play a crucial role in regulating the climate by sequestering carbon dioxide, while wetlands act as natural filters, removing pollutants from water. By preserving natural ecosystems, we can ensure the continued provision of these vital services. Moreover, conservation yields substantial economic benefits, in addition to supporting biodiversity and human well-being. Natural ecosystems provide a diverse range of ecosystem services, including recreational activities, tourism, and the extraction of natural resources. Coral reefs, for example, support lucrative fisheries and tourism industries, generating billions of dollars in revenue annually. By conserving natural ecosystems, we can guarantee the long-term viability of these industries (Kumari et al. 2024).

Climate change mitigation is another significant benefit of conservation. Natural ecosystems like forests and wetlands possess carbon sequestration capabilities, reducing atmospheric greenhouse gas concentrations. Conservation initiatives such as reforestation and habitat restoration can amplify this capacity, enhancing the role of natural ecosystems in climate regulation. In summary, conservation is vital for maintaining planetary health and resilience. By safeguarding natural ecosystems, we can concurrently support biodiversity conservation, human well-being, economic development, and climate change mitigation. We must prioritize conservation and strive toward a more sustainable future (Were et al. 2019).

11.7 Conclusions:

Bioresources are essential biological materials that originate from nature, characterized by their sustainable renewability and biodegradability. Throughout history, various bioresources have played a significant role in human development. Agricultural bioresources, particularly crops, are among the fundamental necessities for humans. Additionally, bioresources sourced from forests and various industries serve as potential and economically viable feedstocks for producing high-value products. Products such as biofuels, biopolymers, biosurfactants, enzymes, antibiotics, and organic acids can be generated from different bioresources. Among these products, biofuels have garnered considerable attention as clean and environmentally friendly alternatives to traditional fuels.

Similarly, other products such as biopolymers, biosurfactants, enzymes, organic acids, and antibiotics are valuable items with potential applications in the chemical, food, and pharmaceutical industries. While bioresources play a vital role in the bioeconomy and contribute significantly to a nation's economy, it is crucial to handle them with care to prevent overexploitation.

To conserve biodiversity, it is important to utilize bioresources in a manner that does not disrupt the planet's genetic and species diversity or harm critical habitats and ecosystems. Furthermore, it is essential to maintain a balance between different bioresources, as focusing solely on specific resources (e.g., food crops) for commercial gain can threaten food security and increase food prices. Therefore, effective management of bioresources can transform waste into wealth.

Bioresources are essential components of the bioeconomy, so it is crucial to take strong measures to raise awareness about their importance and limitations. This can be achieved by encouraging reactions and stimulating discussions across all sectors of society. If needed, strict legislation and policies should be implemented to develop a structural framework for biodiversity conservation.

11.8 References:

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