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Food Biodiversity as an Opportunity to Address the Challenge of Improving Human Diets and Food Security

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ABSTRACT

Scientists have warned for several years that food systems have become major drivers of environmental degradation, malnutrition, and food insecurity. In this paper, we present arguments from specialists that suggest that in the transition to more sustainable food systems, biodiversity and food security can be mutually supportive rather than conflicting goals. We have divided the opinions of these scientists into two "Big Topics". First, they examine the synergies and challenges of the intersection of biodiversity and food security. In the second section, they explain how various forms of food biodiversity, such as mushrooms, terrestrial wild animals, aquatic animals, algae, and wild plants, can contribute to food security. Finally, we present three main pathways that, according to these experts, could guide the transition toward biodiversity and food security in food systems.

Keywords: Food Biodiversity, Food Security, Nutrition, Wild Foods, Sustainable Development.

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INTRODUCTION

The idea that biodiversity conservation and food security are incompatible is based on a narrow view of food security as solely related to food production (Fischer et al. 2017). Some theories (e.g., land-sparing, Malthusian and neo-Malthusian, production possibility frontier, ecological modernization theory, etc.) assume that increasing food production will automatically lead to food security (Béné et al. 2019; Meli et al. 2019). However, the case of Brazil illustrates the weakness of this logic. Data from the National Food Supply Company of Brazil (CONAB) show that in the 2022/2023 harvest, grain production reached a new record of 312.4 million tons, surpassing the previous record set in 2021/2022 by 41.5 million tons (CONAB 2022). Despite being a major producer and exporter of commodities such as meat, soy, and corn (Aragão and Contini 2021), food insecurity in Brazilian households has also reached new highs. In 2020, 9%, or 19 million people, experienced severe food insecurity (a proxy for hunger); in 2022, this number rose to 33 million, or 15.5% of the population (PENSSAN 2021, 2022). Additionally, even though Brazil is a major agricultural supplier, the prevalence of anemia among children under two years old is 10%, with the highest rate being found in the North region at 17% (ENANI 2021). Moreover, anemia is more prevalent among nontribal river dwellers (ribeirinhos) in the northern region at 59% (Torres et al. 2022) and even higher among indigenous peoples such as the Yanomamis at 68% (Basta and Orellana 2020). Therefore, food security is not the automatic result of food production.

According to the Food and Agriculture Organization (FAO 1996), food security is defined as a state in which people have access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences while being able to maintain an active and healthy lifestyle and preserving cultural diversity and economic, social, and environmental sustainability. This concept is supported by four key pillars: availability (a reliable food supply), accessibility (the resources to obtain proper food), utilization (food quality and health conditions), and stability (permanent access to food). Therefore, based on this definition, food production (a proxy for availability) does not auto-

matically lead to food distribution to people (access), as these are distinct food security levels. Furthermore, by considering that food security is more than production, biodiversity can provide a range of opportunities to enhance access to nutritious and safe food (i.e., utilization) (El Bizri et al. 2020; Lachat et al. 2018) at all times (i.e., stability) (Tregidgo et al. 2020). It is difficult to quantify exactly how much of the world's biodiversity is neglected as food. However, it is widely recognized that a significant proportion of the world's biodiversity is underutilized or undervalued as food. For example, a study (Khoury et al. 2014) used national per capita food supply data published by the FAO to analyze trends in the richness, abundance, and composition of agricultural commodities measured in the food supply of 152 countries, comprising 98% of the world's population, between 1961 and 2009. Although there may be approximately 30,000 edible plant species on the planet (FAO 2010), according to the study, just 50 of the measured agricultural commodities (such as wheat, rice, and corn) contribute to the top 90% of calories, protein, fat, and weight in the world. The increasing reliance on a smaller number of crops to feed a growing population poses a real threat to food security (see Figure 1).

Biodiversity conservation and food security can be mutually reinforcing rather than competing goals. The Convention on Biological Diversity defines biodiversity as *the variability among living organisms from all sources including but not limited to, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystem* (UNEP 1992). There are many synergies between food security and biodiversity, as highlighted in a literature review by Blicharska et al. (2019) that examined the contributions of biodiversity (SDG14 and SDG15) to sustainable development goals (SDG2). These contributions can be broken down into the critical pillars of food security. At the availability level, biodiversity improves soil fertility, structure, quality, and health; provides crop pollination; and controls pests. At the utilization level, it improves dietary quality. At the stability level, it increases agricultural output and future yields, provides potential new crops, and maintains productivity in marine ecosystems. In addition, genetic diversity is important for increasing the resilience of agri-food systems to threats such as pathogens and climate change (IPCC 2019; UNEP 2020). These synergies can be achieved through a new paradigm of food production that includes sustainable agriculture, aquaculture and livestock systems, agroecological practices, the safeguarding of native species, varieties, breeds, and habitats, and ecological restoration (IPBES 2019).

Given the various opportunities and challenges that exist at the intersection of food security and biodiversity, we asked specialists in both fields how food biodiversity could help us address the challenge of food security. We surveyed specialists based primarily in the Americas, but some also conducted research in European and African countries. Two main themes emerged from their responses. The first theme focused on the synergies and challenges of the relationship between biodiversity and food security, considering the diverse research areas in which these scientists work. The second theme provided an overview of food biodiversity resources that have the potential to support the transition to sustainable diets while ensuring food security. Figure 2 summarizes the topics covered within "Big Topics" one and two.

BIG TOPIC 1: EXPLORING THE INTERSECTION OF BIODIVERSITY AND FOOD SECURITY: SYNERGIES AND CHALLENGES

This first section summarizes some of the multiple factors that should be considered when exploring the intersection of biodiversity and food security, such as seasonality and stability, indigenous and traditional knowledge, governance approaches, and the global scale. It also identifies the main challenges (e.g., climate change, the emergence of hunger, and the emergence of zoonotic diseases) that we could overcome by considering both people and nature when analyzing and proposing changes to our food systems. All opinions listed below are in alphabetical order.

Aline Martins de Carvalho e Larissa Mont'Alverne Jucá Seabra: Climate change mitigation through a local and biodiverse diet

According to the Intergovernmental Panel on Climate Change (IPCC), the food system is responsible for 11 to 19 Gt CO2-equivalent emissions per year globally, which constitutes 21% to 37% of total anthropogenic emissions (IPCC 2019). The situation is worse in Brazil, where approximately 70% of greenhouse gas emissions (GHGE) are related to the food system (SEEG. System of Estimates of Emissions and Removals of Greenhouse Gases 2019). The high level of greenhouse gas emissions (GHGE) in Brazil can be partly attributed to the country's status as a major agroproducer and one of the world's leading producers and exporters of meat, soy, corn, and other commodities (Belik 2020). One way to mitigate climate change is through the adoption of a local and biodiverse diet.

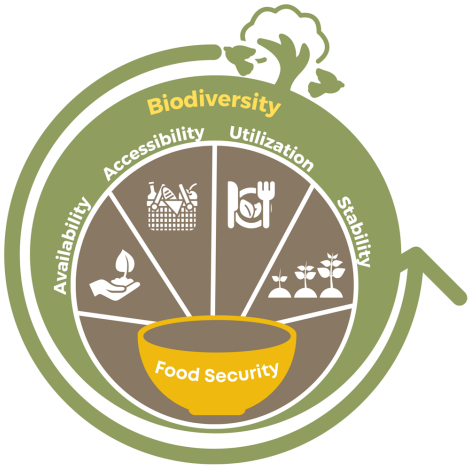

Figura 1. Key pillars of food security, which extends beyond just food production. These components include the availability of a reliable food supply, the accessibility of resources to obtain adequate food, the utilization of food in terms of quality and health, and the stability of permanent access to food.

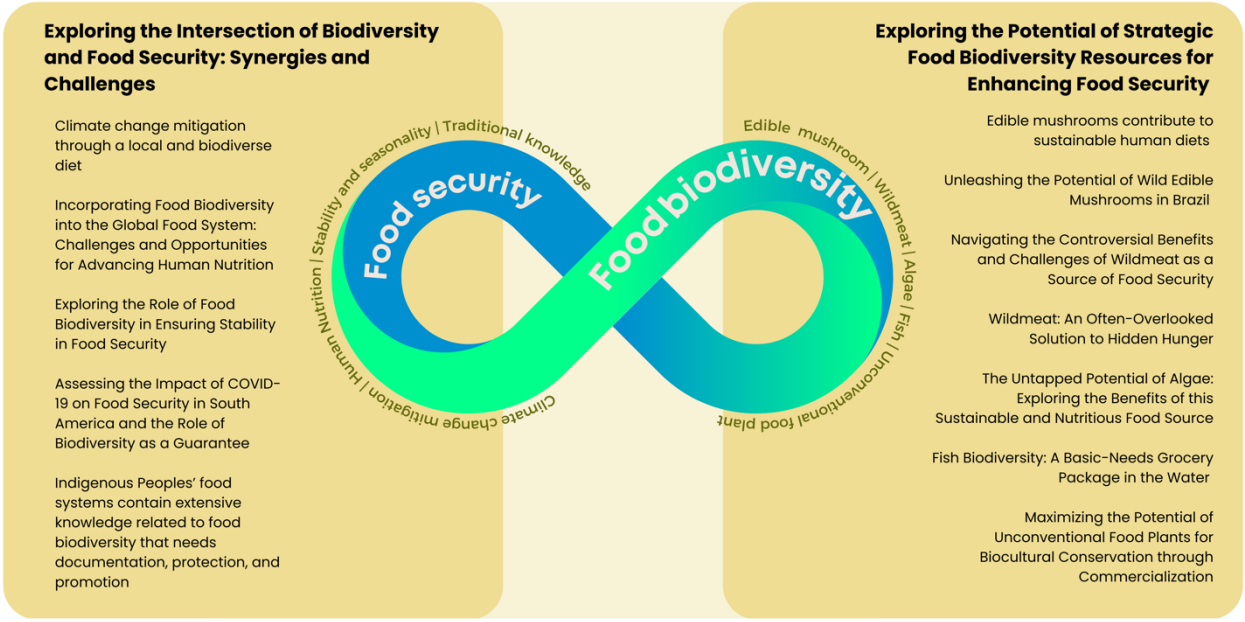

Figura 2. Summary of the synergies and challenges at the intersection of biodiversity and food security (Big Topic 1) and the role of strategic food biodiversity resources in enhancing food security (Big Topic 2).

Food production is the largest contributor to emissions in the food supply chain, but reducing food miles (i.e., the transportation of food) can decrease total emissions by approximately 5%, benefit small local farmers socially and financially, and reduce food waste (Crippa et al. 2021). A more biodiverse diet is a significant dietary change that can have environmental benefits, as the current Brazilian diet has a high environmental impact and is of poor quality. In a study optimizing nutritional recommendations for the Brazilian population, all the models showed that reducing red meat and increasing fruits and vegetables would decrease the impact of GHGE from diet by 10-27% (Verly Jr et al. 2022) and increase biodiversity. Currently, beef is one of the most consumed foods in the country and is responsible for 68% of GHGs (Travas-

sos et al. 2020). Other meats, such as goats, which are well suited to the semiarid climate in Brazil, as well as legumes, cereals, fruits, and vegetables (Garzillo et al. 2019), have a much lower environmental impact. Therefore, a local and biodiverse diet can be a solution for mitigating climate change, especially in Brazil.

Danny Hunter: Incorporating Food Biodiversity into the Global Food System: Challenges and Opportunities for Advancing Human Nutrition

Food biodiversity is under threat globally because current agri-food production and consumption rely on a small number of food species. Homogenous diets, limited food access, and underdeveloped markets for trading underutilized, nutrient-rich food biodiversity contribute to the persistence of malnutrition, especially hidden hunger, poverty, and environmental degradation, including biodiversity loss and climate change. This reliance on a narrow range of food crops introduces a significant vulnerability in our food production and food systems, as large areas of monocrops continue to depend on corporate-controlled seed systems that require significant external chemical inputs. Our global agri-food system remains unsustainable and inequitable, with over 80% of global agricultural subsidies going toward industrial agriculture for cereal production and red meat, while less than 1% goes to much-needed fruit and vegetable production, which is nearly universally underconsumed (Hunter et al. 2020). Additionally, very little in the way of subsidies goes toward research and development of underutilized food biodiversity species. The governance and political economy of the agri-food system play a key role in the current crisis humanity is facing. To address this issue, a significant overhaul of the agri-food system is necessary, including a reorientation of subsidies toward more biodiversity-friendly food production systems, including targeted support for untapped, nutrient-rich food biodiversity. The strategic use of locally adapted, culturally appropriate nutrient-rich food biodiversity must be central to this challenge to conserve this biodiversity and offer environmental, livelihood, and health benefits to communities worldwide. Based on our work on this topic at Biodiversity International (Kennedy et al. 2017), we highlight three strategic pathways for how country-driven collaborations and networks employing multisectoral and interdisciplinary approaches can support agri-food system transformation toward biodiversity: 1) providing evidence for the nutritional value of food biodiversity; 2) influencing policy and markets to incentivize food biodiversity; and 3) creating awareness, advocacy, and action around consumer behavioral change.

Daniel Tregidgo: Exploring the Role of Food Biodiversity in Ensuring Stability in Food Security

Food stability, or being food always secure, is often overlooked as one of the four key pillars of food security (Cruz-Garcia et al. 2016). Food instability can be caused by various shocks, such as wars, crop failures, and droughts, but is most commonly a result of seasonality, a characteristic of agricultural food systems worldwide (Vaitla et al. 2009). Food biodiversity, including wildmeat, fish, plants, and mushrooms, is also highly seasonal and is influenced by species phenology - e.g., Nyahongo et al. (2009) - and fluctuating environmental factors that impact harvestability. In areas where people rely on wild food, such as fish, lean seasons can result in severe food insecurity (Tregidgo et al. 2020). Food biodiversity can, however, act as an important safety net during periods of food instability (lean seasons and environmental shocks) (Karjalainen et al. 2010). Increased wild fish (Coomes et al. 2010) and wildmeat (Golden et al. 2019) consumption is common during agricultural lean seasons, while increased wildmeat (Brashares et al. 2004; Endo et al. 2016) and even fruit consumption during periods of fish shortages may offset reduced fish-derived nutrient intake (Tregidgo et al. In review). Wild foods are argued to be more resilient than many farmed foods, making them particularly important natural insurance against shocks in the context of ongoing climate change. In addition, the seasonality of food biodiversity systems can increase dietary biodiversity through the availability of different species throughout the year, potentially leading to improved micronutrient adequacy (Lachat et al. 2018).

Frederico Vasconcelos and Pedro Mayor: Assessing the Impact of COVID-19 on Food Security in South America and the Role of Biodiversity as a Guarantee

Latin America is known for its rich biodiversity, accounting for one third of all animal and plant species on the planet (Raven et al. 2020), as well as for its high agricultural production, which unfortunately also poses a major threat to its biodiversity. The current productive model, combined with other sociopolitical factors, contributes to high levels of social inequality and, as a result, serious problems with food and nutrition security (Rosen and Shapouri 2009). The global health crisis caused by COVID-19

has further exposed these pre-existing vulnerabilities. Our estimates for 2019 in South America showed that 22 million people had moderate and severe food insecurity (Clapp and Moseley 2020). For 2020, during the COVID pandemic, we saw an increase of 12.4% (+84.4 M) in the number of people facing food insecurity in urban areas (Clapp and Moseley 2020). Meanwhile, the contribution of the agricultural sector grew, and food exports increased by 5% (Vasconcelos-Neto et al. in press); however, the population experienced food price inflation of up to 22.5% (October 2020) (The World Bank 2022). In general, efforts to alleviate hunger should take a multisectoral approach, including policies that support agrarian reform, ensure access to education and basic health, reduce poverty and job insecurity, and regulate food prices (FAO 2020a). At the same time, subsistence hunting and fishing have helped to ensure food security in rural societies in South America. Therefore, to guarantee food security and the well-being of these societies that rely on subsistence economies, we advocate for policies that promote the conservation of biodiversity and traditional knowledge (Bodmer et al. 2020).

Harriet V. Kuhnlein: Indigenous Peoples' food systems contain extensive knowledge related to food biodiversity that needs documentation, protection, and promotion

There is growing evidence of the numerous benefits of indigenous peoples' food systems, including the nutrient quality and health and wellness benefits derived from their sociocultural, mental, and spiritual dimensions (Kuhnlein et al. 2013, 2009). These unique foods, derived from plant and animal species, are known to indigenous peoples through their biocentric connection to sustainably managed resources that historically provided adequate diets with traditional knowledge in the many ecosystems inhabited by indigenous peoples around the world. However, these food systems face numerous risks to their biodiversity from environmental threats to indigenous territories and health disparities for indigenous peoples due to poverty and marginalization, leading to a loss of food security and higher rates of obesity and undernutrition. It is important to recognize the scientific and cultural value of the biodiversity of indigenous food systems and to protect this knowledge for both its holders and the global food heritage. Indigenous peoples' food systems should be a priority for research and documentation, promotion, and protection to shift global food systems toward more sustainable diets and food security. Universities, governments, and United Nations agencies can contribute to this effort by conducting research with indigenous peoples using free, prior, and informed consent and by empowering women and youth with intercultural food and diet education at all levels, benefiting both indigenous communities and the wider global population (FAO 2021a, 2021b).

BIG TOPIC 2: EXPLORING THE POTENTIAL OF STRATEGIC FOOD BIODIVERSITY RESOURCES FOR ENHANCING FOOD SECURITY

The FAO (2017) defines "food biodiversity" as the *diversity of plants, animals, fungi, algae, and other organisms used for food, including the genetic resources within species, between species, and provided by ecosystems.* This final section summarizes how various forms of food biodiversity, such as mushrooms, terrestrial wild animals, aquatic animals, algae, and wild plants, can contribute to food security. We have received two comments about wild meat and edible mushrooms each. In the case of these food resources, we have placed the opinions alongside each category.

EDIBLE MUSHROOMS

Fillipe de Oliveira Pereira: Edible Mushrooms Contribute to Sustainable Human Diets

Promoting food security necessarily involves facilitating access to food, diversifying the diet, and sustainably producing food. Thus, wild and cultivated species of edible mushrooms can be strategic in achieving these goals. The consumption of mushrooms has long been part of the dietary history of humanity. Traditionally, eastern regions of the planet have a higher consumption of mushrooms, but this distinction has lessened with broadened access to edible species in the West. At present, people in urban areas around the globe may find species dried, fresh, canned, or frozen (Niazi and Ghafoor 2021). Therefore, here, I present three points that support the use of edible mushrooms to meet the challenge of improving human diets and food security. First, mushrooms improve the quality of the human diet, as they are high in protein, vitamins, and minerals and low in fat. In addition, they are rich in dietary fiber and are also recognized as prebiotic and antioxidant agents (Niazi and Ghafoor 2021). Second, growing edible mushrooms contributes to a sustainable food production system (circular food chains) because people may use agronomic and urban wastes to prepare suitable substrates for mushroom cultivation (Grimm et al. 2021). Third, funga,

represented by wild edible mushrooms, plays a central role in conserving the traditional knowledge of peoples and the biodiversity of the planet due to the cooperative relationship of funga with fauna and flora (Oyanedel et al. 2022).

Nelson Menolli Jr. e Mariana de Paula Drewinski: Unleashing the Potential of Wild Edible Mushrooms in Brazil

Wild edible mushrooms (WEM) are often overlooked as a nonwood forest product, but they are an important resource that has gained attention in recent years. While traditional use of WEM by indigenous and traditional groups in the Amazon region has been documented (Vargas-Isla et al. 2013), their consumption is still not widely practiced in Brazil. However, interest in foraging for fungi and mushrooms has been growing, and access to information on WEM has increased with the publication of reports, books, and species guides in Portuguese, as well as scientific outreach profiles on social media. Some mycological tourism initiatives have also been conducted, primarily in southern and southeast Brazil. There are approximately 400 species of WEM in Brazil, with approximately 80 species consistently recorded in the country (Drewinski 2023). Even in nonnative forest plantations, such as those of Pinus and Eucalyptus species, it is possible to find ectomycorrhizal mushroom species that can be used as a food resource. In addition to the species that are already known, many others remain undiscovered and could potentially become new food resources. Mushrooms are a limited, seasonal resource that represents an important phase in the life cycle of a fungus. Therefore, studies on the domestication and cultivation of wild species are important for diversifying mushroom production, ex situ conservation of genetic resources, and food sovereignty. WEM are related to at least 11 of the 17 goals of the 2030 Agenda for Sustainable Development (Pérez-Moreno et al. 2021). Due to its great ecological, sociocultural, economic, medicinal, and biotechnological significance, WEM can promote forest sustainability, mitigate greenhouse gas emissions, conserve biodiversity, reduce hunger, improve human nutrition and health, conserve traditional knowledge, empower women, and stimulate economic development (Pérez-Moreno et al. 2021). Despite the importance and growing interest in WEM, it is crucial to note that recognizing edible species requires a great deal of knowledge and skill. Therefore, people should not consume wild mushrooms without first ensuring their specific identification and previous edibility records.

WILD MEAT

Guillermo Ros Brull: Navigating the Controversial Benefits and Challenges of Wildmeat as a Source of Food Security

In various parts of the world, wildmeat serves as a primary source of protein (Fa et al. 2002) and micronutrients (Sarti et al. 2015) and plays a crucial role as a source of income for indigenous peoples and local communities (Coad et al. 2019). In addition, the process of finding, pursuing, hunting, and consuming wildmeat is closely tied to local ecological knowledge and influenced by cultural norms. However, in the post-COVID-19 context, various stakeholders (FAO 2020b) have argued for a ban on subsistence hunting to prevent future zoonotic disease spillover (Andersen et al. 2020) and to address the current trend of wildlife loss caused by large-scale commercial hunting for wildmeat in urban areas (Nasi et al. 2011). While a ban on hunting may seem to be a straightforward solution, it would threaten food security in tropical forest areas where there are no alternative food sources. Similarly, transitioning to cattle farming in these areas would require the clearing of tropical forests, leading to the loss of habitat for wildlife (Booth et al. 2021), an increase in the emergence of new diseases (Allen et al. 2017), and the erosion of indigenous and local knowledge and value systems (van Vliet and Mbazza 2011). Therefore, the sustainable use of wildmeat represents an opportunity to reconcile and achieve both sustainable development and conservation goals (Blaikie 2005). To take advantage of this opportunity, we must (1) devolve decision-making and resource control to local communities, (2) consult with local and national governments and civil society to apply international frameworks in a context-specific manner, and (3) develop conservation strategies that consider both scientific evidence and local sociocultural values and practices (Armitage 2005).

Patricia Carignano Torres: Wildmeat: An Often-Overlooked Resource to Avoid Hidden Hunger

Hunger is estimated to affect approximately 800 million people worldwide (FAO 2021c), but hidden hunger - deficiencies in micronutrients - affects billions of people. These deficiencies can lead to health impairments such as iron-deficiency anemia (IDA), which can compromise physical and cognitive development (Micronutrient Initiative 2009). Animal-source foods (ASFs) can be critical in avoiding certain micronutrient deficiencies because they have high levels of micronutrients that are more bioavailable than vege-

table sources. Wildmeat, which has not been well researched, can therefore improve nutrition and health, particularly in the context of some traditional food systems and given that billions of people cannot afford healthy diets (FAO 2021c). Wildmeat consumption has been shown to increase micronutrient intake, such as iron and zinc, in urban and peri-urban Amazonian households (Sarti et al. 2015). The authors argue that households not consuming wildmeat were at greater risk of anemia in the short term and other chronic health problems in the long term. In fact, the only two studies that directly investigated wildmeat consumption and health outcomes found an association with a lower prevalence of anemia. In rural Madagascar, in a context of low ASF consumption, removing access to wildmeat would increase the number of children with IDA by 29%, three times if only considering children in the poorest households (Golden et al. 2011). Even in a context with high fish consumption, in Brazilian Amazonia, wildmeat consumption was associated with higher hemoglobin concentrations in children from extremely poor rural households (Torres et al. 2022). The authors estimated that the prevalence of IDA would increase by 10% if wildmeat became unavailable. More research is needed to investigate the contribution of wildmeat to health outcomes, but the evidence thus far suggests its importance for vulnerable populations living in forested areas. Replacing wildmeat with domesticated meat is often infeasible in contexts of monetary poverty and can also be environmentally damaging due to land conversion (Nunes et al. 2019). Therefore, sustainable management of wildmeat offtake is crucial.

ALGAE OR SEAWEDE

Lara Silva, Alice Medeiros, and Michelle Jacob: The Untapped Potential of Algae: Exploring the Benefits of this Sustainable and Nutritious Food Source

Algae are important for the health of the oceans because they are a primary source of oxygen and food for many marine species. Furthermore, algae can be an important food resource for humans. Edible algae can be found in a variety of aquatic environments, including oceans, lakes, and rivers. They are rich in nutrients and have been used as a medicine and food source in many parts of the world for centuries, as is the case for some Asian countries and islands worldwide. (Tiitii et al. 2022). Some common types of edible algae include kelp (*Laminaria* spp. and *Macrocystis* spp.), nori (*Porphyra* spp.), and spirulina (*Arthrospira* spp.). Algae can be consumed fresh, dried, or processed in a variety of ways, e.g., cooked, fried, boiled, seasoned or in algae-based products (Pérez-Lorens 2019). As the world debates the transition to sustainable food systems, edible algae could play an important role in the development of more sustainable and nutritious food sources. There are two reasons for this. First, algae can be grown with minimal inputs and have a high productivity rate due to their short life cycle (FAO 2018). Second, they are also a good source of nutrients and can be used as a source of protein and other micronutrients, such as vitamin B12 (Kwak et al. 2010; Rauma et al. 1995), a vitamin previously thought to be exclusive to animal-origin foods, as well other micronutrients (El Din and El-Sherif 2012; Ito et al. 2016), such as calcium and iron. Further research is necessary to gain a deeper understanding of the socioeconomic and cultural characteristics of food consumers to promote the global consumption of algae, particularly in contexts where the sustainable production or harvesting of this food resource is a viable opportunity.

FISH

Priscila Lopes: Fish Biodiversity: A Basic-Needs Grocery Package in the Water

Consumption of aquatic animals, mostly finfish, rose from 9.9 kg in the 1960s to 20.2 kg/capita/year in 2020, an annual increase of 1.4% mainly driven by upper-middle-income countries (FAO 2022). This increase in demand has been met with the support of aquaculture, as many economically relevant fish stocks show worrying signs across the globe (Pauly and Zeller 2016). Wild fish still provide 44% of the world's fish intake (FAO 2022), with marked differences between fish consumed by wealthier classes and fish consumed by the poor. While richer countries and richer people within various countries may prefer to consume a few species that are mild in taste, popular, or easy to handle (Lopes et al. 2017), the poor rely on a much greater diversity of species, particularly in freshwater environments (Kolding et al. 2019). For 3.3 billion people, aquatic animals provide approximately 20% of their protein intake, which can be as high as 50% or more in some countries and regions (FAO 2022). In places in the Brazilian Amazon, for example, fish intake can reach more than 800 g of fish/capita/day (Corrêa et al. 2014). For the poor living by water bodies, fish may be the most important source of animal protein and essential micronutrients (Funge-Smith and Bennett 2019; Hicks et al. 2019). As various threats to biodiversity relentlessly advance (e.g., unchecked adoption of the Blue Economy agenda, large river dams, and climate change), not only are species lost but risks to food security

and the sovereignty of already vulnerable populations increase (Lopes et al. 2021). In addition to the environmental, health, and cultural consequences, the loss of fish biodiversity means that vulnerable people are further impoverished, as they need to divert part of their income to acquire an important part of their basic-needs grocery package through conventional markets.

UNCONVENTIONAL FOOD PLANTS

Rafael Vasconcelos: Maximizing the Potential of Unconventional Food Plants for Biocultural Conservation through Commercialization

Unconventional food plants (UFP) have gained popularity worldwide, particularly in the context of transitioning to sustainable food systems. UFPs are little-used or little-known plant species, mainly outside of their natural habitats. These plants are often associated with traditional knowledge and have previously been recognized by researchers under different names, highlighting their importance in food security strategies (Simonetti et al. 2021). Recently, the use of these plants by renowned chefs and their promotion on various media platforms has sparked growing interest and curiosity among potential consumers. This presents a promising opportunity for businesses, particularly in the context of supporting family farming and sustainable extractivism. Therefore, it is important to consider the potential for UFP to generate income while also promoting biocultural conservation. The idea of conserving biodiversity through the commercialization of its resources has been debated for decades (Evans 1993). However, the complex relationships involved in markets for biodiversity products make it difficult to automatically associate them with sustainability or degradation, although the latter seems to be more common. When seeking to evaluate the potential for promoting the commercialization of UFP as a biocultural conservation strategy, there are several questions that need to be considered, including the following: what is the influence of the inherent features of the products, such as flavor, nutritional value, and perishability, on their marketing potential? How do ecological and management aspects, such as the conservation status of natural populations, collection site, method of production, and ease of cultivation, impact their production potential in a sustainable manner? Do social aspects, such as the production organization, market institutional relationships, land and resource tenure, and governance, contribute to the viability of commercialization? How do economic factors, such as investment capacity, negotiated amounts, and profit sharing along the value chain, impact the viability of the business?

A TRANSITION TOWARD BIODIVERSITY AND FOOD SECURITY IN FOOD SYSTEMS

In Figure 3, we summarize three main pathways that, according to these experts, could guide the transition toward biodiversity and food security in food systems.

It is important to recognize that biodiversity and food security are interconnected and can support each other and to take a holistic approach to promoting both. As we continue to prioritize and invest in education, research, and governance related to biodiversity and food security, we hope that we can take meaningful steps toward realizing and effectively utilizing the potential of biodiversity to contribute to food security in a way that benefits both nature and people. By working together and focusing our collective attention on these issues, we can create positive change and build a more sustainable and secure future for all forms of life on the planet.

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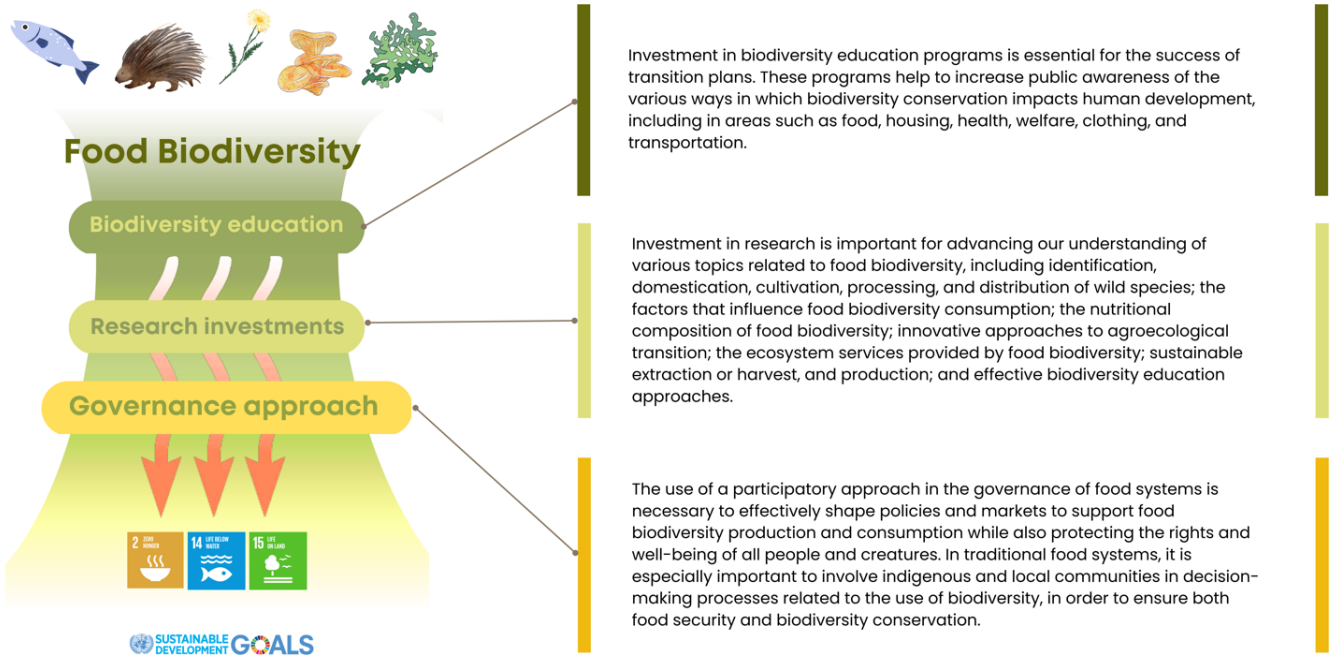

Figura 3. Strategies for Transforming Food Systems to Promote Biodiversity and Food Security in Current Food Systems.

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