

The Role of Agroecology in Food Security in Developing Countries

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Abstract – Global food security is one of the most ambitious goals. However, we are currently facing numerous challenges, including loss of biodiversity, climate change, increasing price volatility, environmental pollution, and resource degradation. Agroecology is one of the main approaches that can make it easy to reach food security by reducing reliance on chemical inputs, preserving biodiversity, emphasizing diverse cropping systems, improving soil health, and better water management. This review highlights the critical role of agroecology in achieving food security, particularly in regions where conventional farming methods have often exacerbated environmental degradation, depleted soils, and heightened vulnerability to climate change. Agroecological practices such as diversified cropping, organic inputs, and reduced dependence on chemical fertilizers contribute to healthier soils, increased biodiversity, and more sustainable food production. Additionally, it addresses key challenges and barriers to widespread adoption of agroecology. Finally, the study concludes that agroecology holds immense potential in reshaping global food systems and fostering long-term resilience by giving recommendations to smaller farmers and developing nations.

Keywords – Agroecology, Food Security, Climate Resilience, Developing Countries, Smallholder Farmers.

I. INTRODUCTION

According to the FAO, food Security is when all individuals have reliable access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life [1]. It has several components, including food availability, access, utilization, and stability, as shown in Figure 1 [2, 3]. Achieving food security globally is one of the most ambitious goals. However, in recent decades, we have faced numerous challenges, including biodiversity loss [4, 5, 6], climate change [7, 8], increasing price volatility [9], environmental pollution, and resource degradation [10, 11]. Additionally, ongoing conflicts such as those in Ukraine, Israel, and Sudan have also made food security issues worse [12, 13]. Many developing countries also struggle with poverty, political instability, and inadequate infrastructure, which disrupts food production and access [14, 15, 16]. Several researchers believe agroecology is a promising approach to improving food availability and building resilience in agricultural systems [17, 18]. Agroecology is regarded as a more comprehensive approach that combines ecological science with social and economic factors, supporting food sovereignty and local food systems [19]. The purpose of this review is to explore the essential relationship between agroecology and food security, specifically how agroecological practices enhance agricultural sustainability, resilience, and biodiversity. It aims to

demonstrate the contributions of these practices to improved food production, reduced vulnerability to climate change, and the empowerment of local communities.

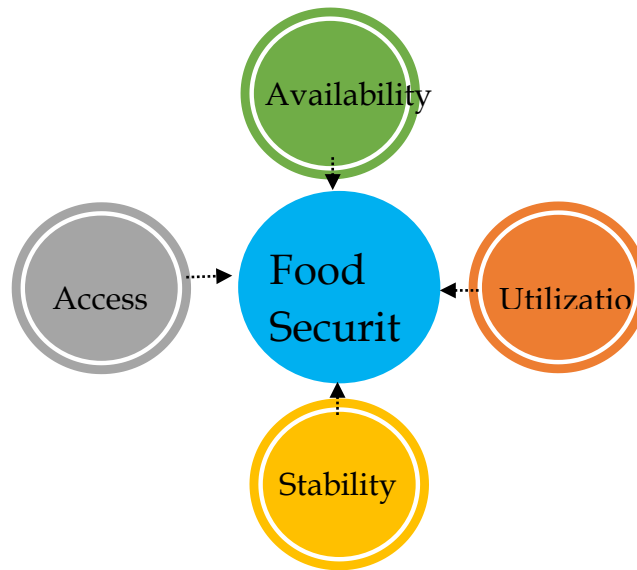


Fig. 1 Food Security Components

Ultimately, this review seeks to offer insights into how the adoption of agroecological approaches can secure food systems while promoting environmental sustainability and social justice, particularly in developing countries.

II. AGROECOLOGY

Agroecology is a multidisciplinary approach that applies ecological principles to the design and management of sustainable agricultural systems. It is considered the science of the interactions between an organism and an environment that humans have altered for food production, as shown in Fig. 2 [20]. While there are several definitions of agroecology, one of the most widely recognized is that it involves the integration of research, education, action, and transformation to promote sustainability across all aspects of the food system: ecological, economic, and social [21]. It optimizes the interactions between plants, animals, humans, and the environment while promoting biodiversity, enhancing soil health, and reducing dependency on external inputs.

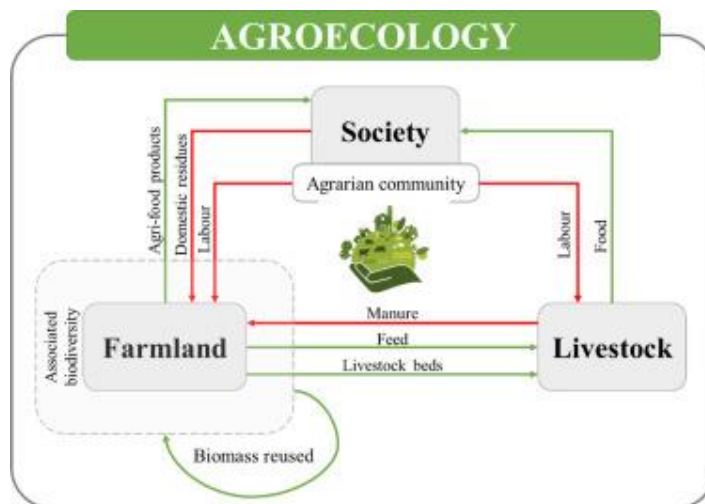


Fig. 2 The relationships between different actors in agroecology [20].

The 13 principles of agroecology were published by the High-Level Panel of Experts on Food Security and Nutrition (HLPE) and are commonly used around the globe [22]. They are classified into three categories: secure social equity, strengthened resilience, and improved resource efficiency, each of which includes several specific principles, as shown in **Figure 3**.



Fig. 3. The main principles of agroecology [22].

Agroforestry, organic farming, permaculture, integrated best management, and low-input agriculture are the main agroecological practices, that contribute to the sustainability of agricultural systems and food security in developing countries by improving productivity, enhancing environmental health, and supporting local communities [23, 24].



Fig. 4. Schematics illustrate agroecological practices [25].

III. AGROECOLOGICAL IMPACTS ON FOOD SECURITY

The current global food system is inadequate for meeting the dietary needs of the population, not because agricultural production is insufficient; we produce enough yield to nourish 10 billion individuals. Unfortunately, approximately 1.3 billion tons of food are wasted each year, while 2 billion people still face food insecurity or hunger, and an additional 1.2 billion are classified as overweight. Therefore, it is crucial to embrace a new paradigm like agroecology, which supports food sovereignty, biodiversity and ecosystem restoration, and distributive justice [26]. Numerous agroecological techniques, such as polycultures, crop rotations, livestock, aquatic species, integrating crops, agroforestry, protecting natural

habitats, and using fewer pesticides, can increase the availability of both cultivated and wild species for human use. Additionally, these practices increase the availability and accessibility of nutritious, diverse food sources and diets, which enhances food security, nutrition, and dietary diversity [27, 28, 29]. Millions of small-scale farmers worldwide currently practice agroecology. France, Germany, the United States, Switzerland, Denmark, and Spain are leading in promoting agroecological practices as a response to climate change, environmental degradation, and food security challenges [17, 21, 30, 31, 32]. Some developing countries including Brazil, India, Ghana, Vietnam, Kenya, Cuba, Mexico, Senegal, Ethiopia, Uganda, Nicaragua, Philippines, and other countries are also practicing agroecological to eliminate food insecurity [33, 34, 35, 36].

Small-scale farmers play a crucial role in global food systems and local economies. For instance, 35% and 24% of the 570 million family farms worldwide are in China and India, respectively [37]. While Africa is the continent facing the most food insecurity compared to the others, less than 15% of Africa's total agricultural area is used by small-scale farmers to generate more than 70% of the continent's food [38]. The JRC technical report, funded by the EU and published in 2020, indicates that certain agroecological practices positively impacted food security in Africa [39]. In Senegal, Burkina Faso, and Ghana, the use of residue mulch, crop mixtures, intercropping rotations, rope-livestock integration, the use of organic manure, conservation agriculture, shifting cultivation, bush fallow system, use of inorganic fertilizers, increased food availability and was identified as a positive practice [39]. In Zimbabwe, various agroecological practices, including integrated pest management, livestock integration, conservation agriculture, and organic production, were classified as having null, positive, and negative impacts [39]. As shown in Table 1, several countries have agroecological practices that positively affect their food accessibility, while others have mixed outcomes, indicating both positive and negative impacts. Agroecological practices not only address food security but also help combat deforestation, reduce pollution, mitigate soil erosion, and improve water quality, thereby promoting environmental sustainability [40, 41]. Several challenges hinder the adoption of agroecological practices in both developed and developing countries, such as a lack of knowledge and training, limited access to resources, inadequate policies, issues with transportation and storage facilities, and cultural beliefs regarding perceived lower productivity and increased labor [17, 42, 43]. Addressing these challenges requires a multifaceted approach, including education, policy reform, financial support, and infrastructure development.

Table 1. Impact of Selected Agroecological Practices on Food Security in Developing Countries

Country	Agroecological practices	Food security	Reference
Bangladesh	Integrated pest management (IPM), conservation agriculture, organic fertilizers	Mixed	[44, 45]
Brazil	Agroecological zoning, integrated crop-livestock-forestry systems	Positive	[33]
Burkina Faso	The use of organic manure, conservation agriculture, Rope-livestock integration,	Positive	[46, 47]
Ghana	Shifting cultivation, bush fallow system, use of inorganic fertilizers, etc.	Positive	[48]
India	Agroforestry, organic farming, mixed cropping, crop-livestock integration	Mixed	[49]
Indonesia	Conservation agriculture, agroforestry, organic farming	Positive	[50]
Mali	Crop residue management, cereal-legume cropping rotations, and biological pest control	Positive	[46, 51]
Senegal	Residue mulch, crop mixtures, or intercropping and rotations	Positive	[52, 53]
South Africa	Organic farming, water conservation practices, crop diversification	Positive	[18]

IV. CONCLUSION

This paper highlights the role of agroecology as a new model for food security in developing countries, as it not only boosts crop yields and diversifies food production but also strengthens local food systems against the challenges posed by climate change, economic instability, and social inequities. Promoting small farmers in developing countries is crucial for achieving food security; however, they face several challenges for which agroecology can provide solutions. To successfully adopt agroecological practices, farmers must first be educated about the importance of these methods and shown how to implement them. Additionally, governments must prioritize agroecological practices in agricultural policies by providing incentives and subsidies for farmers who adopt sustainable methods. It is essential to improve access to resources such as seeds, tools, and financial support for smallholder farmers. Ultimately, the adoption of agroecological practices can pave the way for sustainable agricultural systems that not only meet present needs but also safeguard resources for future generations.

CONFLICT OF INTEREST

The author declares no conflict of interest regarding the publication of this paper.

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