American International Journal of Business Management (AIJBM)
ISSN- 2379-106X, www.aijbm.com Volume 07, Issue 07 (July-2024), PP 392-402

Understanding Agroecology Practice in the Sustainable Production and Use of Organic Fertilizer in Regional Gambia

Morro Krubally[1], Lamin Dampha[2], Banna Sawaneh[3], Fatou Badjie[4]
[1]*School of Business, Economic and Public Administration University of the Gambia. Banjul the Gambia*
[2]*School of Business, Economic and Public Administration University of the Gambia. Banjul the Gambia*
[3]*School of Business, Economic and Public Administration University of the Gambia. Banjul the Gambia*
[4]*School of Business, Economic and Public Administration University of the Gambia. Banjul the Gambia*
**Corresponding Author: Morro Krubally[1]*

ABSTRACT : *The study was conducted to shed light on the current landscape of agroecology and organic fertilizer practices in the Gambia. Agriculture, a significant contributor to greenhouse gas emissions, faces challenges that agroecology seeks to address by integrating ecological principles into farming practices. This study aims to bolster the capacities of farmers in promoting and implementing organic fertilizer practices crucial for sustainable agriculture and food security in The Gambia. A quantitative approach was employed to collect data through questionnaires from 173 representatives from marketing federations in NBR and CRR. Findings revealed a significant engagement in organic fertilizer production, despite challenges such as inadequate materials and inconsistent government support. There's a clear demand for better quality materials, consistent support, and comprehensive training programs to enhance organic fertilizer production and agroecology practices. There's a call for more consistent and accessible support to promote the widespread adoption of organic fertilizers and sustainable agricultural practices. Overall, the study underscores the importance of addressing gaps in training, support, and policy awareness to foster sustainable agricultural practices and improve farm productivity in The Gambia.*

KEYWORDS – *Agroecology, organic agriculture, Sustainability, Organic Fertilizer, Gambia*

I. INTRODUCTION

Agriculture is the second largest emitter of greenhouse gases (GHG) after the energy sector, accounting for approximately 30% of total Green house Gases (GHG) emissions [1]. When agroecology first emerged in the early 1980s, it was most often viewed as a form of alternative to the changes sweeping through the food system as a result of the green revolution, simplification through monocultures, industrialization of all aspects of food production, processing, distribution, increasing corporate control and dominance of the food system [2]. The most common definition of agroecology during the early stages was the application of ecological concepts and principles to the design and management of sustainable agroecosystems, or the science of sustainable agriculture [3],[4].

In its early years, agroecology's primary focus was on the farm or farm agroecosystem [2]. This approach encouraged farmers to shift away from conventional industrial farming inputs and practices (particularly fossil fuel-based chemicals and fertilizers) and toward certifiable organic production systems [5],[6]. Farmers also began to restore diversity to their farming systems when it became clear that simply substituting inputs was insufficient to address the issues common to monoculture systems. Farming systems were redesigned to be resistant to these problems [2]. By the late 1990s, the definition of agroecology had expanded to include the ecology of the entire food system [2]. The agroecosystem was no longer just the farm; it had to encompass all aspects and participants in the food system since everyone eats, including the entire human race. This included the importance of re-establishing close relationships between those who grow the food and those who consume it, as well as reducing the negative effects of the intermediary system that connects the two. Agroecology evolved into a method of creating relationship-based market systems that are fair, just, and accessible to all [7]. Pereira et al. (2018)[5] opined that agroecology has grown in popularity over the last 50 years, but its practices are as old as agriculture itself. Agroecology is described as a science, a movement, and a set of agricultural practices, but at its heart is the application of ecological concepts and principles to the design and management of sustainable agricultural systems[5]. Agroecology integrates the study of the entire food system, including ecological, economic, and social dimensions, and encourages practitioners to recognize system connectivity while emphasizing unique, appropriate, and context-specific solutions. Most small-scale farmers around the world practice agroecology, and they are also among the poorest in the population.

Altieri and Nicholls (2012)[8] argued that alternative agricultural systems should be based on the diverse ecologically based agricultural approaches developed and practiced by at least 75% of the world's 1.5 billion smallholders, family farmers, and indigenous peoples. These alternative farming systems, which are broadly classified as agroecology, are distinguished by the use of ecologically sound technologies, a focus on family farming and local production, low levels of external inputs, and a diverse nature. Thus, making this study significant in the context of agroecology and organic fertilizer practices. Furthermore, this study is significant for The Gambia as a developing country with 47.52% (of total employment) [9] people deriving employment from the agriculture sector. Thus, agroecology presents important opportunities for showcasing alternative agricultural development pathways that are contained within planetary boundaries and that demonstrate innovations that are societally desirable and ethically responsible. Moreover, Pereira et al. (2018)[5] opined that developing countries (such as The Gambia) are uniquely positioned to establish alternative agricultural pathways that maximize livelihood creation and sustainable food production as agroecology is a more appropriate agricultural development paradigm for inclusive innovation in which the poorest and most marginalized participate and benefit from associated innovation processes [10].

Additionally, this study is significant because agroecology goes beyond the science and practice of agriculture. It is also a social movement founded on principles of food sovereignty, ecology, sustainability, gender, justice, farmer networks, land access, resilience, and resistance [11], [12]. When viewed in direct opposition to the negative effects of capital-intensive practices introduced during the so-called "Green Revolution," agroecology has grown as a social movement [5]. Agroecological practices' innovations are gaining recognition as they are guided by local knowledge and implemented through participatory methods and community engagement [8].

This study is critically important as organic fertilizer practices have received much attention in the literature. Organic amendments' impact on crop yield and soil fertility has been studied extensively around the world, and it has been identified as critical for sustainable agroecosystem management[4]. For example, Kwesiga et al. (2020) [13] investigated the effects of repeated applications of green and farmyard manures on rain-fed rice performance in East African rural floodplain environments and discovered that both amendments resulted in a significant increase in grain yield (18-62%), with a positive residual effect on non-amended rice yield in the third year, as well as increased soil fertility. Thus, there is enough evidence, albeit researchers have paid little attention to these systems – to suggest that agroecological technologies promise to contribute to food security on many levels [14]. This is particularly important for The Gambia as an agriculture-based economy. The use of organic manure and compost has been shown to improve the soil organic matter content, water infiltration and retention, and the available water content of soils by 58–86%[15].

Organic fertilizers are materials with specific chemical composition and high nutritional value that can provide sufficient nutrients for plant growth[16], [17]. Organic fertilizers were primarily created by composting animal manure, human excrement, or plant matter (such as straw and garden waste) with microorganisms that fermented at high temperatures [18]. Organic fertilizers improve soil structure, provide a variety of plant nutrients, and introduce beneficial microorganisms into the soil. Organic fertilizers are widely used in agriculture due to their benefits for soil structure and crop yield[19]. Thus, providing significance for this study. Organic fertilization practices can increase crop yields and soil quality and combining organic and inorganic fertilizers was thought to be an effective solution for crop ecosystem sustainability [20]. Organic fertilizers can improve soil structure and fertility while also increasing soil organic carbon and other nutrients[21]. Many studies have shown that applying organic fertilizers to the soil surface can provide a rich food source for microorganisms while significantly increasing microbial community composition and diversity when compared to no application[22],[8],[6].

Furthermore, using organic fertilizers altercation exchange capacity (CEC) increases soil moisture content, resulting in changes in soil fauna community structure and composition in acidic soils [9]. Organic fertilizers promote the formation and stability of earthworm communities due to the more stable nutrients in organic manure after aerobic fermentation [23]. Conversely, others have discovered that long-term use of chemical fertilizers can reduce soil organic matter content and change the activity of soil biota, resulting in changes in soil microbial composition and decreased soil invertebrate abundance and diversity due to environmental constraints and pH reductions [24]. The use of organic fertilizers, with a focus on renewable local farm resources is advantageous in that it is inexpensive, improves soil arrangement, texture, airing, increases the soil's water retention capabilities, and stimulates healthy root development [25]. In the developing countries, such as The Gambia, many farmers use traditional methods that are comparable to organic farming, but are not certified. Thus, providing significance for a greater understanding of the use and application of organic fertilizer by farmers in the geographic context of this study. Hence, given the dynamic and growth trajectory of agroecological practices, this study aims to assess for greater understanding of state of matters in the current practices of the smallholder farmers in the Gambia, particularly in NBR, CRR North and South regions. Furthermore, this study aims to identify areas of improvement for agroecological practices in the study areas and by default the Gambia as a whole.

1.1 Purpose of Study

The overall objective of the project is to strengthen the capacities of small farmers in The Gambia to engage in policy dialogue at the national and regional levels, as well as in the implementation of ecological practices. The specific objectives of the project are to strengthen the research, promotion, production, marketing, and use of organic fertilizers in the Gambia and to promote the consumption of diversified food items produced using organic fertilizers. Thus, the study is significant to agroecology and the use of organic fertilizer in the Gambia.

1.2 Study Area

As a low-income developing country, The Gambia has poverty and unemployment rates of more than 45% and 35%, respectively [26]. The national per capita income in 2019 was $778 [26]. Access to quality education and primary healthcare remains limited across the country, though it is slightly better in cities[27], [28]. According to Beyers and Wackernage (2019) [29], The Gambia has a total productive land area of 1.5 million, defined as its biocapacity with an ecological footprint of 2 million, both measured in global hectares (gha) by the Global Footprint Network [30]. Furthermore, the ecological footprint measures people's demand or dependence on nature/natural capital assets and flows [29]. A country is declared ecologically deficient when its footprint exceeds its biocapacity [30]. The Gambia was declared ecological bankruptcy in 2002, and as of 2016, the country had an ecological deficit of 547,341gha [30]. In 2016, an average Gambian had a per capita biocapacity of 0.7gha, compared to 4gha in 1961, and an ecological or environmental footprint of 1gha [30]. Agriculture and natural resources provide a living for more than 75% of the population in The Gambia. With an increasing reliance on natural capital for consumption, income generation, and wealth accumulation, the average Gambian ecological footprint will more than double by 2050 (urban dwellers more so than rural settlers) [30]. Similarly, as the population grows, the biocapacity deficit expands exponentially. As a result, The Gambia will continue to be not only an economically indebted developing country but also an ecological debtor (importing biocapacity) from countries with natural capital reserves, known as ecological creditors[30].

The specifi study areas are limited to two regions: North Bank Region (NBR) specifically Nuimi and Central River Region (CRR) North and South Upper/Lower Saloum and Lower Fullado respectively. The Gambia is the smallest country in mainland Africa, covering approximately 11,000 square kilometers and bordered by Senegal on all sides except the Atlantic coast. Administratively, the country is divided into seven regions Banjul city Council (BCC), Kanifing Municipal Council (KMC,) West Coast, North Bank, Central River, Lower River, and Upper River) [31]. The Gambia is a low-income West African country where agriculture is practised by two-thirds of the population. Peanuts are the primary export crop, while rice, millet, and sorghum are traditionally grown for food. Over the second half of the twentieth century, The Gambia became increasingly reliant on rice as a dietary staple, but the country's farmers are unable to increase their market share of the burgeoning urban rice demand[32]. Socioeconomically, the regions of The Gambia are not dissimilar. Thus, there are shared geographical and socio-economic characteristics among regions of The Gambia except for the West Coast Region (WCR) which is closer to the Atlantic Ocean and therefore has a different typological weather indicative of coastal regions. Generally, CRR is further East of the Gambia often referred to as rural Gambia. Similarly, the NBR region is in the North of the Gambia. CRR, like all other region, is made up of ten local administrative districts, each headed by a District Chief named Seyfo. According to the 2013 census, The Gambia's Central River Region and has 226,018 inhabitants (Gambia Bureau of Statistics (Gbos) [27]. CRR has good soil structure and fertility, as well as some vegetative cover when compared to the rest of the country, particularly in the north [34]. Almost all CRR residents rely on agriculture, either directly or indirectly, and poor or failed harvests pose a serious threat to the region's food security. Because the region has approximately 105 horticultural marketing federations, the region was conveniently chosen as the study area of this study. As previously stated, NBR is not dissimilar to CRR. Thus, NBR has 68 marketing federations chosen to participate in this study. (See Table 1)

Table 1: Study Area Population

NO.	Area	# of Federation	Population
1	NBR	68	10463
2	CRR-South	41	6308 estimated

3	CRR-North	64	9847 estimated
	Total		**26618**

Source: Field data (2024).

II. LITERATURE REVIEW

2.1 Organic Agriculture

Organic agriculture originated in the early twentieth century. It was one of the first social movements in agriculture, food, and nutrition, with deep roots in Europe and the United States [35]. Many farmers, scientists, and consumers saw organic farming as a significant shift in agriculture [36]. A paradigm shift in society eventually results in the adoption of new ideas for farming [13]. This has also happened in agriculture, with a plethora of "sustainable" farming systems emerging in the last 30 years, influenced at least in part by organic agriculture. These include conservation tillage, integrated pest management, integrated production, precision farming, low-input agriculture, low external input, sustainable agriculture, agroecological farming, and permaculture and agroforestry systems [35].

On the other hand, organic agriculture has evolved into a highly standardized food production protocol governed by 80 national laws [35]. As the organic food trade has expanded, bilateral negotiations on equivalence or even compliance have become an important aspect of the industry. Eighty percent of organic food is consumed in the United States and the European Union, while 75% of producers produce outside of these two major domestic markets [37]. Most European countries have low farmer conversion rates to organic agriculture, despite high market demand and direct payment schemes that encourage conversion [37]. In export-oriented countries, growing trade threatens the regionalization and contextualization of organic agriculture because EU and US market standards are the dominant requirements [35]. The hard work of organic pioneer organizations in the 1970s agreed on the global standard of the International Federation of Organic Agriculture Movements (IFOAM) allowed for a prosperous global trade in organic commodities [38], [39]. Two opposing developments can now be identified: Conventional agriculture is incorporating ecological and social aspects of sustainability, whereas organic agriculture is becoming globally standardized, potentially losing some of its diversity and becoming more business-oriented. As a result, questions arise about organic agriculture's positioning and unique profile in comparison to the rapidly growing number of 435 labels with sustainability claims, including Rainforest Alliance, UTZ, Fair Trade, and others. The majority of them use one or more agroecological farm practices [40]. These debates are particularly heated in Europe, where organic agriculture is supported by political schemes for rural development as well as the agri-environment regulation EU 2078/92 which aims to raise farmer awareness of environmentally friendly farm practices [35]. Ensuring best farm practices and a high level of ecological, social, and economic sustainability is an important issue in this context.

2.2 Agroecology

Agroecology is the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions [10]. Agroecology can be characterized depending on the application of five basic principles: recycling, efficiency, diversity, regulation, and synergies [2], [8], [12], although socio-economic elements need incorporation and greater articulation[10]. Agroecology conservation agricultural approaches do exactly what the name implies: they conserve natural resources while increasing agricultural productivity. Conservation agriculture takes an agroecological approach to plant and animal production, which means it relies on solar radiation to power the system, closes nutrient cycles to prevent loss to the environment, maximizes water infiltration into the soil, uses natural pest control whenever possible, and reduces greenhouse gas emissions [5]. Agroecological approaches recognize that ecological integrity must be maintained and that climatic conditions in different regions will define production boundaries. Thus, with this in mind, the Natural Resources Conservation Service must become standard practices rather than just aspirations [8]. Agroecology goes beyond the science and practice of agriculture. It is also a social movement founded on the principles of food sovereignty, ecology, sustainability, gender, justice, farmer networks, land access, resilience, and resistance [7] [12] Viewed in direct opposition to the negative effects of capital-intensive practices introduced in the so-called "Green Revolution," agroecology has grown as a social movement, fueled primarily by the 2008 financial and food crises [4] Agroecological practices are gaining recognition for their innovations, which are guided by local knowledge and implemented through participatory methods and community engagement [41].

Despite growing support, agroecology remains marginalized in research and innovation policies [5]. To become a viable alternative in the current research and development (R&D) context, agroecology must be integrated into a more inclusive innovation agenda [13] Inclusive innovation refers to the development and implementation of innovative solutions to the problems of the poorest and most marginalized communities, such as those found in Gambia [31]. Small farmers with limited disposable income and little ability to attract profit-driven innovation represent an especially important potential "recipient" of inclusive innovation. Furthermore, small farmers have the opportunity to actively participate in research processes that are relevant to their needs [28].

In an agroecological paradigm, knowledge is viewed as collective and derived from networks of producers, consumers, and researchers; thus, agroecology is inextricably linked to a high level of participatory knowledge exchange [10]. Furthermore, the role of small-scale farmers extends beyond production to the marketing of the finished product, emphasizing local commercialization and distribution schemes, fair prices, and other mechanisms that connect farmers more directly and with greater solidarity to the rest of society [3], [6], [8]. Agroecology is closely related to the promotion of food sovereignty and opposes reliance on global markets; it aims to advance and develop alternative distribution systems such as farmers' markets and local cooperatives [15]. It promotes integrative farming that considers the overall health of the agricultural system.25 Environmental sustainability is a key premise of agroecology, as it is designed to allow producers to rely more on their resources and less on external inputs, thereby directly responding to the Anthropocene's environmental challenges [43]. Furthermore, incorporating local and traditional knowledge into the development of context-specific agroecological practices broadens environmental awareness to include the knowledge of people whose lives and cultures are inextricably linked to the landscapes in which they farm. Agroecology can thus be regarded as a legitimate innovation pathway within agricultural research systems that is more sustainable than the current dominant industrialist regime [5].

2.3 Organic Fertilizer

Organic fertilizers are materials with a specific chemical composition and high nutritional value that can provide sufficient nutrients for plant growth [22], [44], [45]. Organic fertilizers were primarily created by composting animal manure, human excrement, or plant matter (such as straw and garden waste) with microorganisms that fermented at high temperatures [18]. Organic fertilizers improve soil structure, provide a variety of plant nutrients, and introduce beneficial microorganisms into the soil [19], [25]. Organic fertilizers are widely used in agriculture due to their benefits for soil structure and crop yield [23], [45], [46]. Organic fertilization practices can increase crop yields and soil quality, and combining organic and inorganic fertilizers is thought to be an effective solution for crop ecosystem sustainability [47]. Organic fertilizers can improve soil structure and fertility while also increasing organic carbon and other nutrients [21], [48].

Many studies have found that applying organic fertilizers to the soil surface can provide a rich food source for microorganisms while also significantly increasing microbial community composition and diversity when compared to no application [9], [21], [49]. Furthermore, using organic fertilizers alters cation exchange capacity (CEC) and increases soil moisture content, resulting in changes in soil fauna community structure and composition in acidic soils [16], [23], [44], [50]. Organic fertilizers promote the formation and stability of earthworm communities due to the more stable nutrients in organic manure after aerobic fermentation [23]. Others researchers, on the other hand, have discovered that long-term use of chemical fertilizers can reduce soil OM content and change the activity of soil biota, resulting in changes in soil microbial composition and decreased soil invertebrate abundance and diversity due to environmental constraints and pH reductions [47], [51]. Wahyuningsih et al. (2019) [52] found that short-term applications of inorganic fertilizers (urea) significantly increased soil fauna feeding activity after two days when compared to before the application. Tao et al. (2016)[53] also demonstrate that soil organic matter (empty fruit bunch) improves soil ecosystem function by increasing soil fauna feeding activity.

III. METHOD

The present study measured or evaluated the specific objectives by using (quantitative method) such as content-specific reliable questionnaires to measure the level of production, adoption, and use of organic fertilizer. The study used a descriptive design using Stata Statistical Data Analysis Software to make a comparative analysis of the two regions (NBR and CRR-North and South) in the Gambia. Certain metrics were used to measure the practice, and use of organic fertilizer by existing marketing federations.

IV. RESULTS AND DISCUSSION

4.1 Regional Comparison Analysis

4.1.1 The utilization of the infrastructure in the vegetable gardens

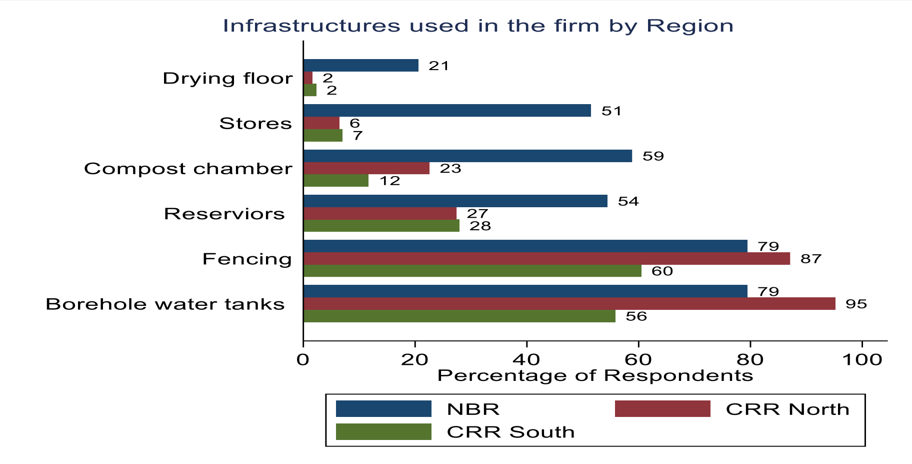
The utilization of the infrastructures in the vegetable gardens significantly varies in the regions (See Fig. 1). The analysis indicates the following:

1) The result reveals that utilization of the borehole water tanks is highest in CRR-North (95%), while NBR registered (79%) and (56%) for CRR-South with the lowest.

2) Concerning fencing materials, are highest in CRR North (87%) than the rest of the regions followed by NBR (79%) and CRR South with 60%.
3) Concerning the use of reservoirs, NBR registered the highest (54%), while CRR-North and CRR-South registered (27%) and (28%) respectively.
4) Concerning the use of compost chambers, NBR registered the highest with (59%), while comparatively, CRR-North and CRR-South registered (23%) and (12%) respectively. The of compost chambers is lowest in CRR-South
5) Concerning the use of stores for safekeeping as for resource protection, NBR again registered (51%). In comparison, CRR-North and CRR-South registered (6%) and (7%) respectively, indicating a near similarity between the two districts.
6) Concerning drying floors, NBR registered the highest (21%), while CRR-North and CRR-South registered an equal score of (2%) showing no contrast.

The above data, therefore, shows that for all indicators used in the graph (figure 36) below, it is clear that comparatively, the use of infrastructure in vegetable gardens is highest in NBR and lowest in CRR-South. Thus, in relative terms, the need for immediate intervention to make the necessary gardening infrastructure available is highest in CRR-South.

Figure 1. Utilization of the infrastructures in the regions

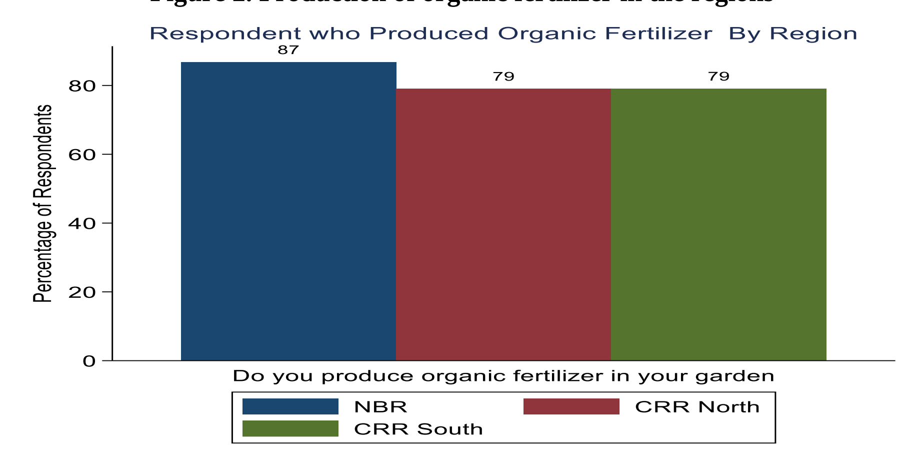


4.1.2 The production of organic fertilizer

The results show a clear disparity between regions in organic fertilizer production (See Figure 2). The results show:

1) The majority of the respondents (87%) in NBR produce organic fertilizer than the rest of the regions followed by CRR South and CRR North with 79% each.
2) Comparatively, NBR has a higher engagement in the production of organic fertilizer. Thus, in relative terms, the need for immediate intervention in the production of organic fertilizer is implicitly higher in CRR-North and South more than in NBR.

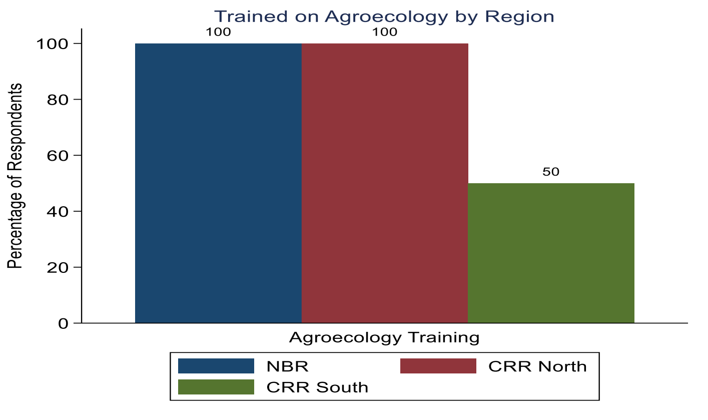
Figure 2. Production of organic fertilizer in the regions



4.1.3Trained on Agroecology by Region

Fig. 3 below shows the percentage of respondents trained in agroecological practices. The findings indicate that all the respondents (100%) in NBR and CRR North received training on agroecology while only 50% of respondents had the training in CRR South.

Figure 3. Percentage of respondents trained in agroecology in the regions



4.1.4 Farmer-to-Farmer Study

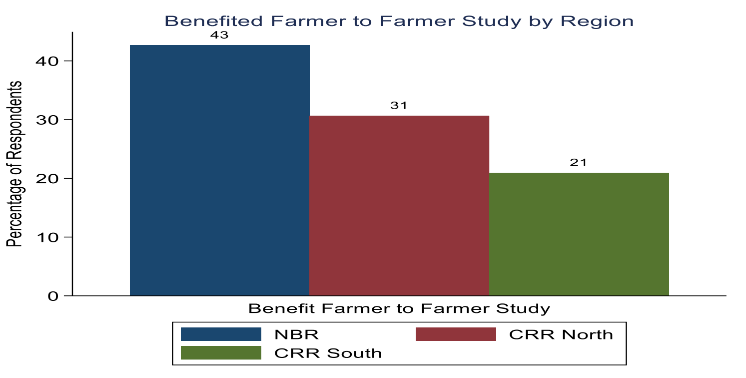
The study reveals a low percentage of the respondents who benefited from farmer-to-farmer study in the regions (See Fig. 4). The findings indicate the following:

1) All the regions had less than 50% of the respondents who benefited from farmer to farmer study tour.
2) However, the highest percentage of the respondents who benefited from farmer to farmer study was observed in NBR (43%) followed by CRR South (31%) and (CRR North (21%).
3) Thus, comparatively, the difference in the experience and benefits gained from farmer-to-farmer study is highest in NBR followed by CRR-North and least in CRR-South.
4) In terms of the need for immediate intervention may be highest in CRR-South followed by CRR-North. This report notwithstanding, it may be necessary to further improve this experience for all regions to at least increase the number of farmers benefiting from farmer-to-farmer studies.

Figure 4. Percentage of beneficiaries of farmer-to-farmer study tours in the regions

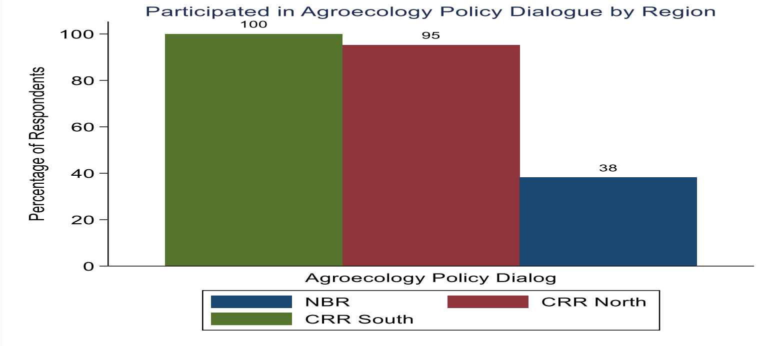
4.1.5 Agroecology Policy Dialogues

The results of the present study indicate the following:



1) All the respondents (100%) in CRR South participated in agroecology policy dialogues
2) 95% of the respondents in CRR North participated (See Fig. 5).
3) The NBR had the lowest percentage of the respondents (38%) who participated in agroecology policy dialogue.
4) Comparatively, the results, therefore, suggest that there is a higher need for improving the involvement of NBR natives in policy dialogues for educational and policy drive purposes.

Figure 5. Participation of the respondents in agroecology policy dialogue in the regions



V. CONCLUSION

The present study on agroecology and organic fertilizer production and use in The Gambia provides valuable insights into the community's dynamics, challenges, and opportunities. Several key findings emerge from awareness of agricultural policies, engagement in policy dialogues, production and usage of organic fertilizers, availability and effectiveness of garden infrastructures and tools, as well as participation in research studies. Specifically, the following points are noteworthy for this study:

Organic Fertilizer Production and Usage**:** There is a preference for organic fertilizers over inorganic ones, with perceived benefits including improved soil health, crop yield, and environmental sustainability. However, challenges in production capacity and accessibility persist, highlighting the need for targeted interventions to enhance training, resources, and support. Furthermore, comparatively, NBR has a higher engagement in the production of organic fertilizer. Thus, in relative terms, the need for immediate intervention in the production of organic fertilizer is implicitly higher in CRR-North and South than in NBR.

Garden Infrastructures and Tools: While basic infrastructures like water tanks and fencing are relatively accessible, more specialized infrastructures and tools face challenges in availability and effectiveness. Government support is acknowledged but often accessed rarely, indicating potential barriers to awareness or accessibility. Comparatively, the use of infrastructure in vegetable gardens is highest in NBR and lowest in CRR-South. Thus, in relative terms, the need for immediate intervention to make the necessary gardening infrastructure available is highest in CRR-South.

Farmer-to-Farmer Study: The need for immediate intervention for farmer-to-farmer study may be highest in CRR-South followed by CRR-North. This report notwithstanding, it may be necessary to further improve this experience for all regions to at least increase the number of farmers benefiting from farmer-to-farmer studies. These kinds of studies are a good source of knowledge sharing, skills improvement, and networking among people with shared interests such as agroecological practices.

Agroecology Policy Dialogues: The NBR had the lowest percentage of respondents (38%) who participated in agroecology policy dialogue. Comparatively, the results, therefore, suggest that there is a higher need for improving the involvement of NBR farmers in policy dialogues for educational and policy drive purposes. These kinds of citizen participation create a sense of inclusivity in policy formulation and drive for adoption and appreciation.

5.1 The limitatons eountered this study are noted as the followes:

Reaching out to respondents posed a significant challenge during the study. The North Bank Region (NBR) and Central River Region (CRR), which were the primary focus areas, have dispersed and often remote communities. This geographic dispersion made it difficult to access all intended respondents within the study timeframe. Additionally, the reliance on community networks and local contacts, while beneficial in some respects, also introduced variability in the response rate. Moreover, there were discrepancies where some names did not correspond with the details in the sampling frame. Additionally, Agricultural communities often have busy schedules, especially in their gardens, which necessitated rescheduling and repeated visits, further constraining the study's timeline. Furthermore, the use of tablets for data collection, while intended to streamline the process, was hindered by poor internet connectivity in many parts of NBR and CRR. Inadequate internet infrastructure in these rural areas meant that data uploading and synchronization with central databases were often delayed. This resulted in inefficiencies and sometimes the loss of data, requiring additional effort to verify and input information manually.

REFERENCES

[1] B. M. Shrestha, S. X. Chang, E. W. Bork, and C. N. Carlyle, "Enrichment Planting and Soil Amendments Enhance Carbon Sequestration and Reduce Greenhouse Gas Emissions in Agroforestry Systems: A Review," *Forests*, vol. 9, no. 6, Art. no. 6, Jun. 2018, doi: 10.3390/f9060369.

[2] S. Gliessman, "Defining Agroecology," *Agroecol. Sustain. Food Syst.*, vol. 42, no. 6, pp. 599–600, Jul. 2018, doi: 10.1080/21683565.2018.1432329.

[3] L. Brzozowski and M. Mazourek, "A Sustainable Agricultural Future Relies on the Transition to Organic Agroecological Pest Management," *Sustainability*, vol. 10, no. 6, Art. no. 6, Jun. 2018, doi: 10.3390/su10062023.

[4] M. Diacono, A. Trinchera, and F. Montemurro, "An Overview on Agroecology and Organic Agriculture Strategies for Sustainable Crop Production," *Agronomy*, vol. 11, no. 2, Art. no. 2, Feb. 2021, doi: 10.3390/agronomy11020223.

[5] L. Pereira, R. Wynberg, and Y. Reis, "Agroecology: The Future of Sustainable Farming?," *Environ. Sci. Policy Sustain. Dev.*, vol. 60, no. 4, pp. 4–17, Jul. 2018, doi: 10.1080/00139157.2018.1472507.

[6] S. K. Yadav *et al.*, "Agroecology Towards Environmental Sustainability," in *Sustainable Intensification for Agroecosystem Services and Management*, M. K. Jhariya, A. Banerjee, R. S. Meena, S. Kumar, and A. Raj, Eds., Singapore: Springer, 2021, pp. 323–352. doi: 10.1007/978-981-16-3207-5_10.

[7] M. A. Altieri and C. I. Nicholls, "Agroecology Scaling Up for Food Sovereignty and Resiliency," in *Sustainable Agriculture Reviews*, vol. 11, E. Lichtfouse, Ed., in Sustainable Agriculture Reviews, vol. 11. , Dordrecht: Springer Netherlands, 2012, pp. 1–29. doi: 10.1007/978-94-007-5449-2_1.

[8] M. A. Altieri, F. R. Funes-Monzote, and P. Petersen, "Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty," *Agron. Sustain. Dev.*, vol. 32, no. 1, pp. 1–13, Jan. 2012, doi: 10.1007/s13593-011-0065-6.

[9] L. K. Abbott and D. V. Murphy, "What is soil biological fertility? Soil biological fertility." Springer, 2007.

[10] R. D'Annolfo, B. Gemmill-Herren, B. Graeub, and L. A. Garibaldi, "A review of social and economic performance of agroecology," *Int. J. Agric. Sustain.*, vol. 15, no. 6, pp. 632–644, Nov. 2017, doi: 10.1080/14735903.2017.1398123.

[11] Ch. S. Rao, A. K. Indoria, and K. L. Sharma, "Effective management practices for improving soil organic matter for increasing crop productivity in rainfed agroecology of India," *Curr. Sci.*, vol. 112, no. 7, pp. 1497–1504, 2017, Accessed: Apr. 22, 2024. [Online]. Available: https://www.jstor.org/stable/24912697

[12] A. Wezel, S. Bellon, T. Doré, C. Francis, D. Vallod, and C. David, "Agroecology as a science, a movement and a practice. A review," *Agron. Sustain. Dev.*, vol. 29, no. 4, pp. 503–515, Dec. 2009, doi: 10.1051/agro/2009004.

[13] J. Kwesiga, K. Grotelüschen, K. Senthilkumar, D. Neuhoff, T. F. Döring, and M. Becker, "Effect of organic amendments on the productivity of rainfed lowland rice in the Kilombero floodplain of Tanzania," *Agronomy*, vol. 10, no. 9, p. 1280, 2020, Accessed: Apr. 23, 2024. [Online]. Available: https://www.mdpi.com/2073-4395/10/9/1280

[14] M. A. Altieri, "APPLYING AGROECOLOGY TO ENHANCE THE PRODUCTIVITY OF PEASANT FARMING SYSTEMS IN LATIN AMERICA," 1999.

[15] R. A. L. Kanton *et al.*, "Organic and Inorganic Fertilizer Effects on the Growth and Yield of Maize in a Dry Agro-Ecology in Northern Ghana," *J. Crop Improv.*, vol. 30, no. 1, pp. 1–16, Jan. 2016, doi: 10.1080/15427528.2015.1085939.

[16] K. Möller and U. Schultheiß, "Chemical characterization of commercial organic fertilizers," *Arch. Agron. Soil Sci.*, vol. 61, no. 7, pp. 989–1012, Jul. 2015, doi: 10.1080/03650340.2014.978763.

[17] J. Rajan and S. Veilumuthu Anandhan, "Survey on nutrient content of different organic fertilisers," *Environ. Monit. Assess.*, vol. 187, no. 6, p. 385, Jun. 2015, doi: 10.1007/s10661-015-4632-1.

[18] K. W. Chew, S. R. Chia, H.-W. Yen, S. Nomanbhay, Y.-C. Ho, and P. L. Show, "Transformation of biomass waste into sustainable organic fertilizers," *Sustainability*, vol. 11, no. 8, p. 2266, 2019, Accessed: Apr. 24, 2024. [Online]. Available: https://www.mdpi.com/2071-1050/11/8/2266

[19] A. Maltas, H. Kebli, H. R. Oberholzer, P. Weisskopf, and S. Sinaj, "The effects of organic and mineral fertilizers on carbon sequestration, soil properties, and crop yields from a long-term field experiment under a Swiss conventional farming system," *Land Degrad. Dev.*, vol. 29, no. 4, pp. 926–938, Apr. 2018, doi: 10.1002/ldr.2913.

[20] R. Gentile, B. Vanlauwe, P. Chivenge, and J. Six, "Interactive effects from combining fertilizer and organic residue inputs on nitrogen transformations," *Soil Biol. Biochem.*, vol. 40, no. 9, pp. 2375–2384, 2008, Accessed: Apr. 24, 2024. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0038071708001727

[21] M. Diacono and F. Montemurro, "Long-Term Effects of Organic Amendments on Soil Fertility," in *Sustainable Agriculture Volume 2*, E. Lichtfouse, M. Hamelin, M. Navarrete, and P. Debaeke, Eds., Dordrecht: Springer Netherlands, 2011, pp. 761–786. doi: 10.1007/978-94-007-0394-0_34.

[22] E.-H. Chang, R.-S. Chung, and Y.-H. Tsai, "Effect of different application rates of organic fertilizer on soil enzyme activity and microbial population," *Soil Sci. Plant Nutr.*, vol. 53, no. 2, pp. 132–140, Apr. 2007, doi: 10.1111/j.1747-0765.2007.00122.x.

[23] M. Bertrand, S. Barot, M. Blouin, J. Whalen, T. De Oliveira, and J. Roger-Estrade, "Earthworm services for cropping systems. A review," *Agron. Sustain. Dev.*, vol. 35, no. 2, pp. 553–567, Apr. 2015, doi: 10.1007/s13593-014-0269-7.

[24] B. Davies, J. A. Coulter, and P. H. Pagliari, "Soil enzyme activity behavior after urea nitrogen application," *Plants*, vol. 11, no. 17, p. 2247, 2022, Accessed: Apr. 24, 2024. [Online]. Available: https://www.mdpi.com/2223-7747/11/17/2247

[25] S. Assefa and S. Taddese, *The Principal Role of Organic Fertilizer on Soil Properties and Agricultural Productivity -A Review*, vol. 22. 2019. doi: 10.19080/ARTOAJ.2019.22.556192.

[26] Worl Bank, "GDP per capita (current US$) - Gambia, The," World Bank Open Data. Accessed: Apr. 28, 2024. [Online]. Available: https://data.worldbank.org

[27] GBoS, . "The Gambia 2013 population and housing census preliminary results 2013. The Gambia bureau of statistics. Standford Libraries.," 2013. [Online]. Available: https:// searchworks.stanford.edu/view/11968270

[28] World Population Review, "Gambia Population." Accessed: Apr. 28, 2024. [Online]. Available: https://worldpopulationreview.com/countries/gambia-population

[29] B. Beyers and M. Wackernagel, "Ecological Footprint, managing our biocapacity budget–Global Footprint Network." New Society Publishers, Gabriola Island (Canada), 2019.

[30] N. K. Dampha, "Change detection (1985-2020): Projections on land-use land cover, carbon storage, sequestration, and valuation in Southwestern Gambia," *Sustain. Environ.*, vol. 7, no. 1, p. 1875556, Jan. 2021, doi: 10.1080/23311843.2021.1875556.

[31] K. S. Touray, "AGROECOLOGY ASSESSMENT OF AGRICULTURAL PRODUCTION AND FOOD SYSTEMS," FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, 2020.

[32] W. G. Moseley, J. Carney, and L. Becker, "Neoliberal policy, rural livelihoods, and urban food security in West Africa: A comparative study of The Gambia, Côte d'Ivoire, and Mali," *Proc. Natl. Acad. Sci.*, vol. 107, no. 13, pp. 5774–5779, Mar. 2010, doi: 10.1073/pnas.0905717107.

[33] Gambia Bureau of Statistic (Gbos). The Gambia 2013, "Population and Housing Census Preliminary Results Count , 102pp.," GBOS, 2013.

[34] S. Yaffa, "Loss and damage from drought in the North Bank Region of The Gambia," *Loss Damage Vulnerable Ctries. Initiat. Case Study Rep. Bonn U. N. Univ. Inst. Environ. Hum. Secur.*, 2013, Accessed: Apr. 28, 2024. [Online]. Available: https://www.academia.edu/download/83560924/The_Gambia_Case_Study_Report_on_Loss_and20220409-27348-te43mp.pdf

[35] U. Niggli, Ed., "Incorporating Agroecology Into Organic Research –An Ongoing Challenge," *Sustain. Agric. Res.*, 2015, doi: 10.22004/ag.econ.230389.

[36] NARI GAMBIA, "The Gambia Ecological Agriculture Developement Project Work Plan 2004-2005," 2004. [Online]. Available: https://www.reap-canada.com/online_library/IntDev/id_gambia/21%20GEAD%20Project.pdf

[37] J. Lernoud, H. Willer, and L. Kilcher, *The world of organic agriculture: Statistics and emerging trends 2013*. FiBL, 2013.

[38] B. Geier, "IFOAM and the history of the International Organic Movement.," in *Organic farming: an international history*, 1st ed., W. Lockeretz, Ed., UK: CABI, 2007, pp. 175–186. doi: 10.1079/9780851998336.0175.

[39] O. Schmid, "Development of standards for organic farming.," in *Organic farming: an international history*, 1st ed., W. Lockeretz, Ed., UK: CABI, 2007, pp. 152–174. doi: 10.1079/9780851998336.0152.

[40] A. Wezel, M. Casagrande, F. Celette, J.-F. Vian, A. Ferrer, and J. Peigné, "Agroecological practices for sustainable agriculture. A review," *Agron. Sustain. Dev.*, vol. 34, no. 1, pp. 1–20, Jan. 2014, doi: 10.1007/s13593-013-0180-7.

[41] O. Ruiz-Rosado, "Agroecología: una disciplina que tiende a la transdisciplina," *Interciencia*, vol. 31, no. 2, pp. 140–145, 2006, Accessed: Apr. 23, 2024. [Online]. Available: http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0378-18442006000200011
[42] "Innovation in agroecological and organic farming systems." Accessed: Apr. 22, 2024. [Online]. Available: http://www.ecoagri.ac.cn/en/article/doi/10.13930/j.cnki.cjea.200469
[43] "Pathways for the amplification of agroecology: Agroecology and Sustainable Food Systems: Vol 42, No 10." Accessed: Apr. 22, 2024. [Online]. Available: https://www.tandfonline.com/doi/abs/10.1080/21683565.2018.1499578
[44] J. Lee, "Effect of application methods of organic fertilizer on growth, soil chemical properties and microbial densities in organic bulb onion production," *Sci. Hortic.*, vol. 124, no. 3, pp. 299–305, 2010, Accessed: Apr. 23, 2024. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0304423810000075
[45] S. N. Ferdoushi, A. M. Farooque, and M. S. Alam, "Effects of organic and inorganic fertilizer management practices and mulch on the growth and yield of potato".
[46] J. Beeby, S. Moore, L. Taylor, and S. Nderitu, "Effects of a One-Time Organic Fertilizer Application on Long-Term Crop and Residue Yields, and Soil Quality Measurements Using Biointensive Agriculture," *Front. Sustain. Food Syst.*, vol. 4, Jun. 2020, doi: 10.3389/fsufs.2020.00067.
[47] Z. Zhou, S. Zhang, N. Jiang, W. Xiu, J. Zhao, and D. Yang, "Effects of organic fertilizer incorporation practices on crops yield, soil quality, and soil fauna feeding activity in the wheat-maize rotation system," *Front. Environ. Sci.*, vol. 10, Nov. 2022, doi: 10.3389/fenvs.2022.1058071.
[48] B. E. Daadi and U. Latacz-Lohmann, "Organic fertilizer use by smallholder farmers: typology of management approaches in northern Ghana," *Renew. Agric. Food Syst.*, vol. 36, no. 2, pp. 192–206, Apr. 2021, doi: 10.1017/S1742170520000228.
[49] J. A. Ukoje and R. O. Yusuf, "Organic Fertilizer: The Underestimated Component in Agricultural Transformation Initiatives for Sustainable Small Holder Farming in Nigeria," *Ethiop. J. Environ. Stud. Manag.*, vol. 6, no. 6, Art. no. 6, Dec. 2013, doi: 10.4314/ejesm.v6i6.10S.
[50] J. Gerke, "Carbon Accumulation in Arable Soils: Mechanisms and the Effect of Cultivation Practices and Organic Fertilizers," *Agronomy*, vol. 11, no. 6, Art. no. 6, Jun. 2021, doi: 10.3390/agronomy11061079.
[51] C. Lazcano, X. Zhu-Barker, and C. Decock, "Effects of Organic Fertilizers on the Soil Microorganisms Responsible for N2O Emissions: A Review," *Microorganisms*, vol. 9, no. 5, Art. no. 5, May 2021, doi: 10.3390/microorganisms9050983.
[52] R. Wahyuningsih, L. Marchand, and J. P. Caliman, "Impact of inorganic fertilizer to soil biological activity in an oil palm plantation," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2019, p. 012017. Accessed: Jul. 07, 2024. [Online]. Available: https://iopscience.iop.org/article/10.1088/1755-1315/336/1/012017/meta
[53] H.-H. Tao, E. M. Slade, K. J. Willis, J.-P. Caliman, and J. L. Snaddon, "Effects of soil management practices on soil fauna feeding activity in an Indonesian oil palm plantation," *Agric. Ecosyst. Environ.*, vol. 218, pp. 133–140, 2016, Accessed: Jul. 07, 2024. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S016788091530147X

Author: Morro Krubally
School of Business, Economic and Public Administration University of the Gambia. Banjul the Gambia