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Applying Organic Fertiliser to Enhance Productivity of Subsistent Farming Systems in Regional Gambia: A Comparative Study of CRR- North and South.

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ABSTRACT: The study was conducted to provide insight into the use of organic fertilizer to enhance production in subsistence farming systems. The current landscape of organic fertilizer use in the Gambia is not well-defined. Agriculture, a significant contributor to the GDP of the Gambia, providing a livelihood for most Gambians, faces challenges that the user of organic fertilizers seeks to address by integrating ecological principles into farming practices. This study aimed to understand the state of organic fertilizer use to bolster farmers' capacities to promote and implement organic fertilizer practices crucial for sustainable agriculture and food security in The Gambia. A quantitative approach was employed to collect data through questionnaires from 351 small-scale farmers in the Centra River Region (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 use. There's a call for more consistent and accessible support to promote the widespread adoption of organic fertilizers and the reduction and eventual abandonment of chemical fertilizers. Overall, the study underscores the importance of addressing gaps in knowledge and support, to foster sustainable agricultural practices and improve farm productivity in The Gambia.

Keywords – Organic Fertilizer, Gambia, CRR, Sustainability, Chemical Fertilizer

I. INTROUCTION

Small farms are estimated to feed roughly half of the world's hungry people[1]. To combat global food insecurity, it is imperative to prioritize the needs of small-scale farmers in developing countries[2]. Many developing countries, particularly those in Africa, face a slew of issues that must be addressed to improve the sustainability of food production. To address all of these issues, many researchers have identified low-external input sustainable agriculture as a preferred development strategy for the problem of food security[2]. Integrated farming, agroecological practices, pest management, and, in particular, organic farming are the most important sustainable agriculture systems introduced in recent years[2].

Nonetheless, organic farming may vary by region. Many researchers, including [3], [4], [5], [6] have proposed organic farming as an environmentally friendly agricultural production system. Organic farming (using organic fertilizer) is thus a holistic production system that takes into account long-term environmental sustainability and primarily aims to produce food in an environmentally friendly manner[3], [6], [7], [8]. Organic fertilizer provides environmental benefits such as biodiversity conservation, improved soil quality, reduced evaporation and water harvesting, strengthened adaptation strategies, reduced greenhouse gas emissions, and increased energy efficiency[9]. Using organic fertilizer aligns with the goals of environmentally friendly production, improving animal health and welfare, and promoting high-quality products[2]. The International Federation of Organic Agriculture Movements (IFOAM) defines organic farming as being based on four basic principles: health, ecology, fairness, and care for people and ecosystems.

There is compelling evidence to support the claim that organic farming can contribute to food security[5], particularly in certain regions such as Africa. On the other hand, in developing countries where the majority of farmers are small-scale, the conventional agricultural system fails to meet the basic needs of resource-poor farmers[2]. This is due to their inability to afford costly synthetic inputs, demonstrating how poverty and food insecurity frequently coexist[2]. As about three-fourths (70%) of the poor in the world are living in sub-Saharan Africa and Asia, investing in agriculture is an effective strategy to improve their livelihood[5,9]

This study is critically important as organic fertilizer production has 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[11]. For example, Kwesiga et al. (2020)[12] 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 available, even though researchers have paid little attention to these systems, to suggest that agroecological technologies promise to contribute to food security on many levels[13]. 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%[14].
Organic fertilizers are materials with a specific chemical composition and high nutritional value that can provide sufficient nutrients for plant growth[15], [16]. 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[17]. 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[18]. 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.[19] Organic fertilizers can improve soil structure and fertility while also increasing soil organic carbon and other nutrients[20]. 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[21].

1.1 Problem Statement

Studies show that organic farming (use of organic fertilizer) can provide farmers with a variety of economic benefits, including cost savings due to lower input costs[2]. They can also increase their income by selling their byproducts, entering organic markets with certified products, and charging higher prices[22], [23]. Despite these benefits and opportunities, small-scale farmers still face significant challenges when transitioning to an organic system[4]. First and foremost, organic farm yields are approximately 25% lower than conventional farm yields; however, this difference is highly dependent on context and local characteristics[24].

On the other hand, studies also contend that organic farming is not a viable option for smallholder farmers in many regions, including Africa, who are unable to produce adequate amounts of compost and green manures[2], [25], [9]. Farmers typically need about 5 years to see the best return on their investment. Farmers who adopt certified agroecological practices must also deal with risk management issues during the three-year transition period[7]. As previously discussed, small-scale farmers who choose agroecological practices face a variety of opportunities and challenges. This study will examine the opportunities and main challenges of agroecological practices for small-scale farmers in the study area (CRR-North & South) in the Gambia. The farming system commonly practiced in this zone is traditional mixed farming, in which smallholder resource-poor farmers produce crops and livestock side by side. Crop production is primarily carried out on arable land, which is characterized by soils with a low water-holding capacity and thus prone to erosion. Most farm activities are limited to rain-fed agriculture (some farmers use animal traction), and the main food crops grown are cereals (maize, early and late millets, sorghum, and rice); cash crops are groundnut and sesame. Early millet and groundnuts are the most important crops grown in the zone, with low production and productivity owing to the limited use of chemical fertilizers and their high cost, low rainfall of less than 600 mm, and a short growing season of less than 79 days. Crop varieties with a growing period greater than 79 days will not thrive in this agro-ecological zone.[26] Thus, this study is significant for the potential results and recommendations in providing possible and viable solutions for the production and use of organic fertilizer in the Gambia.

1.2 Purpose of Study

The overall objective of the study was to strengthen the capacities of small-scale subsistent farmers in The Gambia to engage in the production and use of organic fertilizer. The study's specific objectives are to strengthen the research, promotion, production, marketing, vulgarization/extension, and the 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 for agroecology knowledge and the production and use of organic fertilizer.

1.3 Study Areas: CRR- North and South (Central River Region-North and South)

The CRR has a total area of 2,895 km2 and comprises 10 districts with an average density of 55 persons/Km2. The region is strategically divided into two areas by the River Gambia. The northern part of the region, which has five districts, is often differentiated from the southern part, which also has five districts[27]. The northern part is referred to as the Kuntaur local government area, and the southern part as the Janjanbureh local government area. However, Janjanbureh is the regional capital. The Kuntaur local government area has 5 districts with densities ranging from 32 persons/Km2 to 90 persons/Km2 with an average density of 47 persons/Km2. On the other hand, Janjanbureh districts have 32 persons/Km2 to 240 persons/Km2 with an average density of 61 persons/Km2. (See map of CRR- Fig. 1)

Map of the Central Region Region (CRR)

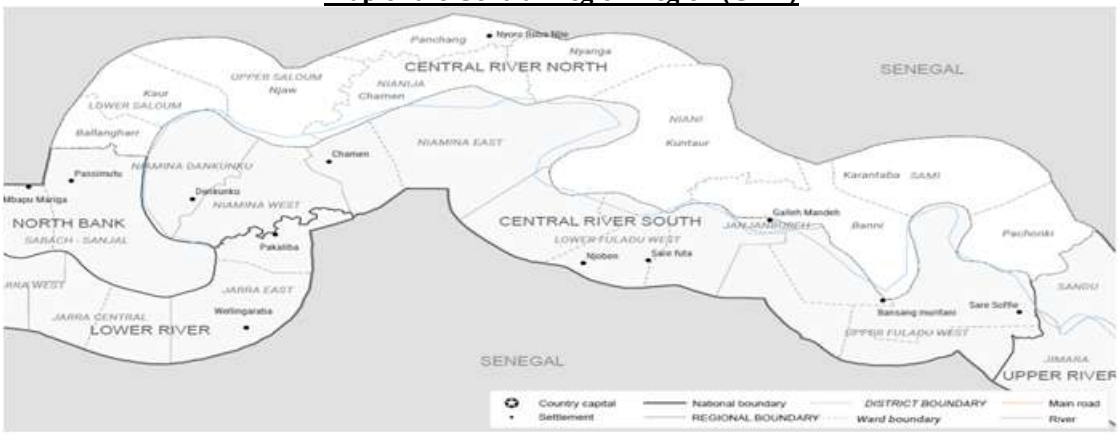

Figure 1.*Source:* [28]

II. METHODOLOGY & SAMPLING

2.1 Research design

The present study adopted a mixed-methods approach, combining both quantitative and qualitative methods to gather a holistic understanding of agroecology and organic fertilizer practices in The Gambia, and drawing data from horticultural marketing federations in NBR and CRR (North and South). Studies of farming systems with similar objectives to the current study are typological mixed methods analyses to classify prevailing practices among farmers and identify farmer characteristics that determine their proclivity to engage in those sets of practices[29]. Such analyses typically use multivariate statistical approaches with a variety of techniques[30]. The most commonly used techniques in this regard are factor analysis (FA), principal component analysis, and cluster analysis[31]. The usefulness of each of these techniques is situation-dependent. From the literature, we identified a universal set of observable organic fertilizer use decisions to support possible sub-sets of decisions by farmers in the study area. Since there is no prior information about how farmers make organic fertilizer decisions, we could not assume any number or nature of expected factors. Hence, the present study applied exploratory factor analysis on observed decisions/actions of farmers to identify common factors/challenges and opportunities engaging in agroecological and organic fertilizer practices. Thus, based on the objectives of the study, the nature of the study was exploratory. Hence, the study adopted an exploratory research design using a micro survey (questionnaire and focus group discussions).

2.2 Population

The CRR comprises ten local administrative districts, each headed by a District Chief named Seyfo. According to the 2013 census, The Gambia's Central River Region has 226,018 inhabitants Gambia Bureau of Statistics (Gbos), 2013). The area has good soil structure and fertility and some vegetative cover compared to the rest of the country, particularly in the north [33]. Almost all CRR residents rely on agriculture, directly or indirectly, but poor or failed harvests seriously threaten the region's food security. Because the region has approximately 105 horticultural marketing federations, the region was chosen as the subject of this study. See Table 1 for the distribution of households by district in CRR-North and South.

Table 1: CRR South- District-Number of Household Distribution

CRR-South (Janjanbureh)	District	Household No.	Percent (%)
1	Niamina Dankunku	894	6.0
2	Niamina West	758	5.0
3	Niamina East	2521	17.0
4	Lower Fuladu West	3714	26.0
5	Upper Fuladu West	5925	41.0
6	Janjanbureh	653	5.0
TOTAL		**14465**	**100**

Source: [34]

Table 2 CRR- North District-Number of Household Distribution

CRR-North (Kuntaur)	District	Household No.	Percent (%)
1	Lower Saloum	1935	18.0
2	Upper Saloum	2006	18.0
3	Nianija	1121	11.0
4	Niani	3337	30.0
5	Sami	2564	23.0
TOTAL		**10963**	**100**

Source: [34]

2.3 Sampling

The population of this study was stratified first by regional population, followed by farming districts, followed by farming households, and finally active farmers, male or female. The respondents were randomly selected in their respective districts. Stratification of the population was necessary to achieve the aim of the study's participant representation. Farming communities are found in all five regions of the Gambia. However, this study requires that participants be sourced from specific farming communities. Thus, stratification of the populationby started by: (1) identifying the communities of interest regionally; (2) as per the scope of the study; CRR-North & South were selected; (3) identifying farming districts in the selected regions; (4) identifing farming households in the community, and lastly (5) identified farmers (Male and Female) for participation in the study. Furthermore, the difficulty in accessing all rural households of the regions warranted the use of stratified sampling. Therefore, stratified sampling was appropriately used to ensure that the study obtained an accurate representation of the Gambian population, of which a significant number (approximately 70% of the population earn their living through subsistent agriculture). Moreover, the stratified sampling approach was the most appropriate for the present diagnostic study because of the availability of information (list of households in the regions/districts provided by the Gambia Bureau of Statistics(GBoS)[34].

Following the initial sampling framework, there arose a need to expand the sampling framework. This resulted in the adoption of the convenient and random sampling method. Convenient sampling and randomly selecting three districts in each region were deemed necessary for determining the number of questionnaires for the selected districts of each region. The present study was able to access the list of farming households in the Gambia using GboS data. Thus, the present study determined 50110 farming households (Krejcie and Morgan formula to determine the sample size of the study-1713). Questionnaire distribution by district in a region was calculated based on the proportionate-to-size method: (district household size/region household size x sample size).

Because of a coincidence, this diagnostic study was conducted in the rainy season of August in the Gambia. During this period (August), access to certain identified districts in each region was practically insurmountable. Some of the districts were marred by inaccessible rural roads, practically prohibiting access to study participants in some parts of the country, rural Gambia. Convenient sampling was appropriately used in exploratory research, such as the present study, where the researcher is interested in getting access to inexpensive and readily available data. Thus, three accessible districts were randomly identified selected to participate in the study: CRR-North & South. Based on the three districts selected in each region, the sample size for the study therefore was determined as follows 758:

Table 3: CRR-South Number of Questionnaires Proportioned to each district

CRR-South Districts	No. of Household	Percentage Share (%)	No of Questionnaires
Niamina Dankunku	894	0.21	74
Niamina West	758	0.18	63
Niamina East	2521	0.61	214
Total	**4173**	**100**	**351**

Table 4 CRR-North Number of Questionnaires Proportioned to each district

CRR-North Districts	No. of Household	Percentage Share (%)	No of Questionnaires
Lower Saloum	1935	0.38	136
Upper Saloum	2006	0.40	143
Nianija	1121	0.22	78
Total	**5062**	**100**	**357**

III. FINDINGS

3.1 Male engagement in organic fertilizer usage by districts in CRR

- **CRR North**: Strong **Very High Engagement (37%)** and **High Engagement (32%)**, indicating robust participation. (See Figure 3)
- **CRR South**: Notable **High Engagement (38%)** and **Moderate Engagement (30%)** with balanced levels. (See Figure 3)

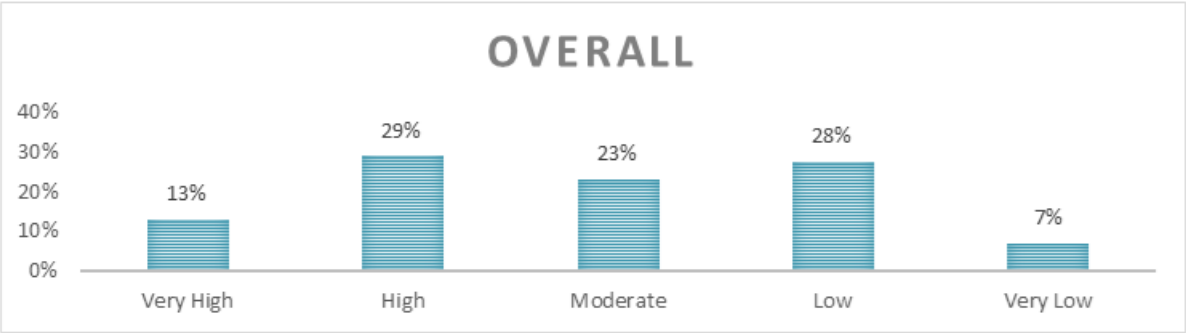

Figure 2 measurement scale

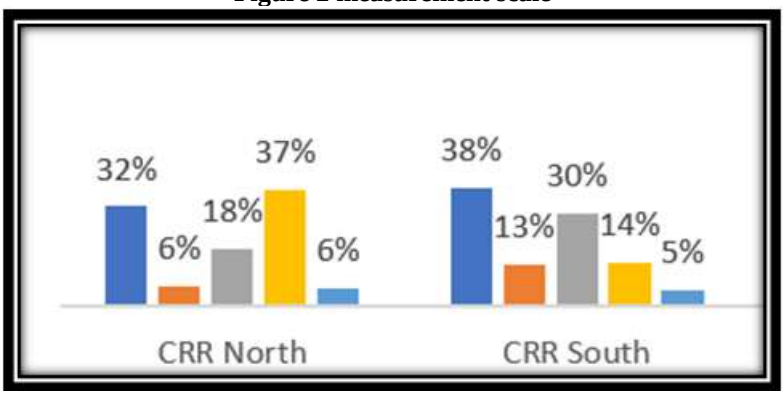

Figure 3 CRR engagement in use of organic fertilizer

High Low Moderate Very High Very Low

3.2 Female engagement in organic fertilizer usage by districts in CRR

- **CRR North**: Strong **Moderate Engagement (33%)** and **High Engagement (30%)** with some Very High and Very Low Engagement. See Figure 4.
- **CRR South**: Highest **High Engagement (40%)** with a significant share of moderate participation. See Figure 4.

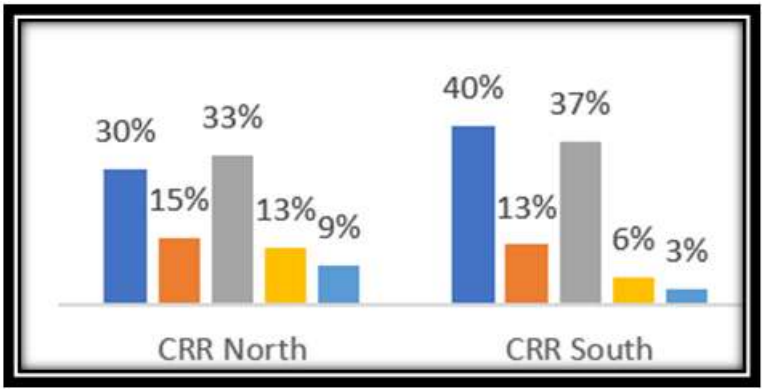

Figure 4 CRR engagements in use of organic fertilizer

High Low Moderate Very High Very Low

3.3 Summary of findings

CRR North shows the highest male engagement in organic fertilizer usage, particularly in high and very high categories. Female engagement in organic fertilizer usage varies across CRR South leading with high engagement, overall, females show strong participation, particularly in high and moderate engagement categories. These regional disparities suggest that some areas have adopted organic fertilizers more readily, while others, lag in engagement.

IV. CONCLUSION

The study on organic fertilizer production across key farming regions in The CRR region in the Gambia highlights There is a strong community engagement in the use of organic fertilizer in CRR., particularly among women, but their efforts are hindered by a lack of resources, such as access to tools, raw materials, and necessary infrastructure. The study reveals that despite their willingness to adopt sustainable farming practices, many farmers lack the requisite skills and support, limiting the scalability of agroecological initiatives. On the other hand, opportunities exist for improving organic fertilizer use. The potential for cost-effective organic fertilizer production as a substitute for expensive chemical fertilizers presents an economic advantage, especially for smallholder farmers. With better support, including access to modern tools, land, and training, organic fertilizer production can be scaled to meet local and regional market demands. The study also found that despite efforts to promote organic fertilizer use, there is a significant gap in market access, which discourages farmers from fully engaging in the use of organic fertilizer. Addressing these barriers, particularly by creating better market linkages and improving infrastructure, will be critical for the successful implementation of use of organic fertilizers.

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