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Level of Agronomic Practices Adopted and Yield of Sorghum in the Tempane District of the Upper East Region, Ghana

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ABSTRACT

Sorghum is vital in ensuring food security for millions of people in regions where it is a staple food. It forms a significant part of the diet in northern Ghana. However, the regions are challenged with adverse climatic conditions, prolonged drought, desertification, and poor agricultural practices, making drought-tolerant crops like sorghum a food security crop. The study aimed to identify the agronomic practices adopted by the farmers in sorghum cultivation in the Tempane District of the Upper East Region of Ghana. A purposive sampling technique was used to obtain a sample size of 90 individual farmers in three communities of the District. A questionnaire was used to collect the data, which was analysed using SPSS. The study showed that 84.4% of the farmers use the Bullock ploughing method in land preparation, indicating a reliance on traditional practices, as most farmers could not afford the cost of tractor ploughing. Of the farmers, 90% practice continuous cropping without improved fallow periods and 60% control weeds only once. Most farmers cultivate one acre of land and 84.4% plant low-yielding seed varieties. Yields are low, 66.6% reported yields of 9-10 bags per acre, while 83.3% obtained 31-40 bags on 3 acres. Planting time impacted yields; early June planting resulted in higher yields (10-15 bags) per acre compared to lower yields (5-7 bags) when planted in July. Early and timely planting is advantageous in sorghum cultivation to improve yields. It was recommended that there is a need for targeted training programs aimed at educating farmers on improved agronomic practices in sorghum cultivation in the Tempane district.

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INTRODUCTION

Sorghum [*Sorghum bicolor (L) Moench*] is a resilient crop, well adapted to growing in harsh environments (Chanda & Umetsu, 2024), particularly in tropical and subtropical regions. Its ability to withstand drought makes it an essential crop in areas with limited water resources, such as Africa and Asia's arid and semi-arid regions (Sahara et al., 2023). Sorghum is vital in ensuring food security for millions of people in the regions where it is a staple food (Hossain et al., 2022). Its cultivation in Ghana is particularly important, as the crop forms a significant part of the diet for communities in the five northern regions: Northern, Savannah, North East, Upper West, and Upper East (Kudadjie, 2006). These regions face challenges related to climate, coupled with widespread poor soil fertility (Elaine et al., 2021a).

Sorghum is gaining recognition for its industrial applications. One of the most prominent uses of sorghum is as a substitute for barley in the brewing industry and the trend has provided local farmers with new income opportunities (Aruna and Visarada, 2019). This substitution also offers economic benefits to the breweries by reducing their reliance on imported barley, thus conserving foreign exchange (Aruna and Visarada, 2019). In Ghana, it is a key raw material for rural women who use straws of the plant to weave baskets and mats, contributing to the cottage industries that are an essential part of rural livelihoods (Seglah et al., 2019).

Despite its economic and food security importance, sorghum yields in Ghana remain low, particularly in smallholder farming systems. Average yields in farmers' fields are reported to be less than 2.0 tons per hectare (t/ha), far below the 4.5 to 5.0 t/ha yields achieved in more developed agricultural systems (Elaine et al., 2021b). In the Upper East Region, for example, annual yields are estimated at just 0.7 t/ha (Abdul-Rahaman, 2023). These low yields limit the potential for sorghum to meet both dietary and income needs for smallholder farmers, contributing to persistent poverty and food insecurity in the region. The decline in production can be attributed to various factors, including climate variability, poor agronomic practices, low soil fertility, and low access to improved seeds and fertilizers.

This study aimed to identify the agronomic practices adopted by the farmers in sorghum cultivation in the Tempane District as a piece of baseline information for an intervention of extension education on the adoption of improved agronomic practices to enhance sorghum cultivation.

MATERIAL and METHOD

Study Area

Tempane District is one of the fifteen districts in the Upper East Region of Ghana. It was formerly part of the then-larger Garu-Tempane District in 2004, until the part of the district was split off to create Tempane District.

It covers an area of 1,230 km^2 and lies approximately on latitude 10^o 38l N and 110 N and longitude 0^o 06l E and 00 23l E. The Tempane District shares boundaries with the Garu District to the north, the Pusiga District to the northeast, the Bunkpurugu and Nyankpanduri Districts to the southeast, and the Republic of Togo to the east. The district's population according to the 2021 population and housing census stands at 86,993, with 41,268 males and 45,725 females.

About 80 to 90% of this population is engaged in subsistence farming and petty trading. The district experiences a tropical savannah climate with unimodal rainfall and a prolonged dry season. The vegetation is mainly the Sahel savannah type, consisting of scattered drought-resistant trees, shrubs, and grasses that often get burnt during the long dry seasons. The average amount of rainfall during the period is between 800 and 860 mm per annum. The main crops grown in the area are sorghum, pearl millet, maize, rice, and soya beans.

Sampling and Data Collection

A purposive sampling technique was used to select sorghum farmers in the three selected farming communities: Sazunde, Nadigire, and Kongo. A total of 90 farmers were selected for the study, and 30 farmers were selected from each community.

Data was collected through the use of structured questionnaires administered to the selected sorghum farmers. The questionnaire was designed to gather quantitative data on various aspects of sorghum cultivation, including land preparation methods, planting time, and agronomic practices. The data collected was analysed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize the data.

RESULTS and DISCUSSION

Demographic Characteristics of Respondents

Table 1 shows that most respondents are male (74.4%), with females representing only 25.6%. This indicates that sorghum cultivation in the Tempane District is male-dominated and the majority of the farmers (70%) are within the 31-50 years age group, followed by those aged 51-60 and above (21.1%), and only 8.9% of farmers are between 20-30 years of age. The dominance of middle-aged and older farmers suggests that sorghum cultivation in the area relies heavily on experienced individuals.

The educational levels of the respondents showed that a significant portion (61.1%) of the farmers have no formal education, while 30% have basic education, 6.7% have secondary education, and only 2.2% have tertiary education. The low level of education among farmers could be a major barrier to the adoption of improved agronomic practices.

Table 1. Demographic characteristics of respondents

Variable	**Frequency**	**Percentage**
Gender		
Male	67	74.4
Female	23	25.6
Total	90	100.0
Age		
20-30	8	8.9
31-50	63	70.0
51-60 and above	19	21.1
Total	90	100.0
Level of education		
None	55	61.1
Basic	27	30.0
Secondary	6	6.7
Tertiary	2	2.2
Total	90	100.0
Marital Status		
Married	79	87.8
Single	9	10.0
Widowed	2	2.2
Total	90	100.0
Household size		
1-5	55	61.1
6-10	31	34.4
11-15	4	4.4
Total	90	100.0
Years of growing sorghum		
1-5	71	78.9
6-10	16	17.8
11 years and more	3	3.3
Total	90	100.0

The years of experience in sorghum farming showed that most respondents (78.9%) have been growing sorghum for 1-5 years, followed by 17.8% with 6-10 years of

experience, and 3.3% with more than 11 years. This indicates that the majority of farmers are relatively new to sorghum cultivation.

Farm Size of Sorghum

Table 2 shows the distribution of farm sizes among sorghum farmers in the Tempane District. The data revealed that the majority of farmers (52.2%) cultivate one acre, while 37.8% cultivate two acres of land, and only 10% cultivate three acres of land.

Table 2. The farm size cultivated by the farmers

Size	Frequency	Percentage (%)
One Acre	47	52.2
Two Acres	34	37.8
Three Acres	9	10.0
Total	90	100.0

Farming System Adopted

The majority of the farmers (73.3%) practice mixed cropping, which involves growing sorghum alongside other crops. This method was likely employed to manage risks associated with crop failure, improve soil fertility, enhance food security, and diversify the range of crops harvested. In contrast, only 26.7% of farmers engaged in sorghum monocropping (Table 3).

Table 3. Farming system adopted by farmers

Methods	Frequency	Percentage (%)
Mono-cropping	24	26.7
Mixed cropping	66	73.3
Total	90	100.0

Land Preparation Methods Adopted by the Farmers

Table 4 shows sorghum farmers' land preparation methods; the majority of the farmers (84.4%) use a bullock plough, indicating a preference for animal-powered tillage, likely due to its affordability and suitability for smallholder farmers. A small proportion of farmers (8.9%) rely on manual land preparation, suggesting that some farms may be too small to justify mechanized cultivation methods, or the farmers may lack access to resources like animals or machinery. Only 6.7% of farmers use tractors, reflecting limited access to or affordability of modern mechanized cultivation equipment.

Table 4. Land preparation methods adopted by the farmers

Land Preparation Method	Frequency	Percentage (%)
Manual	8	8.9
Bullock Plough	76	84.4
Tractor	6	6.7
Total	90	100.0

Varieties of Seeds Planted by the Farmers

Table 5 shows the seed varieties used by sorghum farmers in the District. The majority of farmers (54.4%) use local seed varieties saved from their previous season's crops, which are low-yielding. This might be due to the farmers not having access to the improved varieties or possibly because they could not afford them. However, about 33.3% of farmers use both improved and local varieties, and 12.2% exclusively use improved seed varieties, suggesting a willingness to adopt improved seeds if readily available.

Table 5. Seed varieties used by farmers

Variety	Frequency	Percentage (%)
Improved	11	12.2
Local	49	54.4
Both	30	33.3
Total	90	100.0

Weed Control

Table 6 illustrates the frequency of manual weed control; 60% of the farmers control weeds once during the cultivation period, while 40% control weeds twice. Most farmers may rely on a single weeding session, which might not be sufficient for optimal plant growth.

Table 6. Frequency of weed control

Period of Weed Control	Frequency	Percentage (%)
Once	54	60.0
Twice	36	40.0
Total	90	100.0

Control of Pests and Diseases

The majority of farmers (86.7%) in the district actively control pests and diseases on their farms. Only 13.3% of farmers reported not engaging in pest and disease control.

This high percentage reflects the farmers' importance of mitigating these pest risks to ensure better crop health and yields (Table 7).

Table 7. Control of pests and diseases on farms

Response	Frequency	Percentage (%)
Yes	78	86.7
No	12	13.3
Total	90	100.0

Fertilizer Application

Most of the farmers (82.2%) apply fertilizers to their crops, indicating widespread use of soil nutrient-enhancement practices. On the other hand, 17.8% of the farmers do not use fertilizers, which could be attributed to factors such as financial constraints, limited access to fertilizers, and reliance on traditional methods of farming (Table 8).

The majority (61.1%) of the farmers use inorganic fertilizers, suggesting a preference for chemically based solutions that are often associated with quicker and more immediate crop yields. And 32.2% used organic fertilizers, possibly due to cost-effectiveness and the desire to maintain soil health. A small fraction (6.7%) of farmers use a combination of both organic and inorganic fertilizers.

Table 8. Application of fertilizers

Response	Frequency	Percentage (%)
Yes	74	82.2
No	16	17.8
Total	**90**	**100.0**
Type of Fertilizers		
Organic	29	32.2
Inorganic	55	61.1
Both	6	6.7
Total	**90**	**100.0**

Adoption of Fallow Periods in Sorghum Production

A higher percentage (90%) of the sorghum farmers in the Tempane District do not leave their lands fallow. Only 10% of the farmers reported practicing fallow periods.

Fallowing, which involves leaving land uncultivated for a period to restore soil fertility, is traditionally considered an effective way to allow the soil to regenerate its nutrients naturally.

Improved fallow involves planting leguminous crops to quickly replenish the soil. However, after sorghum harvest, 64.4% of the farmers leave the land bare; only 35.6% plant legumes such as soybean and cowpea. Planting legumes after sorghum harvest is a beneficial agronomic practice, as legumes can enhance soil fertility through

atmospheric nitrogen fixation, thereby improving soil nutrient levels for the subsequent crops (Table 9).

Table 9. Adoption of fallow periods in sorghum production

Response	Frequency	Percentage (%)
Yes	9	10.0
No	81	90.0
Total	90	100.0
Planting of legumes		
Yes	32	35.6
No	58	64.4
Total	90	100.0

Yields Based on Planting Time

The majority (88.9%) of the farmers planted in June and obtained yields of 10-15 bags on 1 acre, 83.3% obtained 20-25 bags on 2 acres, and 83.3% on 3 acres obtained over 30-35 bags. Comparatively, July planting showed reduced yields, particularly in the 1-acre category, where 11.1% obtained less than 10 bags. On 2 acres, 16.7% of farmers reported yields below 20 bags, and 16.7% obtained less than 30 bags on 3 acres. This reflects potential challenges associated with the late planting of Sorghum (Table 10).

Table 10. Yields (50 kg per bag) based on planting time

Planting time	1 Acre	2 Acres	3 Acres
June	10- 15 (88.9%)	20-25 (83.3%)	30-35 (83.3%)
July	5-7 (11.1%)	10-18 (16.7%)	18-25 (16.7%)

DISCUSSION

The demographic profile of the respondents indicated that the majority of the farmers (74.4%) were males and within the age group of 31-50 years. This aligns with previous research by Essel et al. (2022) who indicated that agricultural labour in rural areas was predominantly male and that middle-aged individuals are typically the most active participants in farming. Furthermore, the level of education among the respondents highlights a significant portion had no formal education, which may limit their access to modern agricultural techniques and innovations.

Regarding land preparation methods, the predominant use of bullock ploughing underscores traditional farming practices that are still prevalent in the region. The low adoption of tractor use (6.7%) suggested limited access to resources and technology, which aligns with findings by Yaro et al. (2021), who highlighted the barriers to mechanization in rural agriculture. The over-reliance on traditional farming methods

could hinder productivity and increase labour intensity, ultimately affecting the district's overall economic viability of sorghum farming. This is in line with (Anang and Asante, 2020), who stated that in the northern parts of Ghana, farming is highly labour-intensive and with inadequate mechanization.

Soil fertility improvement practices showed that the minimal use of fallow periods (10.0%) and lack of planting legumes after harvest suggest a need for soil fertility management practices. Low rate of cover cropping and limited adoption of fallow periods are a potential neglect of long-term soil improvement.

In addition, the practice of continuous cropping (90.0%) could result in crop failures, declined soil fertility, low yields, and pests and diseases becoming endemic. This situation emphasized the need for policies that encourage farmers to increase sorghum production, as there are readily available markets for the crop, and to improve their economic and income levels.

The farmers in the Tempane District use the sorghum stalk for firewood, which shows the importance of it as a resource for household energy requirements, thus reducing the cutting down of scarce trees for fuelwood. This assertion was supported by Osei et al. (2021), who stated that crop residues can provide sustainable energy needs to rural communities.

Late planting in July resulted in lower yields compared to early planting in June. This has implications for climate variability on sorghum. In an area characterized by unimodal rainfall patterns, rainfall is unpredictable due to climate change effects, and in some years, the rainfall begins late in June and farmers prepare the land and wait for the rains till July to plant their crops. This tends to affect the yields of sorghum negatively. Wrong planting dates are considered as one of the most important factors that affect crop productivity in Ghana and the entire West African region (Kumi et al., 2023).

CONCLUSION and RECOMMENDATION

In the three communities surveyed in the Tempane District of the Upper East region. Bullock ploughing was the primary method of land preparation, indicating a reliance on traditional practices. The subsistence sorghum farmers depend on traditional methods of farming without improved agronomic practices, resulting in low yields, though there is high demand for the crop. Increased production per unit area has the potential to increase economic activity and increase income for the subsistence farmers. The farmers use seeds from the previous harvest, which are low-yielding. There is a need to promote higher-yielding sorghum varieties in the district. Late planting affected yields of sorghum; therefore, timely planting is crucial for enhancing productivity. Not all, there is a need for extension education on the rainfall patterns within the region due to climate variability.

Targeted training programs are required to educate farmers on improved agronomic practices in sorghum cultivation in the Tempane District.

Conflict Interest

The authors have declared that there is no conflict of interest.

Author's Contribution

MMA designed the questionnaire, supervised the research work and wrote the manuscript. EA conducted the field survey, administered the questionnaires to the farmers, and conducted an analysis of the data.

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