RESTORATION AND CONSERVATION OF THE GLOBALLY SIGNIFICANT BIODIVERSITY AREA IN TANO OFFIN FOREST RESERVE THROUGH PARTICIPATORY FOREST MANAGEMENT APPROACH WITH FOREST FRINGE COMMUNITIES

PRELIMINARY PROJECT REPORT

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LIST OF ACRONYMS

FAO	-	Food and Agriculture Organization
UNEP	-	United Nations Environment Programme
GSBA	-	Globally Significant Biodiversity Area
FC	-	Forestry Commission of Ghana

1.0 INTRODUCTION

1.1 Project Background

Deforestation and forest degradation remain ongoing at an alarming rate globally. Evidence showed that over the last three decades, an estimated area that has been converted from forests to different land use accounts to about 420 million hectares (FAO and UNEP, 2020). Similarly, Ghana's tropical forest which forms part of the 34 areas rich in biodiversity is under heavy threat (Arcilla, Holbech and O'Donnell, 2015; Acheampong, Macgregor, Sloan and Sayer, 2019). Through human activities, the nation's forests cover declined sharply from 8 million hectares to about 1.9 million hectares (Ikpe, 2016). The remaining forests are still heavily threatened by illegal chainsaw operations, wildfires, prolonged droughts, diseases and pests etc.

The extent of degradation may be attributed to the reliance on forest resources as the main livelihood option for existence by forest fringe dwellers. Estimates show that over 10% of Ghana's population live around forest reserves and directly or indirectly derive benefits or incentives from timber and non-timber forest products (Ahenkan and Boon, 2011; Acheampong *et al.,* 2019). Further, communities in proximity to forests are noted to derive about 38% of their income from the reserves (Appiah *et al*., 2009; Ahenkan and Boon, 2011; Acheampong *et al.,* 2019).

Concerning Tano Offin forest reserve, it is noted to have been created in 1927 with the aim of supplying timber for the local market and other products on permit (Hawthorne and Abu-Juam, 1995). As part of high forest zone assessment and inventory in 1999, the Forestry Commission (FC) of Ghana identified unique biodiversity of international interests in some portions of the Tano Offin forest reserve. These areas covering about 44% of the entire reserve was earmarked as the Globally Significant Biodiversity Area (GSBA). The aim for reservation as a GSBA was to preserve the rare fauna and flora confined in the area (FC 2007; McCullough *et al*., 2007; Adotey and Belford, 2021).

An assessment of the forest stock by Hawthorne and Abu-Juam (1995) revealed human activities such as agricultural and infrastructural expansions, illegal felling operations and wildfires as the factors resulting in the degradation of the reserve. Recent studies however have revealed some level of disturbances within the GSBA (Adotey and Belford, 2021; Somuah *et al*., 2021). The extent of damage revealed in literature is alarming and has dire consequences on the fauna, flora and the ecosystem as a whole. As a result, concerted efforts beyond the conventional form of forest management that excludes local communities and other relevant stakeholders are required. This study emphasis on participatory forest management and also recognizes the inclusiveness of all relevant stakeholders' particularly local communities' in protecting the natural resource base.

The findings of this study have revealed the level of dependency on the GSBA and have identified the needs of local communities which if realized would reduce threats to the existence of unique diverse life forms in the ecosystem. Further, the findings of this study contribute to reduction in forest biodiversity extraction therefore meeting the demands of Sustainable Development Goal 15.

1.2 Overall Project Objectives

1. Conduct initial assessment on plant diversity in the GSBA.
2. Identify and measure degraded portions of the GSBA.
3. Stakeholder engagements involving forest fringe communities, CSIR-FORIG and Forestry Commission Staffs.
4. Restore degraded portions of the GSBA by engaging forest fringe communities, CSIR-FORIG and Forestry Commission Staffs.

As part of achieving the overall project objective 3 which aims at conserving the GSBA, needs assessment of local communities were carried, the following specific objectives were adopted.

- To assess socioeconomic benefits derived fringe communities.
- To assess awareness of livelihood programs
- To assess local communities' willingness to participate in alternative livelihood programs.
- To assess local communities' preferences for alternative livelihood interventions.

1.3 Organization of the Report

Following the introductory section, which provides background of the project, general and specific objectives, the next section (Section 2) focuses on the methodology, describing the various approaches employed, study area, study design and data collection approach, and data analysis. Section 3 presents the results and discusses the findings, while section 4 is on conclusion.

2.0 MATERIALS AND METHODS

2.1 Study Site Description

The study was carried out in the GSBA of the Tano Offin forest reserve. The Tano Offin forest reserve falls under the Nkawie Forest District of the Forestry Services Division of Forestry Commission of Ghana. The reserve lies between latitudes 60° 54' and 60° 35' North and longitudes 10° 57' and 20° 17' West (Kyereh, Dei-Amoah, and Foli, 2006). The total size of the reserve is estimated to be around 413.92 km^2 of which the Globally Significant Biodiversity Areas (GSBA) covers about 44% (178.34 km^2) (FC, 2007; Adotey and Belford, 2021). Rainfall is bimodal in this area. The major raining season starts from May to June. The lean season spans from September to October (Adotey and Belford, 2021). The major dry season starts from the middle of November and ends in the middle of March. Average annual rainfall is estimated to be around 1,250 mm (Adotey and Belford, 2021). The average maximum and minimum temperatures are estimated around 33.04 ^oC and 21 ^oC respectively.

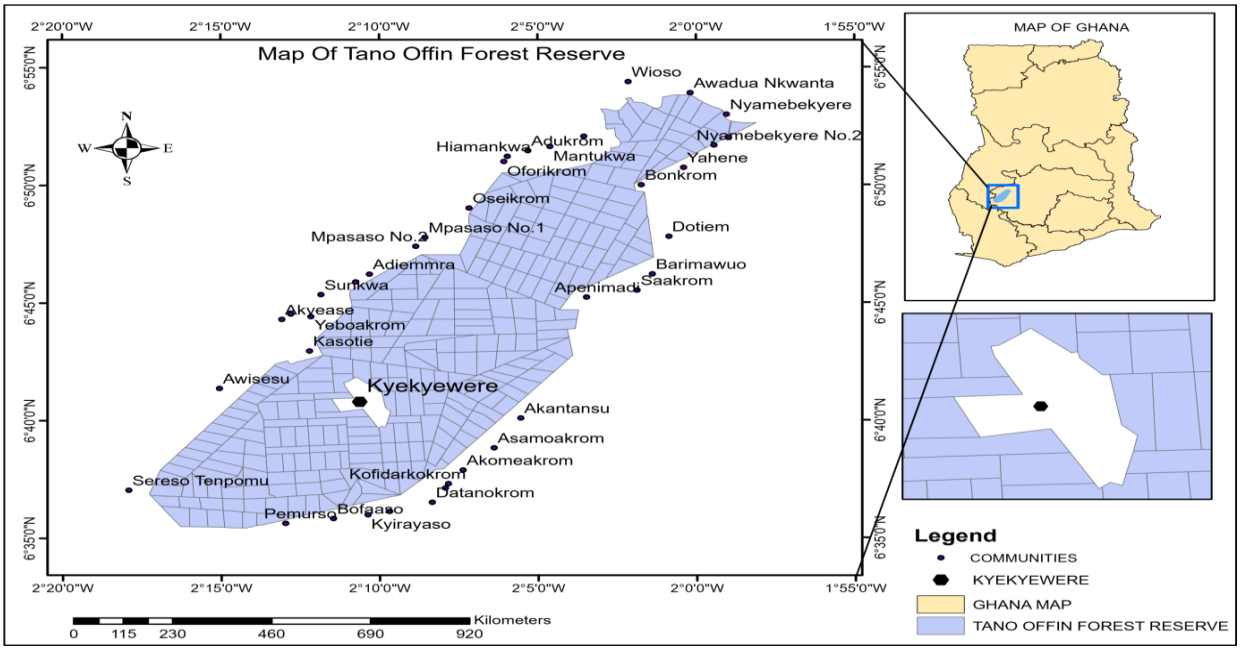

Figure 1. Map of the Tano Offin forest reserve (Source: Somuah, 2018).

2.2 Study Design

The study used two different approaches namely: social survey approach and field-level inventory to elicit information for analysis.

2.2.1 Social Survey Design

The sampling frame (list of all units in the population from which samples were selected) was made up of thirty-three (33) local communities situated around the Tano Offin Forest Reserve. Sampled communities (25 local communities) for the social survey was determined using a mathematical formula of Dickey Watts (1998), cited in Cochran, W.G. (1977) at a ten percent (10%) confidence level. Where n = sample size; N = sample frame; α = confidence level

$$n = N \div [1 + N(\propto^2)] \ldots\ldots\ldots\ldots\ldots \text{ Equation 1}$$

Based on the differences in selected communities' sizes, sixteen (16) household and non-household heads (respondents) were randomly selected in each of the twenty-five (25) fringe communities (Table 1). A total of 400 respondents were randomly selected across the twenty-five (25) communities for a face-to-face interview.

Table 1. Sampled communities for questionnaire administration.

Selected community	Frequency	Percentage (%)	Coordinates	
			Longitudes	Latitudes
Akobraso	16	4.0	N 06˚ 35.133'	W 002˚ 16.067'
Akyeakrom	16	4.0	6.66442˚ N	2.27268˚ W
Apenamadi	16	4.0	N 06˚ 45.247'	W 002˚ 03.353'
Asuokor	16	4.0	N 06˚ 42.706'	W 002˚ 15.271'
Asuontaa	16	4.0	N 06˚ 39.970'	W 002˚18.274'
Ataso	16	4.0	N 06˚ 42.839'	W 002˚ 01.087'
Awisesu	16	4.0	N 06˚ 41.468'	W 002˚ 14.995'
Baakoniaba	16	4.0	N 06˚ 38.289'	W 002˚ 05.182'
Bofaaso	16	4.0	N 06˚ 35.782'	W 002˚ 12.583'
Deseregya	16	4.0	N 06˚ 42.673'	W 002˚ 13.913'
Dodowa	16	4.0	N 06˚ 41.259'	W 002˚ 19.187'
Kramokrom	16	4.0	6.66442˚ N	2.26382˚ W
Kyekyewere	16	4.0	N 06˚ 40.888'	N 002˚ 10.528'
Manhyia	16	4.0	N 09˚ 41.547'	W 003˚ 00.378'
Mpasaaso Achiase	16	4.0	N 06˚ 44.400'	W 002˚ 13.018'
Mpasaaso Number 1	16	4.0	N 06˚ 47.647'	W 002˚ 08.416'
Mpasaaso Number 2	16	4.0	N 06˚ 47.647'	W 002˚ 08.538'
Nwirem	16	4.0	N 06˚ 43.701'	W 002˚ 01.429'
Nyamebekyere	16	4.0	N 06˚ 44.425'	W 002˚ 01.648'
Ofrikrom	16	4.0	N 06˚ 46.099'	W 002˚ 10.381'
Pamuruso	16	4.0	N 06˚ 36.011'	W 002˚ 13.049'
Sreso Achiase	16	4.0	N 06˚ 37.238'	W 002˚18.311'
Sreso Tinpom	16	4.0	N 06˚ 37.291'	W 002˚ 18.169'
Wansambire	16	4.0	N 06˚ 40.087'	W 002˚ 17.187'
Total	**400**	**100.0**		

2.2.1.1 Questionnaire Administration

Data collection involved the use of a semi-structured questionnaire. The questionnaire used highlighted on key issues related to local communities' level of dependency on the Tano-Offin Forest Reserve,

respondents' willingness to participate in alternative livelihood options, and motivation and measures for successful implementation of activities.

Plate 1. Questionnaire administration at Nwirem.

Plate 2. Questionnaire administration at Sreso Tinpom.

Plate 3. Questionnaire administration at Nyamebekyere.

Plate 4. Questionnaire administration at Achiase.

Plate 5. Community engagement at Nyamebekyere.

2.2.2 Plant Diversity Assessment Design

Rectangular plots of ten (10) were randomly established in selected compartments (namely: Compartments 321, 323 and 322) within the GSBA. Coordinates (latitude and longitude) at all the corners of each plot were recorded. In a sampling location, a plot of 50 x 20 m (1000 m^2) was laid with the aid of measuring tape, ranging poles and compass.

Plate 6. **Laying of sample plot in the Tano Offin GSBA.**

2.2.2.1 Measurement of Woody Vegetation

All the trees in the 1000 m² plots with diameter at breast height (d_{bh}) above 5.0 cm were identified by species and d_{bh} measured**.** Diameter tapes were used for diameter measurements. Tree height was estimated due to difficulties in direct measurement.

Plate 7. Measurement of tree diameter at breast height.

2.3 Data Analysis

2.3.1 Social Survey

The data gathered for the socioeconomic aspect was processed using SPSS version 25, Stata version 13, and Microsoft Excel 2019. The results obtained were first screened for consistency and completeness in responses and further analyzed based on the objectives of the study. Additionally, differences and peculiar trends across the communities were descriptively analyzed and presented in tables and graphs.

With regards to the plant diversity data collected, R Studio version 4.2.2 was used for the statistical data analysis. The mean values of the indices for the two study sites were subjected to an analysis of variance test for differences.

3.0 RESULTS AND DISCUSSION

3.1 Community-Based Assessment

A. Respondents Socio-demographic Characteristics

The socio-demographic profile of the respondents is presented in Table 2. Results show that the respondents were more male, about 62%, while the female respondents were less than 40%. The mean age of male and female respondents was 45, meaning most were adults. Most respondents (79.8%) were married, 10.6% were single, and 2.8% were widowed. Those separated and divorced were 4.8% and 2.3%, respectively. Most respondents (79.5%) are the breadwinners of their families. According to breadwinners, their household size on average is 5.4, more than the national average of 3.6 people per

household (Ghana Statistical Service, 2021). Also, they noted that the average number of children in their household is 4.68. About 23% of the respondents have no education. Of those with education, many (50.4%) have completed Junior High or Middle School, while only 2.8% have completed tertiary education. Respondents with only primary education were 18.5%. Over 85% of the respondents are farming in the studied communities (Figure 2). Other respondents are also involved in mining, craftmanship, barbering, beekeeping, storekeeping, and teaching, but they are all less than 1%.

Table 2. Respondents' demographic profile.

Profile	Frequency	Percentage (%)	Mean	Standard Dev.
Gender				
Male	247	61.8		
Female	153	38.3		
Age (years)			45.23	12.28
Marital status				
Married	319	79.8		
Single	42	10.6		
Separated	19	4.8		
Divorced	9	2.3		
Widowed	11	2.8		
Education				
No education	90	22.5		
Primary	74	18.5		
Junior High/Middle School	201	50.4		
Secondary	24	6.0		
Tertiary	11	2.8		
Breadwinner				
Yes	318	79.5		
No	82	20.5		
Household size			5.44	3.38
Number of Children			4.68	2.65

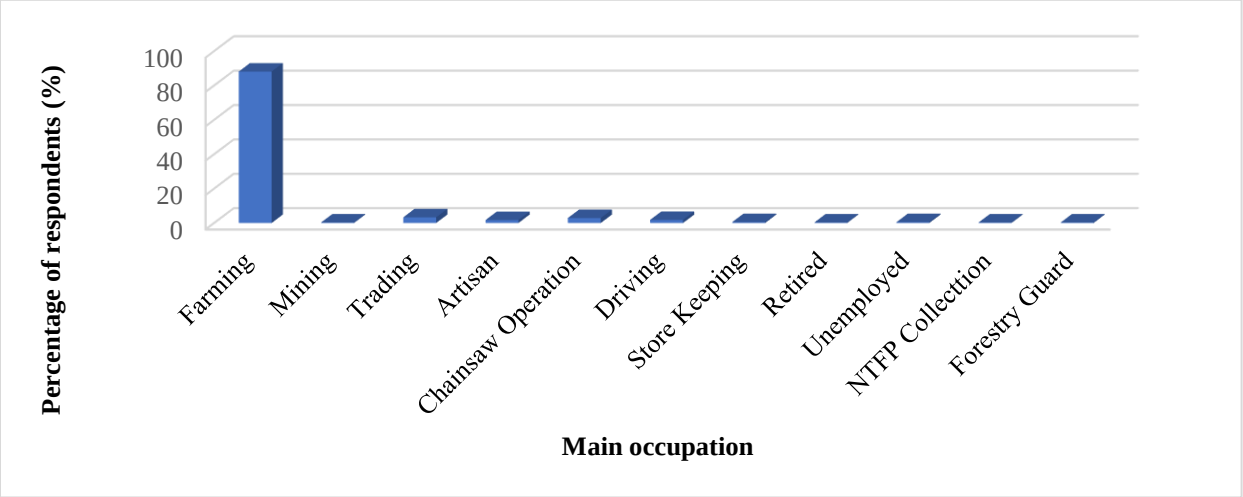

Figure 2. Percentage distribution of respondents' main occupation.

B. Level of Dependency on Tano-Offin Forest Reserve

The level of agreement or disagreement on benefits or products derived from the forest reserve by respondents is shown in Table 3. These benefits include meat from hunting, bamboo and rattan collection, drinking water, fuel wood, timber, snails, mushrooms, and medicinal products. Most respondents strongly disagree that they derive meat from hunting in the reserve (37.5%) and collect bamboo and rattan (46.8%). Nonetheless, the majority of respondents strongly agree that they get drinking water (79.5%), fuel wood (79.8%), timber (42.3), snails (44.8), mushrooms (54.5%), and medicinal products (56%) from the reserve. Less than 10% of the respondents neither agree nor disagree (neutral) about the stated benefits derived from the Tano-Offin Forest Reserve. Independent between groups (gender) analysis of variance (ANOVA) indicated no statistically significant difference between responses from male and female respondents from the studied communities for seven of the benefits derived from the forest reserve, except meat from hunting (P-value = 0.004). Results also show that most respondents (81%) depend more on the forest reserve (Figure 3). Only 2.5% of the respondents are somewhat independent of the reserve, while 6.3% are dependent.

Table 3. Respondents' perception on the benefits derived from the reserve.

Benefits	Number of Respondents (%)					P-value
	1	2	3	4	5	
Meat from hunting	21.8	16.0	9.3	15.5	37.5	0.004***
Bamboo and rattan collection	16.5	12.5	6.8	17.5	46.8	0.685
Drinking water	79.5	9.0	3.0	3.8	4.8	0.732
Fuel wood	79.8	12.0	2.3	3.0	3.0	0.508
Timber	42.3	14.0	6.1	13.8	24.0	0.736
Snails	44.8	17.8	7.3	10.3	20.0	0.183
Mushroom	54.5	19.5	6.5	7.0	12.5	0.485
Medicinal products	56.5	20.5	4.3	7.0	11.8	0.340

Scale of assessment: 5-point Likert scale (1 = strongly agree; 2 = agree; 3 = neutral; 4 = disagree; 5 = strongly disagree). Statistically significance level at 99% (P < 0.01***); 95% (P < 0.05**); 90% (P < 0.1*)

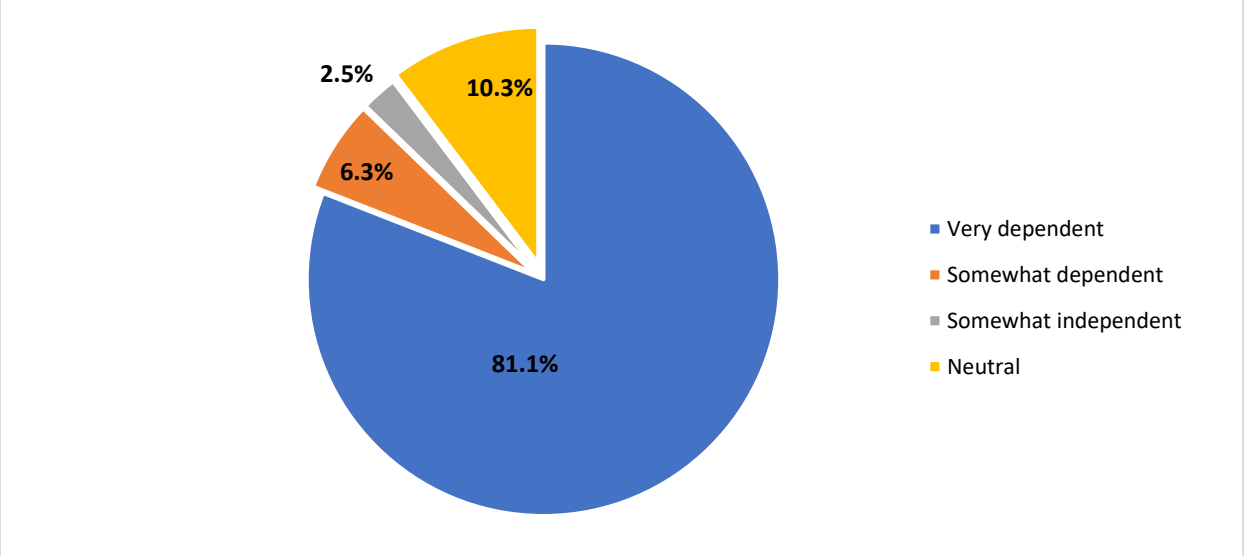

Figure 3. Percentage distribution of respondents' level of dependency on the forest reserve.

Reasons for extracting products from the Tano-Offin Forest Reserve

The reasons respondents extract products from the Tano-Offin Forest Reserve are presented in Table 4. Results show that most respondents strongly agree that they pick products from the forest reserve because of good market prospects (33.8%), quick way of earning income (34.8%), and ready job opportunities (33.5%). From the table, more than 50% agree that extracting products from the reserve is a source of job opportunities, ways of getting income, and marketing products. Results from the ANOVA show no statistically significant difference between responses from male and female respondents on the various reasons for extracting products from the reserve; *good market prospects (P-value =0.913), quick way of earning income (P-value = 0.428), and ready job opportunities (P-value = 0.130).*

Table 4. Respondents' perception on the reasons for extracting products from the reserve.

Reasons	Number of Respondents (%)					P-value
	1	2	3	4	5	
Good market prospects	33.8	22.8	5.5	14.8	23.3	0.913
Quick way of earning income	34.8	22.0	5.8	22.0	22.5	0.428
Ready job opportunity	33.5	21.8	8.1	13.3	23.5	0.130

Scale of assessment: 5-point Likert scale (1 = strongly agree; 2 = agree; 3 = neutral; 4 = disagree; 5 = strongly disagree). Statistically significance level at 99% (P < 0.01***); 95% (P < 0.05**); 90% (P < 0.1*)

Cost and benefit of extracting products from the Tano-Offin Forest Reserve

According to the respondents, the average cost and benefit of extracting products from the forest reserve are GHC 2,457 and GHC 2961, respectively (Table 5). This shows that the respondents are able to generate income from extracting products from the reserve. The benefit-cost ratio is more than 1, which shows profitability of products extraction in the Tano-Offin Forest Reserve.

Table 5. Mean distribution of cost and benefit of extracting products from the reserve

Item	Number of Observation	Minimum	Maximum	Mean	Std. Deviation
Cost	400	100	3500	2457	1251.1
Benefit		100	400	2961	1322.4

C. Alternative Livelihood Options

The respondents were asked about their awareness of any alternative livelihood option or program in their communities. Results show that about 52% of the respondents are aware of alternative livelihood options, while 48% are unaware (Figure 4). Most respondents (75.8%) have been involved in some alternative livelihood programs in the communities, while the rest have not. The notable programs respondents have been involved in were batik tie and dye, beekeeping, grasscutter rearing, plantation development, snail rearing, soap making, and trading. However, many of the respondents were involved in plantation development (23%), followed by snail rearing (19%) and soap making (17%).

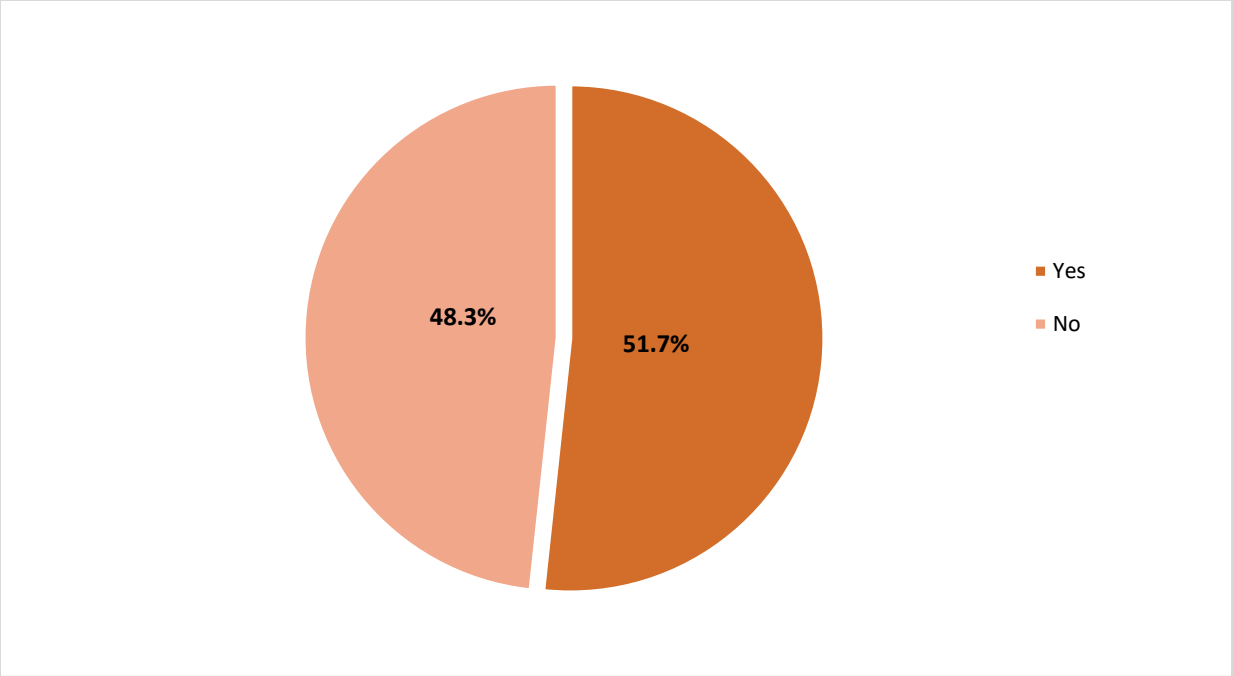

Figure 4. Percentage distribution of respondents' awareness of alternative livelihood options.

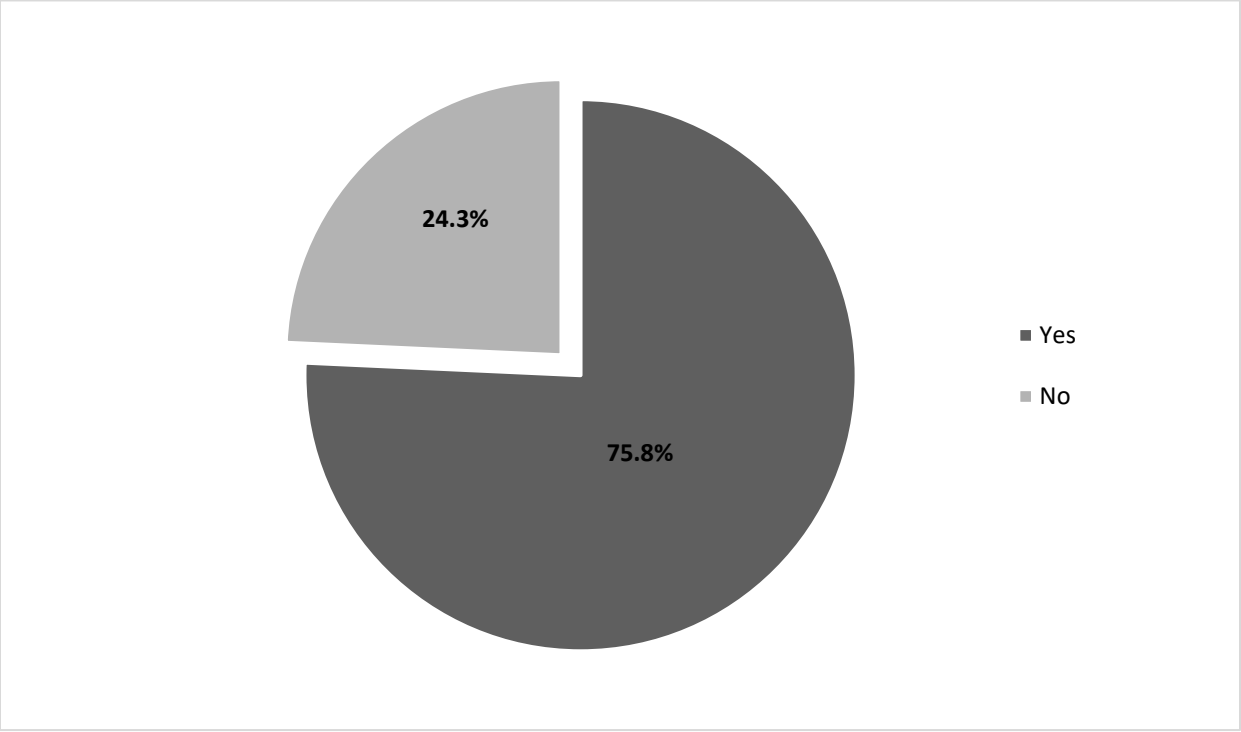

Figure 5. Percentage distribution of respondents who have been involved in alternative livelihood options or activities.

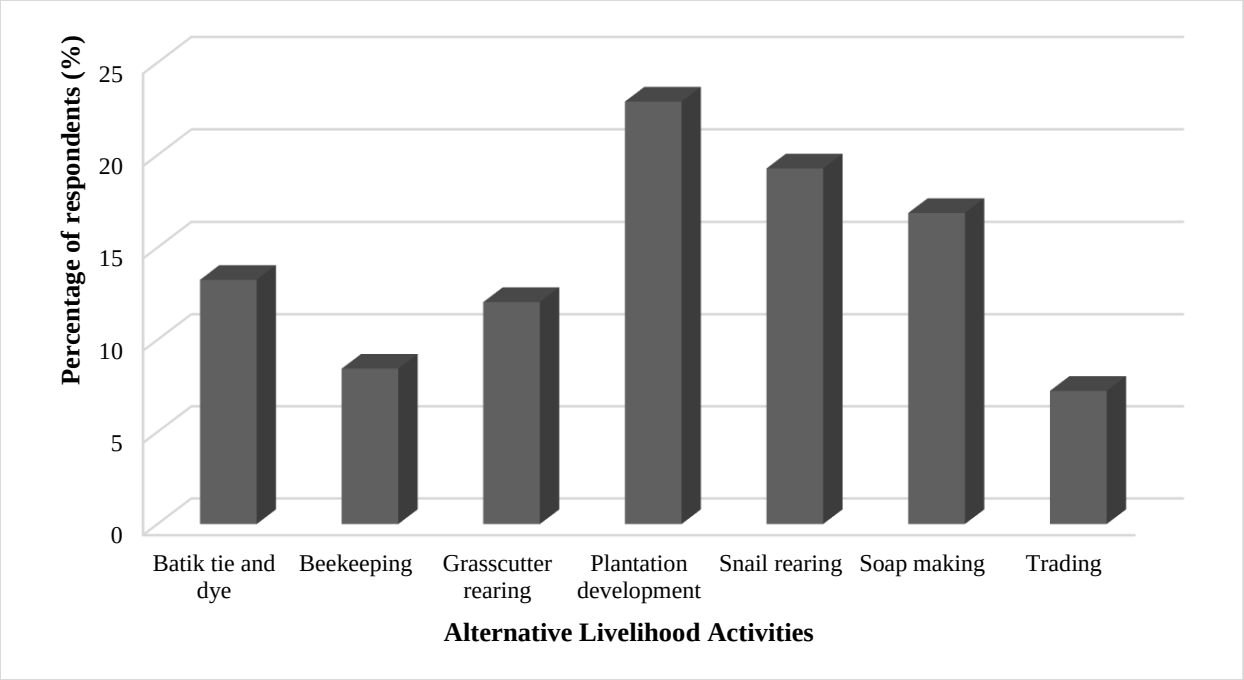

Figure 6. Percentage distribution of alternative livelihood activities respondents have been involved in.

Willingness of respondents to participate in alternative livelihood program

The respondents' willingness to participate in alternative livelihood programs is presented in Figure 7. Most respondents (95%) are willing to participate in alternative livelihood programs, while 5% are unwilling. Results show in Table 6 that of those who want to participate, the majority of them strongly agree because of income (78.3%), illegal timber operation is risky (49.3%), illegal timber operation has no future or has become less profitable (51.2%), forest and timber resources are being depleted and need to be restored (55%), improving our standard of living (71.8%), employment (73%), increase food production (74.3%), and water bodies are drying out (51.7%). Independent between groups (gender) analysis of variance (ANOVA) indicated no statistically significant difference between responses from male and female respondents of the reasons for willing to participate in alternative livelihood program.

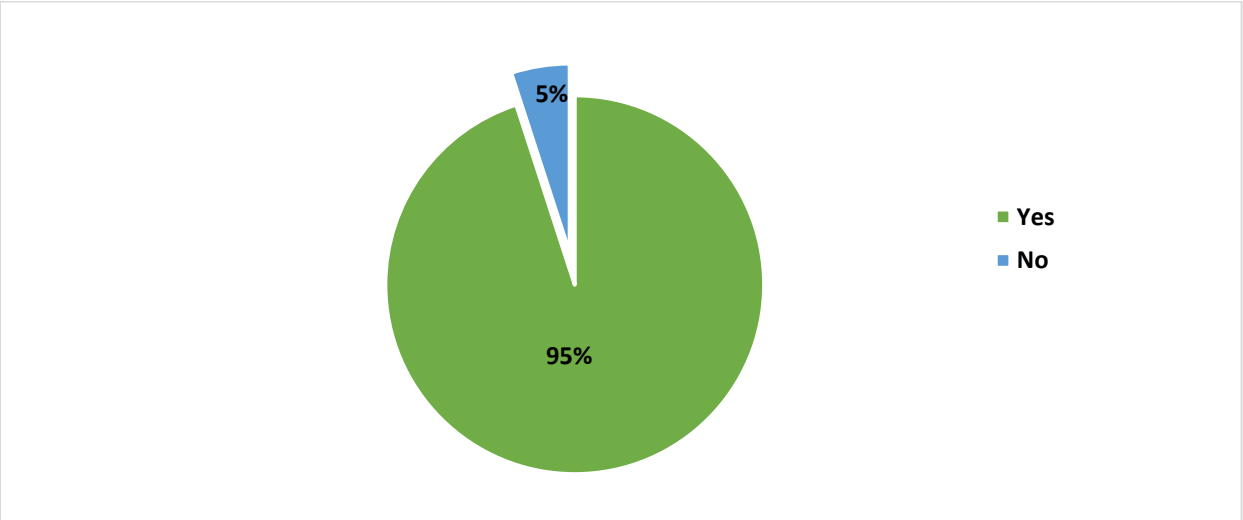

Figure 7. Percentage distribution of respondents' willingness to participate in alternative livelihood program.

Table 6. Respondents' perception on the reasons to participate in alternative livelihood program.

Reasons for WTP	Number of Respondents (%)					P-value
	1	2	3	4	5	
Income	78.3	16.0	5.0	0.5	0.3	0.979
Illegal timber operation is risky	49.3	27.5	11.5	4.0	7.8	0.209
Illegal timber operation has no future or has become less profitable	51.2	22.5	13.1	4.8	8.5	0.747
Forest and timber resources are being depleted and need to be restored	55.0	23.0	5.1	0.3	7.2	0.211
To improve our standard of living	71.8	17.5	7.8	1.5	1.5	0.601
Employment	73.0	18.8	6.8	1.0	0.5	0.609
Increase food production	74.3	16.8	7.1	1.0	1.0	0.651
Water bodies are drying out	51.7	22.3	15.0	6.8	4.3	0.590

Scale of assessment: 5-point Likert scale (1 = strongly agree; 2 = agree; 3 = neutral; 4 = disagree; 5 = strongly disagree). Statistically significance level at 99% (P < 0.01***); 95% (P < 0.05**); 90% (P < 0.1*)

Alternative livelihood options respondents prefer

The alternative livelihood options respondents prefer are presented in Table 7. According to the results, most respondents prefer snail rearing (69.5%), vegetable cultivation (68.0%), mushroom production (64.5%), planting fruit trees (63.0%), beekeeping (59.3%), ruminant rearing (59.3%), grasscutter rearing (54.5%), cultivating fast-growing indigenous timber species (50.5%), cultivating cash crops (46.5%), and cultivating medicinal plants cultivation of short rotation exotic species (46.5%). Results from the ANOVA show no statistically significant difference between responses from male and female respondents of their preferred alternative livelihood program.

Table 7. Respondents' perception on the preference of alternative livelihood programs.

Alternative Livelihood Program	Number of Respondents (%)					P-value
	1	2	3	4	5	
Snail rearing	69.5	15.5	1.5	5.5	8.0	0.531
Mushroom farming	65.5	17.1	3.6	4.5	10.5	0.853
Bamboo cultivation	35.3	12.3	7.8	13.3	31.3	0.092
Bee keeping	59.3	12.5	3.8	8.8	15.8	0.257
Grass cuter rearing	54.5	11.5	6.6	9.8	17.8	0.278
Vegetable farming	68.0	13.7	3.0	3.8	12.5	0.339
Rearing of ruminants and rodents	59.3	13.6	5.3	6.5	15.3	0.498
Planting fruit trees	63.0	12.0	3.0	6.0	16.0	0.885
Planting cash crops e.g., Cashew	46.5	16.8	4.8	9.2	23.0	0.738
Planting multipurpose trees e.g., Leucaena	44.8	14.8	7.5	8.0	25.0	0.669

Cultivation of short rotation exotic species e.g., Teak, Cedrela	46.5	5.3	5.1	18.5	24.8	0.820
Cultivation of fast-growing indigenous timber species e.g., Ofram, Onyina, Mahogany	50.5	16.6	4.6	7.8	20.8	0.472
Cultivating medicinal plants	46.8	16.7	6.5	9.5	20.5	0.470

Scale of assessment: 5-point Likert scale (1 = very important; 2 = somewhat important; 3 = neutral; 4 = unimportant, 5 = very unimportant). Statistically significance level at 99% (P < 0.01***); 95% (P < 0.05**); 90% (P < 0.1*)

D. Motivation and Measures for Successful Implementation of Activities

What will motivate respondents to participate in alternative livelihood programs and the measures to ensure successful implementation of activities are presented in Table 8 and Table 9, respectively. Most respondents were of the view that improvement of standards of living (79.8%), access to financial or credit facilities (75%), regular monitoring and supervision (67.3%), assistance from the government (64.8%), and formation of an association to protect the forest (62%) will motivate them more to participate in alternative livelihood programs (Table 8). These responses show no statistically significant difference between male and female respondents, except improvement of standards of living (P-value = 0.04) and access to land (P-value = 0.08).

Table 8. Respondents' perception on what will motivate them to participate in alternative livelihood programs.

Alternative Livelihood Program	**Number of Respondents (%)**					**P-value**
	1	**2**	**3**	**4**	**5**	
Access to financial or credit facilities	75.0	16.5	3.5	3.3	1.8	0.478
Improvement of standards of living	79.8	17.6	0.5	1.5	0.8	0.044**
Restoration of the lost forest	55.5	28.0	6.8	3.6	6.3	0.678
Regular monitoring and supervision	67.3	21.9	5.3	2.0	3.8	0.510
Training and capacity building	65.3	27.8	4.3	1.3	1.5	0.795
Access to land	58.3	12.1	1.1	4.8	8.3	0.083*
Assistance from the government	64.8	20.1	3.8	2.8	2.3	0.827
Illegal timber operation has no future	52.8	26.3	8.8	4.8	7.5	0.749
Formation of association to protect the forest	62.0	28.0	4.5	3.5	2.0	0.467

Scale of assessment: 5-point Likert scale (1 = very important; 2 = somewhat important; 3 = neutral; 4 = unimportant, 5 = very unimportant). Statistically significance level at 99% (P < 0.01***); 95% (P < 0.05**); 90% (P < 0.1*)

In Table 9, the measures to ensure successful implementation of alternative livelihood activities vary. Most respondents indicated that credit facilities (77.8%), market access (68.5%), training and capacity building (62.5%), and access to extension service (62.5%) will ensure successful implementation of alternative livelihood activities. However, there was no statistically significant difference between male and female respondents' perception on the measures.

Table 9. Respondents' perception on measures to ensure successful implementation of alternative livelihood activities.

Alternative Livelihood Program	Number of Respondents (%)					P-value
	1	2	3	4	5	
Credit facilities	77.8	17.3	2.8	2.4	0.0	0.808
Access to market	68.5	26.1	4.5	0.8	0.3	0.514
Provision of seedlings	50.5	29.3	6.6	3.1	10.8	0.493
Training/capacity building	62.8	31.5	3.6	1.3	1.0	0.987
Access to extension service	62.5	31.1	5.1	1.3	1.3	0.522

Scale of assessment: 5-point Likert scale (1 = very important; 2 = somewhat important; 3 = neutral; 4 = unimportant, 5 = very unimportant). Statistically significance level at 99% (P < 0.01***); 95% (P < 0.05**); 90% (P < 0.1*)

Factors that can militate against the success of respondents' preferred alternative livelihood activity are presented in Table 10. Results show that factors such as transportation, labour, and access to land can militate against the success of the programs. Over 45% of the respondents strongly agree with the factors stated above. Results from the ANOVA show no statistically significant difference between responses from male and female respondents on the things that can militate against the success of the alternative livelihood program.

Table 10. Respondents' perception on measures to ensure successful implementation of alternative livelihood activities.

Alternative Livelihood Program	Number of Respondents (%)					P-value
	1	2	3	4	5	
Access to land	48.8	8.8	7.3	13.0	22.3	0.908
Lack of ready market	41.0	15.1	7.3	21.5	15.3	0.104
Lack of access to extension services	40.0	17.0	9.3	19.8	14.0	0.540
No/inadequate monitoring	40.5	19.5	8.0	19.0	13.0	0.133
Long-term nature of some alternative options	43.0	19.5	9.6	18.0	10.0	0.820
Labour	49.0	18.3	6.3	18.3	13.5	0.205
Transportation	55.3	9.3	5.5	13.3	16.8	0.810

Scale of assessment: 5-point Likert scale (1 = strongly agree; 2 = agree; 3 = neutral; 4 = disagree; 5 = strongly disagree). Statistically significance level at 99% (P < 0.01***); 95% (P < 0.05**); 90% (P < 0.1*)

3.2 Plant Diversity Assessment

A. Woody Tree Composition

A total a number of 288 trees were identified and measured during the inventory (Appendix Table 12). *Broussonetia papyrifera* was the most dominant species recording 86 trees. *Trichilia monadelpha* recorded the second highest of 12 trees with many of the species spotted just once in the entire sample plots.

B. Tree Species Diversity

The species diversity showed that the site was generally invaded by *Broussonetia papyrifera*. The mean *Trichilia monadelpha* of 2.11 ± 0.79 and mean Simpson's index of 0.78 ± 0.18 (see Table 11) are similar to 2.55 and 0.9 for Shannon-Wiener index and Simpson's index respectively attained for the same study site by Adotey and Belford (2021). With a Shannon Weiner diversity of 2.74 to 2.99 indicating intermediate secondary forest (Adotey and Belford, 2021), the value (2.11 ± 0.79) for this study depicts massive degradation of the GSBA are inventoried. The Shannon index indicates that the *Broussonetia papyrifera* invasion compromises the diversity of indigenous plant species within the forest ecosystem. There is, therefore, the need to control the species to protect the integrity of the GSBA.

Table 11. Species diversity in the study site.

	Shannon Weiner Diversity index	Simpson diversity index	Inv	Peilou's Evenness
Mean	2.11075	0.778118	6.966059	0.343253
SD	0.793231	0.184798	3.769958	0.136117
SE	0.250842	0.058438	1.192165	0.043044
Min	0.693147	0.390533	1.640777	0.264155
Max	2.861756	0.901361	10.13793	0.721348

4.0 CONCLUSION

The study has revealed the state of dependence and anthropogenic threats to the GSBA in Tano Offin forest reserve. This requires serious attention to safeguard such a unique ecosystem of international interest from losing its productivity and functionality. However, with the community-based assessment revealing high majority of the people (95%) willing to participate in other sustainable alternative livelihood support programs is a meaningful way to lessen the pressure on the GSBA in the quest o conserving it.

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APPENDIX

Table 12. Tree species identified and measured in sample plots.

Species scientific names	Total	Site (%)
Albizia adianthifolia	3	0.0104
Albizia zygia	3	0.0104
Alstonia boonei	6	0.0208
Antiaris toxicaria	3	0.0104
Aubrevillea platycarpa	1	0.0035
Baphia nitida	1	0.0035
Bombax buonopozense	3	0.0104
Broussonetia papyrifera	86	0.2986
Buchholzia coriacea	1	0.0035
Calpocalyx brevibracteatus	2	0.0069
Carapa procera	1	0.0035
Cedrela odorata	4	0.0139
Ceiba pentandra	3	0.0104
Celtis adolfi-friderici	3	0.0104
Celtis mildbraedii	9	0.0313
Celtis zenkeri	7	0.0243
Chrysophyllum albidum	3	0.0104
Cleistopholis patens	5	0.0174
Cola gigantea	2	0.0069
Cola nitida	3	0.0104
Corynanthe pachyceras	2	0.0069
Crotonogyne chevalieri	1	0.0035
Diospyros monbuttensis	2	0.0069
Discoglypremna caloneura	2	0.0069
Distemonanthus benthamianus	1	0.0035
Elaeis guineensis	2	0.0069
Entandrophragma angolense	9	0.0313
Entandrophragma candollei	3	0.0104
Entandrophragma cylindricum	4	0.0139
Ficus exasperata	3	0.0104
Ficus vogeliana	3	0.0104
Funtumia elastica	9	0.0313
Gmelina arborea	1	0.0035
Guarea cedrata	2	0.0069
Hannoa klaineana	2	0.0069
Hymenostegia afzelii	1	0.0035
Khaya ivorensis	1	0.0035
Lannea welwitschii	1	0.0035
Lecaniodiscus cupanioides	3	0.0104
Leucaena leucocephala	5	0.0174
Mansonia altissima	1	0.0035
Mareya micrantha	1	0.0035
Milicia excelsa	1	0.0035
Monodora myristica	2	0.0069
Musanga cecropioides	10	0.0347
Myrianthus libericus	2	0.0069
Pouteria altissima	2	0.0069

Pterygota macrocarpa	2	0.0069
Pycnanthus angolensis	3	0.0104
Rauvolfia vomitoria	3	0.0104
Ricinodendron heudelotii	4	0.0139
Rinorea oblongifolia	2	0.0069
Scottellia klaineana	1	0.0035
Sterculia oblonga	4	0.0139
Sterculia rhinopetala	6	0.0208
Sterculia tragacantha	4	0.0139
Strombosia pustulata	1	0.0035
Terminalia superba	3	0.0104
Tetrapleura tetraptera	1	0.0035
Trema orientalis	1	0.0035
Trichilia monadelpha	12	0.0417
Trichilia prieureana	9	0.0313
Trichilia tessmannii	1	0.0035
Triplochiton scleroxylon	5	0.0174
Vernonia amygdalina	1	0.0035
Abundance	**288**	0.0104