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Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing *Escherichia coli* in the Calgary Health Region: emergence of CTX-M-15-producing isolates. *Antimicrob. Agents Chemother.* 51: 1281-1286.

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*Full Length Research Paper*

# **Access to and utilisation of forest resources: Evidence from common property forest management in Swaziland**

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**A major challenge facing Swaziland is how to maximise the use of forest resources while still maintaining their sustainability. Forest resources are being depleted and degraded due to poor access controls, inequities in land-tenure and user rights. The research was conducted using the Institutional Analysis and Development (IAD) framework as the underlying scheme. The main objective of this study was to investigate access to and utilisation of forest resources in the selected chiefdoms in Mahlangatsha Inkundla. The survey methodology whose target population was from the two chiefdoms were household heads was adopted in this study (N = 185). Data were collected using questionnaires. Stratified random sampling technique which combined both stratification and randomization were used. Findings revealed that, access levels of households to forest resources were different. Whilst access to community forest resources was restricted, the natural forest resources were open to extraction by anyone. Institutional and community rules that are used to regulate access to forest resources lack effectiveness. Consequently, there are problems of deforestation, degradation, illegal harvesting, and lack of involvement by community members to manage forest resources. The study recommends that, local people should be educated about rules that regulate access to forest resources and common rules be set at the local level.**

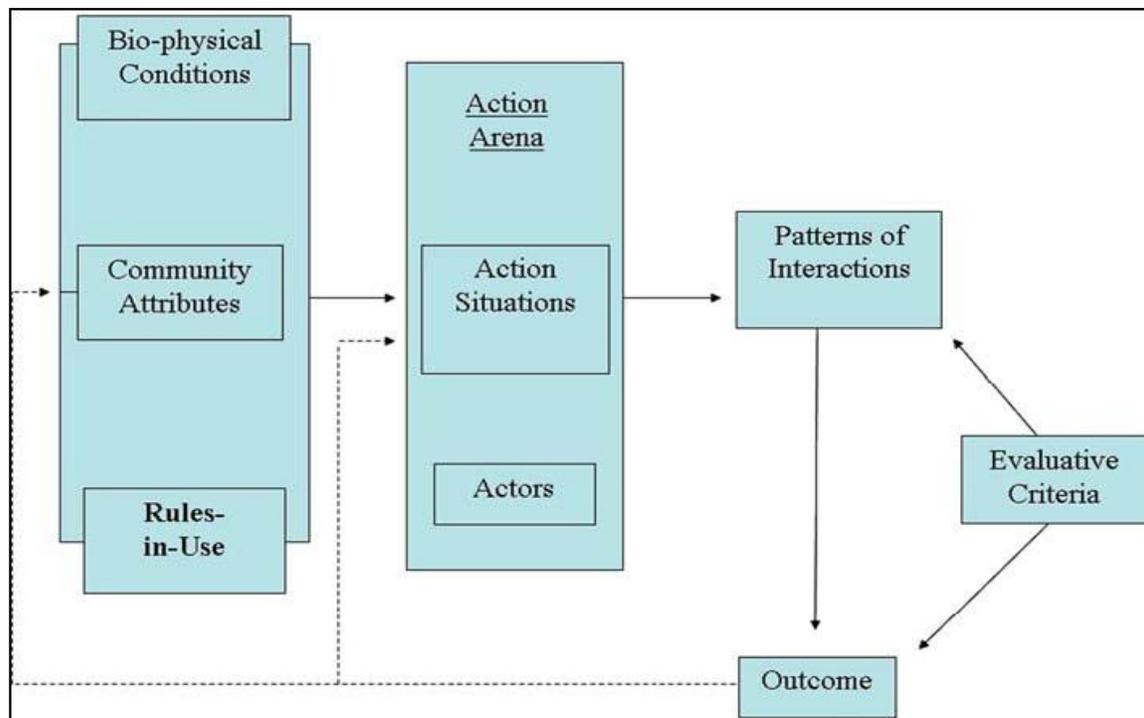
**Key words:** Utilisation of forest resources, Acces of forest resources, forest management, sustainability.

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## **INTRODUCTION**

The contribution of forest resources to the livelihood strategies of poor people has long been appreciated as significant. Most rural poor people rely directly and indirectly on forests for their livelihoods. How to ensure that poor people have rights and opportunities to access forest resources, as well as responsibilities for the sustainable management of forest resources, has become a central question in debates (Shimizu and Trudel, 2006; Tevera and Mukora, 2007). People in most developing countries often depend on extracting

resources from nearby forests for their livelihoods, whether for consumption or fuelwood, or as a source of income. Community or social forestry relates to forestry activities by rural people in the local environment. It involves community and individual participation in the planning, execution and management of a variety of social and economic forestry elements (Tevera and Mukora, 2007) It is people's needs which, in theory, determine tree planting and harvesting priorities. People are seen as partners in the planning and management of



**Figure 1.** The focal level of analysis of the IAD framework. Source: Ostrom et al. (2007).

forest resources, rather than as resource exploiters to be controlled or excluded. Forestry can play a significant role for the well being of the people living in and around the forest areas, and conversely, these people can play a major part in making the forests around them more productive. Managing forests primarily with a view to protecting, developing and utilising them is sustainable forest management.

To this end, the requirements for fuelwood, fodder and construction timber required by the people for their consumptive and productive purposes have been regarded as important benefits to communities (Fisher, 2004). According to a National Forest Policy Green Paper (2000) in Swaziland, forests are even more important for the immediate beneficiaries, the people that are employed in the forest industry, or make a living from trade in forestry products. All rural people directly benefit from the forest as they depend on a range of forest products which are derived from their immediate environment. Thus, the most important aspect of their role is to act as custodians and ensure sustainable management of the forest resources.

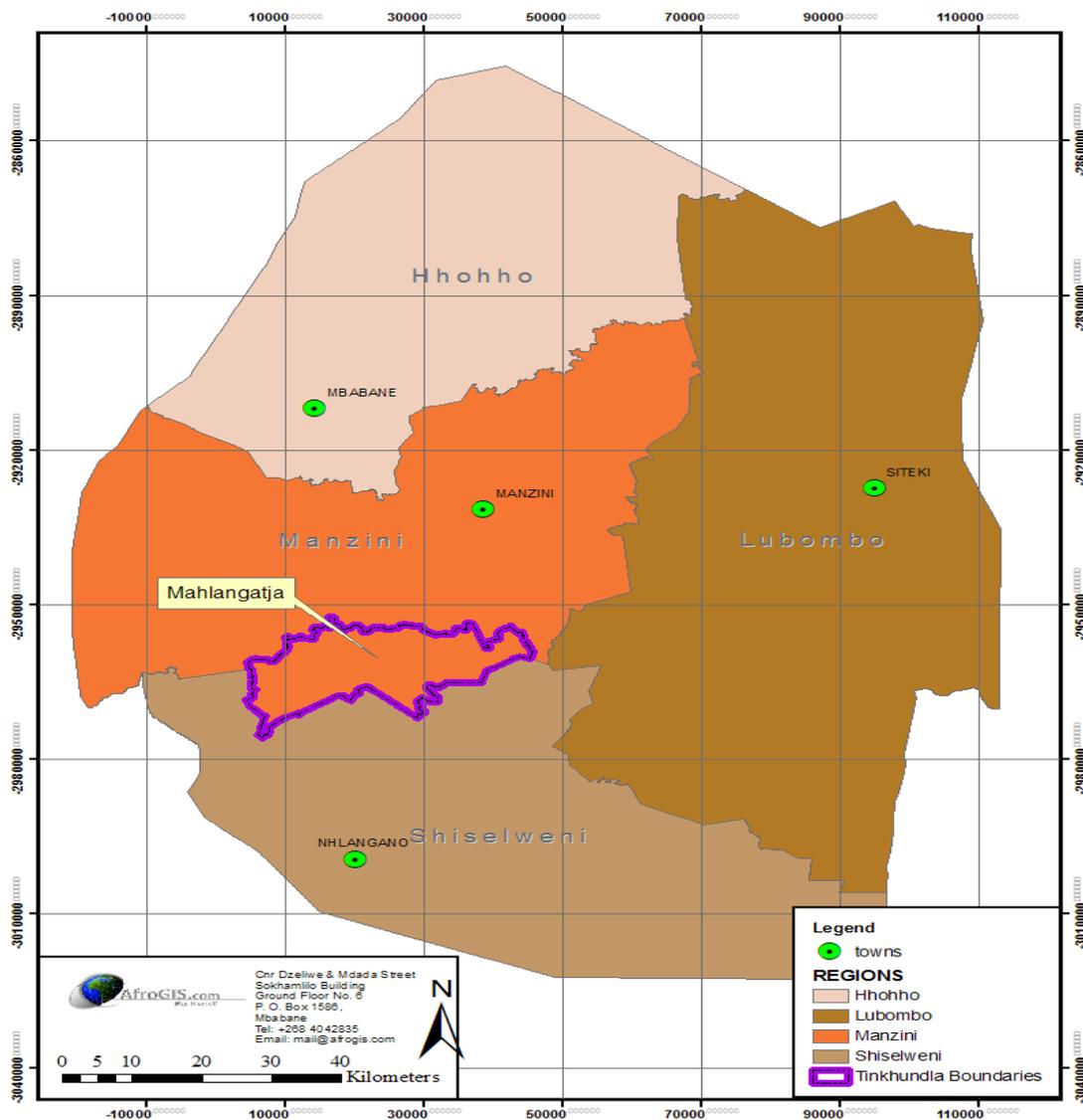
### Conceptual framework

The Institutional Analysis and Development (IAD) framework was used for this study to explore access to and utilisation of forest resources in selected chiefdoms in Mahlangatsha Inkundla (Figure 1). A key feature is its

structure, which extends from the operational level, where decisions directly affect resource access and use, to the collective-choice level, where the rules that govern resource access and use are designed, to the constitutional level, where decisions affect the rules that govern how decisions are taken at the collective-choice level. The IAD framework is one of the most distinguished and tested frameworks in the field of natural resource management (Gibson et al., 2005; Rudd, 2004; Carlsson, 2000). It has notably been used as a basis for developing a theory of common-pool resource management and has been supported in this field by a strong record of empirical research and theoretical development (Ostrom et al., 2007). The IAD framework places emphasis on institutions, rules and actors that create patterns of interactions.

### Study area

The study area covers Sibovu, and Mpolonjeni chiefdoms in Mahlangatsha Inkundla, which is located in the Manzini District of Swaziland. According to the Government of Swaziland in 2007, this region of Swaziland is the most heavily settled and the increase in population is having a negative impact on the natural vegetation. Swaziland is divided into four regions. These regions are; Hhohho; Manzini, Lubombo, and Shiselweni. The regions are shown in Figure 2. The Mahlangatsha Inkundla is situated in the southern part of Manzini region.



**Figure 2.** Map of Swaziland showing the location of Mahlangatsha Inkundla in Swaziland. Source: AfroGIS Swaziland (2008).

Figures 3 and 4 show the location of Mpolonjeni and Sibovu in Mahlangatsha Inkundla, respectively. The study area lies between longitude 31° 00' to 31° 15' E and latitude 26° 45' to 27° 00' S (Figure 2). Sibovu and Mpolonjeni are located between Motane and Tungolubi rivers. The selected chiefdoms are in Mahlangatsha Inkundla and they have natural trees and community woodlots. Mahlangatsha *Inkhundla* is in the Middleveld of Swaziland and is located in an area designated as Swazi Nation Land (SNL).

### Population

The Mahlangatsha Inkundla has 11 chiefdoms. The study

focuses on Sibovu, and Mpolonjeni chiefdoms. The chiefdoms were selected for the study because there are both community woodlots and indigenous forests. The study area has a total population of 3320 people (Government of Swaziland, 2007).

### Soils and vegetation

Sibovu has soils which are generally acidic. Eucalyptus trees are generally grown in Sibovu chiefdom and constitute 15 ha (Government of Swaziland, 2007). According to the Government of Swaziland in 2007, there are also wattle trees which constitute 80 ha. Common forms of plants include small woodlots and fruit trees.

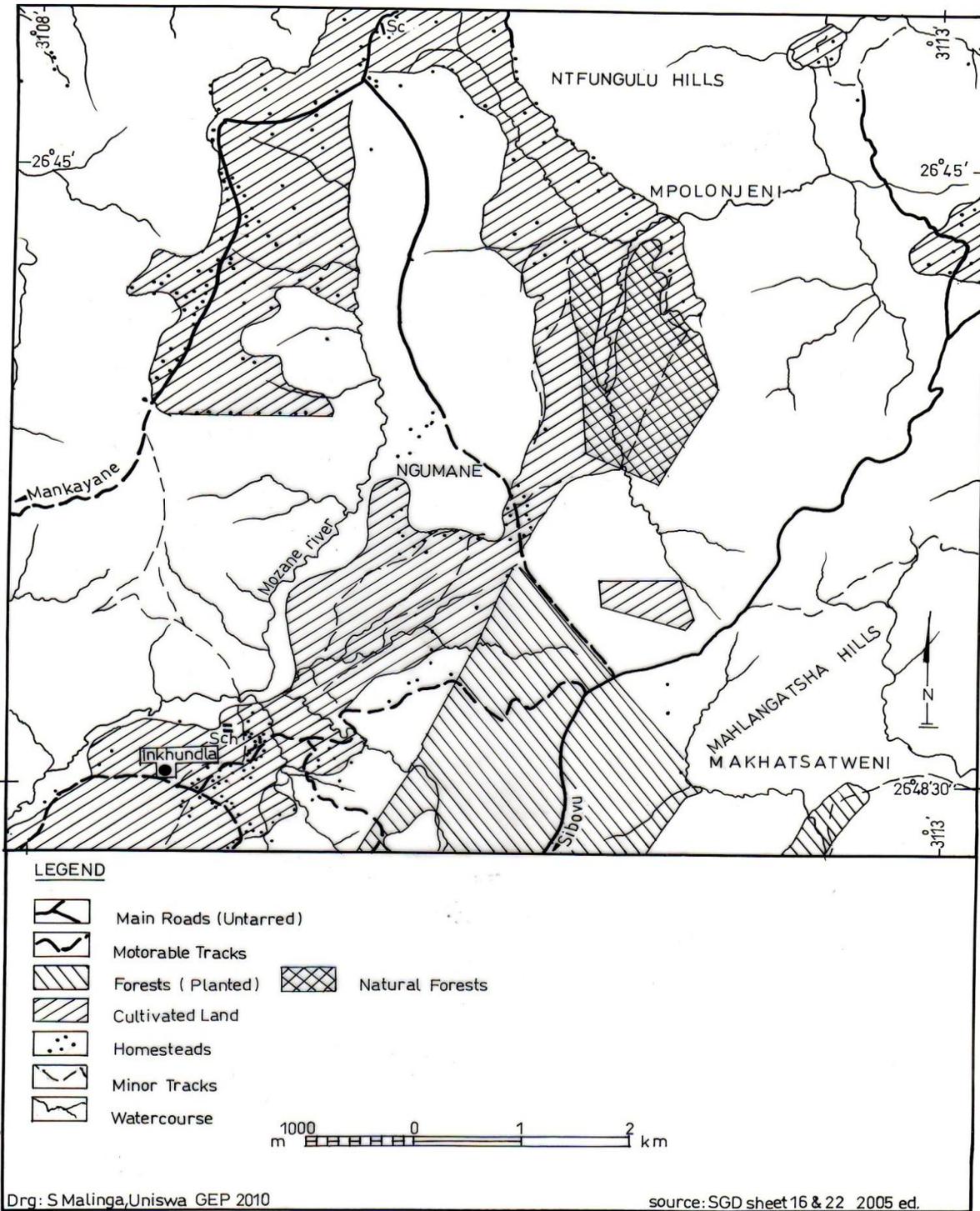


Figure 3. Map showing location of Mpolonjeni (Mahlangatsha Inkundla) Source: SGD Sheet 16 and 22 2005 edition.

Most commonly planted woodlots consist of two introduced wattle species *umtfolo* and *umtfolowesi lungu* (*Acacia mearnsii* and *Acacia Decurrens*, respectively) which may also be referred to as the Black Wattle. The natural trees which are found in Mpolonjeni chiefdom include *Dalbegia*, *Sygium Cummunii*, *Kaya Nyassica* and

others. According to Government of Swaziland in 2007, Mpolonjeni has 120 ha of eucalyptus, 50 ha wattle and 30 ha natural forest. Exotic plantations were introduced in the study area to curb land degradation and to ensure that local communities get products for use. Sibovu and Mpolonjeni chiefdoms practise afforestation using

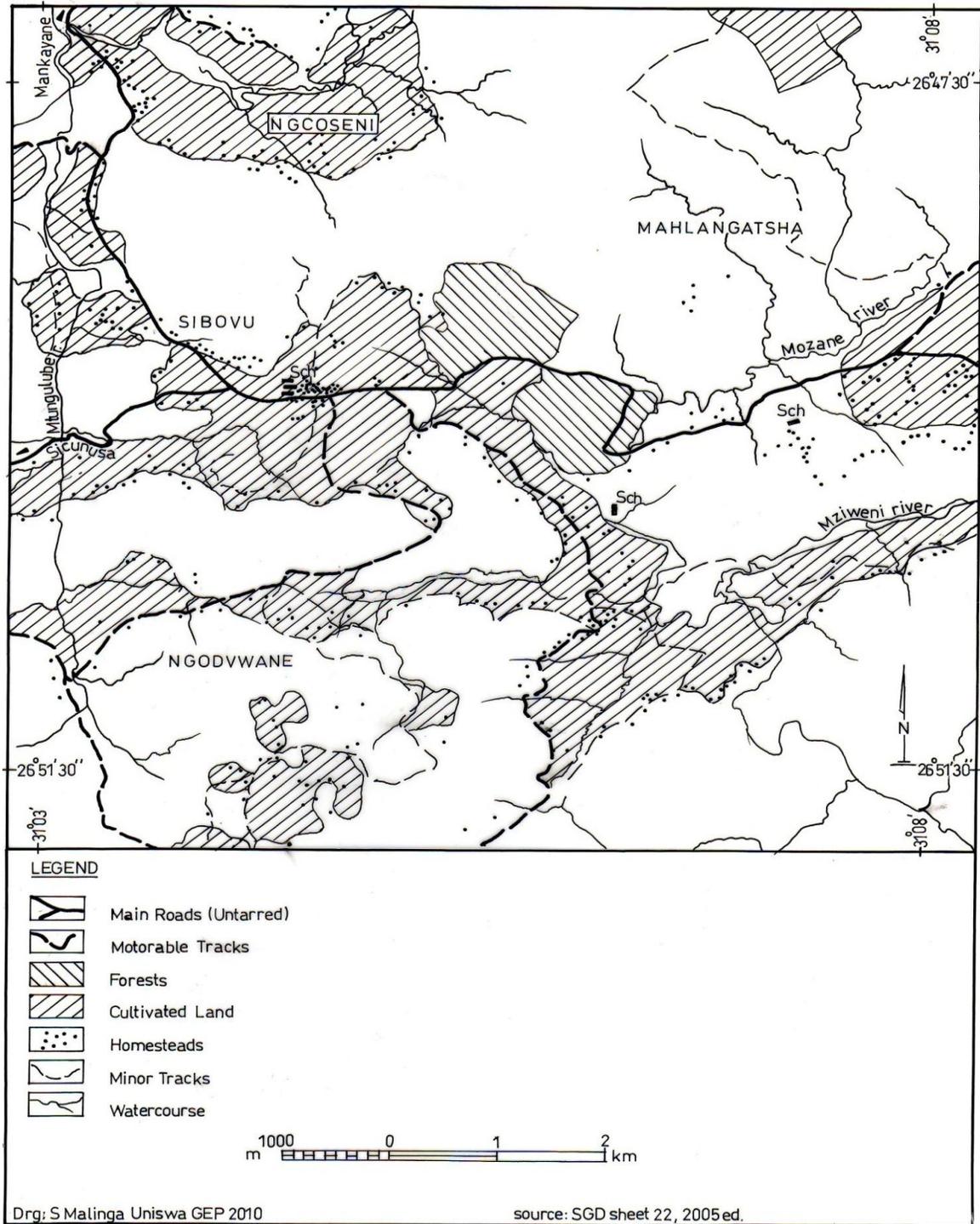
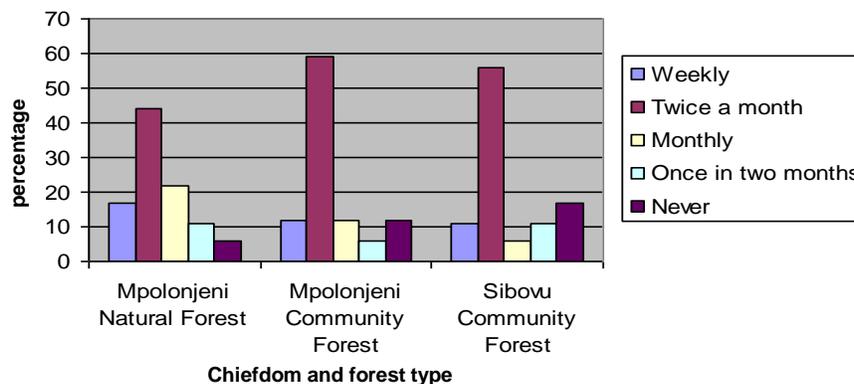


Figure 4. Map showing location of Sibovu. Source: SGD Sheet 22 2005 edition.

seedlings provided by the Mahlangatsha Rural Development Area (RDA) programme which helps in community forestry. Centralized government nurseries have been established by the forestry department for raising seedlings, primarily for the community and individual woodlots on the SNL.

The woodlots are expected to produce wood fuel and poles as well as contributing to soil conservation. Seedlings are issued free of charge by the Swaziland Government and technical expertise were provided by the extension workers on the establishment and management of tree crops. Community woodlots are



**Figure 5.** Frequency of getting to the forest to harvesting forest resources Source: Fieldwork 2009/2010.

established under the supervision of local chiefs, through participatory efforts. The chief nominates a special village committee to select sites for woodlots and mobilize people for the establishment, protection and tending of the woodlots.

## RESEARCH METHODS

### Research design

A quantitative approach was adopted for this study. A household survey incorporating 185 respondents was carried out within the study area. The sampling frame was obtained from the RDA office at Sibovu to get the number of households in the study area. Some names that did not appear on the RDA's office were obtained from the chief runners (*tindvuna and libandla*). A total of 617 households were identified where Sibovu has 425 households and Mpolonjeni has 192 households. In order to make sure that there was meaningful representation from each chiefdom, the researcher selected 30% from each chiefdom (Sibovu-125; Mpolonjeni-60) to make a total of 185 households for the purpose of the study. The researcher got assistance from the RDA's office and members of the *tindvuna and libandla* to locate the households and selected in the sample.

To enable meaningful representation within the chiefdoms the researcher selected 30% sample size from each chiefdom. Therefore, vast majority (125 respondents) were drawn from Sibovu and 60 respondents were drawn from Mpolonjeni. A probabilistic type of sampling namely stratified random sampling, which combined both stratification and randomisation was employed in selecting the study's respondents. This was to enhance the extent of representativeness of the sample. The primary data collecting instrument used was a questionnaire which was administered to heads of households.

### Sampling

The sampling method that was used in this study is stratified random sampling. Stratified random sampling was done by chiefdom. This sampling method was selected for this study to ensure that, a minimum number of households were chosen from each chiefdom. Stratified random sampling was used so that, there will be assurance of enough cases from each group to make meaningful subgroup inferences. Within each of the chiefdom,

simple random sampling was carried out to ensure that each household was chosen by chance.

### Data collection

The researcher conducted a survey research. A questionnaire was prepared for each household in the different chiefdoms and responses were recorded from the household head. The questionnaire used in the study had open-ended questions and close-ended questions (Appendix A).

After coding the findings and ensuring that the data was accurate, a computer program, Statistical Package for Social Sciences (SPSS) was used for statistical analysis. This enabled the production of tables, graphs and means. Analytical tables were also produced to present the data that could not be presented graphically.

### Research findings

Very low proportions of respondents in the study area indicated that, they did not go and harvest forest resources from the natural and community forests (Figure 5). The general pattern which is emerging from the interviewed households is that, due to poverty, most households depend on forest products for their day to day use.

Access to community forest resources in the chiefdoms studied is open to the local communities and to the outside communities though there are some controls done by some traditional leaders to access the forest resources. The results of this study showed that, more than 80% of the community members seek permission to access forest resources from Sibovu and Mpolonjeni community forests whilst the same proportion of respondents (80%) also indicated that, community members need to seek permission to access products from the natural forest in Mpolonjeni. However, permission was sought to help in controlling access to forest resources. As Figure 6 portrays, outsiders need permission to access forest resources then either pay a fee or freely access the forests, whilst community, members either pay a fee or enter freely.. The percentage of respondents who said outsiders seek permission to access forest resources from the community forest is highest in Mpolonjeni (71%) whilst Sibovu constitutes 56%.

Results reveal that, few household heads in Mpolonjeni (18%) and Sibovu (11%) indicated that, it was free to get access into the community forests. It should be noted, however that outsiders pay a nominal fee of E10 and E15 per pole in Mpolonjeni and Sibovu,

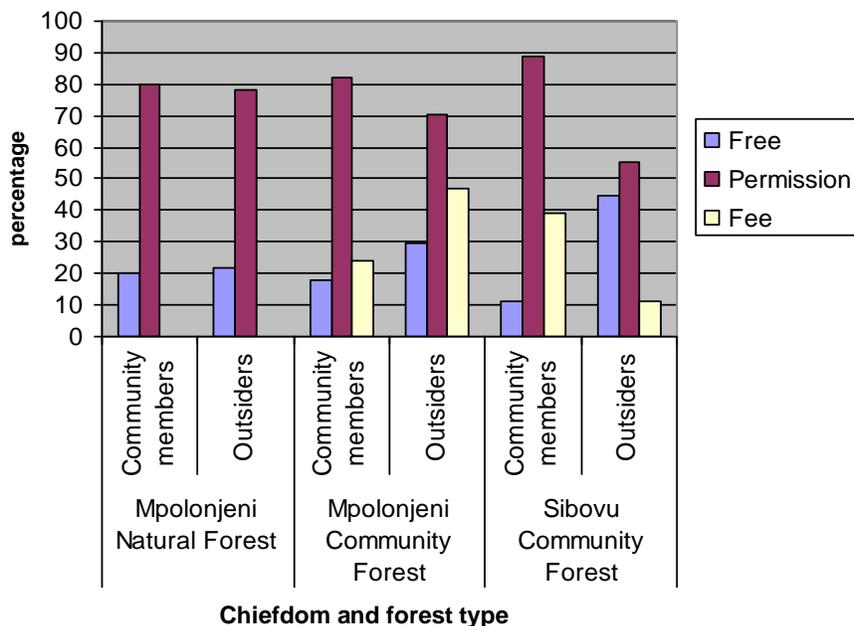


Figure 6. How to get access to the community forests. Source: Fieldwork 2009/2010.

Table 1. Forest products harvested and used.

Resource obtained from the forest	Mpolonjeni community forest (%)	Sibovu community forest (%)	Mpolonjeni natural forest (%)	Source	Uses
Firewood	88	94	88	Trunk	Cooking
Poles	59	83	71	Trunk	Construction, fencing
Seeds	-	-	47	Branches	Necklace making
Medicine	-	-	59	Bark, leaf, fruit	Curing diarrhoea
Fruits	-	-	76	Branches, roots	Food
Leaves	-	-	41	Branches	Medicinal, basket making
Roots	-	-	76	Roots	Medicinal
Honey	35	33	21	Trunk and branches	Food

Source: Fieldwork 2009/2010.

respectively, to access community forest products whilst some local community members do not pay any nominal fee since they are custodians of the community forests. Some of the respondents argued that, although the idea of paying to harvest from the forest sounded plausible theoretically, it was not very practical because some households are too poor to pay the fees, hence end up accessing the forests free of charge.

With respect to forest products harvested and used high proportions of respondents in Sibovu (94%) and Mpolonjeni (88%) said they harvest firewood from the community forest whilst the proportion is also very high in Mpolonjeni natural forest (88%) (Table 1). The proportion of those who harvest poles is highest in Sibovu community forest (83%) whilst in Mpolonjeni, 71% harvest the poles from the natural forest. It was noted that, community members and outsiders need poles from the natural forest in Mpolonjeni for constructing carts which are commonly used as a mode of transport. It is important to emphasize that, most of the products are collected for self-consumption and community rules

require the community members to make a formal request before they can cut trees.

Most respondents (88%) indicated that, if forest products are harvested illegally from Mpolonjeni community forest the culprits are arrested. The percentage of respondents in this category is also high in Sibovu community forest (50%). To the contrary in Mpolonjeni natural forest, only 25% of the respondents said if harvesting is done illegally from natural forest the culprit will be arrested. A high percentage of respondents in Sibovu (50%) indicated that, illegal harvesting of forest resources led to payment of a fine and in Mpolonjeni chiefdom, a very small percentage (12%) indicated that, there was payment of a fine if there was illegal harvesting of products from the natural forest. In the chiefdoms studied, culprits can both be arrested and made to pay fines (Figure 7).

It is worth mentioning that 40% of the household heads in Mpolonjeni said nothing was done if forest resources were harvested illegally from the natural forest. However, the study

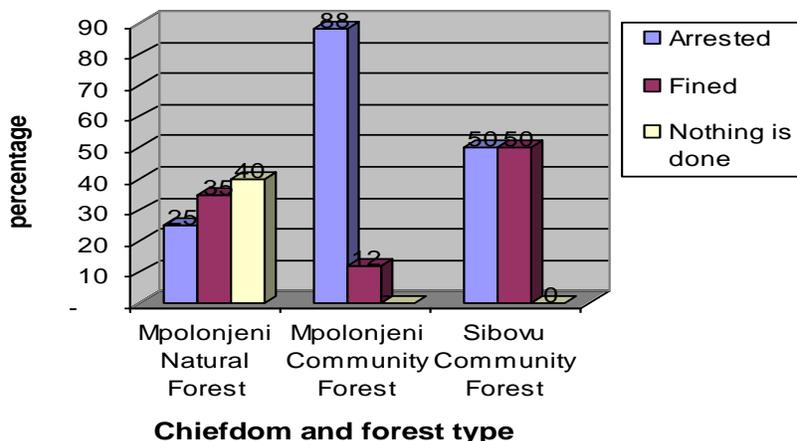


Figure 7. Punitive measures for illegal harvesting of forest resources. Source: Fieldwork 2009/2010.

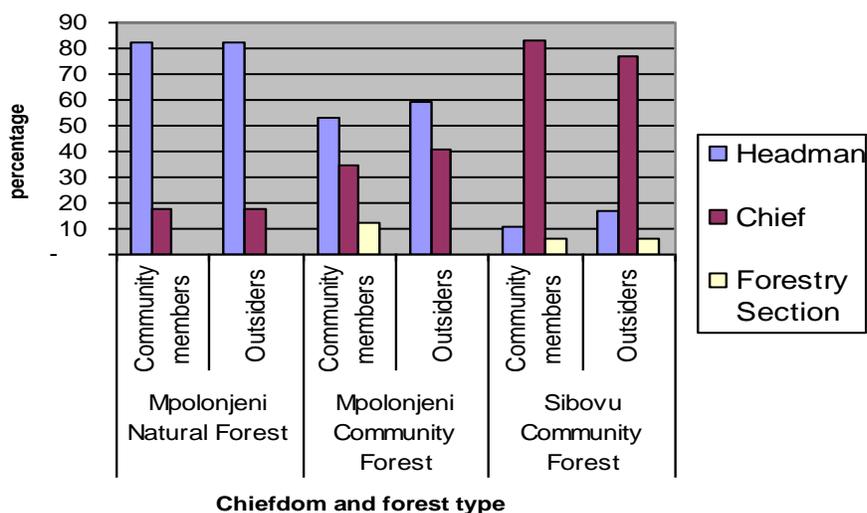
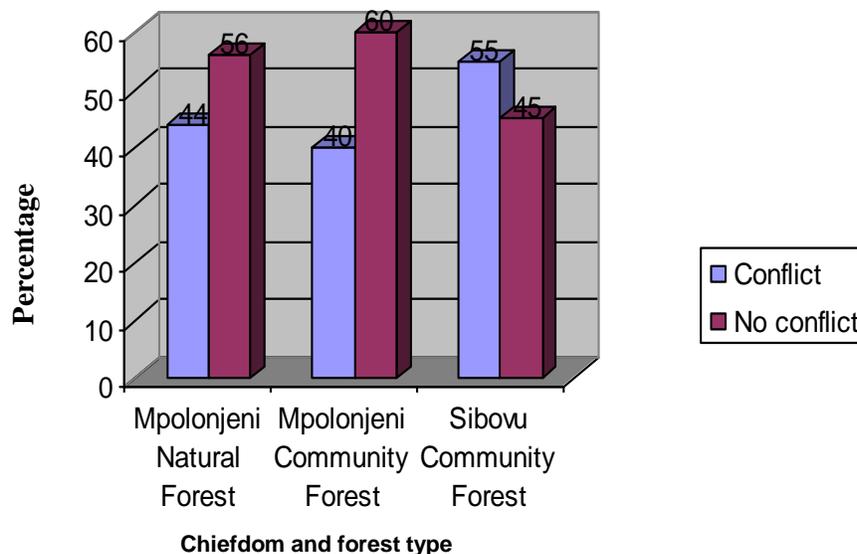


Figure 8. Granting of permission to access forest products. Source: Fieldwork 2009/2010.

established that, the practice of illegal harvesting of forest resources was a result of lack of enforcement of existing rules by traditional leaders in the natural forests in Mpolonjeni.

In the chiefdoms studied, the results reveal that, the local traditional leaders control access to forest resources. A high percentage of respondents in Sibovu said permission for outsiders (78%) and community members (83%) to access forest products from the community forest is obtained from the chief. 53% of the respondents in Mpolonjeni pointed out that, access to the community forest by community members is obtained from the headman and 59% of the respondents said outsiders get permission from the headman. Very few household heads said permission to harvest from Sibovu community forest (6%) and Mpolonjeni community forest (12%) is given by the state through the forestry section. More than 80% of the respondents indicated that, permission to access forest resources from Mpolonjeni natural forest by outsiders and community members is given by the headman (Figure 8).

The results of this study show that, there were conflicts between the management of Government and local institutions in Sibovu community forest (Figure 9). Higher percentage of respondents indicated that, there were no conflicts in Mpolonjeni community forest (54%) and Mpolonjeni natural forest (57%). It emerged from the study that conflicts in Sibovu community forest occurred because of marginalisation which was caused by the inner council of chiefs (Bandlancane). The inner council of chiefs allowed some community members, who were closer to them, to go and harvest forest resources but lacked the expertise on proper ways of harvesting and tended to over harvest which was opposed to the forestry section's rules of harvesting. The study also noted that, conflicts were prevalent in Sibovu between the forestry section and few individual community members who grazed their livestock in the community forest thereby degrading the forests. In addition, in Mpolonjeni it was indicated that, there was a marked communication gap and distrust between the state and the traditional leaders.



**Figure 9.** Conflicts between the management of organisations and local institutions. Source: Fieldwork 2009/2010.

**Table 2.** Who is responsible for collection of forest resources?

Parameter	Mpolonjeni natural forest		Mpolonjeni community forest		Sibovu community forest	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
Forest resource collected						
Firewood	43	58	60	5	60	4
Poles	77	21	48	2	48	5
Honey	53	58	32	-	32	2
Medicine	45	52	-	-	-	-
Fruits	53	57	-	-	-	-
Others	44	58	-	-	-	-

Source: Fieldwork 2009/2010.

The results show that, different members of the households are responsible for collecting different forest resources. Analysis of who is responsible for firewood collection (Table 2) showed that, the percentage of females who collect forest products is highest from Sibovu community forest (60%) and Mpolonjeni community forest (60%) whilst the proportions of respondents is pronounced in Mpolonjeni natural forest (58%). It is important to note that, the proportion of males who collect poles is highest in Mpolonjeni natural forest (77%), followed by those who collect from Sibovu community forest (72%) and Mpolonjeni community forest (72%). The results portray that, the collection of honey from Sibovu community forest (60%) and Mpolonjeni community forest (60%) is more pronounced to males whilst in Mpolonjeni natural forest it is more pronounced to females (58%). Many respondents indicated that, women collect fruits in the natural forest and the proportion is equally high for males (53%). Analysis of collection of forest resources in Mpolonjeni natural forest reveal that, majority of females collect medicine (52%), fruits (57%), and other products (58%).

Analysis of the findings based on the responses also showed that, there are other forest products that are collected such as seeds for necklace-making and leaves for basketry. A further important dimension of the survey is that, among the identified

activities the collection of firewood for own consumption is the main forestry activity carried out by female members of the household in Sibovu, while male members carry out most of the income-generating activities. On the other hand, it seems that among the activities carried out by men some of them can also be carried out by women in that, they are not high energy-consuming, such as honey harvesting, although they may be time-consuming.

## RESULT AND DISCUSSION

### Access levels of households to forest resources

The study has revealed that, community forests and the natural forest in the study area are located on SNL thus, are governed through traditional system. This finding is consistent with that of Gamedze and Jaeger (2006) where all land and resources under SNL are administered and managed by the Chiefs who allocate it to subjects on behalf of the King. However, unlike previous studies, although it emerged that the community

forests are owned by the community whilst natural forests are owned by the state, it is important to note that, few people in Mpolonjeni respect the boundaries of the natural forest whilst boundaries of community forests are well respected by a majority of people. Non respect of natural forest boundaries has led to high cases of illegal harvesting of forest resources.

Community members in the study area as well as outsiders can get into the forest and have access to forest resources from the community and natural forests. From the results it has emerged that, there is access to forest resources in the forests for both community members and outsiders though permission has to be sought first from the traditional leaders. There is restricted access to community forests for both community members and outsiders. As a way of helping to control access into the community forests a nominal fee of E15 and E10 for a pole is paid to the traditional leaders in Sibovu and Mpolonjeni chiefdoms, respectively. This payment is made by outsiders whilst community members do not pay any fee since they are the custodians to the forest resources. On the contrary, community members and outsiders do not pay any fee to harvest forest resources from Mpolonjeni natural forest. Consequently, those who lacked cash to buy the forest resources resorted to stealing the products from community forests. It should be noted that, forest resources in Mpolonjeni natural forest are open to extraction to anyone from the community and outsiders thereby creating the situation of the forest resources becoming open access goods.

Generally, most households in the study area depend on accessing forest resources for their day to day use. There are some variations in distance travelled and time taken to go and harvest forest resources but results from the study show that, people still make an effort to access the products because they depend on them for a living. Community forests have controlled access to community members and outsiders because there are mechanisms in place which allow the communities to exclude outsiders from its forest resources. Forest resources in the natural forest are accessible to any community member and outsiders thereby leading to the forest resource being open to extraction to anyone. The forest resources that are open to extraction include firewood poles and fruits. It is also worth mentioning that, the rules that regulate access to forests are not well enforced by traditional leaders and the state.

### **Forest resources utilised**

The results show that, multiple uses of some indigenous trees which were initially few have led to reduction of the tree species. Consequently, people are now taking more time and travelling longer distances in search of the tree species so that they can get the required forest

resources. The majority of people harvest firewood for cooking from the forests whilst poles are harvested for construction and fencing. Residents use several forest products from the forests for their own consumption, and do not get much out of the forest which can be sold outside. However, analysis of the results showed that, amongst the forest resources that are harvested, some of the products are sold locally, with a significant proportion being sold to urban people whilst small proportions are sold to people from outside the country.

Similarly, Yadav et al. (2003) state that, in Nepal forest, people rely on forests and trees for fodder and bedding materials, for timber and poles for houses and agricultural implements such as ploughs and for fuel wood, which is the most important, and often the only source of energy for cooking and heating for most rural households. In the study area firewood, poles and honey are harvested from the community forests whilst the natural forest provides firewood, poles, seeds, medicine, fruits, leaves, roots, and honey. This heavy reliance on the natural forest for poles arises from the need to construct carts which are used to transport poles and other products. However, it is important to note that, this has contributed to deforestation in the chiefdom.

### **Institutional and community rules that regulate access to forest resources**

The results indicate that, there are rules in use which traditional leaders and the forestry section apply in order to regulate, access, and protect the forest resources. If forest resources are illegally harvested from the community forest, the culprit is arrested and taken to umphakatsi where forest resources are confiscated or a fine is paid.

Illegal harvesting of forest resources is high in both forest management systems. This study has found that, nothing is done when forest resources are illegally harvested from the natural forest and the frequency of illegal harvesting of forest resources is highest in this forest management system. This is due largely to lack of effective rules that protect the forests as well as lack of enforcement of the rules that regulate access to the forest resources. Surprisingly, the rules governing access and protect forest resources exist, but differences exist in knowledge levels of the rules by people and enforcement levels by the local leadership. The state through the forestry section is there to conserve and manage forest resources in the community forest. Based on this the study, it was concluded that, there is lack of involvement by any organisation in managing the natural forest whilst both community and natural forests are not managed by any outside organisations. This is contrary to the observation by Ostrom (2001) that in some countries, community- based forest management institutions have received increasing attention from governments, donors

and Non Governmental Organisations in the past. These organisations see themselves as stakeholders in community managed forests and want to understand how community-based institutions work and how they can be supported, reoriented or recreated to advance particular environment and development goals.

Studies by Odera (2004) note that, virtually all Sub Saharan African countries are experiencing difficulties in managing their forests sustainably in the face of rising challenges and pressures. This has been made worse by increased patronage and state-people conflicts on who owns controls and manages the forest. This situation whereby conflicts exist is evident in Sibovuchiefdom between the forestry section officials and the traditional leaders. Additionally, conflicts also exist between the government and the community members on lack of ownership of the natural forest in Mpolonjeni by the local members. It seems insecurity of land and tree tenure has led to general degradation of the forests in the study area. Consequently, the same characteristic has led to degradation of the forests as evidenced by the unsustainable ways of harvesting forest resources and lack of involvement in management of the forests by community members.

### **Gender roles in collection of forest resources**

Different members of the households were found to be responsible for collecting different forest resources. Collection of firewood, medicine, fruits and other forest resources is a responsibility of women. Males on the other hand are responsible for collection of poles and honey with the exception of Mpolonjeni where the majority of women are responsible for collecting honey from the natural forest. Generally, the collection of firewood for own consumption is the main forestry activity carried out by female members of the household in Sibovu, while male members carry out most of the income-generating activities. On the other hand, among the activities carried out by men some of them can also be carried out by women such as honey harvesting.

### **Conclusion**

The results obtained from the study have helped to cast some light in the understanding of access to and utilisation of forest resources in Swaziland. The approach used was comparative analysis, whereby two chiefdoms were examined. The findings of the study show that forest resources from both community and natural forests can be accessed by community members and outsiders. They also show that, there is restricted access to forest resources from the community forests. Outsiders access forest resources by paying a nominal fee of E10 in Mpolonjeni per pole and E15 per pole in Sibovu whilst community members do not pay any fee. This has

implications for those outsiders who do not possess the cash but are in need of the forest resources since they resort to illegal harvesting of the products. At the same time, forest resources from the natural forest are an open access resource to community members and outsiders. This uncontrolled open access system is leading to excessive use and it is difficult to prevent any user from continuing to subtract units from the natural forest. There is no payment of a nominal fee by either community members or outsiders to access forest resources from the natural forest. It can thus be concluded that, natural forests in Mpolonjeni are open access resources and are unsustainable since they are accessible to anyone and are being degraded because traditional leaders are doing little to protect them.

Extraction of forest resources is mainly for own consumption by the local communities and not much out of the forest resources are sold. Some tree species specifically *Maesa lanceolata* (Umbhongozi) which were initially few and have multiple uses such as provision of poles, firewood, medicine, and fruits have become scarce in the natural forest. The study has revealed that, uncontrolled extraction of firewood for cooking and poles for construction have led to deforestation.

The findings show that, traditional leaders control the access to forest resources in the studied chiefdoms. The natural woodlots are owned by the government while the community woodlots are owned by the community. There are some conflicts between state and traditional leaders in Sibovu. The state and community members in Mpolonjeni natural forest have conflicts on ownership of the forest resources and this has led to lack of involvement in the management of forest resources by community members as is reflected by the high cases of fire outbreaks, and lack of enforcement of the rules that protect the forests.

There are government and community rules that protect forest resources and regulate access and utilisation. Most of the government rules that protect natural forests are not known by community members whilst community rules are fairly known but findings reveal that, they are not effective in protecting the forest resources. What can be inferred from this is that, there is lack of enforcement of rules by traditional leaders and government which could be the leading reasons for high frequency of illegal harvesting of forest resources from the natural forest. What is striking is that, community and government rules that protect community forests are well known and are effective in regulating access and utilisation. The study also noted that, there are no outside organisations that deal with conservation and management of forest resources in the study area.

### **RECOMMENDATIONS**

Based on the results it was clear that, people were not involved in the management of the natural forest since

they made accusations on lack of ownership of the natural forests. The study, therefore, recommends that, there should be improvement of relationships between local community members and the forestry section authorities. The study also recommends that, the relationship between the local institutions and forestry section officials should be improved. Local people are not aware of the rules that protect the natural forests for example, people should harvest stipulated quantities. The study thus recommends that, traditional leaders and the forestry section officials educate people about the rules that regulate access to forest resources and protect the natural forest.

Furthermore, to ensure that the natural forest is protected and well managed, the study recommends that, local community members are provided with economic incentives by the government so that there is maximum involvement in sustainable management of the forest resources. It is crucial that, commonly understood rules are set at the local level with local people generally agreeing upon what rules they should follow and there is need for successful enforcement of the rules by traditional leaders and the government through the forestry section. Agrawal and Goyal (2001) note that, without this agreement, there is less incentive to comply with rules. They further state that, moderately-sized communities who agree on a general set of rules regarding forest use can better afford to share monitoring duties and thus enjoy better forest resources.

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**APPENDIX A**

**Questionnaire for Household survey**

**Demographic and socio economic data**

1.0. Household data.

1.1. Name of the household head .....

1.2. Area of household .....

1.3. Gender:

1.3.1. Male.....

1.3.2. Female.....

1.4. Marital Status

1.4.1. Single .....

1.4.2. Married .....

1.4.3. Divorced .....

1.4.4. Widowed .....

1.5. Age of the household head

1.5.1. < 20 years .....

1.5.2. 20-39 years.....

1.5.3. 40-59 years.....

1.5.4. >60 years .....

1.6. Household composition.

Age (years)	Male	Female
<18		
18-55		
>55		

1.7. Household main economic activities.

Activity	Yes/No	Who is involved
Farming		
Employment		
Fishing		
Small business		
Others(specify).....		

1.8 Education level

1.8.1. No formal education .....

1.8.2. Adult education .....

1.8.3. Primary education .....

1.8.4. Secondary .....

1.8.5. Tertiary.....

1.8.6 Other (specify).....

**2.0 FOREST RESOURCE ACCESS**

**A. Community forests**

2.1. Who owns the community forests?

2.1.2. Central Government.....

2.1.2. Community (Name).....

2.1.3. Others (Specify) .....

2.2. Do you know the boundaries of the forests?

2.2.1. Yes .....

2.2.2. No. ....

2.3. If yes, are they respected?

2.3.1 Yes .....

2.3.2. No. ....

2.4. What happens to a person who enters into the community forests and harvest forest products illegally?

2.4.1. Arrested.....

2.4.2. Fine (Amount).....

2.4.3. Others (specify).....

2.5 How frequently do people enter and harvest community forests illegally?

2.5.1. Everyday.....

2.5.2. Once every week.....

2.5.3. Once per month.....

2.5.4. Once in two months.....

2.5.5. Never.....

2.6 What measures are taken to protect the forest? (Tick the appropriate box/es)

2.6.1. Use of community police

2.6.2. Use of firebreaks

2.6.3. Fencing

2.6.4. Having specific times of harvesting

2.6.5. Limiting the quantities of resources harvested

2.6.6. Other (Specify).....

2.7. What are the main names of trees found in community forests?

Name:

2.8. Do you get into the forest to collect forest products?

2.8.1. Yes-----

2.8.2. No.-----

2.9. If yes, how do you get access to the community forest?

2.9.1. Free-----

2.9.2. Permission-----

2.9.3. Fee (specify)-----

2.10. Who gives you permission to access the forest products?

2.10.1. Headman.....

2.10.2. Chief.....

2.10.3. State (specify).....

- 2.10.4. Other (specify).....
- 2.11. Can people from outside the area access forest products from the community forest
  - 2.11.1. Yes-----
  - 2.11.2. No.-----
- 2.12. If yes, how do they get access to the community forest?
  - 2.12.1. Free-----
  - 2.12.2. Permission-----
  - 2.12.3. Fee (specify)-----
- 2.13. Who gives them permission to access the forest products?
  - 2.13.1. Headman.....
  - 2.13.2. Chief.....
  - 2.13.3. State (specify).....
  - 2.13.4. Other (specify).....
- 2.14. What is the approximate distance to the forest?
  - 2.14.1. <2km -----
  - 2.14.2. 2-5km-----
  - 2.14.3. >5km -----
- 2.15. What is the approximate time taken to get to the forest?
  - 2.15.1. <15 minutes .....
  - 2.15.2. 16-30minutes.....
  - 2.15.3. 31- 60minutes.....
  - 2.15.4. more than 1hour.....
- 2.16. Who is responsible for forest product collection?

Product	Collected by:			
	Gender	Male	Female	All
Firewood				
Poles				
Medicine				
Honey				
Fruits				
Others (specify)				

**B. NATURAL FORESTS**

- 2.17. Who owns the natural forests?
  - 2.17.1 Central Government.....
  - 2.17.2. Community (Name).....
  - 2.17.3. Others (Specify) .....
- 2.18. Do you know the boundaries of the forests?
  - 2.18.1. Yes .....
  - 2.18.2. No. ....
- 2.19. If yes are they respected?
  - 2.19.1 Yes .....
  - 2.19.2. No. ....

- 2.20. What happens to a person who enters into the natural forests and harvest forest products illegally?
  - 2.20.1. Arrested.....
  - 2.20.2. Fine (Amount).....
  - 2.20.3. Others (specify).....
- 2.21. How frequently do people enter and harvest natural forests illegally?
  - 2.21.1. Everyday.....
  - 2.21.2. Once every week.....
  - 2.21.3. Once per month.....
  - 2.21.4. Once in two months.....
  - 2.21.4. Never.....
- 2.22. What measures are taken to protect the forest? (Tick the appropriate box(es))
  - 2.22.1. Use of community police
  - 2.22.2. Use of firebreaks
  - 2.22.3. Fencing
  - 2.22.4. Having specific times of harvesting
  - 2.22.5. Limiting the quantities of resources harvested
  - 2.22.6. Other (Specify).....

2.23. What are the main names of trees found in natural forests?

Name:

- 2.24. Do you get into the forest to collect forest products?
  - 2.24.1. Yes-----
  - 2.24.2. No-----
- 2.25. If yes, how do you get access to the natural forest?
  - 2.25.1. Free-----
  - 2.25.2. Permission-----
  - 2.25.3. Fee (specify)-----
- 2.26. Who gives you permission to access the forest products?
  - 2.26.1. Headman.....
  - 2.26.2. Chief.....
  - 2.26.3. State (specify).....
  - 2.26.4. Other (specify).....

2.27. Can people from outside the area access forest products from the natural forest?
 

- 2.27.1. Yes-----
- 2.27.2. No-----

2.28. If yes, how do they get access to the natural forest?
 

- 2.28.1. Free-----
- 2.28.2. Permission-----
- 2.28.3. Fee (specify)-----

2.29. Who gives them permission to access the forest products?

- 2.29.1. Headman.....
- 2.29.2. Chief.....
- 2.29.3. State (specify).....
- 2.29.4. Other (specify).....
- 2.30. What is the approximate distance to the forest?
- 2.30.1. <2 km -----
- 2.30.2. 2-5 km -----
- 2.30.3. >5 km -----

- 2.31. What is the approximate time taken to get to the forest?
- 2.31.1. <15 min.....
- 2.31.2. 16-30 min.....
- 2.31.3. 31- 60 min.....
- 2.31.4. More than 1hour.....

2.32. Who is responsible for forest product collection?

Product/Collected by	Male	Female	All
Firewood			
Poles			
Medicine			
Honey			
Fruits			
Others (specify)			

**3.0. ROLE OF INSTITUTIONS IN FOREST MANAGEMENT**

**A. Community forests**

3.1 Can you list organizations dealing with forest conservation and management in the area

Name of organization

- 3.2. Are there any outside organizations involved in conserving forest resources?
- 3.2.1. Yes.....
- 3.2.1. No.....

- 3.3. Are there any conflicts between the management of these organizations and those which are under the local institutions?
- 3.3.1. Conflict.....
- 3.3.2. No conflict.....

3.4. List all the rules that you know regarding protection of the community forests

Government rules	Who enforces them	Are they effective?
Community rules		

- 3.5. Do you know any cases of fire outbreak in the community forests?
- 3.5.1. Yes .....
- 3.5.2. No. ....

3.6. If yes what are the reasons of fire in the forests?  
.....

3.7. What is the role of the community when there is fire?  
.....  
.....

- 3.8. Are people being involved in the management of the forests?
- 3.8.1 Yes.....
- 3.8.2. No.....

3.9. If yes, how?  
.....  
.....

3.10. If people are involved in forest management does that increase the level of access to forest resources?

**B. Natural forests**

3.11. Can you list organizations dealing with forest conservation and management in the area.

Name of organization

- 3.12. Are there any outside organizations involved in conserving forest resources?
- 3.12.1. Yes.....
- 3.12.1. No.....
- 3.13. Are there any conflicts between the management of these organizations and those which are under the

local institutions?

- 3.13.1. Conflict.....
- 3.13.2. No conflict.....
- 3.14. List all the rules that you know regarding protection of the natural forests.

Government rules	Who enforces them	Are they effective?
Community rules		

- 3.15. Do you know any cases of fire outbreak in the natural forests?
  - 3.15.1. Yes .....
  - 3.15.2. No. ....
- 3.16. If yes what are the reasons of fire in the forests?  
.....
- 3.17. What is the role of the natural when there is fire?  
.....
- 3.18. Are people being involved in the management of the forests?
  - 3.18.1 Yes.....
  - 3.18.2. No.....
- 3.19. If yes how?  
.....
- 3.20. If people are involved in forest management does that increase the level of access to forest resources?.....

**4.0 FOREST RESOURCE UTILIZATION**

**A. Community forests**

- 4.1. How often do you go to the community forest?
  - 4.1.1. Weekly.....
  - 4.1.2. Twice a month.....
  - 4.1.3. Monthly.....
  - 4.1.4. Once in 2 months.....
  - 4.1.5. Never.....
- 4.2. What are the forest products you harvest and use and where do you get them? Product:

Type	Source	Uses

- 4.3. Who decides on when to harvest resources from the community forests?
  - 4.3.1. Chief .....
  - 4.3.2. Headman.....
  - 4.3.3. State (specify).....
  - 4.3.4. Other (specify).....
- 4.4. Who decides on how to harvest resources from the community forests?
  - 4.4.1. Chief .....
  - 4.4.2. Headman.....
  - 4.4.3. State (specify).....
  - 4.4.4. Other (specify).....
- 4.5. Are forests resources from community forests sold?
  - 4.5.1. Yes .....
  - 4.5.2. No.....
  - 4.5.3. No idea.....
- 4.6. If yes, what resources are sold?  
.....
- 4.7. To whom are the forest resources sold?
  - 4.7.1. Local people.....
  - 4.7.2. People from urban areas.....
  - 4.7.3. Other (specify).....
- 4.8. How are the cash benefits used?.....
- 4.9. What is the main fuel energy you use?
  - 4.9.1. Firewood-----
  - 4.9.2. Charcoal-----
  - 4.9.3. Kerosene-----
  - 4.9.4. Others (Specify) -----

**B. Natural forests**

- 4.10. How often do you go to the natural forest?
  - 4.10.1. Weekly.....
  - 4.10.2. Twice a month.....
  - 4.10.3. Monthly.....
  - 4.10.4. Once in 2 months.....
  - 4.10.5. Never.....
- 4.11. What are the forest products you harvest and use and where do you get them?  
Product :

Type	Source	Uses

4.12. Who decides on when to harvest resources from the natural forests?

- 4.12.1. Chief .....
- 4.12.2. Headman.....
- 4.12.3. State (specify).....
- 4.12.4. Other (specify).....

4.13. Who decides on how to harvest resources from the natural forests?

- 4.13.1. Chief .....
- 4.13.2. Headman.....
- 4.13.3. State (specify).....
- 4.13.4. Other (specify).....

4.14. Are forests resources from natural forests sold?

- 4.14.1. Yes .....
- 4.14.2. No.....
- 4.14.3. No idea.....

4.15. If yes, what resources are sold.....

4.16. To whom are the forest resources sold?

- 4.16.1. Local people.....
- 4.16.2. People from urban areas.....
- 4.16.2. Other (specify).....

4.17. How are the cash benefits used?.....

4.18. What is the main fuel energy you use?

- 4.18.1. Firewood-----
- 4.18.2. Charcoal-----
- 4.18.3. Kerosene-----
- 4.18.4. Others (Specify) -----

Full Length Research Paper

## Growth and yield responses of ginger (*Zingiber officinale*) to three sources of organic manures in a typical rainforest zone, Nigeria

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A field study was carried out in the 2011/2012 cropping seasons at the Teaching and Research, Farms of the Delta State University, Asaba Campus, Asaba, a typical rainforest zone in Nigeria. The aim was to evaluate the responses of ginger to three sources of organic manures namely; cow-dung manure, poultry manure and pig manure at the rate of 20 t/ha. The experiment was a randomized complete block design with three replicates. Growth and yield parameters of ginger were taken at the 4, 6, 8, 10, 12 and 14 weeks after planting (WAP), while fresh weight was taken at 16<sup>th</sup> week after planting (WAP). The growth parameters observed were plant height, number of leaves, leaf area and number of tillers. Data collected were subjected to analysis of variance (ANOVA) and significantly different means in the F-test were separated using the Least Significant Difference (LSD) at 5% level of probability. Results showed significant increase in plant height, number of leaves and leaf area at the 6<sup>th</sup> to 12<sup>th</sup> WAP compared to the control. Growth parameters were not significantly different ( $P > 0.05$ ) at the 4<sup>th</sup> WAP. Plots treated with poultry manure produced the highest plant height of 12.67 cm, highest number of leaves of 14.87 and leaf area of 231.8. This was followed by pig manure with values of 12.12, 14.25 and 222.5 cm. The least mean values of 7.14, 12.58 and 210.5 cm were obtained from the control. The general results indicated that organic manures in the forms of cow dung, poultry and pig manures have great tendency to increase growth characters and yield of ginger in a rainforest zone, Nigeria.

**Key words:** Growth and yield responses, ginger, organic manures rainforest zone, Nigeria.

### INTRODUCTION

Ginger is the rhizome of the plant *Zingiber officinale* that is well consumed as a delicacy, medicine and spices. It is a perennial reed-like plant with annual leafy stems that is about a meter (3 to 4 feet) tall. The plant is usually propagated vegetatively by planting rhizome pieces which produce clusters of white and pink flower buds that bloom into yellow flowers. The mature roots of ginger are fibrous and the juice from old ginger roots is extremely potent and often used as spices and a quintessential

ingredient of Chinese, Korea, Japanese and many South Asian cuisines for flavouring dishes (Jakes, 2007). It is also used largely as recipes such as ginger bread, cookies, crackers, cakes, ginger-ale and ginger beer (Asumugha et al., 2006; Jakes, 2007). The medicinal values of these great ancient spices are widely recognized across the continents to contain a number of unique organic phytochemical ingredients that can take care of some human ailments. Recent studies on health

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related effects of ginger which have also stimulated farmers concern on the growth of the plant have shown the efficacy of the plant in some life challenging ailments such as entero toxin induced diarrhea, diabetic nephropathy, nausea, plasma antioxidant, vomiting, high cholesterol, high blood pressure and inflammation (Chen et al., 2007; Ernest and Pittler, 2008; Kim et al., 2008).

Like any other plant, ginger requires the right kind of nutrients to sustain its growth and maximum yield especially in the humid environment where rainfall is high and nutrient reserves are low due to leaching, and erosion effects. Plant nutrients usually supplied by the soil in most Sub-Saharan environment are often inadequate and sometimes in plant unavailable form hence, they need to be augmented with other sources that are cheap and environmentally friendly. The use of organic manures is one technology that have been exploited overtime and across ages because of its ability to restore soil fertility, supply major plant nutrients, such as N, P, K, Ca, Mg and also stabilizer soil pH (Sanchez and Miller, 1986). Increase in soil chemical properties which are quite essential in crop growth and yield have also been associated with organic manures (Adetunji, 1990). Organic manures however are without their limitations. These include inadequate availability, transportation and handling problems, slow nutrient release, high C:N ratio and sometimes heavy metal pollution (Ayeni et al., 2010). Now that emphasizes are gradually shifting to organic agriculture to maintain soil productivity and limit the use of synthetic fertilizers some of which have contributed to the changing climate, the objective of this study therefore was to evaluate the responses of three sources of organic manures to the growth and yield of ginger in a typical rain forest zone where the crop is aptly grown.

## MATERIALS AND METHODS

### Description of the study area

The study was conducted at the Teaching and Research Farms of the Faculty of Agriculture, Delta State University, Asaba during the 2011/12 cropping seasons. The experimental area is located within latitude 06° 14'N and longitude 06° 49'E of the equator, and lies significantly in the tropical rainforest zone with over 1,650 mm of rainfall per annum. The rainfall is bimodal in character with peaks in July and September. The mean temperature is about 37.3°C; and a relative humidity of about 73.2%. The land area is relatively flat and influenced seriously by seasonal flooding due to its proximity to River Niger that naturally demarcated Delta and Anambra States by the Eastern axis. By nature of its geomorphological settings, the study area overlies the ancient metamorphic crystalline basement complex formation which are considerably more acid than base. They are generally gneisses and pegmatites that gave rise to coarse-textured soils that are deficient in dark ferro-magnesian minerals (Egbuchua, 2012). Land use in the study area is virtually based on rain-fed agriculture and the natural vegetation is typically of rainforest but have been reduced to derived savanna due to repeated clearing and cultivation over the years.

### Field work

An experimental plot measuring 13 × 6 m was selected for the study. The plot was manually cleared, ploughed and made into 16 beds of 2 × 2 m dimensions. From each bed, composite soil samples were collected for pre-planting soil analysis. The treatments which consisted of cow dung manure, poultry manure and pig manure were applied two weeks before planting using incorporation method. The rate of application across board was 20 t/ha<sup>-1</sup>. Seed pieces of ginger rhizomes were cut to contain at least two buds and weighing about 10 g. Each was planted on the beds at a spacing of 20 × 20 cm at a depth of 5 cm. The planted rhizomes were carefully covered with sand and stubble mulch materials. Watering and weeding were done at intervals. Three weeks after planting, KARATE 2.5 EC was sprayed at the rate of 500 ml/ha to control insect pests. The experimental layout was a randomized complete block design (RCBD) with 3 replicates.

### Pre-planting soil analysis

The pre-planting soil analysis was carried out in the Faculty of Agriculture Standard Laboratory Anwai Campus. The most important physico-chemical properties of the soil samples evaluated were: The particle size distribution using hydrometer method as described by Gee and Bauder (1986). The pH was determined in a 1:1 soil/water suspension using digital pH metre. Organic carbon was determined by Walkley-Black dichromate wet-oxidation method (Nelson and Sommers, 1982). Total nitrogen was by micro-kjeldahl distillation technique as described by Bremner and Mulvaney (1982). Available phosphorus was determined by Bray No 1 method as described by IITA (1982). Cation Exchange Capacity (CEC) was determined by 1 N NH<sub>4</sub>AC method (Rhoades, 1982). The chemical contents of the organic manures used in the study were also routinely analysed using appropriate methods.

### Data collection

The growth parameters were determined at 4, 6, 8, 10, 12 and 14 weeks after planting (WAP). The parameters essentially determined were; plant height which was measured from the base of the plant to the apex using measuring tape. Number of leaves per 10 randomly selected beds was measured by counting manually. Leaf area was determined by taking the leaf area per plant, and substituting the number of leaves of each plant by the length and width of the middle leaf. Number of tillers was taken from four plants tagged at the middle of each bed by counting at 14 weeks after planting (WAP). Fresh weight of harvested ginger was done at 16 weeks after planting (WAP) using sensitive balance.

### Data analysis

Data collected were subjected to analysis of variance (ANOVA). The significantly different means in the F-test were separated using the Least Significant difference at 5% level of probability.

## RESULTS

### Initial pre-planting soil analysis

The results of the initial soil analysis is shown in Table 1. The textural class of the soil showed that it was

**Table 1.** Pre planting soil analysis of the study area.

Soil properties	Values
Particle size distribution (%)	-
Sand	83.70
Silt	12.00
Clay	4.30
pH (H <sub>2</sub> O)	5.5
Organic carbon (gkg <sup>-1</sup> )	15.6
Total nitrogen (gkg <sup>-1</sup> )	1.16
Available phosphorus (mgkg <sup>-1</sup> )	4.35
Cation exchange capacity (cmolkg <sup>-1</sup> )	6.75
Textural class	Loamy sand

**Table 2.** Chemical properties of the organic manures used for the study.

Characteristics	Organic sources/values obtained		
	CDM	PM	PgM
N (%)	1.06	2.57	1.67
P (%)	0.52	3.08	2.36
K (%)	0.97	2.47	0.75
Ca (%)	1.07	12.68	3.83
Mg (%)	0.88	0.93	0.54
Fe (mgkg <sup>-1</sup> )	572	1756	1691
Mn (mgkg <sup>-1</sup> )	344	573	505
Zn (mgkg <sup>-1</sup> )	123	722	623
Cu (mgkg <sup>-1</sup> )	22	82	510

CDM = Cowdung manure; PM = poultry manure; PgM = pig manure.

sandyloam in texture. The soil pH was strongly acidic with a pH of 5.5. The organic carbon (15.6 gkg<sup>-1</sup>), total nitrogen (1.16 gkg<sup>-1</sup>); available phosphorus (4.35 mgkg<sup>-1</sup>) and cation exchange capacity (6.75 cmolkg<sup>-1</sup>) were all seemingly low depicting the low fertility status of the study area.

### Chemical content of the organic manures

The analytical values of the chemical content of the organic sources used as treatments are shown in Table 2. The results showed that the three organic sources were high in major macro and micronutrients that can support growth and increase yield of crops.

### Morphological growth characters

#### Plant height

There was a significant effect in the shoot height of ginger as affected by different sources of organic

manures. Plant height was found to be progressively increased with the treatment compared to the control (Table 3). The increase in plant heights were most obvious from the 8<sup>th</sup> week after plant where a significant effect was observed. Plant height got to its highest peak of 12.67 cm with poultry manure treatment. The least value of 7.14 was obtained with the control.

#### Number of leaves

The effects of treatments on the number of leaves (Table 4) showed that treatment also produced significant highest number of leaves than the control at 14 weeks after planting (WAP). The highest number leaves (14.87) were obtained with the application of poultry manures. This was followed by pig manure (14.25) and cow dung manure (13.22). The control experiment recorded the least value of 12.58.

#### Leaf area

Leaf area of plants treated with organic manures was not

**Table 3.** Effects of three sources of organic manures on plant height of ginger (cm).

Treatment (20 t/ha <sup>-1</sup> )	Weeks after planting (WAP)					
	4	6	8	10	12	14
Control (O)	4.55	5.12	6.03	6.32	7.05	7.14
Cow dung manure	4.58	6.65	8.20	9.74	10.23	11.75
Poultry manure	4.59	6.93	8.75	10.78	11.13	12.67
Pig manure	4.59	6.73	8.55	10.17	10.87	12.12
F - LSD (0.05)	NS	NS	0.75	0.91	1.08	0.58

**Table 4.** Effects of three sources of organic manures on number of leaves of ginger.

Treatment (20 t/ha <sup>-1</sup> )	Weeks after planting (WAP)					
	4	6	8	10	12	14
Control (O)	3.0	4.41	6.02	8.21	10.34	12.58
Cow dung manure	3.0	4.45	6.04	9.33	11.23	13.22
Poultry manure	3.0	4.48	7.13	10.13	13.76	14.87
Pig manure	3.0	4.47	6.82	9.85	12.38	14.25
F - LSD (0.05)	NS	NS	6.02	0.27	0.01	0.05

**Table 5.** Effects of three sources of organic manures on leaf area of ginger.

Treatment (20 t/ha <sup>-1</sup> )	Weeks after planting (WAP)					
	4	6	8	10	12	14
Control (O)	153.2	155.2	197.5	202.7	210.3	210.5
Cow dung manure	153.4	155.3	210.3	215.8	218.4	218.7
Poultry manure	153.7	155.7	215.8	222.7	231.7	231.8
Pig manure	153.5	155.5	214.4	219.5	222.4	222.5
F - LSD (0.05)	NS	NS	32.75	29.48	32.72	32.74

statistically different ( $P < 0.05$ ) at the 4<sup>th</sup> and 6 WAP (Table 5). However, progressive increase in total leaf area was observed as from the 8 week up to the 14<sup>th</sup> week after planting. The highest value of 231.8 was obtained with the application of poultry manure, followed by pig manure (222.5) and the least of value 210.5 was in the control experiment.

#### Number of tillers

Irrespective of treatment applied, the number of tillers were not significantly different ( $P < 0.05$ ) at 14<sup>th</sup> WAP (Table 6). The best tillers of 2.8 was obtained with the application of poultry manure while the least (1.3) was in the control experiment.

#### Fresh weight

The fresh weight of harvested ginger (Table 7) at

16 WAP produced significantly highest yield of 114.7 kg/ha with the application of poultry manure. The control treatment had the least yield of 10.7 kg/ha.

#### DISCUSSION

The efficacy of organic manures in promoting crop growth and yield components have been variously studied and reported. Hsieh and Hsieh (1990) has reported high nutrient contents of cowdung, pig and poultry manures which are capable of improving soil quality and increase yield of cultivated crops. Adetunji (2004) has reported reasonable high content of nitrogen, potassium and organic carbon in cow dung manure; high content of copper micro nutrient and lower content of fibrous material in pig manure, and very high content of N.P.K, Ca and micro nutrients in poultry-based manure. The high contents of these macro and micro nutrients have the capacity to improve morphological characters and yield of cultivated crops. Organic

**Table 6.** Effects of three sources of organic manures on the number of tillers at 14 WAP.

Treatment (20 t/ha <sup>-1</sup> )	Weeks after planting (WAP)
Control (O)	1.3
Cow dung manure	2.3
Poultry manure	2.8
Pig manure	2.5
F - LSD (0.05)	0.06

**Table 7.** Effects of three sources of organic manures on fresh weight of ginger at 16 WAP.

Treatment (20 t/ha <sup>-1</sup> )	Weeks after planting (WAP)
Control (O)	10.7
Cow dung manure	11.2
Poultry manure	14.7
Pig manure	12.3
F - LSD (0.05)	0.6

manures also have strong tendency to neutralize soil acidity, raise soil buffering capacity and provide micro nutrients such as Zn, B, Cu and Fe that can influence crop production positively.

In this study, most ginger morphological characters such as plant heights, number of leaves, leaf area were significantly ( $P \leq 0.05$ ) increased with the application of the treatments compared to the control experiment where no treatment was applied. The delay in observing significant effects especially at the 4th week after planting (WAP) could be attributed to low rate of initial decay which is controlled by the C: N ratio and lignin contents of the organic sources. The improvement of ginger growth over the control experiment could be vividly explained by the various nutrient contents of the organic manures. For instance, the chemical quality of poultry manure used as treatment showed high contents of organic carbon (176%), total nitrogen (19.2%), phosphorus (28.7%), potassium (2.46%) calcium (21.0%) and magnesium 3.52% coupled with adequate levels of micro nutrients. Hence, poultry manure gave the best performance in terms of growth parameters and yield indices. Similar studies by Hsieh and Hsieh (1990) and Ojeniyi (2011) showed the potency of poultry manure in improving crop quality, quantity and yield when incorporated into cultivated soil. Ayeni et al. (2010) have equally reported that organic manures when properly used have proven to be very efficient in increasing soil nutrient contents, ensuring positive residual effects and enhancing soil's physico-chemical properties.

Although, the quality of any organic manure is very difficult to quantify due to differences in the quality of

the sources. The results of the study showed that poultry manure was the most impressive on the growth and yield parameters evaluated. This was followed by pig manure and cow dung manure. All the organic manure sources proved better than the control experiment in all the parameters evaluated. This could be attributed to the various nutrient contents of the organic manures.

## Conclusion

The cultivation of ginger in recent years especially in the rainforest zone of Nigeria is at the increase. This is because of high demand of the rhizomes not only as dietary spices but in tackling some ailments of great worries to humanity. These include high blood pressure, high cholesterol level, insomnia and various nausea conditions. The general belief in this part of the World is that ginger has the potency of either reducing or eliminating these ailments and as such its consumption is on the increase. Results of the study showed the efficiency of organic manures in ginger production in all aspects of growth and yield parameters evaluated. Although, the use of organic manures is associated with such problems as slow in nutrient release, high C:N ratio and pollution problem. However, its uses will somehow minimize total reliance on mineral fertilizers which are not only too costly for poor resource farmers to acquire, but are associated with problems relating to soil acidity, nutrient imbalance, inadequate supply of macro and micro nutrients and ineffectiveness due to the blanket method of application.

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