

**THE MICROCLIMATIC EFFECT OF TREES TOWARDS A SUSTAINABLE
THERMAL COMFORT IN RESIDENTIAL BUILDINGS: A STUDY OF BOSSO
ESTATE MINNA, NIGER STATE.**

by

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ABSTRACT

Tropical regions like Nigeria are faced with the challenges of heat especially during the dry season. Residential buildings which serves as an envelope for rest and relaxation after a hard day work must be thermally comfortable in order for the occupants to have the required rest. The development in technology has made architects to seek for thermal comfort through the use of mechanical cooling equipments. A lot of energy is expended in powering such equipment which invariably leaves a lot of ecological footprint. The more energy expended in the provision of thermal comfort, the more the ecological footprint on the environment. Trees have however been found to shield buildings against harsh climatic conditions such as the heat from the sun. Buildings surrounded with trees have been found to be cooler than those without trees. The development of housing estate in Niger state shows that trees which serve as agents of micro climatic conditioners are not put into consideration during the planning and development of these estates .This research takes a look at the factors that influenced tree planting in Bosso estate in Minna Niger state and to what extent these factors can be applied towards the provision of sustainable micro climatic condition in the provision of housing estate in Nigeria.

Keyword: *building, climate, comfort, sustainable, tree.*

1.0 INTRODUCTION

The residential building envelop is a place where a lot of time is spent for rest. This rest is attained only when there is thermal comfort within the building. Nigeria which is in the tropics has a major problem of excessive heat from the sun. The use of external sun shading devices such as vertical, horizontal and egg crates have been found to be expensive and also do not necessarily provide complete shield to the entire building envelop.

This has over time resulted into the use of mechanical means to cool the buildings. The use of such mechanical conditioners however consumes a lot of energy and the more energy consumed by this equipment the more the ecological foot print on the environment. Air conditioners are the single most expensive equipments to run in terms of energy consumption in residential buildings. The mechanical cooling equipments constitute the major energy required in an average home (Steven, 2004).

Studies have also shown that the indoor air quality of an air-conditioned building can be worse than a naturally ventilated one (Sue, 2005). This suggests that it is safer to have the windows opened to have proper cross ventilation than to be boxed up in a building with too much reliance on the air conditioners to provide the air exchange.

Sustainable development has been referred to as development that reduces the impact on the environment without hindrance to the development of future generation. The European commission on general information on sustainable urban design (2000) defined sustainable development as development that delivers environmental economical and social services to all residents of a community without threatening the people and the environment.

The thermal behaviour of each building affects to a great extents the demand of energy a building requires, as such it is the architect's responsibility to control that right from planning and design stage (Steven, 2004).

The development of housing estates in Nigeria comes in multiples of hundreds as such the implementation of sustainable bioclimatic strategy in one dwelling would amount to a lot of positive impact to the environment if this is multiplied by the total number of dwellings in a housing estate. Sustainable strategy in a single building could generate to multiple ecological benefits when put into all the buildings that are being developed in a particular community (Carlos, & Tomonari, 2005).

2.0 LANDSCAPE AND BIOCLIMATOLOGY

Bioclimatology is the science that evolved due to the need to conserve energy and environmental resources with the aim of providing thermal comfort for the occupants of building with consideration given to the local climate. (Richard 2008). The approach here is to have a sustainable means of providing thermal comfort with minimal energy consumption. The major reason for the provision of shelter in the first instance is the protection against harsh weather conditions (Adnan, Omar, & Houshki 2011).

In 1980 in Switzerland, there was a law that banned the use of air conditioning in buildings unless it became absolutely necessary. Surprisingly building designers were able to adapt to the new law in providing comfort without the use of air conditioners, (Sue, 2005).

This suggests that it is possible for Nigerian architects to take proactive stage towards the provision of sustainable thermally comfortable environment through the use of soft landscape elements such as trees. The use of trees as shading devices would reduce the need to cool the building through mechanical means and this would invariably reduce the ecological foot print on to the environment.

The cooling of the building envelop which is the major bioclimatic problem of tropical regions such as Nigeria can be reduced if in the first instance the rise and absorption of solar radiation onto the building is reduced (Steven, 2004).

However, the use of trees as a means of providing shade in buildings has over time not been given much consideration. Trees on the other hand provide a lot of environmental benefits. Amongst such benefits are purification of the air, temperature reduction and other microclimatic effects (Allian & Andre (2011); David, (2010); Toy & Yilmaz (2010). The tree plant as a landscape element provides complete shield to the building if the right choice is made. It completely shield the building envelop and the surrounding, (Michael & Phocas, 2010).

The water stored within the plant cool the environment through Evapo-transpiration as explained by James (2002), which is a process where water stored in plants are released into the environment. The building environment especially the tropical region has a lot to benefit from such process.

The strategy for the provision of sustainable thermal comfort for the occupants of residential building should be the architect's primary goal especially in tropical region like Nigeria. Architect in all ramifications are expected to contribute to mankind with their works towards the attainment of sustainable development, (Joo-Hwa & Boon, 2006).

3.0 THE STUDY AREA

The study area Bosso Estate is situated in Minna the state capital of Niger state. The estate is made up of 210 houses which are comprised of 2 bedrooms, and 3 bedroom and 4 bedroom apartments; this is illustrated in plates 1-4. The distribution is 37%, 33 % and 30 % respectively as illustrated in fig1. The estate was completed in 1980. These houses were allocated to the civil servants immediately after completion. However the buildings were sold on owner occupier basis in 2001. Some of the occupants over the time had their accommodation leased out to tenants. The vacant plots were also sold to the public which has resulted into further residential development.

DISTRIBUTION OF HOUSE TYPE



Fig 1 showing the distribution of the house types in the estate. Source field survey 2011

AIM AND OBJECTIVES

The aim of the study is to determine how trees can be used as micro climatic elements in residential buildings towards sustainable cooling strategy.

OBJECTIVES

The objectives were;

- i. To identify types of trees preferred and planted by occupants of residential buildings within the study area
- ii. To identify the buildings that has trees and their respective locations.
- iii. To identify reasons behind the choice of trees
- iv. To understand how tree can be used as sustainable cooling strategy in residential buildings.

4.0 RESEARCH METHODOLOGY

The research was carried out using field survey where a structured questionnaire was administered to the entire occupants of Bosso estate by trained research assistants. A total of 237 questionnaires were administered and 12 were returned unanswered. The total questionnaire analysed was 225 which represents 95% of the total number of questionnaire administered. The data collected were analysed using SPSS statistics 17.0

The questionnaire was administered to all the houses in the estate and also the developed vacant plots with the help of trained research assistants.

5.0 DATA ANALYSIS.

5.1. STATISTIC OF HOUSES THAT HAVE TREES.

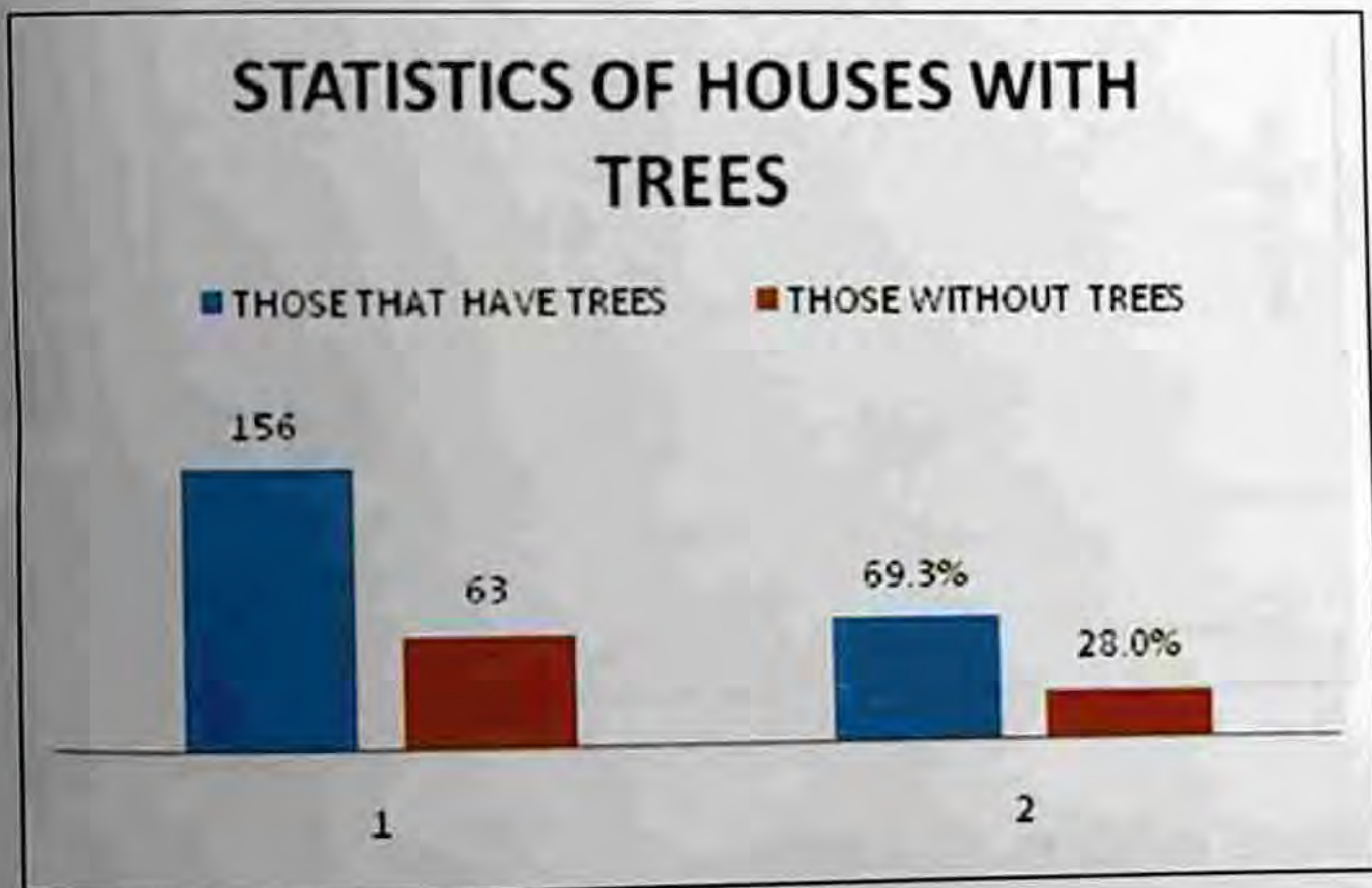


Fig.2. showing the number of houses that have trees planted. Source field work 2011

The study carried out showed that 156 household which represent 69.3 % of the total number of respondents have trees planted in their compound as shown in fig 2. While only 63 houses which represent 28 % of the respondents do not have trees planted in their compound. The major reasons for not planting tree were the non availability of space, the fear of the trees affecting the structure of the building. The cross tabulation of those that have trees planted in their compound as illustrated in fig 3 shows that 103 number of the households have the trees planted by the tenants and 15 number of the households planted by the landlords. Those that met the trees in the compound or do not know who planted the trees are represented by 33 number of households.

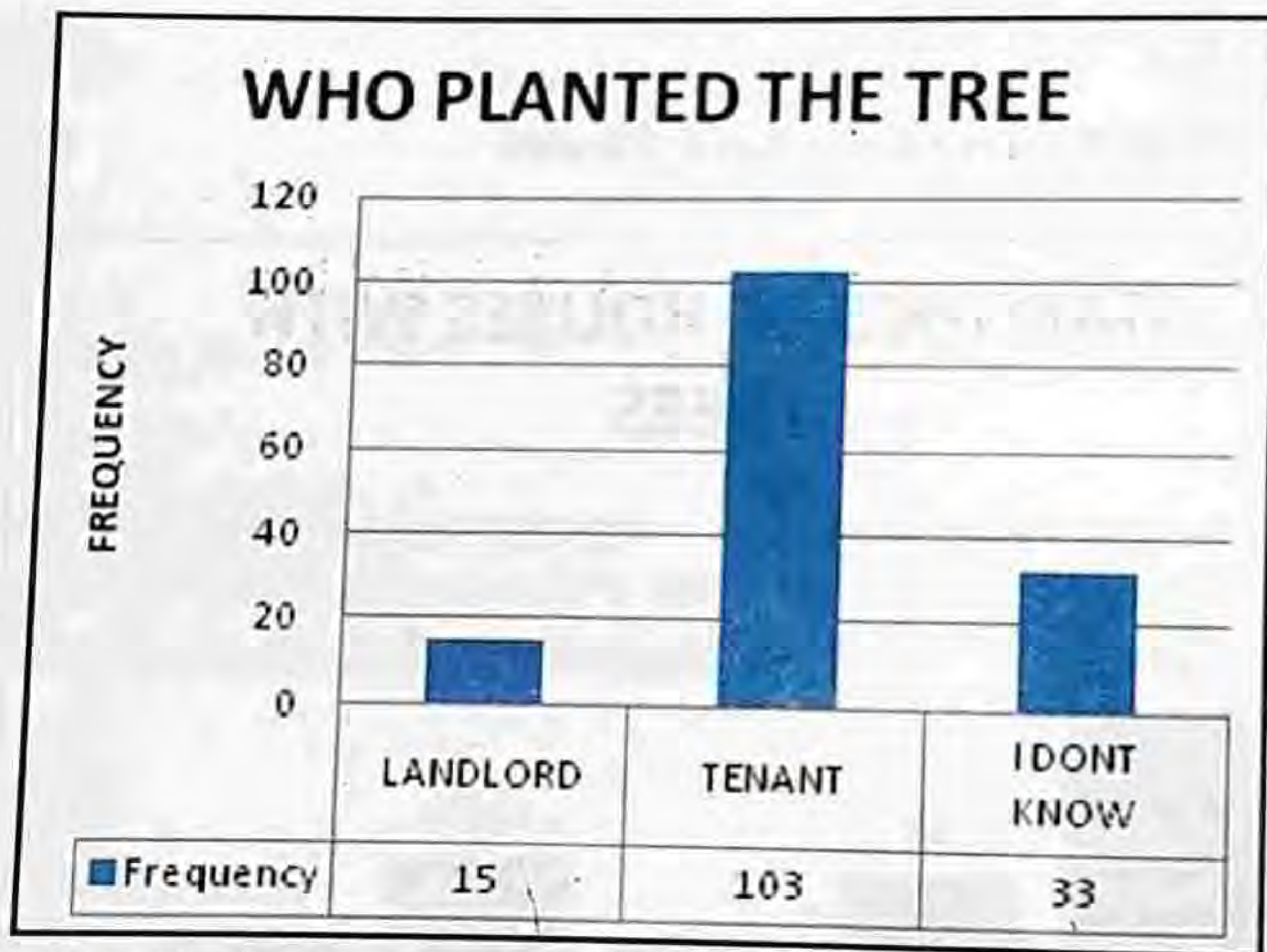


Fig 3: Showing the person that planted the trees. Source field work 2011

5.2 THE AGES OF TREES PLANTED

The survey shows (fig 4) that 43% of the households have their trees planted for over 8 years while 26 % of the households have their trees planted within 5 to 7 years, while 18 % of the respondents have their trees planted between 2 to 4 years. The remaining 13% of the respondents had their trees planted recently within the last 1 to 2 years.



Fig 4. Showing the period of the trees planted. Source: Author field survey 2011.

5.3 DURATION OF STAY IN THE ESTATE.

The survey (fig 5) shows that 46% of the occupants of the estate have been living in the estate for 8 years and above and 21% of the occupants have been living in the estate for 5-7 years, while those that have been living in the estate between 3-4 years constituted 14% and the remaining 19% have been living in the estate within the last 1 to 2 years.



Fig 5: Period of stay in the estate by the occupants. Source: field survey 2011.

5.4. PURPOSE FOR PLANTING TREES

Trees as landscape elements are planted for economic benefits, for shade and also for beautification. The study carried out shows that 40% of respondents planted the trees for the purpose of providing space for relaxation while 35% of the respondents did plant the trees to provide shade to the building envelope. Trees as beautification elements were not given much consideration as this registered only 19% of the respondents that have trees in their compound. However those that planted tree for the fruit benefit are 5% of the respondents. This is illustrated in fig 6



Fig 6: Purpose for planting tree, Source: Author's field survey 2011.

The data shows that the main reasons for planting of trees are dominated by the need to provide shade for the building and also for relaxation.

5.5. LOCATION OF TREES

The survey shows that those that have trees planted only in front of the house have the highest number of 27% followed by those that have trees planted only at the back at 17%. However there are those that have trees located both at the back and also in front at 26% as illustrated in fig. 7. The side of the buildings had the least number of trees at 12%. The planting of tree within the building registered 13%.

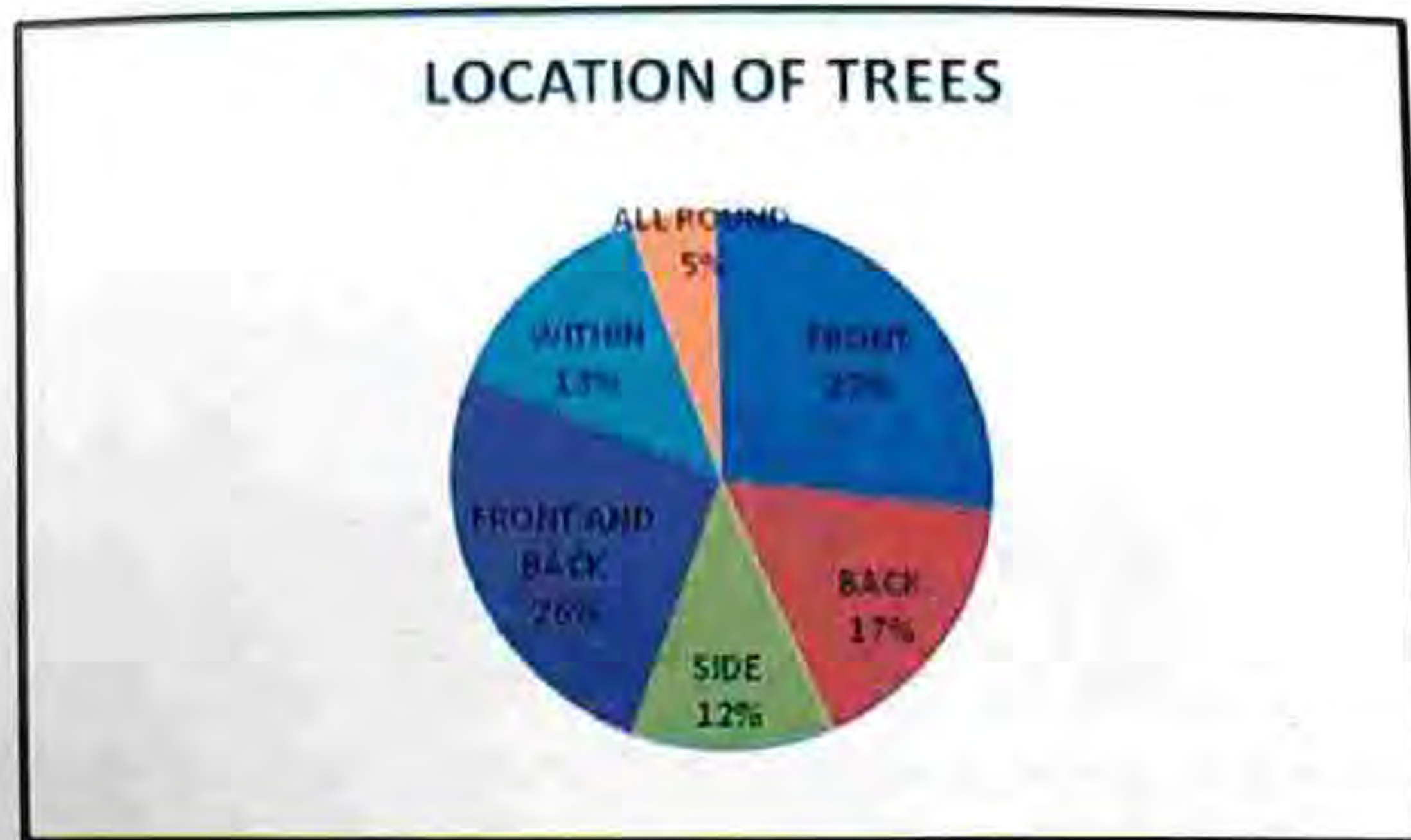


Fig 7. Showing the location of trees planted, Source: Author's survey 2011.

5.6 TYPES OF TREES PLANTED

The predominant factors for the planting of trees as earlier illustrated in fig 6 were for the purpose of providing shade to the building and also for providing an outdoor relaxation point for the occupants. However the study carried out showed that economic trees were also used by the occupants to provide the shade. The distribution is illustrated in fig 8 with economic trees as sun shading elements at 64% while the non economic trees at 26%. Those that have both economic and non economic trees planted registered 10%.

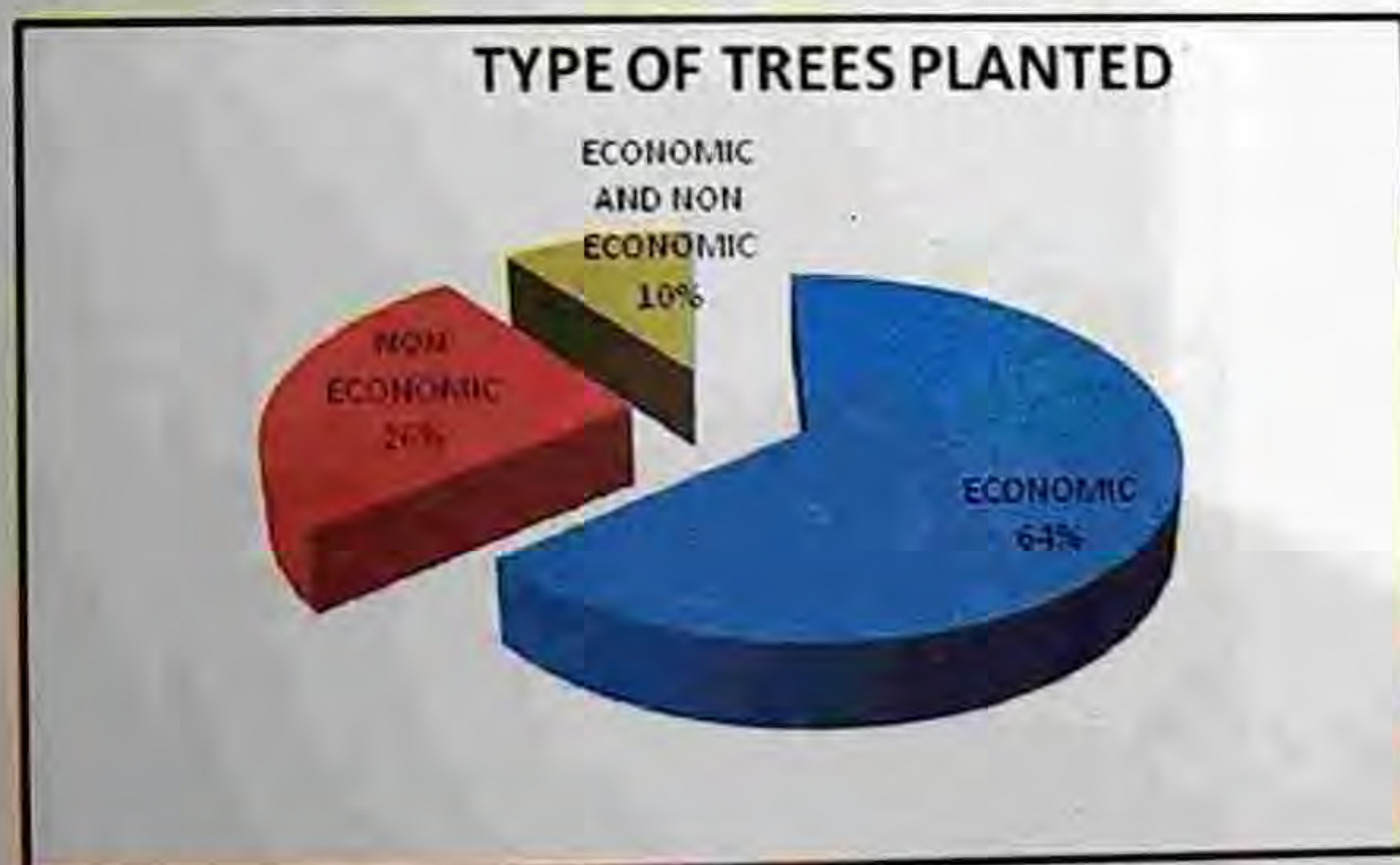


Fig 8. The type of trees planted, Source: Author's survey 2011.



Plate 1: showing 2bedroom apartments without trees: source authors survey 2011



Plate 2: showing 2bedroom apartment with trees; source author's survey 2011



Plate 3: showing a row of 3bedroom apartments; source authors survey 2011



Plate 4: Showing a row of 3 bedrooms at Bosso Estate. Source author's survey 2011

The illustrations show that while some houses have one or more trees planted in their compound some have none. The figures 9 and 10 below illustrate the typical floor plans of 2 bedrooms and 3 bedrooms houses in Bosso Estate Minna.

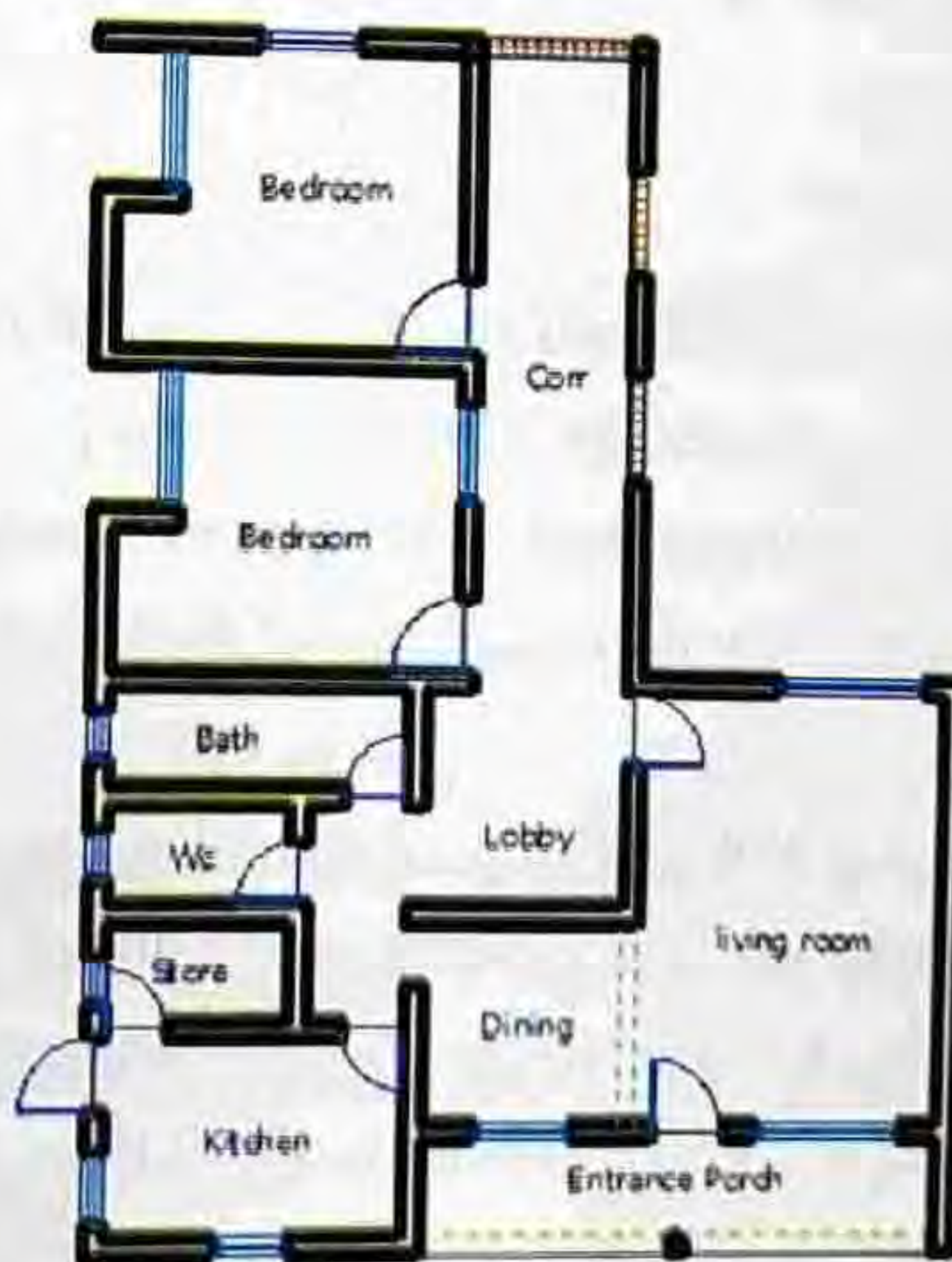


Fig 9: A typical 2 bedroom floor plan at Bosso Estate Minna:source authors survey 2011

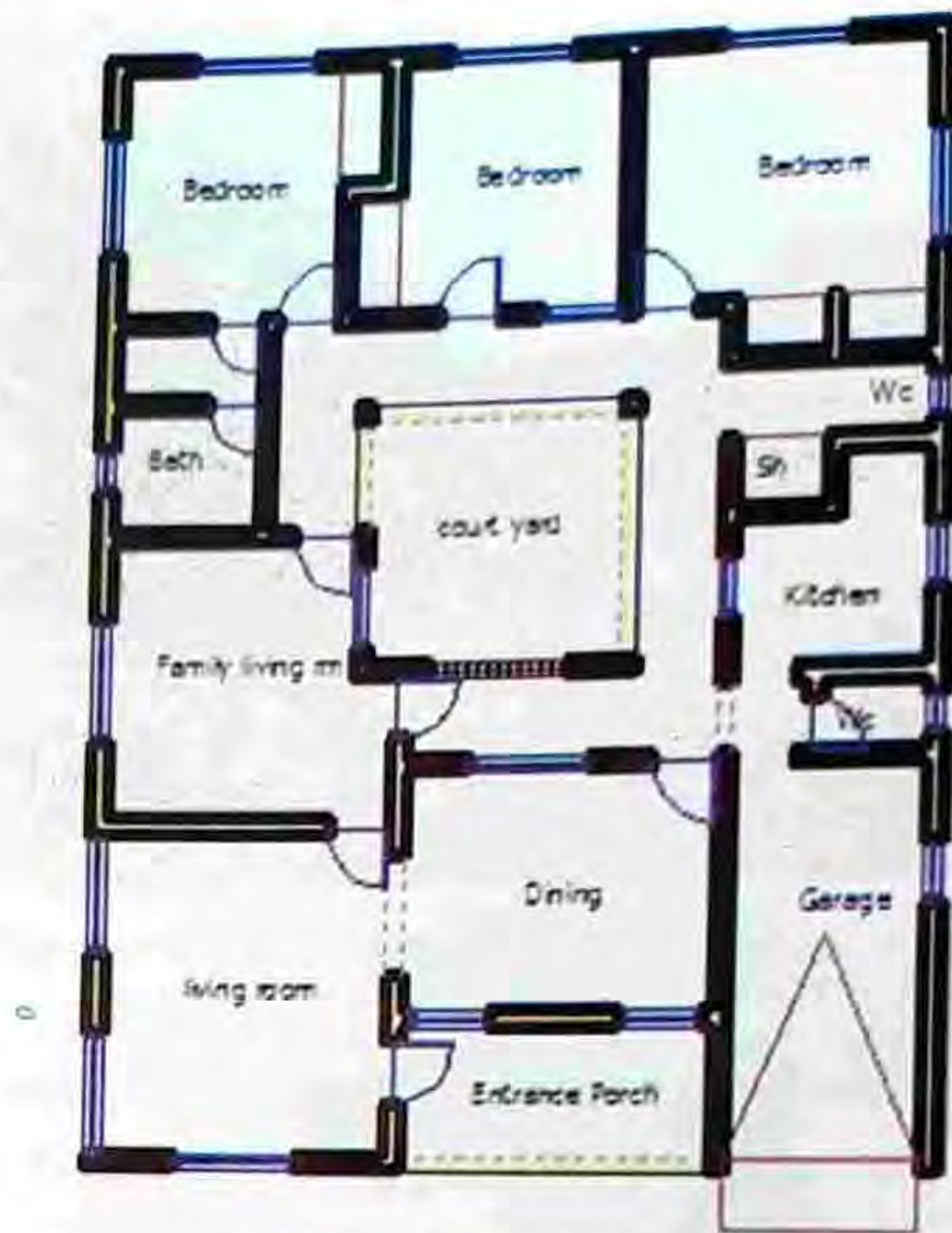


Fig 10: A typical 3 bedroom floor plan at Bosso Estate Minna:source authors survey 2011

6.0 DEDUCTIONS

The deduction from the study carried out can be outlined as follows.

1. Trees were not provided as landscape elements in the provision of the housing estate; however majority of the occupants had trees planted during their stay in the estate.
2. The most preferred tree type by the occupants of the estate is the economic trees, (trees that produce fruit.)
3. The preferred location for the planting of trees by the occupants of the residential building is the front and the back of the back of the house. The non planting of the trees by the side of the house is attributed to the non availability of space.
4. The microclimatic effect of trees in residential buildings is appreciated by most of the occupants.

5. The status of the occupants of the estate did not have effect on the planting of trees as majority of the trees planted were by tenants.
6. The occupants that did not plant tree in their compound attributed it to the non availability of space, difficulty of nurturing and the fear of buildings being affected by the tree.

7.0 RECOMENDATIONS

1. The government through its building development regulatory agencies at the Federal, State and Local levels should ensure that estate developers incorporate the provision and planting of trees as part of the external works to be carried out in any estate development.
2. Adequate setbacks should be provided all around the building so that trees can be planted around the building.
3. People are more likely to nurture economic trees because of the direct benefit derivable as such adequate studies should be carried out to ascertain the relationship of the common economic trees and their micro climatic effect on buildings.
4. The positioning of trees in front of each house has a very high acceptability and as such a good avenue of trees can be formed in housing estates.

8.0 CONCLUSION

The provision of housing estate by government and private developers should also focus on using soft landscaping especially the planting of trees in the provision of houses as the bioclimatic effects of trees cannot be overemphasised. The end users of these buildings should not be left with the sole responsibility of planting trees since most of them would not put into consideration the technicalities associated with it, as this may result into creating an unplanned landscape. The incorporation of tree planting as part of the external works in estate development will contribute positively towards the improvement of the environment and also providing a thermally comfortable micro climate of any given estate.

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