THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF GEOGRAPHY

G 421 PROJECT

TITLE:

ASSESSMENT OF AGROFORESTRY AS AN ALTERNATIVE TO CONVENTIONAL FARMING IN KASISI.

BY
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DECLARATION

" I, Luwi Weston, declare that the project has been compiled by me and that the work recorded is my own. All the maps and diagrams were drawn by me; all quotations have been appropriately acknowledged. The sources of materials have been specifically acknowledged and the project has not been previously submitted for any academic award. "

Signature ....

Date: ......02 / 10 / 95..................

DEDICATION

To my father and mother who have sacrificed a lot for my sake. I will always love you.

ACKNOWLEDGEMENTS

My research project, out of which arises this report, owes its success firstly to God and then a number of people whose mention here is worthwhile:

Mr. J. Volk: my supervisor. Your criticisms, suggestions, encouragement, brotherly attention and advice surged me forward. Indeed you were more than just a supervisor to me.

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LIST OF CONTENTS

CHAPTER FOUR

CHAPTER FIVE

CHAPTER SIX

LIST OF FIGURES

Figure

LIST OF TABLES

Table

LIST OF APPENDICES

Appendix

ABSTRACT

Agroferestry has been suggested as a solution to problems of rural development especially among the small scale farmers. The International Center for Research in Agroforestry(ICRAF) at Chalimbana Research Station introduced on-farm agroforestry trials in Kasisi to evaluate whether results obtained on-station would be reflected from on-farm trials. The objective of this study was to assess the contribution of agroforestry to the improvement of maize yields on farmers fields during the 1993/94 growing season.

The mode of data collection included scheduled and unscheduled interviews which were used to collect information from farmers in Kasisi and agroforestry researchers at Chalimbana Research Station.

Planted fallows with *Sesbania sesban* are being promoted as an improved agroforestry system that would help improve crop production among resource poor farmers in Kasisi. Results from this study showed maize yields to be far below the expected average in both conventional and agroforstry plots. These low yields were attributed to late planting of maize, low quantities of fertilizers applied than recommended, shorter fallow period for agroforestry plants, and low rainfall during the season. However, monetary losses in agroforestry plots were lower than those of conventional

plots. Yields in agroforestry plots were slightly higher than those from conventional farming plots but the difference was not statistically significant.

Therefore, it would not be prudent at this time to conclude that agroforestry would help to produce better yields than conventional cultivation methods. It is thus suggested that researchers should improve monitoring on how farmers follow recommendations. The drought had significant impact on the crop yields and hence the study should be repeated in order to observe how the crop would perform in seasons with normal rainfall and also longer planted fallow lengths.

CHAPTER ONE

1.0 INTRODUCTION

Many parts of Zambia are experiencing major difficulties in growing enough food and in providing wood energy with which to cook it. Low productivity is related to the deterioration of the environment which is as a result of deforestation and poor farming practices. The scenario is more pronounced among the peasant farmers who are involved in shifting cultivation and tend to use chemical fertilizers inappropriately making even the fertile lands of the country be unproductive.

This low productivity, land deterioration, increase in population pressure on the land, and increase in inorganic fertilizer prices have led to the realization that the successful future development of these areas lies in the adoption of integrated land-use systems which take account of the various factors contributing to the present constraints. In short, land-use systems that can adapt to the adverse effects of climatic change and prevent or reverse the available damage caused by inappropriate use or over use of resources are needed. One such a system is " agroforestry " which has been defined as " *all practices that involve a close association of trees or shrubs with crops, animals, and/or pasture. This association is both ecological and economic* " (Rochelean et al., 1988, p.15).

To this effect it has been seen necessary to investigate alternative farming systems to the traditional bush fallow systems which allow land to lie fallow for five or more years (Nye and Greenland, 1960). During fallow or rest period, Nye and Greenland(1960) have reported an increase in nitrogen and phosphorous. Nitrogen is one major nutrient that is easily recognized as a nutrient constraint and a quick indicator for decline in soil fertility in cereal based cropping systems in the unimodal rainfall miombo ecozone as indicated by AFRENA(1994).

Therefore, improved fallow systems through the use of nitrogen-fixing and fast growing trees such as *Sesbania sesban* should reduce the traditional fallow period, and at the same time accomplish comparable nitrogen, and other nutrient increases to the traditional bush fallow systems.

In account with the above views, my thesis is centered on the performance of subsistence farmers of Kasisi who practiced agroforestry technology in 1993/94 season as on-farm trials for Chalimbana Research Station.

1.1 RESEARCH OBJECTIVE

The objective of this study is to assess whether agroforestry technologies being promoted in Kasisi area increased crop yields among subsistence farmers.

1.2 RATIONALE OF STUDY

While the virtues of agroforestry's contribution to development have been widely publicized, the results have mostly come from research stations. It is important to provide information on the performance of these technologies being propagated on the actual farm situation. On-station research receives all the care needed in experiments to prevent local variations and yet on the farm situation these controls are not possible. Results obtained from on-farm research should not differ significantly from on-station results in order that farmers obtain the same advantages of the technology. This study therefore will provide information on the performance of agroforestry technologies being promoted in Kasisi.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 THE NEED FOR AGROFORESTRY

The deterioration of the environment has been due to man's activities. Shifting cultivation and bush fallow systems have been, and still are, the dominant food production systems and owing to increased population pressure, land is becoming limited: " *As productive land become scarce, small scale farmers have been pushed into fragile upland forest areas and marginal lowlands that cannot support subsistence agriculture*" (Winterbottom and Hazlewood, 1987, p.101).

Declining forest area and rising population pressure have forced farmers to shorten fallow periods which is an important component in making the soil regain its fertility in shifting cultivation systems. This results in degradation of the productive capacity of the land and reinforces the downward spiral of forest destruction. A detailed study by the Food and Agriculture Organization of the United Nations (FAO) on the future world food situation concluded that, " *by the end of the century shortage of land will have become a critical constraint for about two-thirds of the population of the countries* " (FAO, 1981, p.81). The document further points that the demand of developing countries for food and agricultural products is expected to double during this period of time.

The growing demand for food in developing countries will require bringing new land into production and improving the productivity of existing cropland. FAO(1981) has estimated that cropland will account for about one-quarter of the growth in food output from 1975 to 2000. Most of the needed increase in food production will therefore have to come from increasing the productivity of existing cropland primarily through the application of modern high-yield agricultural technologies. Winterbottom and Hazlewood(1981) contend that such technologies have to be both sustainable and appropriate to the ecological and economic, and social constraints faced by small scale farmers. One response to this challenge that is receiving increasing attention worldwide is "agroforestry". "Agroforestry" is a concept based on the development of the interface between agriculture and forestry. It is a sustainable multipurpose production system whose outputs can be adjusted to local needs. Beets(1989, p.27) contends that:

> *The aim and rationale of agroforestry systems and thus technologies are to optimize positive interactions between the components themselves(trees/shrubs and crops/animals) and between these and the physical environment; this will lead to a higher total, a more diversified and/or a more sustainable production from available resources than is possible with other forms of land-use under prevailing ecological and socio-economic*

conditions.

In account with the above view, agroforestry has been identified to contribute a lot of benefits to small scale farmers of which some include the following: helping to control deforestation, increasing agricultural production, meeting the needs of the low-resource farmers, and generating employment and income.

2.1.1 Helping to control Deforestation

" Wood provides the main source of domestic energy for more than half the population of the world and currently supplies more energy than is derived from the world's nuclear power industry " (Farmer, 1988, p.7). Increased pressure on land for agriculture and rising fuelwood demand in many tropical developing countries have combined to cause widespread deforestation. This is leading to a serious energy crisis for many rural poor and the distinct possibility of irreversible environmental damage.

Frasser(1988) contends that in order to combat deforestation, the adoption of agroforestry practices can relieve pressures on the natural forests by meeting local needs through farm and community tree resources. Thus, farm trees are a significant source of fuelwood production in farming systems. In addition, agroforestry is capable of establishing a permanent, sustainable land-use system in areas where traditional patterns of shifting cultivation and fuelwood gathering have broken down because of population growth and increasing land-use pressures.

2.1.2 Increasing Agricultural Production

According to SIDA(1992), one of the best ways of protecting the environment is to increase productivity from the land already used for agriculture. This is so because increased agricultural production due to areal expansion leads to deforestation and increased use of marginal lands not suited for agriculture. Therefore, best results would be achieved if trees were incorporated into the farming systems. Nair(1993) argues that the most significant contribution of trees may be their favorable influence on soil fertility. The evidence indicates that the added nutrients and organic matter from the presence of trees lead to favorable effects on soil fertility more than compensate for any negative effects of trees from shading and competition for water.

2.1.3 Meeting the Needs of Low-Resource Farmers

The majority of rural dwellers in developing countries are small scale farmers or landless people faced with a number of physical and socio-economic factors that constrain their ability to move beyond the daily struggle for subsistence. Generally they have very limited access to outside inputs and technology, and must rely on locally available resources to meet the whole range of subsistence and cash needs. Winterbottom and Hazlewood(1981) contend that by its nature, agroforestry is a small scale activity that is oriented to producing multiple outputs to meet local needs. As such it can help farmers minimize risks by producing a more diversified and stable farming system.

2.1.4 Generating Employment and Income

Sharrow(1983) indicates that there is more production from an acre of land and potentially more net profit. Product diversity could help stabilize your income_being able to sell logs when livestock prices are low and to retain standing trees when livestock prices are high, strengthens your cash flow and provides more marketing options.

The view of Sharrow indicate that multiple outputs have significant potential for generating employment and income opportunities for rural households. In areas of wood scarcity, household income can be increased indirectly by producing forest products on farms that would otherwise have to be purchased. Kotschi(1990) contends that agroforestry systems can also provide raw materials for traditional small scale enterprises such as saw milling, carpentry, wood carvings and basket making.

2.2 THE ROLE OF AGROFORESTRY

In sub-Saharan Africa, agroforestry is frequently invoked as a solution to problems of land and water degradation, as an answer to shortages of food, fuelwood, cash income, animal fodder and building materials. Rochelean et al(1988) argue that the droughts and famines of recent decades have alerted many to the need for rehabilitating degraded land and water resources in Africa's dry regions, as well as for developing appropriate, sustainable land-use and production systems. Weber and Storey(1986) contend that farmers and livestock owners need alternatives to the modern agricultural technologies and simplified cropping systems that have been promoted over the last few decades as part of development efforts.

While the experts may disagree on whether famines, droughts and resource degradation are natural disasters or caused by misuse of the environment, there is a general consensus that future land-use systems and technologies must give people more flexibility to respond to rapid shifts in economic and ecological conditions. In addition, Rao and Roger(1990) have argued that new production systems must maintain, or in many cases restore, the soil and water resources upon which rural life depends.

In this context, several traditional agroforestry systems have in fact sustained people for generations in a variety of African environments. According to Rachelean et al. (1988), the intercropping of trees like *Acacia albida* with millet and sorghum in the West African Sahel is one of the best known examples of a successful traditional agroforestry practice. Less well known but equally significant are the *"sylvopastoral systems developed by people who depend on managing livestock and their fodder sources in African Savannah lands "* (Rochelean et al., 1988, p. 30).

The levels of productivity that can be sustained in cropping systems, as Nair(1993) contends, largely reflect the potential and the degree of management of the resource base. This means that high productivity comes only from systems where management intensities necessary for sustainability are attained without extensive depletion of the resources. One such a system is the Improved Tree Fallow.

2.3 IMPROVED TREE FALLOW

In Kasisi area, the improved tree fallow was the agroforestry system being tested as on-farm trials by Chalimbana researchers. Nair(1993, p. 68) defines improved tree fallow as " *a traditional system that uses preferred tree species as the fallow species (as opposed to* *colonization by natural vegetation), in rotation with cultivated crops as in traditional shifting cultivation."* The reason for using such trees is production of an economic product, or improvement of the rate of soil amelioration, or both. Seppler and Nair(1987) contend that species suitable for improved tree fallows are usually limited to trees and shrubs with soil-improving qualities. Rochelean et al. (1988) have argued that the best species seem to be those which enhance soil fertility, especially by fixing nitrogen and which establish ground cover quickly. It is against these facts that Scientists have intensified their research on trying to improve good production through agroforestry systems and practices like the improved tree fallows.

Results obtained by Kwesiga and Coe(1994) from Msekera Regional Research Station show that *Sesbania sesban* can increase maize grain yield at reduced or no fertilizer input. In fact, increased crop yield after a fallow period has been widely reported (Agboola, 1980; Hamid et al., 1984; Saleen and Otsyina, 1986; Prinz, 1987; Palm et al., 1988). The magnitude of yield increment after each successive fallow was very high in the experiment. It is interesting to note that maize yields in the fallow plots continued to increase 2-3 years after whereas the control plots showed a decline. A similar trend was reported by Kang and Moormann(1977).

In the light of what has been discussed under the literature review, there is still need to identify traditional agroforestry practices and those developed from research in order to improve crop production and protect the environment.

CHAPTER THREE

3.0 DESCRIPTION AND LOCATION OF STUDY AREA

3.1 LOCATION

Kasisi area is situated to the north-east of Lusaka town and it is about 6.5 Kilometers from the International Airport junction. Figures 3.1.1 and 3.1.2 indicate the location of the study area.

3.2 CLIMATE

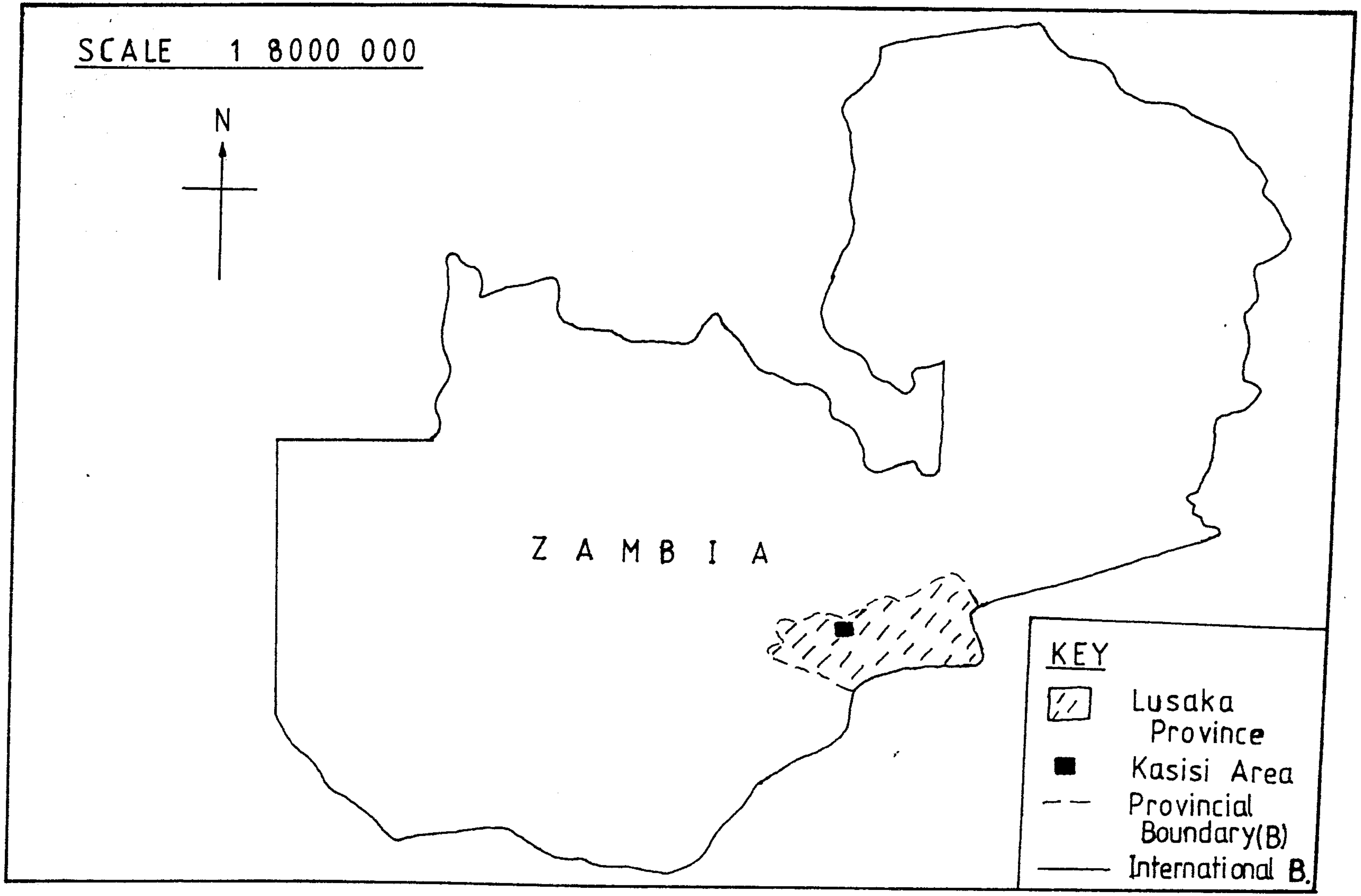
The climate of Kasisi, as that of the whole Lusaka area, is determined by the movement of the Intertropical Convergence Zone across the country. Its annual weather pattern is influenced by the modifying altitude and distance from the ocean. According to AFRENA(1994), the rains were late during the 1993/94 season and ended up abruptly in March with a monthly rainfall of 1.0mm. The total rainfall for the 1993/94 season was 544mm and this was 63% of the average total annual rainfall (Figures 3.2.1 and 3.2.2).

The mean monthly maximum and minimum temperature for the long term average (26 years) and the 1993/94 (September, 1993 through August, 1994) are given in Figure 3.2.3.

3.3 RELIEF AND DRAINAGE

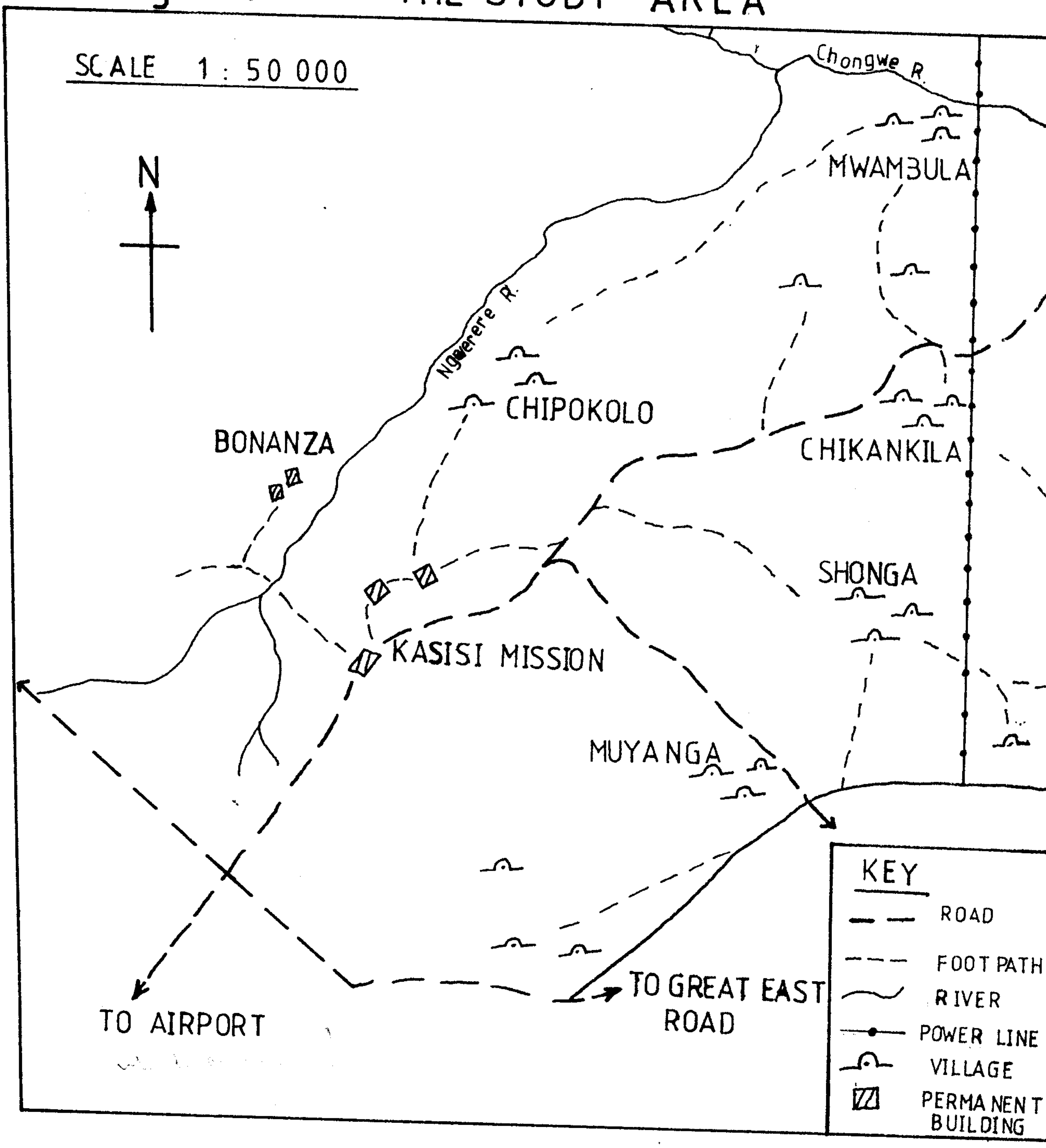
Kasisi area is characterized by a gentle plateau. The relief of the area ranges between 1100 - 1300 meters above sea level. The area is drained by two streams. To the

Fig. 3.1.1 POSITION OF KASISI AREA



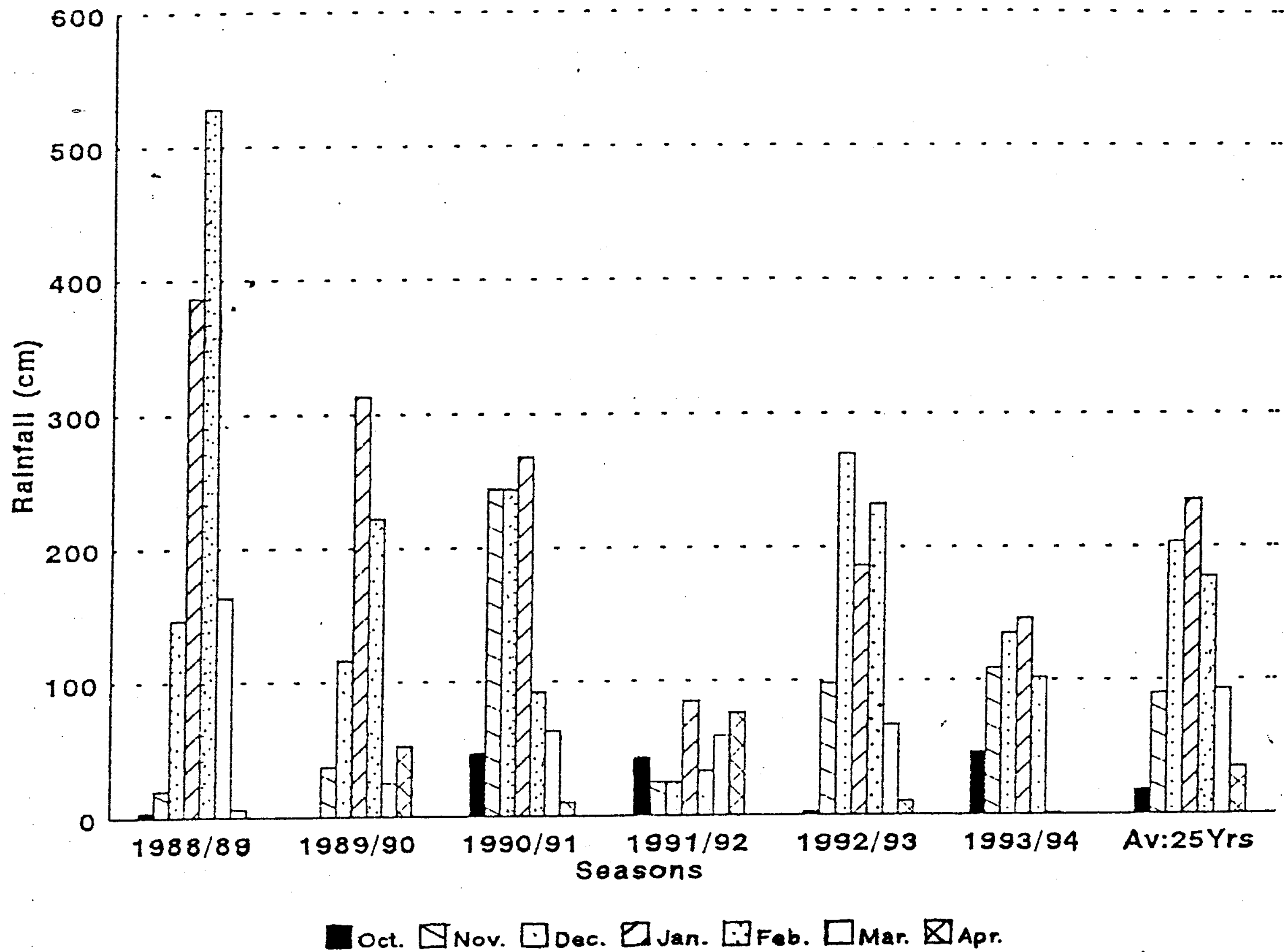
SOURCE: Chikuma et al., 1985.

Fig. 3.1.2 THE STUDY AREA



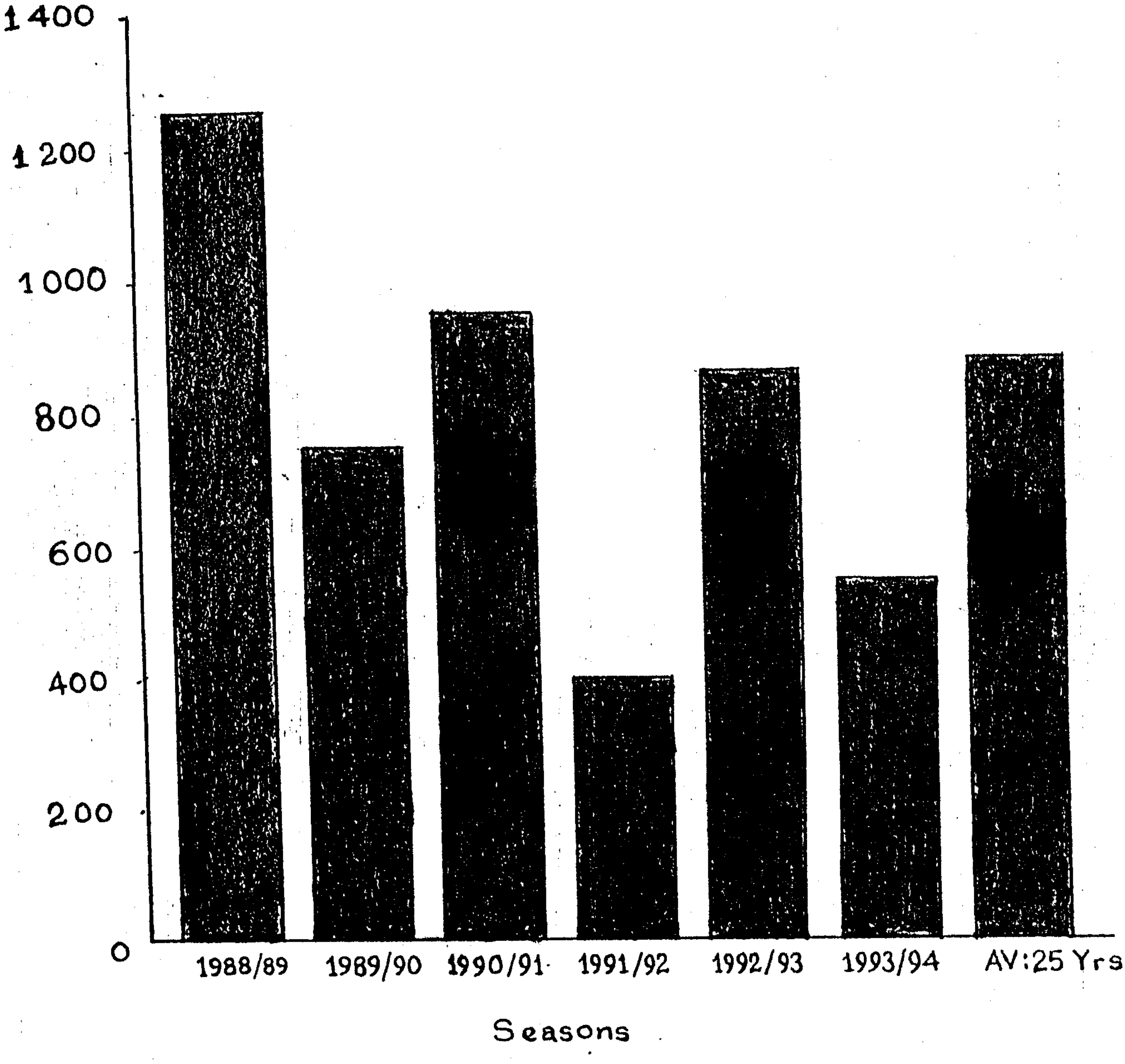
Source: Adapted from parts of sheet no.s 1528 A2, A4 & 152831,33

Fig. 3.2.1 MONTHLY RAINFALL AT LUSAKA INTERNATIONAL AIRPORT



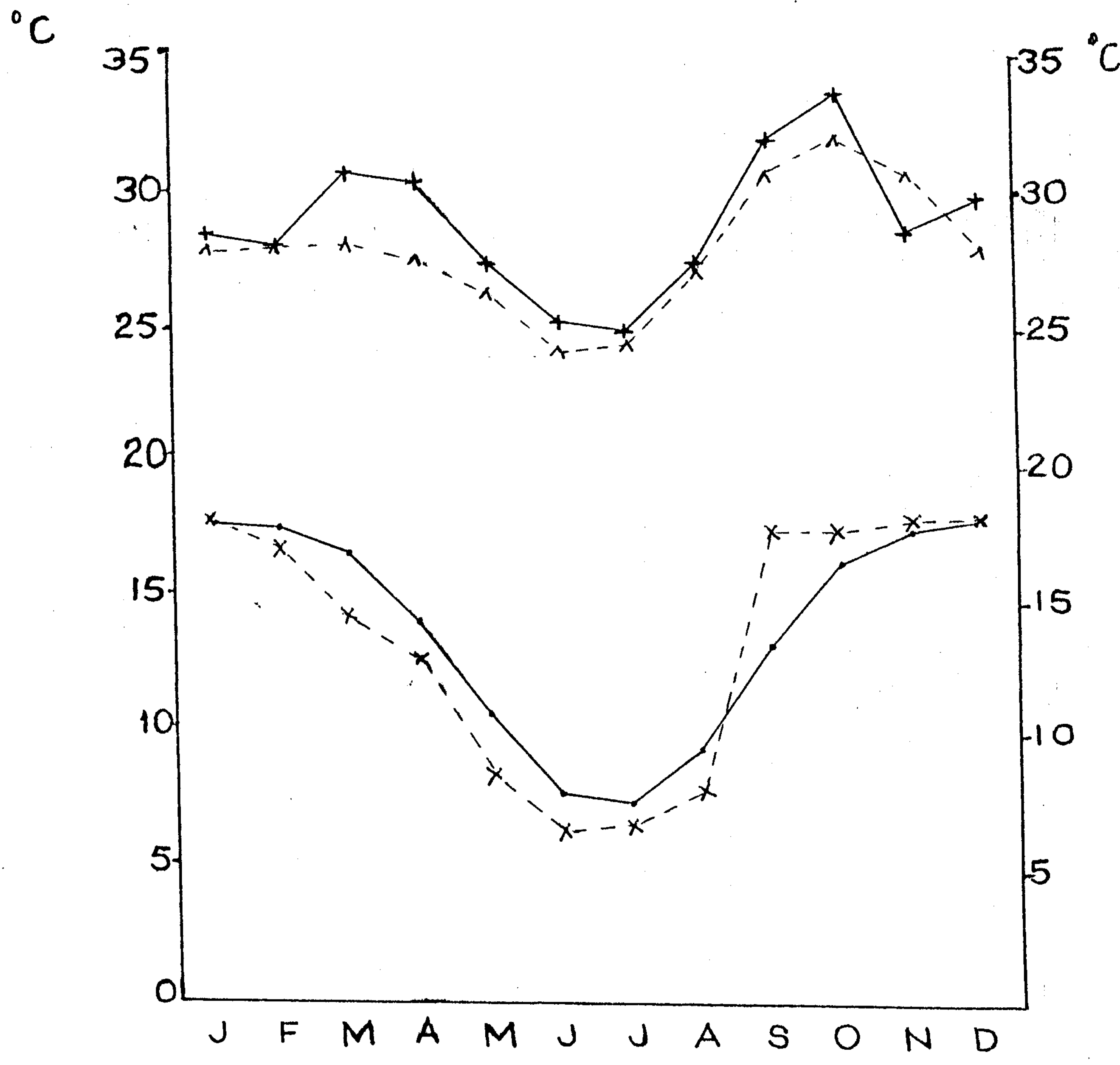
Source: AFRENA, 1994

Fig.3.2.2 TOTAL RAINFALL FOR SIX SEASONS



Source: AFRENA, 1995.

Fig. 3.2.3 TEMPERATURE



—+— Max Temp (1994) —×— Min Temp (26 Yrs Av) —A— Max Temp (26 Yrs A

—•— Min Temp (1994)

SOURCE: AFRENA, 1994.

north-west of Kasisi we have the Ngwerere stream which stretches up to the northern part where it joins Chongwe river. Ngwerere stream stretches from the University of Zambia.

3.4 SOILS

Generally the soils of Kasisi area are highly influenced by climate and the underlying ancient rocks of the Katanga system(Soil Survey Staff, 1975). Most of the area has an isophythermic soil temperature regime. The soils range from sandy clay loam to sandy clay alfisols with patches of utisols (Kamara, 1993).

3.5 VEGETATION

Kasisi area is dominated by a deciduous woodland type of vegetation called Miombo. Little of the original vegetation survives today because of clearance for cultivation and charcoal burning. The major causes of vegetation destruction include demands for building materials and fire wood. Along the Ngwerere stream, a few patches of *Acacia* species can still be observed although most of them have been cleared for grazing.

CHAPTER FOUR

4.0 METHODOLOGY AND DATA COLLECTION

4.1 DATA COLLECTION

Collection of data was done through the use of scheduled interviews for both farmers and researchers. Scheduled interviews were used to collect particular information from the respondents. Unscheduled interviews were conducted in form of discussions with farmers so as to allow them give a detailed account on their understanding about certain topics within the area of agroforestry. In these unscheduled interviews with farmers, most of the qualitative data was collected. As for quantitative data, in some cases farmers found it difficult to quantify their data and I therefore employed some allometric measurements to estimate the data I was provided with.

4.2 SELECTION OF STUDY AREA

The fact that Chalimbana Research Station had some on-farm trials in Kasisi to evaluate the potential of *Sesbania sesban* improved and managed fallows on farmers' fields, it became imperative for me to conduct my study in this area. In fact it was the only area that had some on-farm trials for the station during the 1993/94 growing season.

4.3 SOURCES OF DATA

Researchers from the Chalimbana Research Station provided me with information on their findings concerning the on-farm trials. This information is considered as secondary data and the other secondary data came from the Ministry of Agriculture, University of Zambia main library and departmental library for geography department, Survey Department, City Airport Meteorological Station, and Chalimbana Research Station library. Primary data came from the interviews I had with farmers of Kasisi who were participating in agroforestry research under the supervision of researchers from Chalimbana.

4.4 SAMPLING PROCEDURE

Chalimbana Research Station had only 10 on-farms in the 1993/94 season in Kasisi. Of these, one of them had left the area during the time of my visit. Since the sample size was too small, I decided to consider all of them (that is 9 farmers) for my study.

4.5 PILOT SURVEY

A pilot survey was undertaken for five days visiting the nine farmers. This enabled me to test the adequacy and clarity of my questionnaire for farmers. In addition, I was able to make some appointments with them so as to visit them later.

4.6 DATA LIMITATIONS

In this research I was faced with some limitations of which some include the following:

1. Quantitative data from farmers is not very accurate since most of the quantities were just estimated and this could have led to an over-estimation or under-estimation of quantities.

2. It was discovered that only men were targeted by Scientists in their agroforestry technology dissemination to small scale farmers. Therefore, the results obtained are biased towards men.

3. The results obtained are not very reliable since the 1993/94 season poor rains experienced in the country affected the crop yields.

CHAPTER FIVE

5.0 RESEARCH FINDINGS

5.1 ON-FARM TRIALS

On going research work at Chalimbana and Chipata show that *Sesbania* improved fallows increase maize yields(Kamara, 1990, 1992; Kamara and Chikasa, 1992; Kwesiga et al., 1991). As such there was need to verify the technology under farmers' conditions. Kasisi area in the north-east of Lusaka was selected for the on-farm trial because the area is known to have severe soil fertility problems due to poor soil management, and severe shortages of wood as most of the trees around had been cut(AFRENA, 1994). Hence the need to introduce technologies like improved fallows to address these constraints.

A short-rotation fallow system with *Sesbania sesban* was undertaken because, according to AFRENA(1994), researchers have confirmed that *Sebania's* nitrogen-release mechanism seems better suited to short-rotation fallow systems. Furthermore, most of the nitrogen derived from these trees is not cycled through leaf litter, but rather through the decomposition of the root system accompanied by shedding of nitrogen-fixing nodules when the trees are felled (Salazar et al.. 1993).

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Ten small scale farmers were initially selected for on-farm trials. However, during my study there were only nine farmers as one had moved out. On each farm, *Sesbania sesban* was planted and left to grow for one year. During the 1993/94 season, it was cut at ground level and separated into wood and foliage and weighed.

5.2 MANAGEMENT OF MAIZE PLOTS

On each of the nine fields I visited there were two treatments imposed. A one year *Sesbania sesban* fallow treatment and one year continuous maize treatment(farmers' practice) as control. The plots were 20m x 20m = $400m^2$ per farm for the *Sesbania sesban* fallow and the conventional plots. The seedlings were planted at 1m x 1m spacing equivalent to 10 000 trees per hectare. According to farmers, these plots were too small to satisfy their need for crop yield.

The number of live *Sesbania sesban* trees in the fallows was recorded at 12 months after planting to calculate survival during the fallow period. Four farmers had their fields ploughed by a tractor while the other five had their's ploughed by oxen. The conventional plots received an average of 142 Kg/ha Diammonium phosphate broadcast at planting as basal dressing. The conventional plots also received an average of 82.8 Kg/ha of Urea as top dressing, half at maize knee high and at 35 days after planting. Details of this are indicated in Table 5.2.1. Maize was planted on all farms in January due to late ploughing by farmers. The planting space was between rows of 75cm and 25cm within rows. The plots were weeded twice. As for labor, this was shared among family members. In some cases the farmers employed some people to do the job for them.

TABLE 5.2.1

The average cost of farming based on fertilizer input

RESPONDENT NO.	Type of Fertilizer Input: Basal dressing (Diamonium Phosphate) (Kg/ha)	Top dressing (Urea) (Kg/ha)	TOTAL COST (K12000/50Kg)
1	220	155	90 000
2	110	90	48 000
3	190	60	60 000
4	100	25	30 000
5	140	110	60 000
6	90	35	30 000
7	150	100	60 000
8	170	80	60 000
9	110	90	48 000
MEAN	142	82.8	54 000
SE	±15.7	±13.98	±6 451.7

5.3 PERFORMANCE OF *SESBANIA SESBAN*

Table 5.3.1 illustrates the performance of *Sesbania sesban* on farmers' fields. Survival was relatively high averaging 82%. The mean biomass yields for pruning which were applied to the plots was 245 Kg/ha. The wood yield averaged 3.42 t/ha. Trials with poor survival experienced lower biomass production and grain yields.

5.4 MAIZE YIELD

The average grain yields obtained from conventional farming plots among the contact farmers was 489.8 Kg/ha while that from planted fallows was 583.3 Kg/ha. A one way analysis of variation(ANOVA) was carried out to test the significance of the difference between the means of grain yields from conventional farming and planted fallows. Farmers were used as blocks and the treatments were conventional farming and planted fallows. The F-test (at p=0.05) indicated that there was no statistically significant difference between the yield from conventional plots and that of planted fallow.

5.5 PARTIAL COST-BENEFIT ANALYSIS OF PLANTED FALLOW VIS-A-VIS CONVENTIONAL FARMING

A partial cost benefit analysis was done to highlight costs and benefits of planted fallows as an agroforestry land use system to convectional farming during the 1993/94 season.

A partial cost benefit analysis was opted because a complete cost benefit analysis was beyond the scope of this study.

TABLE 5.3.1

Performance of *Sesbania sesban* 12 months after planting

Respondent No.	Survival (%)	Pruning Yield (Kg/ha)
1	88	99
2	90	295
3	86	102
4	42	79
5	87	94
6	79	172
7	92	807
8	93	336
9	84	220
MEAN	82	245
SE	±5.6	±81.5

Source: Chalimbana Agroforestry Center, 1994.

TABLE 5.4.1

Grain yield from the fields

RESPONDENT NO.	CONVENTIONAL FARMING(Kg/ha)	AGROFORESTRY (Kg/ha)
1	625	750
2	625	500
3	579	750
4	579	250
5	500	625
6	500	500
7	375	875
8	375	500
9	250	500
MEAN	489.8	583.3
SE	±46.2	±66.3

$LSD_{0.05}$ between means of conventional and fallow = 1.45

TABLE 5.5.1

Partial Cost Benefit Analysis of Conventional Farming Compared to Agroforestry

INPUT	CONVENTIONAL FARMING(K)	AGROFORESTRY(K)
Fertilizer	54 000	-
Ploughing	30 000	30 000
Weeding	40 000	40 000
Total cost of inputs	124 000	70 000
Maize Yield(i.e., output)	33 374	42 250
Total output-Total input	-90 626	-27 750

Note: A negative sign indicates a loss made.

On average the cost of fertilizer in Kasisi area at the time of my visit was about K12 000 per 50Kg. The average quantity of fertilizer input per farmer was 142 Kg/ha for basal dressing and 82.8 Kg/ha for top dressing. This means that the total cost of fertilizer per hectare was about K54 000. The total cost of ploughing the field per hectare was about K30 000 while the cost of weeding per hectare was K20 000. Since weeding was done twice, this means that about K40 000 was spent per hectare. In account with the above costs, the total comes to about K124 000. As for the approximate total cost involved in the planted fallow fields was about K70 000 as Table 5.5.1 indicates.

According to the yields indicated in Table 5.4.1, the mean yield for control plots is about 489.8 Kg/ha. In monetary terms this is equivalent to about K33 374 since maize was selling at K6 500 per 90 Kg in Kasisi. This meant that after spending about K124 000 per hectare, a peasant farmer made a loss of about K90 626 per hectare. As for planted fallow yields, after selling his maize, a peasant farmer made a loss of about K27 750 per hectare.

CHAPTER SIX

6.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

6.1 DISCUSSION

Results show that there was poor yield of maize from both agroforestry and conventional farming. The average maize yield was about 489.8 Kg/ha while that from agroforestry was about 583.3 Kg/ha. However, the difference in yields between conventional farming and agroforestry was statistically not significant. The average expected maize yield range from 4000 to 5000 Kg/ha and yet these farmers of Kasisi during this season (1993/94) obtained less than 600 Kg/ha on average in each farming system. These low yields by farmers in Kasisi were attributed to several factors among which include the following: poor management of the plots by farmers; farmers were advised by ICRAF researchers to apply 200 Kg/ha of Diamonium Phosphate as basal dressing and 150 Kg/ha of Urea in split applications. Unfortunately farmers applied less than the recommended rates of fertilizer (Table 5.2.1). The average basal dressing applied by farmers was instead about 142 Kg/ha and 82.5 Kg/ha of top dressing. The total fertilizer input is very low and this could have led to the low grain yield obtained at the end of the season. According to farmers, the low input of fertilizer was due to the fact that other fields needed fertilizer too. Most of them could not afford to buy enough fertilizer for all their fields since it had become expensive due to removal of subsidies on fertilizer and agricultural inputs.

The other reason for poor results would be due to the fact that maize was planted late. This was because ploughing time for the trial coincided with planting maize and beans in *the target area and this meant less attention put on the* trial fields. Ploughing was a major constraint for Kasisi area, as contended by ICRAFT researchers, for both on-farm trials and the normal farming in the area. Use of tractor or oxen was expensive and some farmers had to wait for long periods before they could have their fields ploughed. Eventually the delay in ploughing could have led to late planting of maize which could not favor the growth of the crop adequately.

Table 5.3.1 shows that the average survival percentage of *Sesbania sesban* of about 82% obtained in farmers' fields was not very different from that obtained by researchers at Chalimbana of about 98.5%(AFRENA, 1994). However, the average biomass yield of about 245 Kg/ha of dry matter obtained from farmers' fields is less than half to that obtained from the research station at Chalimbana where they obtained about 935 Kg/ha of dry matter(AERENA, 1994). This biomass is very important for soil fertility improvement on maize production in the one year improved fallow technology as contended by Nair(1993). Table 5.3.1 shows that farmers with the lowest biomass production registered very low maize yields in the fallow plots.

The low *Sesbania sesban* biomass production in farmers' fields could be attributed to the fact that the care that farmers offered to *Sesbania sesban* was not adequate to guarantee any better yield. Farmers have other fields to attend to, and as a result less attention is directed to the trials. Scientists have the resources to put in their trials to make sure that accurate results are obtained. The other thing most likely to have caused low biomass production or a variation in biomass production among the farmers is local variation in soils. The villages are located in different areas of Kasisi region with different local soils and this affects the growth of plants. Different soils have different fertility levels.

Results reported by Kwesiga and Coe (1994) on *Sesbania* planted fallows indicated that the benefits from this practice increased with longer fallow periods. The fallow period in this study was only one year and maybe the yield in planted fallows would have increased if the fallow period was extended to more than one year.

Weather conditions experienced in the study could also be said to have contributed to poor performance of maize. According to Figure 3.2.2, climatical data obtained from Lusaka International Airport meteorological station (as a reference point for weather recordings) show that the region received rainfall below average (i.e., average precipitation for 25 years) during the 1994/93 season. To make matters worse, Figure 3.2.1 shows that the rains stopped in February which is two months earlier than normal. This situation could also have contributed to low performance of both agroforestry and conventional farming in Kasisi area. In addition to the above view, Figure 3.2.3. shows that the area had temperature recordings above that of 26 years average recorded. These high temperatures could have affected the growth of the crops too by increasing transpiration.

Looking at the costs incurred in farming by farmers, the two treatments had different costs since they demanded different attentions. As indicated earlier on, a focus on the cost of farming goes beyond what has been considered in my thesis. However, figures indicated in Table 5.5.1 show that the cost of agroforestry was less than that of the conventional farming. In any case both treatments had registered some losses when total inputs and total outputs are converted in monetary terms. The losses experienced were largely a result of low fields.

6.2 CONCLUSION AND RECOMMENDATIONS

Apparently the results obtained from one year improved *Sesbania sesban* fallow imposed in Kasisi area by researchers of Chalimbana can not conclude that agroforestry can improve crop yields among small scale farmers in Kasisi. The results were further affected by the drought, poor farmer management of research plots, late planting of maize, early stoppage of rainfall, high costs of fertilizers which somewhat made it difficult for farmers to afford the required amount of fertilizers, and shorter period of fallow with *Sesbania sesban*.

Because of the poor results obtained from the on-farm trials conducted in Kasisi area, the following recommendations are made:

- In order to improve on the results obtained from on-farm trials, researchers should employ a constant monitoring mechanism so as to ensure that farmers are following the recommendations on good crop management and husbandry to avoid low fertilizer applications and late planting.

- Agroforestry is meant to help small scale farmers and therefore its implementation should be centered on peasant farmers who can not afford the expensive methods of farming. This view should be respected in future because some of the farmers targeted by researchers in the 1993/94 season could afford expensive ways of farming.

- Some farmers complained that the size of the trial plots were too small to benefit them in case of good results. Therefore, in future it would be of value to farmers if trial plots were increased in size.

- Since the results obtained from the on-farm trials conducted in Kasisi are not conclusive enough, researchers should continue these on-farm trials taking into account the recommendations above.

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APPENDIX 1

STATISTICAL ANALYSIS ON THE YIELDS OF CONVENTIONAL FARMING AGROFORESTRY

Data Table

Treatments (p)	Blocks(r) 1	2	3	4	5	6	7	8	9	Treatme Sum	Me
1(Control)	625	625	579	579	500	500	375	375	250	4408	48
2(Fallow)	750	500	750	250	625	500	875	500	500	5250	58
BlockTotal	1375	1125	1329	829	1125	1000	1250	875	750	9658(y)	
BlockMean	687.5	562.5	664.5	414.5	562.5	500	625	437.5	375	-	1073

$$Correction\text{-}Factor(C) = \frac{y^2}{rp} = \frac{(9658)^2}{9\times2} = \frac{93276964}{18} = \underline{5182053.6}$$

Anova Table

Source of Variation	DOF	Sum of Squares (SS)	Mean Square (MS)
Total	17	457178.4	
Block	8	200937.4	25117.18
Treatment(T)	1	39386.84	39386.84
Error(E)	8	216854.2	27106.78

For treatments,

$$Calculated, F = \frac{MST}{MSE} = \frac{39386.84}{27106.78} = 1.45$$

$$F_{0.05}(1,8) = 5.32$$

Calculated F < Table F, therefore there is no significant difference between the two treatments.

APPENDIX 2

A. QUESTIONNAIRE FOR RESEARCHERS

1. Name ....

2. What kind of agroforestry technology are you imposing on farmers of Kasisi area? ....
....
....
....

3. What are some of the advantages of the technology you have mentioned above? ....
....
....
....

4. What are some of the disadvantages? ....
....
....
....

5. Why did you decide to conduct your on-farm trials in Kasisi? ....
....
....
....

6. How many farmers have adopted your technology?
....

7. Why the number you have mentioned in Q.6? ....

....

....

8. a)How many trial plots does each farmer have? ....

b)How are the trial plots managed by farmers? ....

....

....

9. Do you encourage them to apply any fertilizer?

Yes( ) No( )

10. If yes, in which plot(s) and why? ....

....

....

11. What is the name(s) of the fertilizer applied? ....

....

12. What is the quantity applied and when? ....

....

....

....

13. Were farmers able to meet the cost of fertilizer? ......

....

14. Do you carry out any Dry Matter measurements?

Yes( ) No( )

15. If yes, give reasons why. ....

....

....

16. After planting your trees, do you assess the performance? Yes( ) No( )

17. If yes, why do you do this? ....

....

....

18. How do you assess the performance of trees?

....

....

....

19. Were there any differences got in terms of results between on-station trials and on-farm trials?

Yes( ) No( )

20. Give reasons for your answer in Q.19? ....

....

....

....

B. QUESTIONNAIRE FOR FARMERS

1. Name ....

   Sex Male( ) Female( )

2. What is the name of agroforestry technology researchers are imposing on your farm? ....

   ....

3. In your opinion, is it a good technology?

   Yes( ) No( )

4. Give reasons for your answer in Q.3. ....

   ....

   ....

5. How many trial plots do you have? ....

6. What are their measurements? ....

7. Is the size of conventional and agroforsetry plots small or large? Small( ) Large( )

8. If small, what size of plots would you prefer? ....

   ....

9. Who cultivated the trial plots? ....

   ....

10. What was the cost of ploughing and weeding(if any)? ....

    ....

11. How was the planting of maize done? ....

    ....

    ....

12. Did you apply any fertilizer in your plots?

    Yes( ) No( )

13. If yes, what type of fertilizer and when was it applied?

....

....

14. What was the approximate amount of fertilizer applied?

....

15. What is the cost of fertilizer? ....

16. What was the quantity of maize yield per plot? ....

....

17. Was the yield low or high? ....

18. What would be the reasons for your answer in Q.16? .....

....

....

....

19. How much was a 90Kg bag of maize selling? ....

....

20. Was the selling price favorable or not?

Yes( ) No( )

21. How many people were involved in managing the trial plots? ....

22. Any other costs incurred in practicing agroforestry?

....

....