CASHEW AGROFORESTRY IN THE CONTEXT OF THE NATURAL RESOURCES OF THE WESTERN PROVINCE OF ZAMBIA

by

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the requirements of the degree,
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ABSTRACT

The soil and climatic conditions in the Western Province of Zambia are suitable for cashew growing and cashew agroforestry. Within the Western Province, cashews perform best on the upland areas that have more fertile soils and abundant ground water. Farmers have responded positively to cashew growing, and are capable of switching from cashew monoculture to intercropping. Cashew has good potential as a base crop in agroforestry systems featuring forest and crop species such as mango, mungongo, eucalyptus and grevillea. Cashews showed good adaptation to drought conditions in agroforestry trials. During the first 7-10 years, the cashew interspaces can be used for intercropping with cassava, bulrush millet, bambarra nuts, soy beans, cow-peas and pigeon peas. During the first year of growth, deep root system crops such as finger millet and sorghum can out-compete newly transplanted cashews for nutrients and moisture.

Optimum output for a single cashew tree is achieved after 7-10 years. Cashew interspaces are out-grown after 7-10 years. Age of the tree, spacing, soil fertility, plant variety and plant protection are the important factors that determine yield levels. An ideal cashew estate in the Western Province is expected to produce about 500 kg of nuts per ha per annum, at a spacing of 10 x 10 m. At 10 x 10 m spacing, a hectare accommodates 100 cashew trees while at 12 x 12 m spacing, only 70 trees can be accommodated. Cashew-

based agroforestry can provide nuts, food, fodder, fuel-wood, poles and timber. Intercropping helps in weed control, fire prevention and soil conservation. The deep-root system of cashews can help to recycle soil nutrients.

Cashew pests and diseases are undermining yields and efforts of farmers. Transportation problems, poor access to credit, late delivery of seedlings and land tenure are serious constraints to the development of the cashew industry, according to the findings of the present study. The following major recommendations are made:

1. Cashew should be grown as an agroforestry crop, rather than as a monoculture.
2. Research should produce cashew varieties and planting methods that enhance intercropping, retain soil moisture and enhance soil nutrients and organic matter content.
3. Extension service messages should emphasize cashew intercropping practices.
4. Future studies should address transportation problems, which are a major constraint.
5. Cashew farmers should have representation in agricultural marketing institutions.
6. There should be credit provision to cashew farmers.
7. Nurseries of cashew tree-seedlings should be established at primary schools in strategic locations.
8. Constitutional laws pertaining to land tenure should be enforced.

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1. INTRODUCTION

1.1 Preamble

Zambia is a land-locked country in southern-central Africa, lying between 8° and 18° south latitude and 22° and 34° east longitude (Figure 1). The total land area is about 750,000 km^2, (Planning Division, 1988). In 1990 the total population was about 7.81 million (Central Statistics Office, 1991). The average annual population growth rate is about 3.7 percent (NCDP, 1989, 52). At this growth rate the total population could be estimated to have been around 8.09 million in 1992 and be around 8.38 million in 1993. However, the actual population figure could be slightly lower due to improved family planning and increased mortality rates as a result of deteriorating health care.

The economy is dominated by the copper mining industry which contributes more than 90 percent of export earnings and about 50 percent of Gross Domestic Product (GDP) (NCDP, 1989). However, export earnings from copper sales have fallen drastically over the years due to a decline of copper prices on the international market as well as a drop in production. The problem has been compounded by the fact that the mining industry is highly dependent on imported

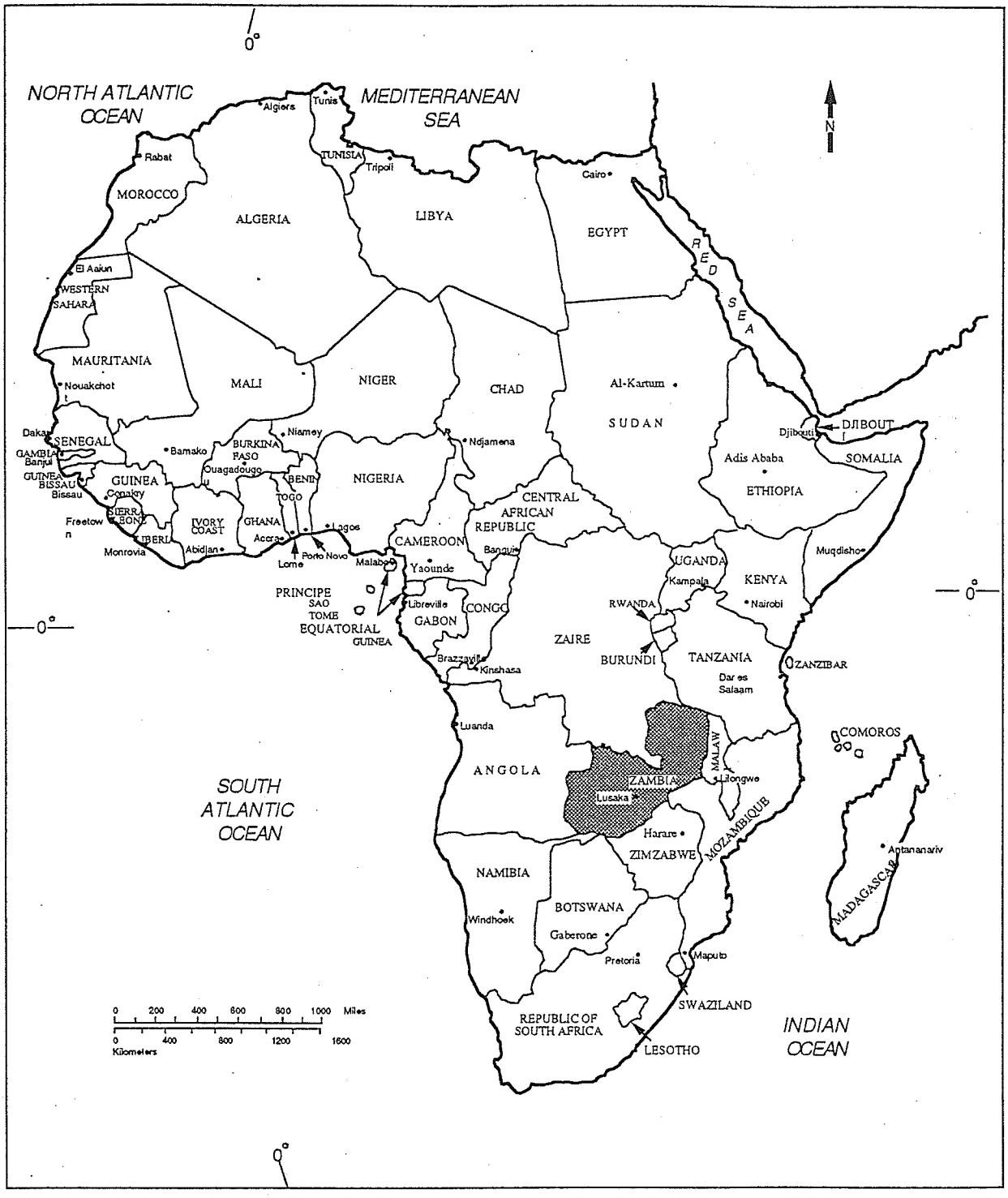

Figure 1

Location of Zambia in Africa

inputs against a backdrop of a drastically devalued local currency. This, together with the fact that copper is a non-renewable resource has induced the Zambian government to diversify economic activities specifically into the Agricultural sector.

Consequently cashew nut (*Anacardium occidentale L*) cultivation in the Western Province was identified jointly by the Zambian government and the Food and Agriculture Organisation of the United Nations as a viable export crop. More details, regarding the background to cashew growing are presented in Chapter 5. Government policy objectives and agricultural extension service support focused exclusively on the potential economic benefits that could be generated by cashew nut growing and development. The potential of soil conservation through cashew-based agroforestry has not been articulated. It has neither been spelt out as part of government policy objectives nor as a component of extension services.

1.2 Background Information

Agriculture contributes about 16 percent to GDP and also accounts for only 2 percent of export earnings (NCDP, 1989). However, agriculture contributes 65 percent of value added to the manufacturing sector (NCDP,1989, 88). Agriculture is the largest sectoral employer mainly through

informal subsistence farming. Although statistics indicate only a 16 percent contribution to GDP, the majority of the country's population live on informal subsistence farming, and the real value of agriculture is not reflected in the GDP figures.

Therefore, despite the significance of mining in the economy, agriculture is the mainstay of the majority of the population. This is indicated by the fact that 71.9 percent of the total labour force (economically active population) live in rural areas (NCDP, 1989, 60). About 77.3 percent of the employed labour force are in the informal sector (Ibid). Only 22.7 percent of the employed labour force is in the formal sector including mining and agriculture. About 72 percent of the employed labour force in the informal sector are in subsistence agriculture (NCDP, 1989, 67). The low contribution of agriculture to GDP and export earnings, is largely due to the undeveloped potential.

The major policy objective of the Zambian government regarding agriculture has aimed at maximising development and exploitation of potential resource endowments of specific regions in order to produce crops for domestic consumption as well as surplus for export (NCDP, 1989). This objective is spelt out in the country's Development Plans. The aim of the 1989-93 Plan is "to promote regional development on the basis of the characteristics and development potential of each region" (NCDP, 1989, 27).

Due to the comparative advantage criterion, from the point of view of soils and climate, agricultural investment and production have concentrated in six of Zambia's nine provinces to the exclusion of the Western Province. This has mainly been due to the fact that the Western Province mostly has soils that have inadequate nutrients and low rainfall conditions which have made it less attractive to agricultural investment.

1.2.1 The Western Province

The Western Province is the third largest province of Zambia, covering one sixth of the country or 130,000 km^2 , roughly the size of England (see Figure 2), (Programme Evaluation, 1988, 3). In 1990, the population of Western Province was 607,497 (Central Statistics Office, 1991). The Province has an annual population growth rate of 1.6 percent per year (Programme Evaluation, 1988, 5). At this growth rate, the population in the Province is estimated to have been around 627,000 in 1992 and be around 637,000 in 1993.

Western Province is characterised by a savannah mono-modal rainfall regime ranging from about 900 to 1,000 mm per annum (African Development Fund, 1980). Variation in day length during a change from one season to another is insignificant. Temperatures are relatively moderate with a maximum of 30-34^{0}C during the rainy season (October to April) and a limited incidence of frost (in the lowlands)

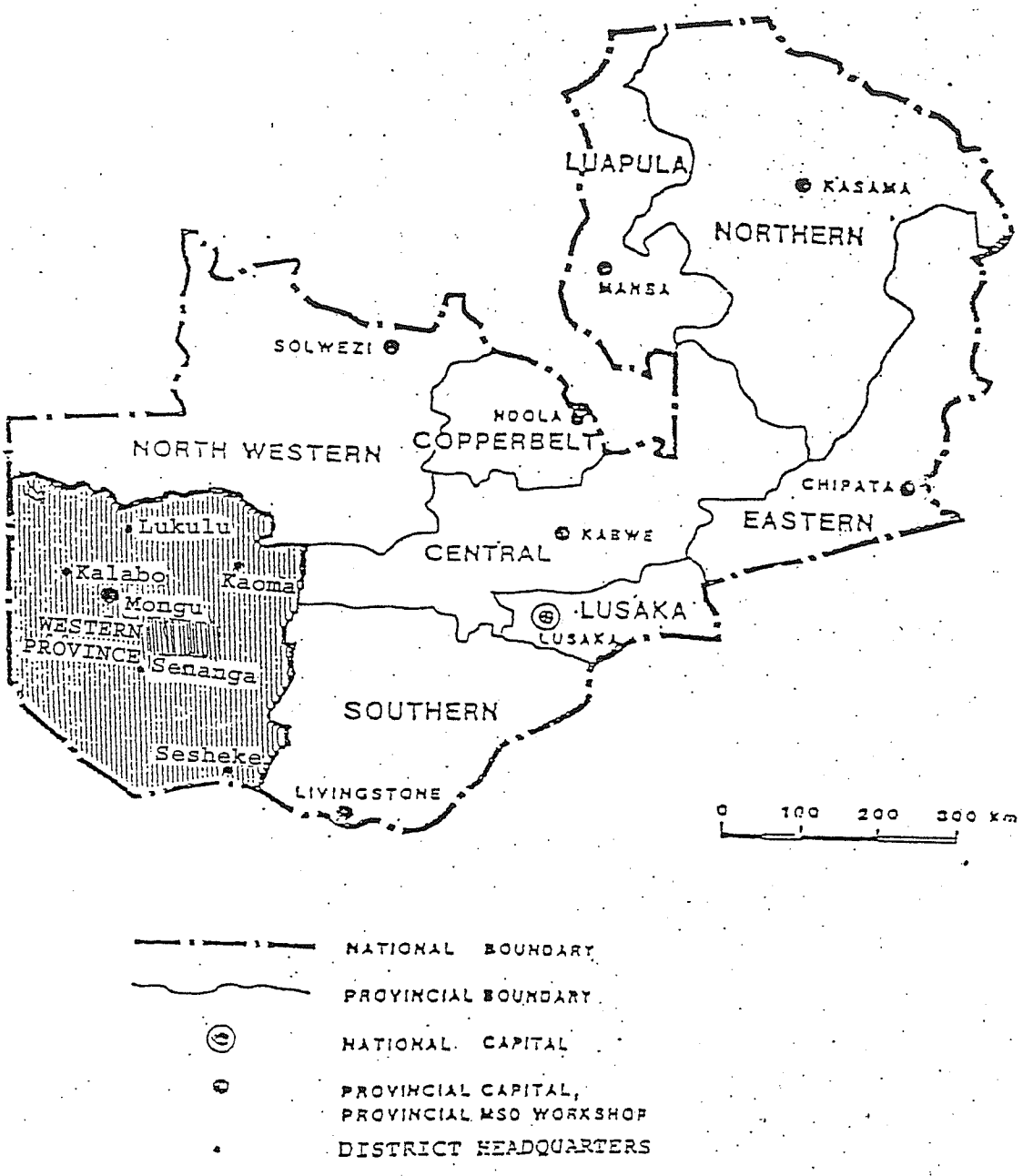

Figure 2
Location of Western Province in Zambia

during the cold months of May to August (Ibid).

The Province is also characterised by two major land systems; the wet lowlands and the dry uplands. The uplands cover approximately 90 percent of the province and the lowlands comprise the remaining 10 percent (Programme Evaluation, 1988). The height of both the uplands and lowlands ranges from 900 m to 1350 m above sea level. The lowlands mainly constitute the Zambezi flood plain (see Figure 3). The uplands support light forests and bush or woodland savannah type of vegetation. Both the uplands and lowlands are part of the uplifted Kalahari-Okavango Basin. This makes the uplands look like an extension of the Kalahari desert of Namibia. The climate and soils on the uplands tend to be similar to, although rainfall is greater than, what is found in the Kalahari desert. The soil in the uplands is typically pure loose coarse sands also known as Kalahari sands (Barotse sands) with low fertility and high drainage capacity. The land-use pattern in Western Province is largely characterised by an agro-pastoral subsistence economy. This type of economic sustenance is explained further in Chapter 4.

Historically, cashew nut growing was introduced to the Western Province during the colonial days, in 1958 (Eijnatten, 1984, 6). The local people were encouraged to grow a few cashew trees in their backyards to help stave off soil erosion. The cashew trees also provided snacks to the

Figure 3

The Zambezi flood plain after the floods have receded (July, 1991) - Notice some early burning in the background

local people in form of raw or roasted nuts. Chapter 5 gives more details regarding the status of these cashew trees.

According to the 1989-1993 Development Plan, Western Province produces an average of 80,000 x 90 kg bags of maize per annum (NCDP, 1989, 753). The Province imports about 170,000 x 90 kg bags of maize (*Zea mays*) annually, which is more than twice as much as it produces. Maize production, the staple food crop, constitutes roughly half of the total crop production (food and other commercial crops such as cotton and tobacco) in the province. Other crops grown include bulrush millet, finger millet, sorghum, cassava, bambarra nuts, tobacco, sunflower, paddy rice, pumpkins, soy beans, groundnuts and sweet potatoes.

The potential for increasing production of most of the crops in the Western Province is limited by poor soils and relatively low rainfall. The potential that exists is only for drought resistant crops such as sorghum, bulrush millet, bambarra nuts, cassava and cashew nuts on the uplands, as well as paddy rice in the flood plains and seepage zones of the lowlands.

During the late 1970's, cashew nut growing was acknowledged by government authorities as an appropriate alternative cash crop for the frost-free uplands of Western Province (Eijnatten, 1984). Activities geared towards cashew nut growing and development were extensively

initiated in the 1980's.

The Zambia Cashew Company (ZCC) was established in 1986 with investments from; Zambia Industrial and Mining Corporation Limited (ZIMCO), Zambia National Provident Fund (ZNPF), Zambia State Insurance Corporation Limited (ZSIC), Landell Mills Associates, British Petroleum (A) Limited as well as the Commonwealth Development Corporation (Planning Division, 1991 and ZCC Quarterly Report, 1991). The mandate of ZCC is both to grow and to purchase raw nuts, and to process and market (export) cashew nuts. The ZCC has been developing its own cashew plantations, as well as purchasing cashews from local farmers. The company's plantations are aimed at ensuring reliable and stable supplies of raw nuts.

ZCC plantations were only started in 1987/88. Plantations require about 3 to 5 years before the cashew trees start producing nuts for the market. In the meantime ZCC started processing and marketing cashew nuts bought from local small-holders.

Financial and technical support from the Netherlands, Italy and the Food and Agriculture Organisation (FAO) of the United Nations is directed at supporting Zambian government Research and Extension services to cashew nut growing and development in the Western Province (Planning Division, 1991).

1.3 Issue Statement

Almost over 1.3 million ha of land in the Western Province has been earmarked for cashew growing by monoculture (ARPT, 1991). This poses problems of accelerated land degradation. Practices of cashew monoculture are being disseminated to small scale farmers through the government Agriculture extension service. The potential for cashew growing in an ecologically and economically viable agroforestry intervention in the Western Province has not yet been pursued or explored vigorously. This potential has not yet been identified by the government extension services as an objective to be pursued, and not explored beyond field experiments (see Chapter 6). At the institutional level, extension activities directed at cashew nut growing and development focus exclusively on narrow economic goals, encompassing 'cultivation, processing and marketing' of cashew nuts. There is no expressed policy objective, let alone targeted goals aimed at ensuring that cashew nut growing enhances sustainable agriculture by encouraging cashew-based agroforestry. Moreover, cumulatively large areas of savannah bush land are being uprooted to make room for cashew trees. Chapter 5, section 3.4 gives specific figures on hectareage already cleared for cashew cultivation. A total area of 1,316,875 ha of land has been identified as being suitable for cashew growing

(Adaptive Research Planning Team-Western Province, [ARPT] 1991). There is also ever-increasing pressure on local forests due to growing needs for firewood and charcoal, overgrazing, expanding local construction and other local wood-demanding activities. The sandy and loose soils also remain highly prone to both wind and water erosion. There is a possibility that these conditions may be worsened by the cashew enterprise depending on the cropping system or methods of cultivation being applied as well as the extent to which the forest resource base is being displaced by cashew plantations.

A complicating factor is that, the Western Province is slowly being encroached by the "arid ecological conditions" of the Kalahari desert. Drought conditions are becoming more persistent particularly in the central and south-western parts of the Province. It is not known if this is part of a long-term global climate change. These changes have resulted in the loss of natural vegetation, and has also caused severe crop failures since 1979. Therefore cashew cultivation by monoculture will compound problems in the sustainability of land-use. It is thus imperative for Agriculture extension services to promote cashew cropping systems that are geared towards agroforestry. If cashew growing is undertaken with a parallel objective of integrating cashew schemes into a viable form of agroforestry intervention, resource conservation and

economic needs can both be met concurrently. Conservation through agroforestry can help in achieving sustainability of land-use, thereby reducing environmental stress manifested in various forms such as drought conditions.

1.4 Objectives

The general aim of the study is to examine and identify the potential and constraints pertaining to the functioning of cashew nut growing and development, as an agroforestry intervention for the upland areas of the Western Province. The study investigates the feasibility of pursuing cashew nut growing and development as an agroforestry venture besides being an income generating enterprise, in Western Province. Feasibility is assessed from an institutional standpoint, in terms of government extension support services and the type of cashew cropping systems or cultivation methods that are being advocated. The study specifically addressed the following objectives:

i) identify the ecological potential for agroforestry in cashew growing in the Western Province of Zambia.

ii) examine current cashew extension activities, as administered by the Department of Agriculture of the Zambian government in the central uplands of the Province within Mongu district.

iii) analyze and offer information pertaining to cashew

cultivation methods disseminated through the Extension Services Branch of the Department of Agriculture.

iv) identify the role of the ZCC in the development of cashew growing.

v) identify constraints to the pursuit of agroforestry through cashew growing.

vi) based on the findings of the study, offer recommendations to the Zambian government and other stake-holders such as international donor agencies. The recommendations are in support of cashew growing and cashew-based agroforestry. Such recommendations are aimed at enabling a balanced integration of the soil conservation role and the economic role that the cashew nut enterprise can play in the Western Province, thereby making agriculture more sustainable.

1.5 Scope

The study explores cashew extension services as they are carried out by field workers. Farmer perceptions and responses to cashew extension support in general, are also examined. Given time limitations and logistic considerations, factors such as farmers' access to finance and inputs, as well as marketing details; are only examined to the extent that they affect the development of cashew growing. Cropping systems leaning towards agroforestry are

also highlighted and contrasted with cashew schemes.

These specific points and scope limitations have been determined by the objectives of the study. Time and financial limitations also entail that the scope focuses only on specific points of direct relevance to the objectives of the study.

1.6 Methods

Research work for the study, entailed the application of four methodologies. The methods were used to collect relevant qualitative and statistical data. The purposes and expected outputs of each of the methods are explained in Chapter 2. These methods are;

(i) review of literature and documents pertaining to cashew activities

(ii) interviews with officials, field workers and farmers

(iii) questionnaire to field workers, and

(vi) field and observation survey.

Direct and structured interviews were used with nineteen field extension workers. Based on information provided by the questionnaire and the cashew development officer in Mongu, the nineteen extension workers were servicing 1,977 cashew farmers by 1991. These cashew farmers were spread over a total surface area of about 50,000 km^2. This total area is based on the summation of camp areas for the 19

agricultural camps used as a representative sample of all the potential areas for cashew growing in the Province. An accompanying questionnaire was also administered to the field extension workers. This approach offered a balanced and comparative analysis of the responses generated by the two different methods.

Informal and less structured interviews were conducted with middle and upper level management agricultural officers, dealing with extension services related to cashew nuts. These interviews covered officials at national, provincial and district levels.

Field observation survey and interviews were also used to assess the way cashew farmers make use of extension services. These were also used in order to gauge farmer perceptions about cashew extension support services. Through qualitative surveys, the study outlines what extension workers do and how they do it with respect to cashew growing.

Interviews, observation survey and review of relevant documents were used to collect qualitative data and statistics pertaining to activities of the Zambia Cashew Company (ZCC). All four methodologies were relied upon to examine the way extension workers in the study area convey messages and impart methods of cultivation and land management that have a bearing on both cashew growing and agroforestry.

The qualitative data and statistics generated through these methods were then used to evaluate the specified objectives of the study. The results of the evaluation were in turn used to specifically determine whether cashew nut growing in the Western Province can serve as a viable agroforestry intervention.

On the basis of the above analyses as well as constraints and potentials that were established, appropriate recommendations are made. The recommendations are directed to the Zambian government and Donor Agencies who are stake holders in development activities being carried out in the Province. Details on methodology are spelt out in Chapter 2 and the Appendices.

1.7 Client

The client for this study is the Permanent Secretary, Ministry of Agriculture and Fisheries of the Zambian government. Besides the client, there are other stake-holders such as other government ministries, departments and international agencies. These institutions have interest in development activities in the Western Province and in some of the issues addressed by the study. Specifically, the following departments and institutions have a direct stake in the study:

(i) the Lands Department in the Ministry of Lands, Water

and Natural Resources.

(ii) the Provincial Planning Unit in the Western Province and the provincial Departments of Agriculture, Forestry and Lands.

(iii) the Zambia Cashew Company (ZCC) which is a joint venture between the government and the private sector, and

(iv) the Donor community such as; the F.A.O (Food and Agricultural Organisation), the Netherlands and Japanese missions in Zambia, NORAD (Norwegian Development Agency), SIDA (Swedish Development Agency) and CIDA (Canadian Development Agency). All the Donor Agencies listed above have an interest in development activities pertaining to the study area and Zambia in general.

1.8 Importance of the Study

The importance or justification for the research undertaking is closely linked to the client, as well as other stake-holders, research and teaching institutions. The study provides an appraisal of the actual needs and potentials of cashew nut extension and land use in the Western Province of Zambia.

Through this study it has been possible to highlight major constraints to a viable cropping system, stemming from

socio-economic conditions, circumstance and government policy. These, together with economic constraints are better understood through a broader perspective that the study offers. Linking up extension messages with ecological sustenance needs to be done within the context of what is socially and economically affordable.

This report provides a summary of cashew growing and agroforestry as well as reference material both for planners, practitioners and students. Finally, the study helps identify future research needs, both in agroforestry and cashew growing.

CHAPTER 2

2. METHODOLOGY

2.1 Introduction

Different situations and problems require different appropriate research methods, (Michael Patton, 1988). Due to the nature of issues that were investigated in this study regarding "Cashews and agroforestry", as spelt out by the six objectives in Chapter 1 Section 4, qualitative methods of inquiry were identified to be more appropriate and useful for the purpose. Parametric methods of measurement and experimental design could not be applied to issues of this nature which are multifaceted and in which most variables of interest have 'unquantifiable attributes'. For instance, not all the essential elements of cashew extension services could be quantified in terms of numbers. The effects of cashew activities and extension approaches on agroforestry, can not all be expressed in terms of numbers. Not all constraints to cashew agroforestry can be expressed in numerical terms.

Qualitative methods of inquiry have been applied in a holistic approach. This is based on the premise that a concise description and thorough understanding of the cashew nut program as a whole in Western Province is essential for

understanding specific components of cashew nut growing and development activities. In this regard comprehensive information in the form of primary data about the growing of cashews in Western Province is required in order to assess whether the cashew orchards or plantations can be a viable agroforestry system.

To provide a comprehensive perspective on cashew nut growing and development in the Province, multiple sources of data were accessed using multiple methods. The methods used were:

(i) review of literature and cashew related documents
(ii) interviews
(iii) questionnaire and
(iv) observational and field survey.

These methods have been applied through an inductive approach, of understanding specific issues pertaining to cashews and related activities, through investigation and analysis rather than imposing any presupposed expectations on the research process. A framework of the specific issues is offered in Appendix A.

2.2 Review of Literature and Cashew-related Documents

Relevant literature on agroforestry as well as cashews has been reviewed, and the findings have been incorporated in Chapters 3, 5 and 6. Relevant findings from literature

sources have been incorporated into the study and used in analyzing field results. Both qualitative data and relevant statistics were obtained from documents pertaining to cashew activities.

2.3 Interviews

Interviews were conducted with officials, field extension workers and cashew farmers. Goals and routine activities of cashew extension services were established through these interviews. Through the interviews, data was generated that provides perspectives on impacts of cashew growing from the point of view of farmers, extension workers and other staff involved in and with expertise in cashew growing activities in the Province.

Two types of interviewing were used. These were:
(1) The General Interview Guide Approach. This was based on an outline of a set of issues that were inquired from senior personnel and officials involved with cashew growing activities, particularly cashew extension services.
(2) The Standardized Open-ended Interview. This was directed at extension workers in the field and farmers. This type of interview consisted of a set of questions in a sequential order asking the same questions to each respondent.

The general thrust of the interviews was to obtain facts and perceptions concerning cashew field activities and implementation processes of agricultural extension services towards cashew growing. Specifically the opinions of field workers and farmers pertaining to cashew growing methods and extension services were obtained through interviews. Specific issues addressed by the interviews appear in Appendix (A).

2.4 Questionnaire

In order to find out more information that may have required some reflections on the part of respondents, concerning the growing of cashews, a questionnaire was administered to the field extension workers. To allow for depth and detail to emerge, open-ended questions were asked thereby avoiding fitting responses into predetermined or standardized categories.

The open-ended questionnaire enabled the research process to capture agriculture extension workers "in their own terms" and to grasp the "raw reality" of their basic perceptions about the way they have oriented their extension activities. That is, it enabled them to put their ideas and experiences in their own words. It also offered a framework within which these field workers could present accurately and thoroughly their points of view. The questionnaire that

was used is appended in Appendix (B).

2.5 Observational and Field Survey

Besides interviews, the questionnaire and review of documents, personal observation of cashew fields was also applied. These observations also offered a visual impact and grasp of the effect of the methods in use. Observational survey enabled an understanding of cashew growing and related activities beyond the insights obtained through interviews and questionnaires. Visual contact and images of cashew fields augmented the process of "learning" about the performance of cashews in the study area.

Direct observation of field activities pertaining to cashew growing generated more comprehensive and salient information about cashew growing in the Province. Observation survey offered a vivid picture of how cashew farmers apply cultivation methods and innovations disseminated by extension service workers. It also offered visual impressions regarding the general performance of the cashew crop in the field.

Among other things observational survey allowed:

1) A better understanding of the context within which cashew growing activities take place.

2) First hand experience of the day-to-day concerns and problems pertaining to cashew activities, thereby allowing

an application of the inductive approach that eliminates prior conceptualizations.

3) A grasp of what agriculture personnel and farmers could have assumed irrelevant, and therefore do not mention in either the interviews or the questionnaire.

4) A grasp of information or processes that respondents could have been reluctant to disclose.

5) Reflections and introspection on the part of the researcher that helped in establishing the fundamental processes that are central to the growing of cashews.

6) Finally, observational survey enabled the observation of what does not happen in terms of soil conservation in the growing of cashews as well as from the context of planned goals.

Cluster sampling was used for interviews and the questionnaire administered to a total of all nineteen (19) field extension workers in Mongu, the central district of the Province. These field workers serviced 1,977 cashew farmers over a total area of about 50,000 km^2. Cluster sampling was also applied in the interviews conducted with four provincial officials and three district officials dealing with cashew extension services and cashew research. Two senior officials dealing with agricultural extension at the national level were interviewed. One official (Agricultural Manager) from the Zambia Cashew Company (ZCC) was also interviewed.

Twenty-three (23) cashew farmers were randomly sampled for interviews as well as observational and field survey over the same area that field extension workers were targeted. Cashew plantations of the ZCC were also observed. The study involved a total of 52 respondents.

2.6 Data Analysis

After collection of all the required statistics and qualitative data, analysis categories were employed. The content of collected data was classified into appropriate categories. A "Process/Outcomes matrix" was used to organise the data. Where Process represented the implementation of activities. A "Process/Outcomes matrix" essentially refers to a table indicating the various results achieved for corresponding specific activities of extension service.

Variations in the cashew program processes (activities) and responses were sought. Through the approach of inductive analysis, patterns and categories of analysis emerged from the data and tables were developed from the analysis categories. Patterns, and categories were developed to explain variations and contrasts in cashew growing activities. Thus the content analysis of findings entailed a measurement of the primary data based on classification categories. Logical analysis was applied in

the observational survey. The findings and analysis appear in Chapters 5 and 6.

2.7 Conclusion

The verification and validation of qualitative analysis has been determined by the consistency of findings generated by different data collection methods and the consistency of the different data sources. The use of a combination of observational survey, interviewing, questionnaire and document or literature review enabled the use of different data sources to validate and cross-check field findings.

CHAPTER 3

3. LITERATURE REVIEW

3.1 Introduction

Agroforestry in the form of trees, crops and animals being jointly or simultaneously raised together on a given parcel of land, has at one time or another existed all over the world (Gholz, 1987). Traditionally, this practice, has been undertaken on small farms. However, it has now been replaced by separately managed units of large scale conventional agriculture and forestry in many of the world's developed areas.

In the Western Province of Zambia, the economic base and means of sustenance of many family units entail raising crops alongside domestic livestock such as chickens and cattle. Citrus trees such as oranges, bananas, mangoes and guavas are also grown. Although this economic base exists on a subsistence scale, it does provide potential combinations of horticultural perennials with seasonal food crops that can constitute agroforestry packages.

In general, agroforestry can combine nutrient and soil-conserving trees as well as soil improving perennials with food crops to sustain productive capacity of utilised land (Gholz, 1987, Nair, 1987 and Sanchez, 1976). Any

combination of trees with crops that leads to the efficient utilisation of soil nutrients which could not be achieved under one type of plants constitutes agroforestry. Various forms of agroforestry may offer soil protection against excessive heat from the sun, as well as wind and water erosion (Gholz, 1987 and Nair, 1987).

Top soil lost through soil erosion, unlike nutrients, can not be replenished by chemical fertilizers. However, vegetation cover can help restore the natural ingredients of the soil (Gholz, 1987). Vegetation can provide organic matter which contributes to soil formation. This, together with farmer income constraints, make biological approaches, such as the use of nitrogen-fixing trees or forest fallows, the most viable option to maintaining or regaining productive capacity of the land in areas of developing countries such as Western Province.

3.2 Agroforestry

The International Council for Research in Agroforestry (ICRAF) defines agroforestry as practices and systems of land-use whereby woody perennials are deliberately grown on the same land management unit as annual crops and/or animals (Gholz, 1987). Lundgren and Nair (1987) broadly explain agroforestry as entailing conservation of soil fertility and prevention of soil erosion.

Nair (1987), Young (Gholz, 1987), Sanchez (1976), and others present agroforestry as a major practical land management option for maintaining soil fertility and productivity in many parts of the tropics. Gholz (1987) ascribes the resurgence of interest in agroforestry to the failure of large scale agriculture and forestry monoculture in less developed countries, particularly in the tropics.

Nair (1987) outlines the various scientific activities being undertaken in relation to the enhancement of soil fertility and productivity through agroforestry. Such activities include those by the Tropical Soil Biology and Fertility Programme (TSBF), International Board of Soil Research and Management (IBSRM), International Institute of Tropical Agriculture (IITA) and the International Council for Research in Agroforestry (ICRAF).

Vergara (1987) points out that in high population density areas, agroforestry involving simultaneous and continuous cropping of annuals and perennials, performs better than forest fallowing. Nair (1987) on the other hand, cautions against use of inappropriate species of trees and poor management. These, especially in dryer environments can have negative effects on the soil and other living species.

Brewbaker (1987) notes that many nitrogen fixing tree species constitute secondary forests which are shrubs or small trees. Nair (1987) points out that, among other

things, desirable species of woody perennials can improve the nutrient economy resulting from varying nutrient absorbing zones of the root systems of the component species. This indicates that sustainability is promoted by integrated agroforestry that uses perennial species which maximise productivity.

3.3 Agriculture and Tropical Land Use

Zambia is one of the developing countries that lies within the tropics. In this regard it is characterised by a tropical climate and land features. Sanchez (1976) points out that the economies of most tropical countries are based on agriculture. Population growth in these countries is generally increasing at a faster rate than is the growth in agricultural output.

Agriculture in the tropical regions is non-homogeneous in terms of farming systems or methods and the range of crops cultivated. Tropical agriculture is characterised by shifting cultivation, settled subsistence farming, nomadic herding, livestock ranching and plantation systems. Major food crops grown in the tropics are; cassava, corn, rice, sweet potatoes, yams, sorghum, millet, peanuts, beans, wheat and ground nuts.

In the Western Province of Zambia, agriculture takes the form of settled subsistence farming combined with fallow

practices and cattle raising on mostly communally owned pastures. The major food crops are cassava, corn, bambarra nuts, sweet potatoes, sorghum, millet and pumpkins. As noted in chapter one, the poor soil and low rainfall conditions limit the range of crops that can be grown in the Province compared to other tropical areas.

Sanchez (1976) observes that variability in temperature and rainfall patterns as well as seasonal distribution is the main criterion for differentiating tropical climates for agricultural purposes. This differentiation is also enhanced by the heterogeneity of soil types across the tropics. The Kalahari sands of Western Zambia, for instance, are very unique even within the context of soils found in other parts of the country. According to Sanchez (1976), savannas are major types of vegetation, constituting 43 percent of the total area in the tropics. Despite the presence of agriculturally poor areas such as Western Province, most of the potentially arable land in the world lies in the tropics (Ibid).

Brewbaker (1987) points out that the primary limiting nutrient to crop and animal production in many tropical soils is nitrogen. This is against the background that most of the nitrogen fixing trees are largely tropical or sub-tropical in origin.

Vergara (1987) points out that many modern monoculture farms in upland forests become unproductive over time,

mainly due to soil degradation or exhaustion. Meagre capital resources of farmers in these developing countries inhibit the alternative use of chemical fertilizers. Therefore the adoption of low-cost agroforestry land-use systems to enhance soil conservation and minimize the loss of nutrients, is the most viable alternative for maintaining productivity.

Soil impoverishment results from the erosion of nutrient bearing soils and the leaching of soluble nutrients due to heavy rains. While the abundant solar radiation prevalent in the tropical countries, enhances photosynthesis, it can also result in excessive moisture loss through evapotranspiration. Tropical upland areas are also inherently susceptible to ecological degeneration. The rapid break-down of organic material, caused by high temperatures and heavy down-pours also enhances the potential loss of nutrients through leaching and run off.

Although some plants can become dormant in the dry season, the tropics do not experience periodic plant dormancy that could be caused by extreme seasonal temperature variations. However, exhaustive land-use methods have led to a decline in agricultural productivity. McCuaig and Manning (1982) note that intensive monoculture practised in modern agriculture requires ever increasing management intervention and inputs to prevent nutrient

depletion and erosion.

Moran offers a perceptive analysis highlighting positive factors of agricultural land-use in tropical Africa (Zamora et al., 1979). Moran notes that shifting cultivators practice multi-cropping that reflects differential nutrient requirements of crops, needs and available resources (Ibid). This assertion is supported by the fact that, after burning the vegetation, farmers initially plant crops such as corn, rice and millet that demand more nutrients. Root crops and plantains are later intercropped and end up providing soil cover which reduces leaching and erosion.

Rocheleau (1987) also cites the traditional practices of shifting cultivation in northern Zambia which are combined with intercropping of cereals and legumes. Such traditional land use methods are currently being improved upon with modern techniques to make them more viable. Moss and Moran stress the significance and importance of land use (Zamora et al., 1979). They assert that land use is at the centre of issues relating to rural development in Africa. Land-use together with land tenure, as explained in Chapter 4, are critical to the expansion of agricultural production.

3.4 Potential Benefits of Cashews in Western Zambia

Tree crops that have attributes of natural vegetation but can also be grown as domesticated crops, belong to an agroforestry system called agrosilvicultural systems (Nair, 1987). On the basis of this categorisation, cashews would also be classified as belonging to the agrosilvicultural systems.

Eijnatten (1984) points out that large quantities of cashew nut produce can provide farmers in western Zambia with a dependable and stable source of income. Besides income, horizontal linkages in marketing and local processing will generate employment and skills. Accumulated income can provide investible surpluses within the local communities which can be further used to improve the quality of life. Cashew trees can be raised as plantation crop mixtures with a wide range of food crops such as millet, cassava and legumes under small holder production systems. Eijnatten (1984) indicates that cashews can be intercropped with cassava.

Eijnatten further points out that Cashew trees as an agroforestry species have the potential to feature in improved fallow, multi-species tree gardens, plantation crop combinations, multipurpose trees in shelter-belts, land reclamation, or wood lots for green manure, depending on agronomical factors (Ibid). It remains, however, to

establish which agroforestry system or combination of systems is viable for the Western Province of Zambia.

On the basis of extensive explanations and illustrations regarding agroforestry, offered by Gholz (1987), Nair (1987), Onweluzo (O'Keefe, 1977), Moran (Zamora et al.,1979), Onyemelukwe (O'Keefe, 1977), and many others, one can postulate that the leaf litter and other plant parts of cashew trees, can increase the organic matter content of the soil in cashew growing areas of Western Province. Since performance is more positive and self sustaining when innovative practices are developed from existing local practices, the potential extension of on-going cashew schemes into land conservation mechanisms would be most appropriate.

3.5 Extension Services and Small Scale Farmers

Agricultural extension services play a vital role in disseminating innovative methods of farming and animal husbandry to small scale farmers in developing countries such as Zambia. Dillon points out that small scale farmers generally operate on a restricted resource base (Valdes et al., 1979). This assertion is valid in the sense that small scale farmers have limited access to land in comparison to commercial farmers.

Fragmented pieces of land that small scale farmers own in Western Province, for instance, are allotted according to traditional custom and are not encompassed by the common law practised in the country. Consequently small-scale farmers unlike commercial farmers do not have title deeds on their pieces of land. Due to lack of finances, small-scale farmers have access to land that is less fertile than that accessible to commercial farmers. Small scale farmers also lack the financial means with which to secure the necessary farming inputs such as farm implements, seed/seedlings, pesticides and hired labour. Above all, they do not have the appropriate modern technical know how with which to enhance their production effort.

Rocheleau (1987) highlights the need to incorporate the perspectives of farmers in agroforestry research and development. In this vein some progress might be achieved if innovative cropping systems being envisaged for small scale farmers in Western Province would, among other things, reflect the perceptions of farmers.

Hazell observes that the design of technologies intended for use by small scale farmers must take cognizance of the fact that the farmers themselves should be able to pay for and utilise the innovations (Valdes et al., 1979). Vergara (1987) also expresses a similar position, by asserting that agroforestry techniques are more likely to be adopted by farmers if the perceived benefits can outweigh

the comparative risks involved. Extension services can convey agroforestry, through illustrations to farmers, as a viable land-use technique with minimal or negligible risks. Such illustrations can include field demonstration plots.

3.6 Conservation and Development

The essence of orienting farming practices to systems that can help conserve the versatility of the land is rooted in the goal of sustaining productivity of the land which in turn can ensure development. Onweluzo and Onyemelukwe note that vegetation cover including forests, protect the soil from evaporation and desiccation by enhancing the maintenance of water table levels (O'keefe, 1977). This, together with the protection against wind erosion provided by forests, has helped to offer protection against desertification. On the other hand flooding caused by tropical storms is usually worsened by abnormal surface run-offs which are facilitated by the extensive removal or absence of vegetation cover.

Andreae (1980) notes that the overuse of soils under a one-year-one-crop system in tropical regions leads to diminishing marginal returns in terms of yields per acre of cultivated land. In the long run the input-output ratio becomes progressively more unfavourable and economically unprofitable.

Dressler (1985) points out that decaying plant material is mostly the main source of mineral nutrients for tropical soils. Tropical trees absorb nutrients and reincorporate them into the vegetation, through their well developed root systems. This implies that forestry or at least the elements of forestry need to be part of the development package for rural areas such as Western Province.

Dobereiner (1977), Onyemelukwe (O'Keefe, 1977), Onweluzo (Ibid), and Hazell (Valdes, 1979) assert that properly planned crop rotation can generate necessary nitrogen inputs through biological fixation, thereby ensuring soil improvement with relatively low investments. This literature also points out that research on reforestation indicates that soft and hard wood legume species can help in both nitrogen fixing and recuperation of eroded soils. Trees and woody perennials on farmlands can slowly improve the physical condition of the soil such as permeability, temperature and drainage.

Gholz (1987) points out that as long as fossil fuel energy is still abundant, the highly productive and profitable mono-cultures are unlikely to be replaced. This is essentially because the abundant availability of fuels such as petrol and diesel together with chemical fertilisers enables the continuous undertaking of separately managed large crop farmlands. Gholz further indicates that in areas where fossil fuel is not readily available and soils have

been degraded, increasing reliance on tree-crop-animal mixtures or agroforestry is inevitable (Ibid). However, it is important to recognise the fact that in many areas such as Western Province such inevitability can only come to bear with some form of intervention. This is so because the necessary awareness regarding the potential and constraints can only be effectively incorporated in extension services when such potential and constraints are systematically articulated. This is essentially what this study attempts to accomplish.

Rocheleau (1987) mentions that the range of technology and management options chosen for natural resource conservation, are determined by the relative value that the local people attach to soils, water, labour and different land uses. For instance, in areas where the farmers can earn high off-farm incomes, labour intensive conservation practices may not be easily adopted. This implies that factor-use and availability should be taken into account in any agroforestry system envisaged for a particular area.

Eisenberg (Gholz, 1987) and Harris (Ibid) highlight the potential role of agroforestry as an intermediate land-use system falling between natural forest management and plantation agriculture. Such a system can maximize bio-diversity while simultaneously offering directly useful products to human beings.

Rocheleau (1987) points out that in circumstances where local motivation or subsidies are not high enough to offset local investments and opportunity costs, long-term conservation strategies should be tied to practices which can yield immediate short-term benefits to local participants. From this perspective it can be viewed that potential incomes derived from cashew nuts both in the short-term and long-term offer a viable incentive for the pursuit of cashew agroforestry.

3.7 Conclusion

There is substantial literature that dwells in detail into the issue of agroforestry. However, literature dealing specifically with cashew trees (*Anacardium occidentale L.*) and their cultivation or cashew nuts is limited in terms of quantity and scope. Much of the literature is in form of short articles that deal mainly with cashew agronomy, ranging from cashew breeding to plant protection. This is particularly true in comparison to literature on annual crops such as corn (*Zea mays*). Within the realm of either trees and tree crops or agroforestry there is still a lot of scope for scholarly research pertaining to cashews. There is need for more literature that focuses on cashews as a tree species or a crop that can be integrated in multi-cropping systems.

Regarding the prevalent shortfalls in agroforestry literature, Gholz (1987) observes that most research in agroforestry has tended to be highly descriptive and/or empirical (Gholz, 1987, 6). Thus if agroforestry is to have a more positive impact on natural resource conservation and sustainable development, more attention should focus on processes and principles as well as linkages of agroforestry systems to immediate human needs. It is in this context that this study attempts to fill some of these gaps by exploring the potential benefits of cashew trees with regard to agroforestry in the Western Province of Zambia. It also examines the potential and constraints pertaining to the pursuit of cashew-based agroforestry in the Province.

Finally, this study subscribes to the popular view advanced by most of the literature that conventional methods of agricultural land-use have upset the mineral and nutrient balance through over use and misuse. It is possible, however, to restore this lost 'mineral and nutrient equilibrium', through appropriate methods of soil conservation and land management such as agroforestry.

CHAPTER 4

4. MAJOR RESOURCE BASED SECTORS

4.1 Introduction

This chapter discusses the major sectors of economic activities with regard to the available natural resources in Western Province. The aim of the chapter is to put into context the resource-environment within which the cashew industry is being developed. The circumstances under which major activities of sustenance are carried out, do impact upon cashew growing and development activities. The chapter is not exhaustive in dealing with these circumstances. It merely attempts to provide some insights into the main issues and problems involved. Facts and specific figures in this Chapter, unless otherwise indicated, are mainly obtained from the Environmental Profile for Western Province, Zambia, edited and principally authored by Dr. Hein Van Gils (1988) of the International Institute for Aerospace Survey and Earth Sciences, The Netherlands.

4.2 Agriculture

Agriculture in Western Province is mainly agro-pastoral in nature. Traditional herds of cattle are raised by

households which also grow cultivated crops.

4.2.1 Subsistence Farming

Crop production is predominantly for subsistence. The majority of the population is rural based. The Zambezi flood Plain has been the major area of subsistence farming. Although the scale of production and methods of cultivation are at a subsistence level, surpluses are sometimes realised during production periods that are accompanied by favourable weather. Surpluses normally lead to commodity exchange transactions, between fish and crop produce such as cassava, millet and sorghum. However, transactions involving money are the main form of commodity exchange.

Overall, agro-ecological conditions in the Province place limitations on agriculture. There is a very narrow range of crops that are suited to the sandy terrain. The sand soils (also known as Barotse or Kalahari sands) found in much of the Province are poor in nutrients. The rainfall patterns are erratic, and accompanied by drought in some years. Only a few crops such as cassava, sorghum and bulrush millet are cultivated in much of the Province.

Staple food crops include cassava, sorghum, bulrush millet, maize, sweet potatoes, pumpkins, vegetables and bambarra nuts. Although maize (corn) is the most preferred starch staple crop, these other crops also form an important food base. These subsistence crops are intercropped and

rotated in some of the fields, depending on the preferences of individual farmers.

4.2.2 Commercial Farming

Commercial farming is very limited in Western Province. The vast sandy soils which are poor in essential nutrients have been a major disincentive to commercial farming. Establishing standard commercial productivity in the sandy soils requires an extensive application of a combination of manure and chemical fertilizers. Regarding the deficiency of nutrients in the sandy soils of Western Province, Gils points out that, "Because of the low soil pH and low Cation Exchange Capacity (CEC) the application of the most common nitrogenous fertilizers in Zambia (ammonium nitrate, urea) has an acidifying effect on the soil, which could result in aluminium (Al) toxicity and/or increasing the phosphorus (P) deficiency. Liming to correct the low soil pH may lead to deficiencies of phosphorus, magnesium, zinc, copper and/or boron due to the low CEC. An adequate approach to fertilizing Barotse sands would be to combine cattle or green manure and chemical fertilizers" (Gils, 1988, 21).

However, small and medium scale commercial farming is concentrated in the north eastern segment of the Province covering Kaoma and Lukulu districts (see Figure 4). This area has relatively better soil conditions and more reliable patterns of rainfall. Major commercial crops in this area

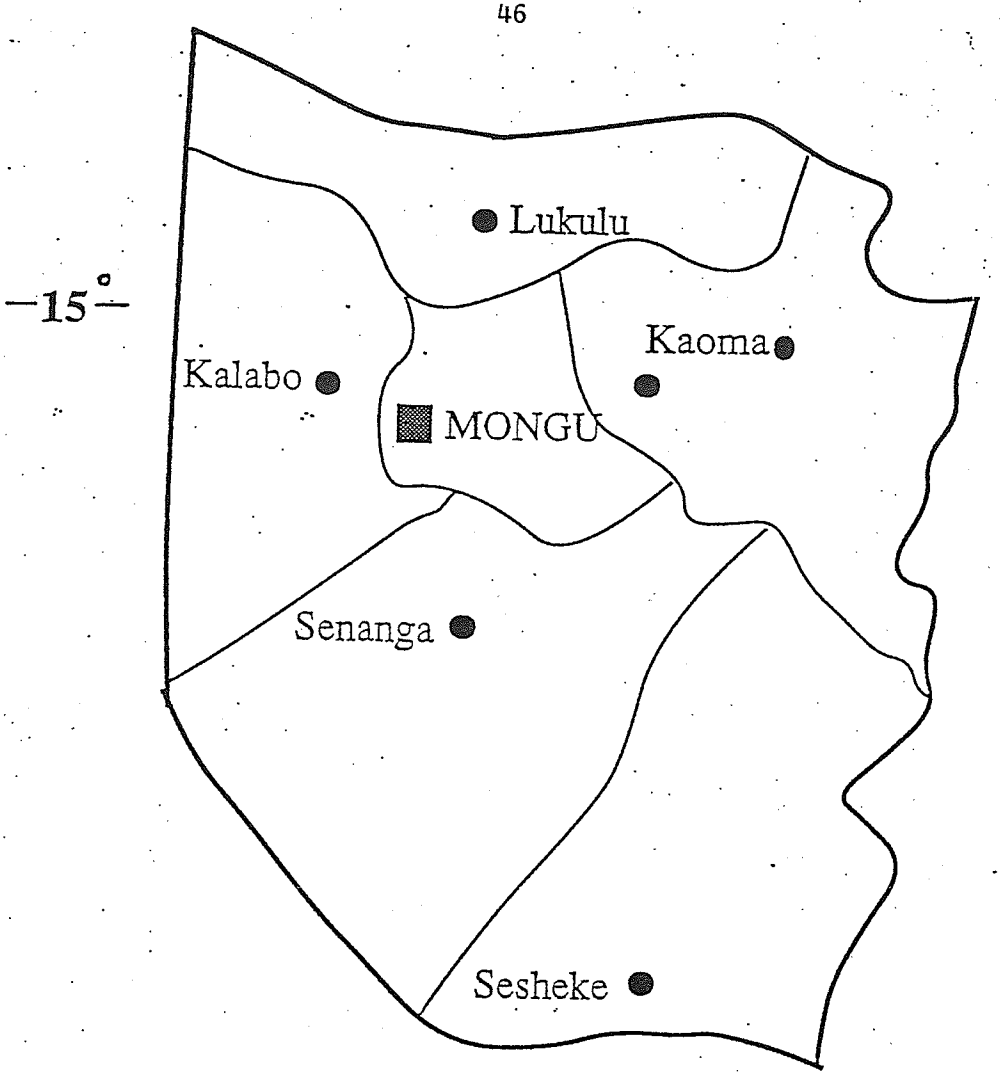

Figure 4
Western Province, Location of Districts

are: maize, cotton, soy bean, paddy rice and tobacco.

The eastern segment of the Province covering Kaoma and Lukulu districts, has soils that range from sandy loams to clay loams. These soils are partly more reddish and more fertile, having higher nutrients and trace minerals and Cation Exchange Capacity (CEC). They react more positively to fertilizer application. They constitute a total of 100,000 ha out of which only 10,000 ha is currently cultivated (Gils, 1988).

4.2.3 Suitability for Specific Crops

Within the Province, Kaoma and Lukulu districts have economic advantage in maize production. Senanga, Sesheke, parts of Mongu and Kalabo districts have economic advantage in the production of sorghum, millet and cassava (NCDP, 1989). Cashew nuts have also been found to perform well in Mongu, Kalabo, Lukulu and Senanga districts. In practice; cassava, sorghum, bambarra nuts and millet are grown all over the Province. The areas where these crops are grown also tend to be suitable for cashew growing except in places that are prone to frost. Water logged soils are not favourable to cashew growing. Cassava, sorghum, bambarra nuts and millet are also not cultivated in water logged soils.

Based on production figures, Kaoma contributes about 60 percent of the marketed total Provincial maize output (Ibid) (see Table 1). Paddy rice, on the other hand, can be grown

TABLE 1

ESTIMATED PRODUCTION OF MAIZE IN WESTERN PROVINCE: 1980-1987, IN 90 KG BAGS

Year	Districts						
	Kalabo	Kaoma	Lukulu	Mongu	Senanga	Sesheke	Total
1980	3540	39000	4020	15960	10899	10000	83419
1981	4800	84970	4450	15931	13426	20898	144475
1982	3646	51840	5750	15140	12845	12900	102121
1983	3477	70665	4500	17001	12664	9369	117676
1984	3780	105948	6865	23682	13294	128011	281580
1985	14527	124003	10089	24394	10100	24264	207377
1986	17049	131083	10337	26794	9482	30829	225574
1987	15747	111926	12356	19212	17079	24912	201232

Source; NCDP, (1989).

successfully in Mongu, Kalabo, Senanga and Kaoma. As a result the Western Province contributes about 18 percent of the total national production of rice (Ibid). The potential for rice cultivation in the Zambezi flood plain requires appropriate water management methods to utilize the flood waters for farming. This vast Flood plain together with the dambo areas (land depressions with pockets of water and grassland), are very suitable for rice growing.

4.2.4 The Cattle Sub-Sector

The traditional cattle industry is the mainstay of the Province's economy. The role of cattle in the local economy is to supply animal traction, manure, milk, beef, security , investment, cash income, dung as fuel, hides and horns for making curios. Animal traction is used in the form of draught power for ploughing and transport (see Figure 5).

The total herd of cattle is estimated at around 500,000, comprising 20 percent of the national herd (Gils, 1988). The Western Province accounts for 25 percent of annual sales of traditionally raised cattle in the country (NCDP, 1989). Traded cattle in the Province is estimated to be only 4.5 percent of the total herd (Ibid).

Most of the cattle is raised in the Zambezi flood plain and areas around the edges of the Flood plain. This area has about 310,000 herds of cattle or about 65 percent of the total cattle in the Province (ARPT, 1990, 24). According to Schultz (1976), 43 percent of farmers, in this area of about 240,600

Figure 5

Oxen are used extensively as draught power, including delivering cattle manure to cashew estates (Cashew estate, north-east of Mongu - July, 1991)

inhabitants, own cattle (ARPT, 1990, 11). Land cultivation in this area is combined with wide spread use of cattle manure.

The annual floods in the Flood plain limit the grazing period there by providing a natural check against overgrazing (see Figure 6). When the Zambezi plain gets flooded, the people move to the uplands with their livestock, preceded by a ceremony called Kuomboka. This occasion is the movement of the Paramount chief (Litunga) from the palace in the Zambezi plain (Lealui) to the palace in the uplands (Limulunga).

The uplands generally have low grazing capacity of about 20 ha per herd of cattle (Gils 1988). A herd of cattle has an average number of 16 animals (ARPT, 1990). Given this low grazing capacity in the uplands, cattle experience energy deficiency during the flood season. The cattle do not receive adequate supplies of nutritional requirements as a result of poor grazing resources.

Some households carry out stubble grazing of crop fields for the sedentary cattle. Consequently when dry-land cereals offer low yields as a result of unfavourable rainfall distribution, cattle productivity also slightly declines. Problems of low fertility and high calf mortality rate, which is about 25 percent, have undermined the potential of the cattle industry (NCDP, 1989). Poor management practices, disease outbreaks and poor nutrition during the dry season, or flood season in the case of the flood plain, are the causes of low fertility and high mortality rates.

Figure 6

Floods recede from the Zambezi flood plain after having imposed a 3-5 months natural break on cattle grazing (June, 1991)

According to the Adaptive Research and Planning Team (ARPT), if cattle numbers will continue to grow at the present rate of 3 percent, the level of maximum grazing capacity will be reached by the year 2020 (ARPT, 1990). Given the uneven distribution of people and animals, certain localities become overgrazed much quicker than other areas. Overgrazing by cattle alone in the uplands is unlikely to lead to desertification or soil erosion. It is more likely to result in the disappearance of certain grasses and in an increase of some woody species. This is because sandy soil is not susceptible to trampling. Overgrazing will exhaust the browse whereas vegetation such as some woody species that are not palatable to cattle will be able to thrive.

4.2.5 Land Tenure

Zambia has a dual law and court system. Statutory law is applicable to State land (Crown land), while customary law is applicable in Reserve areas or land under the jurisdiction of Traditional Chiefs. State land includes areas under the jurisdiction of District councils. Historically, land in the Western Province belonged to the Lozi King (now Paramount chief) through the Lozi royal establishment. During British colonial rule, the legal authority over land of the Royal establishment in Western Province was formalised through legislation. The Barotse Native Courts Ordinance Act (1939) granted overall power over land in the Western Province to the

Litunga (the Paramount chief) (Gils, 1988).

Under customary law, control and access to or ownership of land are allocated by the Paramount chief and his councillors. Land ownership is inheritable but can not be sold or mortgaged. Land can also be leased out but not for a reward. Land ownership also includes rights of production. Different "rights of production" such as picking of fruit, grazing of cattle and catching of fish in lakes and lagoons are attached to the same parcel of land and subject to rights vested in different persons at various times. Land ownership is allocated according to individual needs and social status.

After achieving independence from the United Kingdom in 1964, the Zambian government started reforming laws that pertained to land tenure in the entire country. The Western Province Act (1966) repealed the Barotse Native Courts Ordinance Act (1939) and converted the Province into Reserve land. The Land Tenure Act (1970) stipulates that all the land in the country is vested in the President and belongs to the State. However, customary law still prevails in matters concerning land rights in Reserves. The Subordinate Courts Act (section 16) and the Local Courts Act (chapter 54, section 12) provide for the application of customary law in Reserve land, "as long as such law is not repugnant to natural justice of morality or incompatible with provisions of any written law" (Gils, 1988, 33). Hence customary law is subordinate to statutory law.

Due to the influence of the market economy, eroding traditions changing land-use, moral values and institutions, legislation in Western Province is in transition from a customary towards a statutory system. The evolving subordinate nature of customary law, enacted through legislation indicates the shift in emphasis towards statutory law. The Land Conversion of Titles Act (1975) placed all the land in Zambia, including Western Province, under the President, thereby reinforcing stipulations of the Land Tenure Act of 1970 (ARPT, 1990).

Despite the stipulations of current legislation regarding land tenure, customary laws are still firmly established in Western Province due to its special status, autonomous history and strongly centralized traditional law and court system. According to the Environmental Profile (Gils, 1988), national laws pertaining to the environment such as the Land Tenure Act (1970), the Land Acquisition Act (1960) as well as the Land Reform Act and the Township and Country Planning Act (1979) have not been enforced in Western Province. Other laws such as the National Parks and Wildlife Act (1971), the Forest Act (1974), the Natural Resource Conservation Act (1970) and Water Act (1971) are only partially applied in Western Province.

Given the dominance of customary law in the Western Province, land appropriation and ownership is still largely based on the traditional land tenure system. There is no legislation that provides for the award of land title deeds

through customary law or the traditional land tenure system. Land allocated by the Paramount chief and his Councillors can not easily be converted into leasehold status thereby constituting a basis for collateral security.

4.2.6 Agricultural Credit

Lima Bank is the only financial institution in the Province that offers credit to both commercial and non commercial farmers. The Western Province Cooperative Union (WPCU) also offers some form of agricultural credit to small scale farmers who are members of the Cooperative Union. Lima Bank, a parastatal (Crown Corporation) bank, and the Cooperative Union are the only sources of credit for non commercial farmers in the Province. Farmers who grow cotton also have access to loans offered by the Lint Company of Zambia Ltd. (LINTCO), also a parastatal institution. Farmers who grow tobacco can receive credit from the Tobacco Board of Zambia (TBZ).

All credit received by small-scale farmers is not in form of cash. The credit offered to farmers is in the form of inputs such as seed and chemical fertilizers. Thus the credit can not be offered in form of cash which can be used to meet other farming costs such as land preparation, purchase of pesticides or for hiring labour. The credit is not available in monetary terms due to the risk of funds being diverted to other purposes different from those targeted by the loan

schemes. In Kaoma district, the Cooperative Union also offers loans in form of oxen, ploughs and scotch carts. The loans from all these institutions are repaid either in form of harvested produce or in the form of cash.

Lima Bank has been allocating an average of 31 percent of the total loan requests in Mongu, Senanga Sesheke and Kalabo districts (NCDP, 1989, 759). However, over the years, from 1979 to 1987, Kaoma district has been allocated more funds than the requested total annual amount (Ibid). This trend clearly illustrates the bias toward promoting maize production. Crops such as millet and cassava are not even considered for credit provision.

4.2.7 Agricultural Marketing

Agricultural marketing is conducted by private traders and institutional organizations such as the Western Province Cooperative Union Limited (WPCU) and the Zambia Cold Storage Company (ZCSC). The WPCU was established in 1980. It operates as a multi-purpose organization involved in a variety of activities that include the marketing of agricultural produce and distribution of inputs. The WPCU is also involved in the buying and selling of cattle.

The ZCSC is a parastatal organisation that specialises in the buying of cattle and beef marketing. It buys animals from farmers and process it at its meat processing plant in Mongu. The bulk of the beef is sold to consumers in the urban areas

of the Copper-belt and Lusaka. By 1989, the Province had forty-one marketing depots with a total storage capacity of 39,400 mt of grain. Extra sheds to store approximately 14,000 mt of grains were still required (NCDP, 1989).

4.2.8 Major Constraints Faced by the Agricultural Sector

Small scale farmers in Western Province are widely dispersed over large geographical areas in clusters of farming communities. Servicing these communities from district centres in terms of rendering technical advice and supplying inputs is quite challenging on the part of the government. There is lack of logistics such as transport facilities required for these activities. Therefore inputs such as seeds and fertilizers are delivered late or not at all in many of the communities. Poor road conditions, many of which are impassable during the rain season, combined with lack of vehicles result in crop wastage. Harvested crops are not hauled in time to storage sheds, from where they are normally marketed. The larger distances between district centres and many of the farming communities hinder access to credit because credit officers do not reach these farmers.

The dominance of customary law in the land tenure system continues to hinder the expansion of agricultural production. The traditional tenure system does not favour commercial agricultural production. The plots of land allocated under traditional tenure are small and fragmented thereby only

enabling subsistence agriculture or semi-commercial agriculture. The absence of title deeds on land ownership precludes the use of land as collateral security for access to credit.

4.3 Forestry

4.3.1 Forest Composition

Three quarters of Western Province, equivalent to 9.4 million ha is wooded land due to the fact that Kalahari sands favour tree growth (Gils, 1988). By 1987, there were 346,722 ha of Forest Estates (Ibid). Seven percent of the wooded area, or about five percent of the total surface area of the Province belongs to the Forest Estate or is Forest Reserve Land. Forest Reserves are protected Local Forest areas under the Forest Act (1974). Local Forest and National Forest constitute the Forest Estate. The distinction between National and Local Forests has no legal consequences. Local Forest and National Forest or Forest Estates are areas where logging and firewood collection are controlled and have to be licensed by the Forest Department. In the open areas outside the Forest Estate only charcoal burning and commercial logging have to be licensed but non-commercial uses are free of charge.

Forest patterns relate to drainage patterns. Forests or woodlands on uplands close to valleys and flood plains are

different from those on the water divide plains. The water divide plains are areas that form a boundary of two drainage systems. Due to the variation in climate the drier southern parts of the Province have deciduous Miombo trees while the more humid and less frost-prone northern parts have the evergreen Mukwe.

The composition of different tree species is diverse within the context of savannah woodlands. The Zambezi teak or mukusi (*Baikiaea plurijuga*) is the most important hardwood timber resource in Zambia. Important timber trees of Zambia such as Zambezi teak, mukwa (*Pterocarpus angolensis*) and muzauli (*Guibourtia coleosperma*) all occur only on the Kalahari sands of the Western Province (Gils, 1988).

4.3.2 Uses of Forestry Products and Forest Lands

Wooded areas close to settlements are mainly sources of fuel-wood, herbs, and poles. These areas are also used for shifting cultivation of mostly cassava and bulrush millet. Cassava takes about 1.5 to 3 years before harvesting. Although the full bush/woodland regeneration cycle requires about 30 years, bush fallow under shifting cultivation is as short as 3 to 6 years in forests closer to main settlements (Ibid). However, the overall use of the forest area is relatively light. According to the Environmental Profile for Western Province, less than two percent of the forest areas is used for crops at any particular period (Gils, 1988). The

shortening of the bush fallow cycle, poses a relatively more serious threat to forest regeneration than sheer expansion of agricultural activities.

Apart from shifting cultivation, forest lands also supply the local populations with a wide variety of fruits during the rain season (October to April). During this season, mushrooms are abundantly available in the forests. Fruits and mushrooms are an important supplemental source of nutrition for the local population.

The collection and distribution of fruits and mushrooms is carried out within the context of the informal sector. The collection and management of other forestry food products such as honey has been partially integrated into the formal sector. Forestry operations of the Department of Forestry, such as forest extension services, have been integrated with bee-keeping activities. Frame and bark hives for producing honey and bees wax, for the local market have been established in all the six districts of Western Province.

4.3.3 Commercial Timber Exploitation

Timber logged in the Province is mostly sold to the urban centres of Zambia as sawn-timber. Sawn-timber is used both locally and outside the Western Province as building material and for furniture-making in carpentry workshops. Mukwa (*Pterocarpus angolensis*) is used extensively for house buildings, handcrafts and also as premier furniture-wood used

for cabinet-making, boat-building, plywood, veneers and parquet-flooring (Department of Forestry, 1985). Commercial exploitation of other available hard wood timber trees such as muzauli (*Guibourtia coleosperma*), mubako (*Erythrophleum africanum*), mubombo (*Brachystegia boehmii*), mwande (*Afzelia quanzensis*) and mutuya (*Brachystegia spiciformis*) has not been fully developed. Commercial timber activities centre around the harvesting and marketing of Zambezi teak or mukusi (*Baikiaea plurijuga*). Zambezi teak is used at national level and also exported. There is over exploitation and illegal harvesting of both Zambezi teak and mukwa tree species.

The development of commercial uses of alternative hardwoods could minimize the over exploitation of the teak and mukwa forests. Due to the absence of wood processing industry in the Province, some of the finest hardwoods have not been fully exploited. The Province has only a single wood processing plant, Mulobezi saw mill in Sesheke district. If there were other wood processing plants that could utilize much of the abundantly available hard woods, other than only the Teak or Mukwa trees, pressure on these species could be reduced. Currently treated timber for construction purposes has to be purchased from the urban centres outside Western Province.

The Environmental Profile for Western Province, indicates that the annual exploitation rate of Zambezi teak is 20,000 m^3 (Gils, 1988). At this rate, it is estimated that by the year

2,000 the teak timber resource would be depleted (Ibid). In this regard it can be asserted that the forest management practices for the exploitation of Zambezi teak are not sustainable. There is need for measures that will reduce over dependence on Zambezi teak and mukwa so as to enable these tree species sufficient time to regenerate.

4.3.4 Forest Management Approaches

Over the years, since about the mid-1970's, there has been recognition on the part of the government of the ever increasing human pressures on forests. To reduce pressure on the natural forests in the Province, the Forest Department is undertaking activities of establishing eucalyptus plantations in all the six districts of the Province to meet local demand for fuel wood as well as construction and building poles. According to the 1991 first quarterly Report of the Forestry Department, a total of 410.2 ha of eucalyptus plantations have been established in the Province (Department of Forestry, 1991).

Each of the six districts has a nursery for raising tree seedlings which are later sold to the public as well as supplying the plantations of the Forestry Department. The Departments of Forestry and Agriculture have jointly facilitated the establishment of village/schools woodlots. Current plans include the planting of additional woodlots.

The Forestry Department has also established a commercial

timber treatment plant and a pole seasoning shed at Kaande forestry station in Mongu. The plant mainly treats eucalyptus poles meant for building and fencing purposes.

4.3.5 Major Constraints Faced by Forest Management

One of the major constraints confronting forestry management is the expansion of human activities in the forest areas. This expansion disturbs forest regeneration. Up to fifty percent of the forest area can be in the forest generation phase (Gils, 1988). Virgin forest is hardly available even outside the regeneration areas, due to shifting cultivation of cassava and millet, fuel-wood harvesting, burning, logging and general tree cutting and uprooting for various purposes ranging from medicinal and recreational needs to local construction. There are no regulations to control shifting cultivation or shortening of fallow periods. Damage by animals, specifically cattle, is a major constraint to the regenerative capacity of the teak forests.

One of the constraints faced by the Forestry Department is the lack of wood preservatives (creosote) for treating poles to protect them against destruction by termites and white ants. There is need of greater financial support for the timber treatment plant as part of the general objective of promoting rural development. Inadequate water supply and poor germination of seed are also constraints to the development of plantation forestry.

Targeted goals in terms of expansion of tree plantations, increasing tree seedlings, establishment of local woodlots, monitoring and patrolling, as well as provision of extension services; are not met mainly because of lack of funding and equipment. Equipment needed include; ploughing implements, timber harvesting implements as well as fire fighting equipment. Inadequate transport and manpower are also a major constraint in ensuring effective forest protection and management. The problem of manpower is illustrated by the fact that, on average, a single range guard is responsible for monitoring and managing about 10,000 ha of Forest Estate (Department of Forestry, 1991). The responsibilities of Forest range guards include conducting early burning. Due to lack of transport only limited patrols are conducted on foot, or by bicycle in some cases.

Other factors contributing to the increase in illegal forest extraction in the Forest Estates include lack of knowledge among the public regarding the regulations and existence of Forest Estates. The other major reason is that fines for respective offenses are very low. The fines for offenses as well as fees for licences were first set in 1974 by the Forest Act (Gils, 1988). The fees, fines and prices for timber produce were only subsequently reviewed in 1988 (Department of Forestry, 1988). Replanting after logging is not obligatory. Given the need to redress these factors which undermine forest management, the Forest Act should be updated

to make it more effective. As Gils (1988) points out, there is need for data inventory on timber and fuel-wood as well as a land-use plan to help avoid resource depletion.

4.4 Fisheries

4.4.1 Fish Output

The Fisheries industry is one of the most important sectors in Western Province. Between 1983 and 1988, the amount of harvested fish increased from an annual total of 800 mt to about 4,800 mt per year (NCDP, 1989, 761). This represents a 4,000 percent increase spread over a five-year period. Based on information from the Environmental Profile for Western Province, about 22.5 percent of the harvested fish is sold outside the Province (Gils, 1988). The peak of the fishing activities is during the dry season from around May to October.

The Environmental Profile for Western Province, states that on the basis of analyses of individual catches and interviews with fishermen and fish consumers, the total fish catch is estimated to be 7,000 mt per year (Ibid). The total potential catch or optimum economic yield, in the Flood plain in Western Province excluding lakes and other water bodies outside the Flood plain, is about 15,000 mt per year (Ibid). This is based on a model for predicting yields of fisheries in flood plain areas of tropical regions. This model gives

between 40 kg and 60 kg of fish per year per ha inundated area. The central Zambezi flood plain, in Western Province, has a maximum inundated surface of 5,000 km^2. Applying the stated formula deducted from 25 tropical flood plains, the central Zambezi flood plain gives a yield of approximately 22,000 mt per year. Correcting for the low nutrient content of the water, especially phosphorus, low pH, the marked cold water season and the fact that in some years the Flood plain is not completely covered by water, a resulting estimate would be between 12,000 and 15,000 mt per year (Gils, 1988, 27). More than 80 percent of the fish catch is bream type.

4.4.2 Fishing Methods

Fishing is essentially done on a small-scale basis along the Zambezi flood plain and on selected tributaries as well as accessible lakes. The Flood Plain is approximately 240 km long and about 5,000 km^2 in total surface area (Ibid). More than 75 percent of the fish catches, mainly of bream type are caught with gill nets. The gill nets are set overnight in standing water of rivers and lagoons. Ring and draw nets are also used, mainly for catching bream. Drift nets are used for capturing tiger fish.

A wide variety of traditional methods such as spears and baskets are also used. Fishing activities ranging from the catching of fish to fish marketing are mainly part of the informal sector. Except for the price regulation at

established market centres, most of the activities are not controlled or monitored by government institutions. The land and water bodies from which fishing is done fall under the jurisdiction of customary laws. Fishing rights of individuals or families for most of the lagoons and smaller lakes were granted long ago by the paramount chief (Gils, 1988). The Environmental Profile for Western Province, further indicates that the customary land tenure system has contributed to keeping the catches low and, simultaneously, to conservation of fishery resources (Gils, 1988). This is basically because the tenure system restricts fishing access to some water bodies to only those individuals permitted through the existing fishing rights. These restrictions to fishing and the small-scale nature of fishing operations have placed limitations on the total amount of harvested fish.

4.4.3 Linkage to Other Sectors

In most cases, fishing is a part-time endeavour undertaken by crop and livestock farmers residing in the Flood plain and around other tropical water bodies. To a large extent fishing is a seasonal activity which reaches its peak during the cold season months from May to July, when the floods start to recede. From about August to April fishermen partially or completely engage in subsistence farming and a wide variety of other informal activities.

Cattle rearing and fisheries are complementary in utilization of the Flood plain. Part of the Flood plain vegetation is converted by cattle into readily dissolved organic and mineral nutrients thereby enhancing fisheries (Gils, 1988). Fish farming is being taken up on the uplands, particularly in Kaoma district. By 1989, a total of about 8 to 10 ha of fish ponds were already under production in Kaoma (NCDP, 1989, 762). The fish ponds are in small units established for subsistence means by small scale farmers.

4.4.4 Major Constraints Faced by the Fisheries Sector

Land tenure and fishing rights as explained in Sections 4.1.5 and 4.3.2 have hindered the full exploitation of fisheries in the Flood plain, but at the same time, kept exploitation within sustainable levels. Commercial scale fish harvesting can not be undertaken in most of the water bodies where fishing rights belong to individuals or families. As a result of the dominance of the customary fishing rights tenure system, many lagoons and lakes are not fished while some are under-fished. This is illustrated by the fact that while the potential catch in the Flood plain alone, is estimated to be about 15,000 mt per year, the total fish catch in the Province is estimated to be only 7,000 mt per year.

Inadequate facilities such as transport also undermine fisheries extension work. There is poor enforcement of controls on the minimum mesh size,of 75 mm mesh size for a

net, allowed by the Fisheries Act (Gils, 1988). Many fishermen fish with 38 mm to 50 mm mesh size, thereby catching tiny fishes (Ibid). This undermines the long-term productive base of the fisheries by eliminating the young fishes before they reach a productive stage when they can replenish the fish stocks. Fishing is free of charge and is not licensed. Besides foregone public revenues, controls and regulations become difficult to enforce in the absence of licences and fees. There is also poor monitoring of the fish population and changes in some of the factors that can significantly affect fish yields. The overall net effect of all these factors has been the under-utilization of the potential of the fisheries industry.

4.5 Wildlife

4.5.1 Composition of Wildlife Resources

Presently there are two national parks in the Province, namely: Sioma-ngwezi National park (527,600 ha) and Liuwa plain National park (366,000 ha) (Gils,1988) (see Figure 7). Other areas outside the game parks such as the Luena flats and the Game management area also contain wildlife resources. The west bank of the Zambezi river constitutes a large Game Management Area (GMA), covering 3,807,000 ha (Ibid).

During the 1800's Western Province contained large numbers of wildlife of different species ranging from birds to

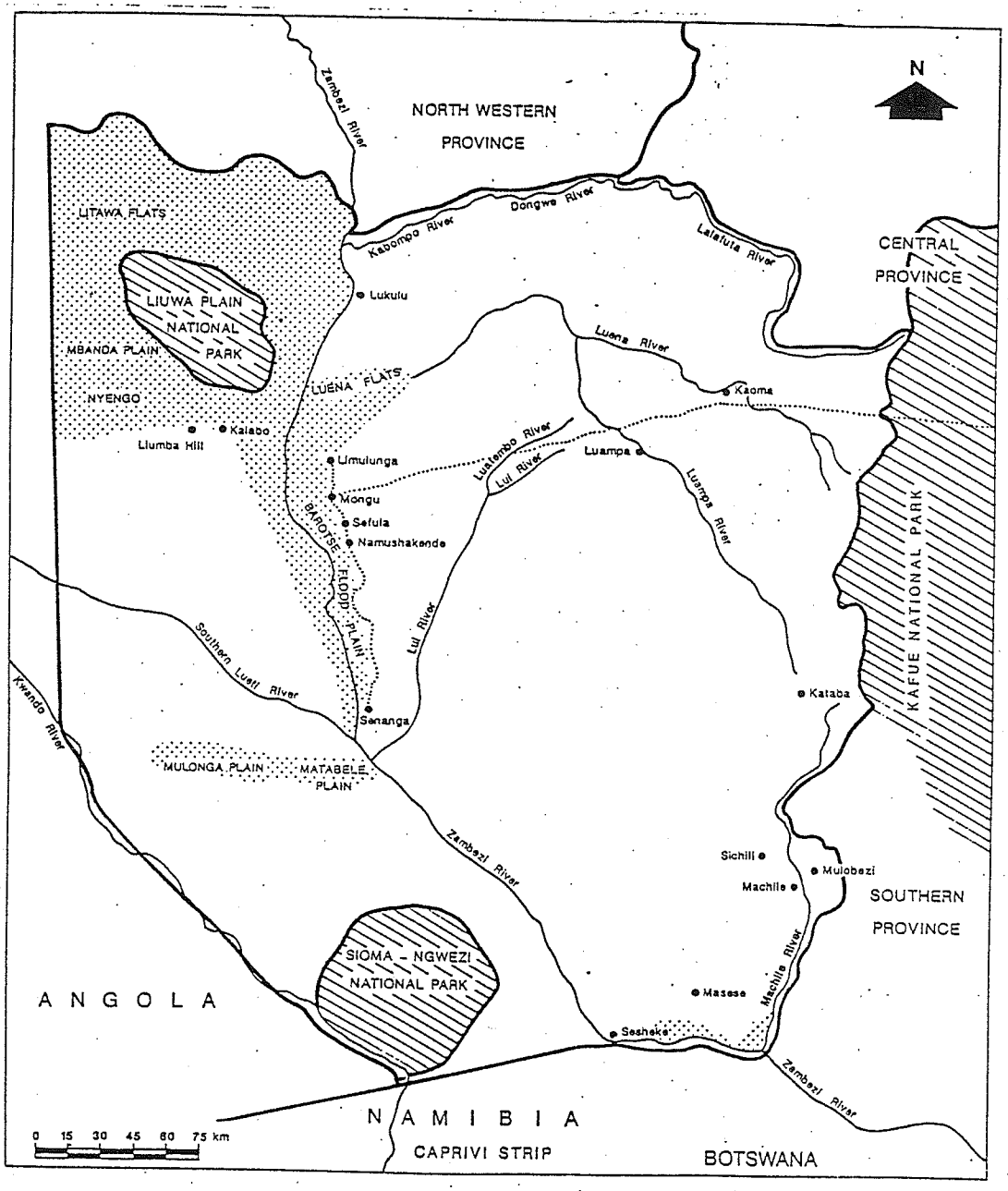

Figure 7

Western Province, Game Parks and Rivers

animals. However, wildlife resources have been declining since the middle of the 20th Century. Wild animals such as elephants and red lechwe now occur only in relatively small numbers.

Available large animal species include; elephant, hippo, eland red lechwe, giraffe, buffalo, kudu, tsebe-sebe, sable antelope, roan antelope, reed buck, lion oribi, baboon, vervet monkey, leopard, cheetah, hyena and zebra. It is estimated that there are about 20,000 wilde-beest and 3,000 red lechwe in the Liuwa Plain National Park (Gils, 1988).

The Liuwa plain National park has wetland habitat that is abundant in waterfowl such as pelicans, egrets, ibis, marabous, geese herons, cranes, etc. These same species are also abundant in the Zambezi flood plain.

4.5.2 Potential for Tourism

The National parks in the Province are too remotely located and not easily accessible to be able to compete for tourism with other parks in the country such as Luangwa and Kafue. However, there is potential for development of small scale tourism that combines waterfowl and crocodile watching, canoeing and fishing in the Zambezi flood plain with hunting and video/photo-safari in the Liuwa plain National park. The Kuomboka ceremony held annually during the month of March attracts a lot of visitors and still has more potential to attract many foreign tourists.

For tourism potential to be fully exploited, there is need for coordination of tourism between the local authorities, including the Royal establishment and institutions that provide tourist services in the country such as private Safari operators. The tourist attractions available in the Western Province need to be properly articulated and marketed to potential tourists both within and outside the country. The wildlife that tourists may be able to see in the Western Province include endangered species such as the rhino, elephant, female eland, giraffe, cheetah and several birds like pelican, eagle, crane and buzzard. These species are fully protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

4.5.3 Major Constraints to Wildlife Management

Hunting in the National Parks is prohibited. Hunting in the GMA is allowed upon purchase of a hunting permit and licence stipulating the type and number of animals to be hunted. Enforcing these regulations requires resources such as manpower, funds and transportation vehicles on the part of the Department of Wildlife Services. There is a general lack of funds for extension work and research as well as enforcement of existing regulations.

Game management in the Liuwa plain National park is constrained by the presence of many village settlements

including cattle. The problem is compounded by the fact that the migration range of most wild animals extends beyond the National parks. There is a high incidence of poaching, illegal tree-cutting and illegal burning within the confines of the National parks.

There is a lack of data on wildlife habitat such as vegetation and drinking water (Gils, 1988). As Gils (1988) rightly observes, poaching combined with the absence of an adequate resource database and land-use plans, pose serious threats to both wildlife habitat and the existence of some animal species. There are two forms of poaching, namely; illegal subsistence and illegal commercial hunting. Subsistence hunting is done essentially to sustain livelihoods, where as commercial hunting is done for the sale of horns, tusks, skin and meat. Inadequate transport is a major constraint faced by the Wildlife Department in enforcing regulations against poaching.

CHAPTER 5

5. CASHEW GROWING AND DEVELOPMENT IN WESTERN PROVINCE

5.1 History of Cashew Growing

5.1.1 Origins

Cashew (*Anacardium occidentale L.*) is a native tree crop of Brazil (FAO, 1983). It was introduced to Southeast Asia and Africa by the Portuguese. Records of cashew growing in Southeast Asia date as far back as 1790 (Horticultural Section). In Africa it was first introduced to East Africa in Mozambique, Tanzania and Kenya.

In India the cashew crop was introduced by the Portuguese about 400 years ago (Kailasam et al., 1986). It was raised mainly for the purpose of performing the role of a soil binder and as an afforestation crop. About 42 percent of total world production of cashew kernels in 1982 was supplied by India (Ibid).

India imports about 300,000 mt of raw nuts for its processing industry (Ibid). The raw nuts imported to supplement India's local production mainly come from Kenya, Tanzania and Madagascar. Over the years, however, there has been development of cashew processing facilities in Tanzania and Mozambique. At the same time China and Brazil have also

emerged as major cashew exporters.

5.1.2 Introduction into Western Province

According to Chibiliti and Latis (1989), Cashew nut trees were first introduced in the Western Province of Zambia in the early 1950's. The aim was to utilise the poor sandy soils common in the area and on which very few other crops can grow successfully. Up to the early 1980's cashew trees were essentially valued for providing shade and as a source of firewood.

An estimated 30,000 to 35,000 cashew trees were planted from 1960 to 1980 (Planning Division, 1991). However, the 1985/86 area census established that only 16,000 trees were still productive although they were infested by plant diseases and pests (Ibid).

5.1.3 Factors Affecting Performance

Lack of research, extension and training support programmes in cashew growing, during the previous years, had led to poor orchard management. Poor production incentives and inadequate marketing facilities had also undermined the take off of the cashew industry. Average tree yields were 1 kg per tree, whereas areas with similar growing conditions in other countries produce 10 kg per tree (Ibid).

The lack of farmer support efforts and appropriate marketing facilities have been cited as factors which in the

past have led to the failure of cashew nut growing to take off as a commercial enterprise. Despite the neglected efforts which had resulted in diseases and poor yields, trees that survived had shown good indication of the agronomic potential for cashews in the Province.

5.2 Cashew Production and Marketing Potential

5.2.1 Government Effort

Given the indicated potential for cashews in the Province, the Zambian government sought technical assistance from the Food and Agriculture Organisation of the United Nations (FAO) to properly assess the prospects of growing cashew nuts as well as the economic feasibility and significance for Western Province and the country in general.

A project under the FAO Technical Cooperation Programme (TCP/ZAM/0002) was carried out from 1979 to 1981 (Ibid). The Project offered positive conclusions regarding prospects for cashew nut production in the Province as well as marketing possibilities. The most suitable areas identified for cashew nut cultivation and production in the Western Province of Zambia were Mongu, Kalabo, Lukulu and Senanga districts.

The FAO Technical Study, however, cautioned against a crush programme of expanded cashew production. This was due to the fact that the cashew trade is highly competitive and many countries in Africa and South America are expanding both

production and processing capacity (FAO, 1983). Instead, a phased development of cashew nut production was recommended. It was also recommended that care should be taken to plant only cashew trees of high genetic quality and with adequate spacing.

5.2.2 Export Potential

The major export markets for cashew nut kernels are Europe, Japan and the United States of America. Export market feasibility was deemed viable because the international markets of cashew nuts had been experiencing a general decline in supply due to production problems faced by some of the major producers such as India, Mozambique, Kenya and Tanzania. For instance, supply of exported cashew kernels from India fell from 59,000 mt in 1975 to 39,000 mt in 1977, a decline of 34 percent over a two-year period (Horticultural Section, 3).

Available data indicate that by 1972 world supply of cashew kernels was more than 100,000 mt per year (FAO, 1983). Between 1972 and 1982 total world production of raw nuts fluctuated between 330,000 and 510,000 mt per year (Ibid). Potential for export of cashew kernels by suppliers in the Western Province does exist due to the fact that over a ten-year period there has been fluctuations in world production of cashew nuts. Export potential also exists because world demand for cashew kernels increases by about 5 percent per year (FAO, 1983).

Based on the conclusions and recommendations of the Technical Study conducted by the FAO Technical Cooperation Programme, the Zambian government sought further support to intensify cashew nut production (Jacob, 1990 and FAO, 1991). A "Cashew Research and Development Project" (CRDP) was initiated in May 1985. The Project (GCP/ZAM/030/ITA) was executed by the F.A.O. and implemented by the Zambian Ministry of Agriculture with funding from the Italian government. The total Donor input, covering a period of five years from May 1985 through April 1990, was $984,455 U.S. (Ibid).

5.3 The Zambia Cashew Company (ZCC)

Facts and figures in this section, except where indicated otherwise, are based on Corporate notes of 1991 obtained from the Zambia Cashew Company.

5.3.1 Incorporation of the Company

The Zambia Cashew Company (ZCC) was incorporated in 1986. Commercial operations began with a turnover of 3 million Zambian Kwacha (K3,000,000) or about $120,000 U.S. in 1988/89. By the end of March 1991, the turnover had increased to K9,000,000 or about $180,000 U.S. The ZCC is a joint venture of Zambian and foreign corporate investors. The composition of the share capital is shown in Table 2. Each share holder contributes a certain amount of capital which in turn

TABLE 2

ZAMBIA CASHEW COMPANY
COMPOSITION OF SHARE CAPITAL
[1991]

Shareholder	Authorised Share Capital (Million K)	Subscribed Share Capital (Million K)
ZIMCO	9.60	7.35
ZSIC	1.50	1.00
ZNPF	1.50	1.00
LMA	2.00	2.52
BOC	3.00	0.00
CDC	5.00	0.00
IFC	3.00	0.00
TOTAL	25.60	11.87

Note: Million K = Million Zambian Kwachas

Source: Planning Division, (1991).

determines their respective voting rights on the Board of Directors. It also determines the respective dividends accruing to each share holder. The Company has been a major driving force in cashew growing and development. The ZCC has implemented cultivation and research programmes as well as cashew extension and technical servicing work to assist smallholder farmers.

5.3.2 Objectives

Since the Company was incorporated in 1986, it has been developing the cashew industry in Western Province. It is undertaking the commercial production, processing and marketing of cashew nuts. According to an Evaluation Report (Planning Division, 1991), the specific major objectives of ZCC are;

(i) raise cashew seedlings for sale to small-holders supported by extension services of the Company,
(ii) purchase and collect cashew nuts from small-holders,
(iii) establish and manage cashew estates,
(iv) process raw nuts to extract edible kernels, and
(v) market edible kernels and Cashew Nut Shell Liquid (CNSL), both locally and internationally.

5.3.3 Targets

Based on the objectives above, specific targets were set. Some of the targets included the following (Planning Division,

1991 and Corporate notes, 1991):

(i) to raise 250,000 cashew seedlings each year and sell to small-holders, starting in 1987/88 growing season.

(ii) establish company estates amounting to 575 ha every year up to a total of 2,700 ha and

(iii) increase the value added of processed kernels by roasting and retail packaging the processed kernels.

5.3.4 Impact on Cashew Farmers

Through its development activities, ZCC has participated in the establishment of more than 10,000 smallholder cashew farmers on about 6,400 ha of land. Smallholder farmers are projected to have the potential for an annual production of 3,000 mt of raw nuts by the year 2,000. The ZCC is the sole buyer of raw nuts from smallholder farmers. The most significant role of ZCC with regard to small-holders is its programme of selling them improved cashew planting material. During the early stages of its operations, ZCC also offered small-holders free extension services on improved cashew management practices.

As illustrated in Table 3, ZCC has established its own cashew estates with a total cumulation of 1,537 ha and a tree population of 271,000 by March 1991 (see Figure 8) (Corporate Notes, 1991). The plantations are expected to have a raw nut potential of 1,300 mt at the rate of 0.5 mt per hectare per annum, upon maturity (Ibid). On the other hand, small-holders

TABLE 3

ZAMBIA CASHEW COMPANY LIMITED PLANTATIONS - AS AT 31/03/91

Location	Farm Size ha	Planted 1986/87 ha	Planted 1987/88 ha	Planted 1988/89 ha	Planted 1989/90 ha	Planted 1990/91 ha	Total ha Cumulative Plantings	Estimated Trees Established
Mabumbu	2000	140	360	660	0	102	1262	210000
Itufa	600	0	21	106	0	1	128	20819
Kalabo	140	0	0	112	34	0	146	14600
Lukulu	1000	0	0	1	0	0	1	100
Total Planted	3740	140	381	879	34	103	1537	245519

Source: Zambia Cashew Company Quarterly Report, 1991.

Figure 8

Zambia cashew company plantation at Mabumbu, Mongu - The cashew trees are about 3 years old - Notice the interspaces (July, 1991)

had a cumulative total of about 643,000 cashew trees on about 9,000 ha of land by 1991. By March 1991, a total of 914,000 cashew trees had been planted in Western Province (Ibid). A combined total of more than 10,000 ha of land in the Province had been planted with cashews by 1991 (ARPT, 1991).

The ongoing development of cashew plantations by the ZCC is illustrated in Table 3. The ZCC also undertakes research and field development activities on improved planting genetic materials from both local and foreign sources. The strategy of the Company to establish genetically improved cashew nut tree varieties resulted in the successful grafting of 23,000 selected trees by 1991 (ZCC, 1991). During the year 1990-91, small holder farmers were projected to supply 190 mt of raw nuts (Ibid). However, they only supplied 56 mt. Small holder cashew supply has been increasing since 1986, without any downward fluctuation. In 1985-86 when ZCC started its commercial operations, raw nut supply from small holder farmers was only 2 mt and this has increased steadily to 56 mt by 1991 (Ibid).

5.4 Cashew Research and Extension

5.4.1 Objectives for the Development of Cashew nut Production

Following the positive conclusions of feasibility studies, the cashew industry was identified by the Zambian government as offering potential for contributing to the

diversification of the rural economy of Western Province. Development of the Cashew nut industry was viewed as a viable means of diversifying the Provincial economy away from dependence on cattle and fish marketing.

In general terms, cashew development activities are aimed at:

(i) providing a base for a rural industry that will create employment opportunities through the processing of cashew nuts,

(ii) increasing cashew nut production and establish marketing channels and generate foreign exchange through exports,

(iii) providing a revenue base for small-holders and contribute to both regional and national income,

(iv) enhancing research and extension activities as well as suitable training and development support to improve the technology and skills in production and processing of raw cashew nuts.

Government support towards the development of cashew nut production has been channelled directly to the Provincial Department of Agriculture in the Ministry of Agriculture and Fisheries. The Department of Agriculture, in turn, has been promoting cashew nut production through research and extension activities. Thus technical support for cashew nut production, from the FAO with Italian funding, has been executed through the Department of Agriculture.

5.4.2 Cashew Research

Research work was initiated, mainly to improve the genetic qualities of cashew trees. Cashew research and development activities were carried out through the Cashew Research Development Project (CRDP) executed by FAO consultants but implemented under the institutional framework of the Department of Agriculture.

The CRDP, which started in 1985, set out to undertake the following activities:

(i) to establish cashew groves in suitable areas and increase these groves in a phased manner during the Project period,

(ii) establish nurseries at convenient centres for the production of high quality planting materials for selling to prospective cashew farmers at reasonable rates

(iii) help improve skills of national cashew extension staff thereby providing adequate field service to cashew farmers,

(iv) establish marketing facilities for the timely and profitable sale of raw nuts by farmers,

(v) establish a pilot processing facility with the necessary equipment for improvements in quantity and quality of the processed produce, and

(vi) apply research in cashew nut culture and improve both propagation techniques and practices to achieve maximum

returns (Planning Division, 1991).

Marketing and processing activities have not actually been carried out by the CRDP. These were relinquished upon establishment of the ZCC in 1986. The ZCC became the sole buyer of raw nuts and processed them for both the local and export markets. The CRDP, placed much emphasis on research activities to improve the genetic attributes of the cashew crop in terms of pest and disease resistance, early maturity and high yielding qualities.

Research on plant protection included the development of a method for screening cashew seedlings and clones, at the nursery stage, for resistance to odium causing powdery mildew disease. Besides genetic improvement, research on cashew also focused on development of suitable agronomic techniques, development of appropriate nutritional studies, cashew-based cropping systems, development of cashew-based agroforestry models, seed germination studies and disease screening and improvement of old uneconomical cashew orchards through suitable rehabilitation programmes.

5.4.3 Cashew Extension

Agriculture extension service offered by the Department of Agriculture in the Province is organised in four levels. It is structured along provincial, district, ward and camp levels. In other words a camp is a subset of a ward which in turn is a subset of a district. The district is a subset of

the Province. Hence the camp extension workers are the ones who are in direct contact with the farmers. Camp officers do actually go out in the field on a routine basis to attend to relevant concerns of farmers. Government (Department of Agriculture) agriculture extension workers from provincial to camp level offer extension services on farming in general, including cashew growing. Initially, extension services pertaining to cashew growing were offered jointly with ZCC extension workers who were deployed to the villages. With the passage of time ZCC phased out its extension service support. Currently only government extension workers offer cashew extension services.

Improved cultural practices and cashew seedling varieties evolve from the on-going joint efforts of the Cashew Crop Research Section and the Western Province Adaptive Research Planning Team (ARPT) at the Regional Agriculture Research Station. Improved methods of cashew cultivation are in turn conveyed to cashew farmers through existing agricultural extension services. Extension services being offered include seedlings distribution as well as dissemination of "appropriate" cashew husbandry and management practices. During the initial years of expanding cashew nut growing, the maximum extension-farmer ratio was 1:311 (Planning Division, 1991). In other words 1 extension worker was offering extension services to as many as 311 cashew farmers in a given camp area. However, more local small scale farmers have been

taking up cashew growing since then, such that by 1991, the maximum ratio of extension worker to farmer was 1:1,200 (Department of Agriculture, 1991). Thus a single extension worker could service up to 1,200 cashew farmers within a given agricultural camp.

During the five-year operational period of the CRDP, the project had conducted fourteen residential training courses of two to three days duration for government extension workers, ZCC extension workers, school production unit staff, Ward chairmen and members of the Cashew nut club. The CRDP also carried out 23 mobile training courses for small-holders throughout the Province, reaching approximately 40 farmers per course (FAO, 1991). The issues mostly focused on by the courses were; cultivation techniques, plant protection and rehabilitation of low yielding moribund cashew trees.

A nursery programme was started by establishing rural and central nurseries to produce cashew seedlings for distribution to small-holder farmers. The programme achieved success at little cost. It had produced about 200,000 seedlings over a five-year period (FAO, 1991). Only 15 percent of these seedlings were used for research trial planting and grafting work, while the rest were supplied to small-holders (Planning Division, 1991 and FAO, 1991). The CRDP also executed an experimental seedlings production and distribution pilot project through a local school production unit involving primary school students and parents engaged in farming. The

project supplied polythene bags and seed nuts to the school production unit which in turn raised cashew seedlings with the participation of students. On-farm demonstrations for cashew management, intercropping with cassava and cashew-based agroforestry gardens were also undertaken by the CRDP.

CHAPTER 6

6. CASHEW GROWING AND EXTENSION SERVICES

6.1 Characteristics of the Cashew Tree

The cashew tree (*Anacardium occidentale L.*) belongs to the genus *Anacardium*, a member of the family of the Anacardiaceae. Anacardiaceae comprises about 60 genera and 400 species of trees and shrubs which grow most abundantly in the tropics (Horticultural Section). Other fruits such as the Mango (*Mangifera indica L.*) belong to this Anacardiaceae family as well.

The cashew tree is a low spreading evergreen perennial tree with a number of primary and secondary branches (see Figure 9). The bark is thick, resinous, round and scaly. Under favourable conditions and protection against pests and diseases, the cashew stem grows erect with a canopy that is symmetrical and mostly umbrella shaped. The tree can grow as high as 15 m. Although the shape of the cashew tree mainly depends on type of variety, growing conditions do influence its appearance. The tree is much smaller and its stem often tortuous when growing under less favourable conditions. In terms of variety, some trees grow tall and have a conical canopy while others remain short and develop an umbrella shaped canopy. A healthy tree can have a dense foliage that

Figure 9

Mature cashew trees, about 5 years old - Malengwa, Mongu

(June, 1991)

provides a heavy shade even during the dry season when leaves of most trees shade off. Such a healthy tree also suppresses weed growth.

The cashew tree has an extensive network of primary and secondary roots which enable it to be an evergreen plant. Its root system covers enough depth and width of ground, thereby making it more likely for the cashew plant to get sufficient nutrients and water. The root system helps the cashew to complete its biological cycle even during prolonged periods of drought or in low water retention soils such as sand.

Cashew is a tree crop with a gestation period that ranges from three to five years. After transplantation of the seedlings, cashews take about 3-5 years before the trees start bearing nuts. While the cashew tree is regarded to have a life span of about thirty to forty years, fifty-year old trees producing about 60 kg of nuts per tree per year were reported to exist in Angola (Horticultural Section).

Pollination of the cashew flowers, from which fruits are produced, is carried out by flies, bees and ants. An indication of the fact that the role of insects as pollinating agents is more critical than the role of the wind is the occurrence of strong scented flowers and sticky pollen grains on the cashew trees. The real fruit of the cashew tree is the kidney-shaped nut. The nut is attached to a juicy, sugary, swollen edible mass, called an apple. The nut is composed of pericarp or shell and kernel.

6.2 Ecological Requirements for Cashew Growing

6.2.1 Climate

Cashew is essentially a tropical crop. Its moisture requirements are quite flexible. It can tolerate a wide range of climatic conditions. There is a wide range of high yielding cashew varieties or hybrids suitable for different agro-ecological conditions. The only limiting climatic factor is the fact that cashew can not withstand frost and extreme cold conditions for a prolonged period of time.

Cashew is very sensitive to frost, particularly in the early stages. Cashews can withstand temperatures dropping close to 0° C for short periods. This could be a problem in valley bottom areas in the Western Province. Temperatures in some of these areas do drop below 0° C during the cold season. For instance a record minimum temperature of -7° C and an average of ten frost days per year have been recorded in Sesheke district (FAO, 1983). The cashew crop may not be commercially viable in areas with mean annual temperatures below 20° C, (Ibid). In most of the major cashew producing areas, mean daily minimum temperatures vary between 15° C and 25° C, while mean daily maximum temperatures fluctuate between 25° C and 35° C, (Horticultural Section).

Areas of high altitude are also not favourable to cashew growing because these areas experience a significant drop in temperatures. Hence the normal habitat of cashew is up to 600

m above sea level (Ibid). However, in South America and tropical Africa, where temperatures are higher, areas of cashew growing reach as high as 1,000 m above sea level. In the case of the Western Province, elevations above sea level range from around 900 m in the south to 1350 m in the north-east (Programme Evaluation, 1988). The African Development Fund gives the average altitude as being around 1000-1100 m (African Development Fund, 1980). Areas in the Province below 1,100 m altitude fall outside the frost zones and are therefore conducive for cashew growing (FAO, 1983). It is mainly depressions, valley bottom areas and areas exposed to east winds that are more likely to be frost prone (Horticultural Section). These areas are therefore not conducive for cashew growing. Optimum monthly average temperatures for cashew are around 27° C (FAO, 1983). Mature cashew trees planted in some of the high altitude areas of the Western Province show encouraging records. This seems to indicate that the duration of the occasional light frosts and the stage of growth of the tree when the frosts occur matter a lot in determining the harm done to the cashew plants.

Ideal moisture requirements for cashews require an annual average precipitation pattern of 600 mm and above (Kailasam et al., 1986). Cashews have been found to grow under rainfall conditions ranging from 500 - 4000 mm per year (Horticultural Section). The cashew plant can survive under drought conditions when its roots can grow deeply into the soil and

draw from water reserves that other crops can not reach.

During flowering and fruit set, heavy rains can have a negative impact on pollination and the quality of nuts, thereby undermining production. Hence, to produce best yields, cashews need a climate with a pronounced dry season of four months or longer. Thus flowering and fruit set take place at the beginning of the dry season or just at the end of the rainy season. Extremely dry air or low humidity during the flowering period can make the flowers wither and result in decreased yields. However, excessive humidity is equally undesirable because it induces the growth of fungi and creates conducive conditions for insect pests to attack the cashew.

6.2.2 Soils

The cashew plant can grow in a wide range of soils. Just like requirements for moisture, nutrient requirements are also very flexible. Cashews can grow in almost all soil types, from the sandy sea coast to lateritic hill slopes and savannah uplands up to an elevation of about 700 m above sea level (Kailasam et al., 1986).

Although cashews can tolerate many types of soil, they grow quickly and start bearing nuts early in red sandy loams as well as light coastal sands. However, cashews can still grow on waste lands of low fertility. In general terms, the ideal soil type, for cashew is loose deep and well drained sandy loam soils. Water logged soils of clayey type with low

permeability are not suited for cashew cultivation. A water table depth of 5-10 m is also desirable for the proper growth of cashew. This is because in the early years before the cashew roots are fully developed there is need for readily available moisture.

6.3 Cashew Cultivation Methods and Extension Services in Western Province

6.3.1 Seeding and Transplanting

In general, the cultural practices for cashew cultivation involve site selection and land preparation, seed selection, sowing, transplanting and planting techniques, weeding and pruning, intercropping and fire protection.

Cashew is a highly cross pollinated crop whose performance can be improved by identifying and selecting high yielding varieties. High yielding trees or varieties are propagated by seed or vegetatively. Seeds or planting material of mother trees are selected on the basis of characteristics such as high yields, nut size, disease resistance, compact canopy and intensive branching with a large number of flower bearing laterals.

Seed nuts are selected from healthy and high yielding trees. There is a wide range of high yielding cashew varieties or hybrids whose performance depends on the existing agro-ecological conditions. Cashew seedlings are in turn

raised directly from selected seed nuts.

To hasten germination, the nuts are soaked in water for two days. They are then planted 3-4 cm deep with the stalk-end facing upwards. Direct sowing of nuts requires irrigation or continuous rains. A dry spell during germination can result in failure.

Cashew hybrid selections are raised by vegetative propagation. Propagation is done by layering, budding and grafting. Vegetatively propagated progenies are true to the parent. Therefore in order to produce best varieties with appropriate qualities, planting material are selected only from trees possessing all the desirable attributes. Kailasam et al. (1986), recommend the selection of vigorous looking mother trees that are about 15-25 years old and yielding about 15 kg of nuts per year.

Seedlings are transplanted when they are about two months old (see Figure 10). The optimum time for transplanting is around November/December just when the rains are steadily on. This enables the plants to get well established and be able to withstand the following dry season. Planting of cashew seedlings is done in pits of 50 x 50 x 50 cm with some fertilizer or livestock manure (Kailasam et al., 1986). Planting holes are recommended to be spaced at 10 x 10 m (Latis, 1989). At this spacing one hectare accommodates 100 trees. Ropes and sticks are used to demarcate the planting holes in straight lines. Planting holes are filled with about

Figure 10

Cashew farmer holding cashew seedlings that are almost ready for transplanting, immediate background are mango trees and further beyond are cashew trees - Malengwa, Mongu (June, 1991)

10 kg of dry cattle manure per hole, mixed with soil. Alternatively fertilizer can be used in combination with cattle or vegetative manure. However, filling the planting holes with black soil of clayey texture is not recommended because it is likely to be impermeable with water and can thus prevent free drainage. Chemical fertilizers are not highly recommended for use in Western Province because of the poor capacity of the soil to assimilate them and make them available to the plants. Due to the coarse sandy soil, chemical fertilizers leach out of the top soil quickly. Thus cattle manure is preferred for application not only in the planting holes, but also for annual application around the trees.

6.3.2 Orchard/Plantation Management

Cashew seedlings require irrigation during the dry season. However, cashews can not withstand water logged soils. On the edges of the Flood plain and valleys, cashews are grown on sloping areas. Soil erosion and leaching of plant nutrients are generally expected in such areas. In cases where intercropping is not practised, low herbaceous species such as grass and small shrubs are encouraged to be left between the cashew rows as long as there is periodic slashing or trimming to prevent over growing. Such vegetation helps protect the soil from being desiccated and eroded as a result of strong sun-light, heavy rains and wind caused

erosion.

Mulching, shading and watering are carried out during the first dry season to protect the young seedlings. In the absence of irrigation facilities the activities of a farmer and the labour force are under utilized during the dry season. It is thus advisable that in such circumstances cashews should be treated as part of the general farming activities and be planted between the annual crops. The cashew trees will thus benefit from the management and attention given to the annual crops. Weeding requirements in such fields will be reduced as the trees grow and much of the labour will focus on harvesting.

One conventional practice is to keep the area around the cashew tree clear of all weeds. The slashed vegetation between the trees, where there is no intercrop, is left in the field to decompose and increase soil organic matter. Cashews require a clearance of at least 1.5 m around the seedlings to avoid interference in the first year of planting.

Coppicing, the process of cutting the tree about 50 cm above ground level, is done to rejuvenate trees. Coppicing is done to trees that have grown too old, trees over 30 years or trees that have been damaged severely by insects, frost or fire. This process entails protecting the cut with water-proof paint to prevent rotting.

During the dry season, grass has to be slashed or uprooted in order to prevent the risk of fires to the cashew

field. Cashew plantations are protected against fire by creating a fire-break, a clearing of about 10-15 m wide around the plantation. Thorough weeding and ploughing-in all the dry organic material between trees can further enhance protection against fire.

Ohler (1979) estimated that under favourable conditions, cashews can grow in height at the rate of 1 m per year, the canopy diameter grows at about 1.5-2 m per year during the first 5-6 years (FAO, 1983). After 5-6 years, growth slows down. In the first 6-8 years planting density determines the yield per ha (FAO, 1983). During these initial years, the more cashew trees there are in a hectare, the more nuts will be obtained. However, yield levels drop as soon as the canopies of the cashew trees begin to touch. Nut bearing becomes progressively limited to the upper branches and the "roof" of the canopy (FAO, 1983). This is due to the fact that flowering and fruit-set of cashew are very sensitive to shade. Therefore optimum planting density (spacing) depends on the exploitation period (economic life) used for calculation. For instance an economic life of 25 years for a cashew orchard would require a spacing of about 12 x 12 m in order to obtain optimal yields (Eijnatten, 1983).

6.3.3 Nutrient Content and Nutritional Requirements

Since soil in the uplands of Western Province are low in nutrients, plants such as cashews tend to absorb low levels of

nutrients of certain elements in comparison to similar plants from different areas. For instance, Chibiliti and Latis (1989) found cashew trees sampled from Western Province to be in a very low nutritional status with regards to phosphorus (P) potassium (K) manganese (Mn) boron (B) and zinc (Zn) when compared to other cashew growing countries.

A standard mature cashew tree requires about three to four times as much nitrogen (N) as it requires phosphorous (P) and potassium (K) (see table 4) (Ibid). Cashews have been found to respond well to fertilizer application in other countries. Two split-doses of fertilizer applied to a tree every year, are recommended. Such doses should be applied just before and after the rains. In India, the total recommended application is 500 g of N, 125 g P_2O_5 and 125 g K_2O per tree per annum (Kailasam, et al., 1986).

Although the sandy soils of Western Province are extremely leached, a study done by Chibiliti and Latis (1989) showed that the leaves of cashew plants in Western Province have levels of N, Ca and Fe which are not significantly different from concentrations of these elements in similar results from Kenya, Madagascar and Brazil. Nitrogen, Ca and Fe were found to be reasonably well supplied to cashew plants although the soils in Western Province are extremely poor in N, Ca and Fe (Ibid).

TABLE 4

MEAN NUTRIENT CONCENTRATIONS IN LEAVES OF NORMAL HEALTHY CASHEW PLANTS IN WESTERN PROVINCE

PLANT AGE	No. of Replications	NUTRIENT CONCENTRATIONS								
		%DM					ppm DM			
		N	P	K	Ca	Mg	Zn	Fe	Mn	B
Seedlings 0-4 months old	4	2.93	0.09	0.25	0.10	0.13	18.25	77.25	60.25	20.73
Young trees 1-2 years old	4	1.63	0.02	0.14	0.15	0.10	8.13	64.38	98.50	11.25
Mature tress/ tender leaves	6	1.98	0.03	0.15	0.08	0.08	9.25	76.17	72.58	11.83
Mature trees hard leaves	6	1.72	0.02	0.09	0.12	0.07	8.67	78.83	73.17	12.65
Suckers	3	3.23	0.02	0.20	0.08	0.06	5.00	95.50	76.00	20.30
Coefficient of variation % (C.V)		43.63	80.41	97.73	30.69	39.64	54.00	28.40	42.44	37.80

Source: Latis and Chibiliti, 1989.

6.3.4 Extension Service Activities

Extension services on cashew growing are executed by agricultural extension workers. Zambian government personnel executing extension services towards cashew nut growing are divided into the following two categories.

1) Agricultural officers, at District, Provincial and National levels; falling into middle and upper level management categories.
2) Field agricultural extension workers who have frequent and more direct contact with the farmers. These extension workers come in contact with farmers on a daily basis, during official working days.

Field workers constitute Ward officers (previously known as Block Supervisors) and Camp officers, both ranked as Agricultural Supervisors and Agricultural Assistants respectively. Extension service activities include establishing cashew demonstration fields, conducting field days, implementing mobile and residential training courses, as well as conducting regular Training and Visit (T and V) operations. Improved cashew cultivation methods are conveyed to farmers through all these extension activities. Mobile courses are training sessions offered by agricultural experts by moving from one farming community to another in targeted areas. Residential courses, on the other hand, entail that targeted farmers travel to Farmer training centres for training sessions. Each district in the Province has one

Farmer training centre. Table 5 offers a summary of part of the 1991 field study. Table 5 indicates the area of coverage, target population, number of cashew farmers, cashew acreage and number of cashew trees serviced by a single agricultural camp officer in the central part of the Western Province in which extension workers and cashew farmers were sampled. The results in Table 5 are based on responses to the questionnaire and interviews.

Based on these 1991 field study results, it can be concluded that on average a single camp officer services an area with a geographical coverage of about 400 km^2. The range of cashew farmers serviced by one camp officer varies from 3 to 1,200 with a mean of about 115. The number of cashew farmers in a given agricultural camp is determined by various factors such as geographical location and population distribution. Table 6 gives more results from the questionnaire which are also consistent with responses to the interviews. Table 6 illustrates specific cashew cultivation/cultural practices conveyed to farmers through extension activities in each of the respective agricultural camp areas.

6.3.5 Harvesting and Processing

In some exceptional cases trees start producing nuts in the first or second year. Normally, trees start bearing nuts in the third year. Output increases year by year and is

TABLE 5

EXTENSION PRACTICES AS INDICATED BY THE QUESTIONNAIRE

	Agriculture Camp	Total Camp Area Sq. km	Total Population Served	Cashew Area ha	Planned Future Area ha	Number of Cashew Farmers	Cashew Trees Planted
	1	286	4500	98	50	50	9762
	2	1350	15000	211	4	1200	21100
	3	368	2080	60	10	112	6000
	4	378	2600	20	300	15	6500
	5	750	155000	2546	23000	120	260000
	6	510	2940	9	6	120	900
	7	28000	12000	0	0	0	0
	8	540	2500	25.7	30	45	2570
	9	300	2700	4	55	21	405
	10	375	2500	1.5	50	6	30
	11	200	2500	20	150	20	1000
	12	192	1800	35	70	9	5000
	13	420	3750	4	0	3	300
	14	500	2625	35	100	125	95685
	15	375	1475	38	30	85	3800
	16	160	3210	2.5	6	6	180
	17	20000	2128	1	1000000	10	140
	18	500	2401	15	2250	5	33
	19	400	2056	13	30	25	1000
Total	19	55604	223765	3138.7	1026141	1977	414405

TABLE 6

CASHEW EXTENSION SERVICE ACTIVITIES IN NINETEEN DIFFERENT AGRICULTURAL CAMPS AS INDICATED BY THE QUESTIONNAIRE

CAMP	FARMING / CULTIVATION METHODS	NUMBER OF DEMO. FIELDS	FARMER CONTACT FREQUENCY	CASHEW FIELD DAYS
1	Spot planting 10 x 10 m	nil	twice a week	nil
2	line planting	nil	weekly	nil
3	spacing, line planting, weeding, pruning	1, 1.25 ha	daily	yearly
4	line planting, 10 x 10 m spacing	1, 50 x 50 m (1 lima) = 0.25 ha	weekly	nil
5	line planting and intercropping	1 2,000 ha	8-12 times per month	once per year
6	spot planting, 10 x 10 m spacing	nil	4 times per month	nil

CAMP	FARMING / CULTIVATION METHODS	NUMBER OF DEMO. FIELDS	FARMER CONTACT FREQUENCY	CASHEW FIELD DAYS
7	seedlings use, in contrast to seeds	nil	weekly	nil
8	intercropping with other field crops	nil	5 times per month	nil
9	spot planting 10 x 10 m spacing	1 25 x 25m	2 weeks per month	nil
10	intercropping with cassava	1 0.25 ha	4-5 times per month	nil
11	line planting 10 x 10 m	1 (1 lima) 0.5 ha (50 x 50 m)	weekly	nil
12	spot planting 10 x 10 m spacing	nil	daily	nil
13	spot planting 10 x 10 m spacing transplanting	nil	2 times per month	nil

CAMP	FARMING / CULTIVATION METHODS	NUMBER OF DEMO. FIELDS	FARMER CONTACT FREQUENCY	CASHEW FIELD DAYS
14	spot planting 10 x 10 m spacing transplanting	4 25 x 25 m (0.25 ha)	15 times per month	nil
15	line and spot planting, 10 x 10 m spacing	2 by 3 limas (0.75 ha)	2 weeks per month	nil
16	spot planting 10 x 10 m spacing	nil	all year round	nil
17	spot planting 10 x 10 m spacing	3 by 1 lima (3 x 0.25 ha)	2 times per month	yearly
18	use of certified seedlings, manure use, 10 x 10 m spacing	1, 5 plants	4 times per year	nil
19	spot planting, 10 x 10 m spacing	none	once per month	nil

NB: 1 Lima is equivalent to 0.25 hectares.

optimum after seven to ten years. Yield is determined by several factors such as age of the tree, spacing, soil fertility, type or variety of planting material, pests and diseases as well as overall management.

According to the Cashew and Research Development Project (CRDP) an ideal cashew orchard in Western Province is expected to produce about 500 kg of nuts per ha per annum (Jacob, 1990). At a spacing of 10 x 10 m, the optimum annual yield at maturity, should therefore be about 5 kg of nuts per tree. This is based on the fact that at 10 x 10 m spacing, one hectare or 10,000 m^2 accommodates 100 trees that produce a total of 500 kg of raw nuts annually. Harvesting of the nuts is mostly done between October and January, although some nuts are harvested throughout the year. During harvesting, picking of nuts from the branches is not recommended but instead nuts are picked regularly after they fall to the ground.

Harvesting cashew nuts is time consuming and labour intensive. Maturing takes place over a long period of time. Depending on climatic conditions, weekly intervals between each harvest are regarded as being ideal. Fully matured nuts are collected manually every day. The nuts are separated and sun-dried for 2-3 days before they are ready for processing and packaging. Processing of cashew nuts involves the recovery of kernel from raw nuts either manually or by mechanical means. The whole process includes moisture conditioning, roasting, shelling, drying, peeling, grading and

packaging.

Moisture conditioning involves the sprinkling of water on dried nuts to bring them to a moisture level in the range of 15 percent to 25 percent (Kailasam et al., 1986). After moisture conditioning the nuts are then roasted to make the shell brittle. The methods used for roasting are ; drum roasting, open pan and hot oil bath. Shelling can be done manually or by hand and leg operated shelling machines. The ZCC initially used manual methods but later introduced shelling machines. The next process of sun-drying for 2-3 days helps to loosen the testa. In fully developed cashew industries such as in India, drying is done in specially constructed drying chambers. Peeling is done manually either by gentle rubbing of the kernel using fingers or by knives.

Grading starts at the peeling stage. During grading, wholes are separated from pieces. The whole kernels are further sorted out to meet internationally recognised specifications based on size, colour and weight of kernels. Finally, packaging is done in air-tight tins, usually having a capacity of 4 gallons. Each tin is packed with 11.34 kg. of kernels. After the tins are filled with kernels, air is then drawn out of the tins and replaced by carbon-dioxide. The tins are then hermetically sealed and are then readily available for marketing. Marketing and processing activities are solely carried out by the ZCC.

6.4 Economic Benefits of Cashews

6.4.1 Economic Viability of Cashew Nut Growing in the Western Province

Economic aspects of cashew in the Western Province have been analyzed by the FAO Technical Study (1983), Eijnatten (1984) and the Western Province Adaptive Research Planning Team (ARPT) (1991). Although two out of the three studies were done ten and nine years ago, they can still indicate how economically viable it was, at the time that decisions were made, for the Zambian government to promote and support cashew growing. The FAO Technical Study indicated that a good yield of cashew nuts in the Western Province would, on average, provide farmers with returns of about $940 U.S per ha or per mt (FAO, 1983). Shipping costs to European ports were estimated to be about $200 U.S per mt. The wholesale price of the nuts (whole kernels) in western markets was estimated to be about $5,000 U.S per mt in 1982 (FAO, 1983). The FAO Technical Study (1983) indicated that even if farming and processing costs are taken into consideration, the cashew industry would still be economically viable, at the indicated selling price.

Eijnatten (1984) acknowledged the fact that the future of cashew in Western Province will depend on the interplay between production costs for the farmer, processing costs for the marketing institution, consumer demand and price levels

for the cashew kernels. Eijnatten (1984) made detailed gross margins calculations for the cultivation of cashew and cassava as well as for the combined cassava/cashew cultivation. The gross margins were calculated on the basis of the following assumptions:

(1) Yields of a single tree will be:

0.2 kg raw nuts in year 2

0.5 kg raw nuts in year 3

1.5 kg raw nuts in year 4

3.0 kg raw nuts in year 5

5.0 kg raw nuts in year 6

6.0 kg raw nuts from year 7

The year of planting is year 0.

These yield levels are supported by past purchasing records from 1972 to 1976 and field trials of 50 cashew trees at Namushakende, in Mongu (Ibid).

(2) No fertilizer application or pest and disease control (pesticides).

(3) Economic life of a cashew tree was set at 25 years.

(4) 1 ha will have 70 cashew trees at 12 x 12 m spacing

(5) Farm gate price of cashew was set at K0.20 (Zambian Kwacha), at K0.40 or K0.60 for 1 kg of raw nuts.

(6) Farm gate price for cassava was K16.00 per 50 kg of processed and dried cassava roots.

(7) Productivity of cassava is taken to be 12 mt of fresh roots or 3.5 mt of dried cassava chips per ha.

(yield levels of up to 23 mt of fresh roots per ha are achieved).

Eijnatten (1984) further provides the following summary of costs for cashew cultivation. 15 person-days per ha are required for land preparation involving the stumping of trees and shrubs. K64.00 per ha is spent on ox-ploughing. 20 person-days per ha are needed for uprooting remaining stumps. K0.10 per plant is spent on planting material. 3 person-days per ha are needed for establishment of 70 trees (at 12 x 12 m spacing). About 25 percent of the plant material fails in year 1, hence 1 person-day per ha is spent on gapping. 7 person-days per ha are spent on construction of grass protection around each of the 70 trees, during the first dry season. 15 litres of water are required per plant in one application per month in the months of August, September and November. Water application will require 21 person-days. Weeding is done once during the first year and thereafter twice until the tree becomes reasonably big at 8 years of age. Thereafter only one weeding/slashing operation per year is required. 10 person-days are required for every weeding round.

Harvesting requires inspection of all plant sites at weekly intervals for a period of 3 months, from November to January. This requires 12 person-days per ha from the third year till the sixth year, thereafter 24 person-days per ha are required. For drying and bagging the harvested produce, 4

person-days are required in year 3, 5 person-days from year 4 to 6 and 9 person-days in subsequent years. Gunny bags, with a capacity of 80 kg of raw nuts, cost K0.70. Occasional maintenance of the trees requires 3 person-days in years 7 and 8, 6 person-days from the 9th till the 19th year and 9 person-days every year thereafter. Gross margins per ha and per year are obtained as an average over the 25-year period. Tables 7, 8, 9, 10 and 11 summarise the details from which gross margins are calculated.

A combined cassava/cashew enterprise as indicated by Table 10, has significantly better levels of gross margins than what is given by cashew alone. Returns on cashew increase in later years. The bulk of the cassava produce is used for food by the farmers and only the surplus is sold for cash. When cassava is intercropped with cashew plants, during the first four years of cashew establishment, cashews benefit from the care given to cassava crops. The major initial cost of land preparation benefits two crops at the same time.

The following is the summary of costs of processing cashews as calculated by Eijnatten (1984). The cost of processing cashew nuts per kg of raw nuts is given by the following summary:

Buildings	K3.70
Floating/Soaking	K0.03
Roasting	K8.05
Shelling	K38.02

Drying	K2.15
Peeling	K7.33
Grading/Packing	K1.73
Total	K61.01

The cost of Supervising or Managing the processing activities was estimated at K20.05 per kg of raw nuts.

At the indicated processing costs and farm gate price of K0.20 the profit margin is K0.56 per kg of raw nuts. Eijnatten (1984) indicated that the profit margin could rise to K1.42 per kg of raw nuts, because at that time there was an anticipated selling price increase from K7.15 to K10.00 per kg of processed kernels. Eijnatten (1984) finally concludes that if world market prices of cashew kernels would remain at $6.00 U.S to $7.00 U.S per kg, the cashew industry would remain attractive to both farmers and processors in the Western Province.

In a period of five years from 1984/85 to 1990/91, the farm gate price of cashew nuts rose from K0.20 to K25.00 per kg and to K40.00 per kg in 1991/92 (Department of Agriculture, 1991). According to the Adaptive Research Planning Team (ARPT, 1991), the farm gate price has risen more than the rate of inflation. By 1991, cashew farmers in the Western Province were receiving a U.S. Dollar parity price of $750.00 U.S per mt (or 75 U.S cents per kg of raw nuts) from the ZCC, which is higher than in all the neighbouring countries such as Tanzania and Mozambique (ARPT, 1991). The ARPT (1991) concludes that

TABLE 7

VARIABLE COSTS AND OUTPUT FOR CASHEW CULTIVATION
IN THE WESTERN PROVINCE

Year		Variable Cost per Ha.					Output	of Raw Nuts per Ha.		
	Purchased Inputs	Labour Required						Farm Gate Price		
		Number of Personday	Costs in Levels	Kwacha per	at various Personday		In kg.	In Kwacha at K0.20	at K0.40	at K0.60
	Kwacha		at K0.00	at K1.00	at K2.00	at K3.00		per kg	per kg	per kg
0	71	38	0	38	76	114				
1	2	39	0	39	78	117				
2	1	21	0	21	42	63	14	3	6	8
3	0	36	0	36	72	108	35	7	14	21
4	1	37	0	37	74	111	105	21	42	63
5	1	37	0	37	74	111	210	42	84	126
6	2	37	0	37	74	111	350	70	140	210
7	3	56	0	56	112	168	420	84	168	252
8	4	56	0	56	112	168	420	84	168	252
9	5	49	0	49	98	147	420	84	168	252
10	5	49	0	49	98	147	420	84	168	252
11	5	49	0	49	98	147	420	84	168	252
12	5	49	0	49	98	147	420	84	168	252
13	5	49	0	49	98	147	420	84	168	252
14	5	49	0	49	98	147	420	84	168	252
15	5	49	0	49	98	147	420	84	168	252
16	5	49	0	49	98	147	420	84	168	252
17	5	49	0	49	98	147	420	84	168	252
18	5	49	0	49	98	147	420	84	168	252
19	5	49	0	49	98	147	420	84	168	252
20	5	52	0	52	104	156	420	84	168	252
21	5	52	0	52	104	156	420	84	168	252
22	5	52	0	52	104	156	420	84	168	252
23	5	52	0	52	104	156	420	84	168	252
24	5	52	0	52	104	156	420	84	168	252
25	5	52	0	52	104	156	420	84	168	252
Total	170	1208	0	52	2416	3624	8694	1739	3478	5217

Source, Eijnatten (1983).

TABLE 8

GROSS MARGINS PER HA AND PER YEAR FOR CASHEW CALTIVATION IN WESTERN PROVINCE FOR FOUR LEVELS OF LABOUR CHARGES AND THREE LEVELS OF FARM GATE PRICES FOR CASHEWS

Gross margins per ha, per year		Various levels of costs per Person-day			
		at K0.00	at K1.00	at K2.00	at K3.00
Three levels of farm gate prices per kg	at K0.20	K62.76	K14.44	K-33.88	K-82.20
	at K0.40	K132.32	K84.00	K35.68	K-12.64
	at K0.60	K201.88	K153.56	K105.24	K56.92

Source, Eijnatten (1983).

TABLE 9

OUTPUT OF CASSAVA/CASHEW ENTERPRISE OVER A 25-YEAR PERIOD

Farm gate price of cashew	Contribution from cassava	Contribution from cashew	Joint output
at K0.20	K1,973.00	K1,739.00	K3,712.00
at K0.40	K1,973.00	K3,478.00	K5,451.00
at K0.60	K1,973.00	K5,217.00	K7,190.00

Source, Eijnatten (1983).

TABLE 10

GROSS MARGINS PER HA AND PER YEAR FOR THE COMBINED CULTIVATION OF CASSAVA AND CASHEWS IN WESTERN PROVINCE - AT FOUR LEVELS OF LABOUR CHARGES AND THREE LEVELS OF FARM GATE PRICES FOR CASHEWS

Gross margins per ha, per year		Various levels of costs per Person-day			
		at K0.00	at K1.00	at K2.00	at K3.00
Three levels of farm gate prices for cashews	at K0.20	K139.60	K91.04	K42.36	K-6.32
	at K0.40	K209.16	K160.60	K111.92	K63.24
	at K0.60	K278.72	K230.16	K181.48	K132.80

Source; Eijnatten (1983).

TABLE 11

GROSS MARGINS PER PERSON-DAY FOR THREE ENTERPRISES IN WESTERN PROVINCE AT FOUR LEVELS OF LABOUR CHARGES AND THREE LEVELS OF FARM-GATE PRICES FOR CASHEWS

Gross margins per person-day		Various levels of costs per person-day: at K0.00	at K1.00	at K2.00	at K3.00
Cashew cultivation					
Three levels of	K0.20	K1.30	K0.30	K-0.70	K-1.70
farm-gate prices	K0.40	K2.74	K1.74	K0.74	K-0.26
for cashew	K0.60	K4.18	K3.18	K2.18	K1.18
Cassava cultivation		K9.12	K8.12	K7.12	K6.12
Combined cashew and cassava cultivation					
Three levels of	K0.20	K2.56	K1.67	K0.78	K-0.12
farm-gate prices	K0.40	K3.84	K2.95	K2.05	K1.16
for cashew	K0.60	K5.11	K4.22	K3.33	K2.44

Source; Eijnatten (1983).

the cashew industry is a profitable venture in the Western Province (see Tables 12, 13 and 14).

6.4.2 Uses of Cashew nuts and By-Products

The kernels, extracted from inside the cashew nuts are the most economically valuable products of cashews. These kernels are roasted as mentioned above and then sold as snacks. Nuts of the cashew are used as ingredients in many dishes. The broken kernels are used for a product similar to peanut butter. Smaller pieces of the kernels are used in sweet factories. However, the nuts do not blend well with chocolate.

Cashews have a lot of useful by-products. The kernels contain a high percentage of fats from which oil can be extracted. The oil is of excellent quality, but is not commercially exploited because of the high price fetched by the kernels. There is also potential for the tannin in the testa of the nuts to be used in the leather industry. However, the amount of tannin depends on the amount of testae.

The spongy layer of the shell contains oil in a quantity that is equivalent to about half the weight of the kernel. This oil, called Cashew Nut Shell Liquid (CNSL), is very valuable. It is used for many industrial purposes such as, insulation of varnishes, making of oil and acid proof elements, heat and water proof paints, typewriter oils and automobile brake band linings. Overall, there are more than

TABLE 12

BUDGET FOR ESTABLISHING AND MAINTAINING A ONE HECTARE CASHEW NUT PLANTATION (HAND CLEARING) PIECE WORK (1991)

[Using ordinary seedlings and no fertilisers]

Costs:	1991
YEAR 1	K/HA.
Bush clearing/stumping/cording	1,500.00
Stick protection tents (@ K0.50/tree/day)	50.00
Hole digging (@ K0.30/hole x 200 holes/day)	30.00
Planting (@ K0.30/tree x 100 trees/day)	30.00
Slashing (@ K2.00 for 50m. x 7 person-days) x 3times/year	600.00
Interrow cleaning (@ K2.00 for 1,000 sq. m. x 3 person-days x 3 times/year	600.00
Preparing wood for cords (@ K5.00/cord x 5 cords per ha. including in stumping	50.00
Seedling cost (@ growing cost of K20.00/seedling including transport)	2,000.00
Chemical application (@ K0.40/tree)	40.00
Chemical cost (@ K0.40/tree)	40.00
Survey (@ K250.00/ha.)	250.00
Hand tools depreciation/chemical sprayer @5%	340.00
Fire-breaks (@ 10 person-days/ha. x K50.00/md.)	500.00
Total	6,030.00

COSTS:

YEAR 2	K/HA.
Gap filling (@25 seedlings/ha)	500.00
Gap filling labour (@ K0.25/tree x 50 trees/day)	6.00
Fire-breaks/slashing (between rows as year 1)	600.00
Cleaning (between trees as year 1)	600.00
Chemical (@K0.40/tree)	40.00
Chemical labour (@ K0.40/tree)	40.00
Depreciation	323.00
Pruning @K0.50/tree	50.00
Total	2,159.00

YEAR 3	
Slashing/fire-breaks (as above)	600.00
Cleaning/fire-breaks (as above)	600.00
Pruning/fire-breaks (as above)	50.00
Chemical spraying (as above for labour and chemicals)	120.00
Harvesting and drying @ K0.25/tree	12.50
Depreciation tools/equipment	306.85
Total	1,689.35

YEAR 4	
Slashing and fire-breaks (as above)	600.00
Cleaning	600.00
Pruning	50.00
Chemical plant protection	160.00
Harvesting and drying (@ K0.50/tree)	50.00
Depreciation	291.50
Total	1,751.50

YEAR 5 & UPWARDS	
Maintenance	1,200.00
Plant protection	160.00
Harvesting (@ K0.75/tree)	75.00
Depreciation	276.00
Total	1,711.00

Source; ARPT (1991).

TABLE 13

THE COSTS AND RETURNS OF CASHEW BY SMALLHOLDERS AND SMALL COMMERCIAL FARMERS

COSTS AND RETURNS PER YEAR OF OPERATIONS (KWACHA PER HA)
[Using ordinary seedlings and no fertilisers]

Establishment year	yr1	yr2	yr3	yr4	yr5	yr6	yr7	yr8	yr9	yr10
Costs										
Seedlings	2000	500								
Chemicals	80	80	120	160	160	160	160	160	160	160
Others	340	323	306	281	276	263	249	237	225	225
Total costs										
Own labour	2420	903	426	451	426	423	409	397	385	374
Labour input										
Person-days/ha	70.6	22	11	12.5	13	13.5	15	16	16	16
Nut yield										
[kg./ha.]	0	0	0	50	150	200	300	400	500	500
Gross income										
K25.00/kg.	0	0	0	1250	3750	5000	7500	10000	12500	125000
Net income	-2420	-903	-426	799	3324	4577	7091	9603	12115	12115
cumulative										
net income	-2420	-3323	-3749	-2950	374	4951	12042	21645	33760	458000
year/ha.										
less harvest cost										

Source; ARPT (1991).

TABLE 14

ESTIMATED RETURNS PER HECTARE OVER 15 YEARS FOR A SMALLH

[Based on total costs using ordinary seedlings and no fertiliser or labour]
Farm-gate price in 1991 = K25.00/kg.

Year	Yield [kg/ha.]	Revenue [Kwacha]	Total costs [Kwacha]	Net cash flow [Kwacha]	Cumulative [Kwacha]
1	0	0	6030	-6030	-6030
2	0	0	2159	-2159	-8189
3	0	0	1689	-1689	-9878
4	50	1250	1751	-501	-10379
5	150	3750	1711	2039	-8340
6	200	5000	1711	3289	-5051
7	300	7500	1711	5789	738
8	400	10000	1711	8289	9027
9	500	12500	1711	10789	19816
10	500	12500	1711	10789	30605
11	500	12500	1711	10789	41394
12	500	12500	1711	10789	52183
13	500	12500	1711	10789	62972
14	500	12500	1711	10789	73761
15	500	12500	1711	10789	84550

Source; ARPT (1991).

200 patents, world-wide for different industrial uses of CNSL (Horticultural Section).

The apple attached to the nut, is used for making jam, jelly, syrup, juice, alcoholic and non-alcoholic beverages as well as candied fruit. Some communities use the young tender leaves of cashew as a flavouring for rice. The bark of the cashew is also used for medicinal purposes. The cashew trees can produce gum of very good adhesive quality, slightly similar to arabic gum. The wood of cashew trees is termite resistant and thus can be used in the construction of houses and boats and as fence posts. Cashew fields can also supplement sources of fuel wood. Trimmed branches and trees that have to be replaced due to age or pest infestation are a source of firewood. From a commercial stand point, however, the relatively high costs of processing cashew nuts in comparison to other crops results in a low producer price for cashew nut produce from farmers.

6.4.3 Nutritional Value of Cashew Produce

Cashew proteins contain all essential and non-essential amino-acids. According to J. Gower, the average nutritional composition of the kernel is 21 percent proteins, 45 percent fat and 25 percent carbohydrates by weight (Horticultural Section). The rest are minerals such as phosphorous, potassium, magnesium, calcium, iron, copper, zinc and manganese (Ibid ,41).

The kernels contain about 6,000 calories per kg compared to; 3,600 calories per kg contained by cereals; 1,800 calories per kg by meat and 650 calories per kg contained by fresh fruits (Ibid). The apple is rich in proteins, vitamin C and riboflavin. A cashew apple has about eight times more vitamin C than an orange (Ibid).

6.5 Forms of Cashew Agroforestry

6.5.1 Potential for Cashew Agroforestry

The best performance of cashews in terms of soil in Western Province has been found to be on the upland areas where soils are relatively more fertile and ground water is more abundant. Cassava, bulrush millet, bambarra nuts and cow-peas have also been shown to grow successfully on the same soils.

In Western Province, cashew trees are planted at wide spacing intervals of 10 x 10 m This spacing is slightly wider than the spacing intervals of 8 x 8 m, practised in India (Kailasam et al., 1986, 8). Since it takes several years before the trees cover all the ground, the interspaces are available for the pursuit of agroforestry through intercropping (see Figure 11). Legumes such as cow-peas, bambarra nuts, pigeon peas and groundnuts can be grown in the cashew interspaces. Soy beans are also suitable intercrops. The ARPT (1991) points out that, "The cashew production system

Figure 11

Cashew estates bordered by strips of natural bushes - Contrast the exposed soil surface in the cashew interspaces with that in the strips of bushland - (August, 1991)

is basically agroforestry which fits in well with the past and future use of the upland sands and will prevent rapid deforestation over (the) next 50 years". This assertion by the ARPT, is an indication of the existence of potential for pursuing cashew-based agroforestry in the Western Province.

6.5.2 Limitations to Cashew Agroforestry

In areas where cashews are grown on slopes of hilly ground, intercropping is difficult because of the presence of terraces. However, this is not a problem in the Western Province where most of the cashew growing is done on flat ground away from slopes. After 7 to 10 years the trees start covering all the land thereby making it impossible to intercrop (Latis, 1989).

Intercropping can be carried out during the initial years before the cashews start flowering and bearing the nuts. Fully grown cashews have canopy that leaves no scope for intercropping because the interspaces are almost crowded out and completely shaded. Heavy leaf fall from cashew trees can also obstruct the germination and growth of other field crops.

Crops that have a deep root system such as the tall varieties of some crops like millet and sorghum can out-compete newly transplanted cashews for nutrients and moisture. The more impoverished the soil, the more difficult it is for cashews that are not firmly established to be able to compete for nutrients and moisture with crops that have a deep root

system. Crops such as cotton when intercropped with cashews, increase the incidence of insect pests such as *Helopeltis* spp. which attack cashew.

6.5.3 Field Research on Cashew Agroforestry

The Cashew Research and Development Project (CRDP) carried out intercropping field experiments with cashew as the base crop. The experiments were carried out for four years from 1986 to 1990, at Simulumbe and Mongu. Among the various crops tried, cassava, millet, cow-peas and bambarra nuts (*Voandzeia subterranea*) were found to be suitable for intercropping with cashews (FAO, 1991). The trials indicated that yields of 14,400 kg per ha for cassava, 400 kg per ha for cow peas and 1,000 kg per ha for millet could be obtained when these crops are intercropped with cashews (Ibid).

The CRDP acknowledged the fact that "cashew has considerable potential as a base crop in agroforestry systems" (FAO, 1991, 11 and Jacob, 1991, 10). The CRDP conducted field trials aimed at developing cashew-based agroforestry models for the semi-arid regions of the Western Province. Two models of the Kalahari Agroforestry System were developed. One model constituted half of a hectare planted at Mabumbu Primary School in 1986 (Ibid). The other model constituted one hectare planted in 1987 at a Forest plantation in Mongu. Among the various forest and crop species experimented with; mango, mungongo, eucalyptus and grevillea were found to grow

suitably well with cashews (Ibid).

In both models, cashews excelled over all other crops and forest species in showing drought resistance potential. The cashew-based agroforestry models performed well. Small holder farmers were reported as having shown willingness to accept the cashew-based agroforestry systems because of the potential benefits in the form of food, fodder, fuel-wood, poles, timber, nuts and raw materials for handicraft items (Jacob, 1991).

6.5.4 Benefits of Cashew Agroforestry

Intercropping during the initial years helps in weed control and fire prevention. It also provides soil cover and protection from erosion. Intercropping concurrently offers economic returns generated by other crops before the cashews start producing nuts. Thus any crop suitable for a given area and soil can be planted between the cashew trees.

Leguminous cover crops have the potential to enrich the soil with plant nutrients such as nitrogen. This can provide tremendous benefits to cashews which need more than three times as much nitrogen as they need potassium and phosphorous (Kailasam et al., 1986). Leguminous cover crops when intercropped with cashews can also add organic matter to the soil and prevent soil erosion. Another benefit from an efficiency stand point is that when fertilisers are used on the annual crops, cashew trees in the intercrop benefit from

the residue.

Benefits of cashew agroforestry do not only accrue to the cashew crop. The cashew trees also have the potential to offer benefits to the seasonal crops and perennial crops such as cassava (see Figure 12). The cashew trees can act as shelter belts that provide protection, to the intercrops, and shade against sunlight and heat particularly during spells of drought.

Given the efficiency of the cashew root system in absorbing nutrients and moisture, cashew leaf litter helps recycle these elements and make them available to the intercrops. This is because the cashew roots are extensive and grow very long such that they reach depths where roots of other crops do not reach. This is further backed by the foliar diagnosis study done by Chibiliti and Latis (1989) which showed that the leaves of cashews in Western Province had normal levels of nitrogen, calcium and iron. This is in spite of the fact that the soils in Western Province are extremely low in nitrogen, calcium and iron. This indicates that elements of nitrogen, calcium and iron that are leached in the sandy soils to inner depths, can be retracted by the cashew roots and recycled through cashew leaf litter.

6.6 Constraints to Cashew Growing and Agroforestry

Constraints to both cashew growing and agroforestry can be categorised into two types. These are:

Figure 12

Cashews intercropped with cassava at Mawawa, Mongu - (August, 1991)

(i) bio-physical constraints and

(ii) institutional constraints

6.6.1 Bio-Physical Constraints

The bio-physical constraints entail limitations such as those mentioned earlier in Section 6.5.2. Due to nutrient deficiencies the sandy soils in Western Province can support only a very narrow range of crops that can be suitably intercropped with cashews. Although crops such as bambarra nuts, cassava, cow-peas, sorghum and bulrush millet can be grown successfully with cashews, many other crops can not grow well in the upland areas. Most crops such as maize, soy-beans, groundnuts and potatoes do not do well on the upland sandy soils on which cashews are cultivated.

Pest and disease infestation of cashews limits both the expansion of cashew cultivation and the attainability of maximum potential yields. Results obtained through the questionnaire and interviews showed that cashew pests and diseases are a serious constraint to cashew growing. These results are summarised in Table 15. As indicated by Table 15, about 97 percent of cashew farmers interviewed and 63 percent of extension workers, identified pest attack and disease infestation as a serious problem. This is one of the most critical problems faced by farmers. Farmers complained of the non-availability of sprayers and chemicals for use against cashew pests and diseases. One farmer in Malengwa,

TABLE 15

MAJOR CONSTRAINTS FACING CASHEW GROWING AND DEVELOPMENT AS INDICATED BY THE QUESTIONNAIRE AND INTERVIEWS.

CONSTRAINT	PERCENTAGE OF EXTENSION WORKERS	PERCENTAGE OF FARMERS
1. Transport	89	29
2. Equipment	57	14
3. Protective clothing	26	10
4. Staff Accommodation	5	0
5. Lack of incentives	5	19
6. Poor access to loans	11	19
7. Poor delivery of seedlings	42	14
8. Inadequate market for raw nuts	5	5
9. Lack of residential courses for farmers	5	5
10. Pests and diseases/Lack of sprayers and chemicals	63	95

CONSTRAINT	PERCENTAGE OF EXTENSION WORKERS	PERCENTAGE OF FARMERS
11. Lack of interest from farmers	11	0
12. Lack of attention from cashew specialists	11	0
13. Lack of coordination with Forestry Department	5	5
14. Inadequate rains/water supply	42	38
15. Inadequate training for extension workers	0	5
16. Land tenure/inadequate land	0	10
17. Poor remuneration of staff	0	10

Mr. Kaulembe expressed his sentiments saying that, " we are not asking for free government hand-outs of sprayers and chemicals, we simply want these items to be available in order for us to buy and use them."

Literature by ARPT (1991), Eijnatten (1983), FAO (1991) and Latis (1989) also identified pest attack and disease infestation of cashews in the Western Province as a problem that needs to be addressed in the management of the cashew plants. Pests that cause the most serious problems are; cashew nut weevil (*Mecocoynus loripes*), thrips (*Selenothrips rubrocinctus*) and tea mosquito (*Helopeltis* spp.), (Horticultural Section). With regard to disease infestation, the most serious diseases that attack cashews are; powdery mildew (*Oidium* sp.), damping off of seedlings (*Phytophthora palmivora*), die-back or pink disease (*Corticium salmonicolar* or *Pellicularia salmonicolor*), anthracnosis (*Colletotrichum gleeosporioide*) and inflorescence blight (*Gloeosporium mangiferae* and *Phomopsis*) (Ibid). Other pests include root-borers (*Plocaederus ferrugineus L.*), leaf-miners (*Acrocercops syngramma M.*), leaf and blossom weber (*Macalla moncusalis W.* and *Orthaga exvinacea H.*), and the cashew stem girdler (*Paranaleptes reticulator*), (see Table 16).

According to Latis (1989) the most serious pests and diseases that attack cashew trees in the Western Province are; powdery mildew, stem-borers and tea mosquito. The ARPT (1991) identified mildew and anthracnosis as the two most critical

TABLE 16

MAJOR PESTS AND DISEASES THAT ATTACK CASHEW

Common Nam	Biological Name	Description	Symptoms and effect on cashew
Pests			
Tea mosquito bug	*Helopeltis* Spp.	Reddish brown mirid bug appears when new flushes and panicles emerge	Sucks sap from tender shoots, floral branches, tender apples and immature nuts. Tissues around attacked portions develop necrotic patches - Can lead to drying up of the shoots - Attack on flower branches results in inflorescence blight - tender fruits and immature nuts develop eruptive spots and shrivel up - Can lead to crop loss.
Stem and root borer	*Plocaederus ferrugineus L.*	Dark brown longicorn beetle - lays eggs in crevices of loose bark in the trunk	Grubs hatched from eggs bore into the bark - feeds on the tree - result is the presence of small holes in collar region, oozing out of gum, etrusion of chewed up fibres and the excreta, discolouration of the bark, yellowing and shedding of leaves - eventual death of the tree.
Leaf miner	*Acrocercops syngramma M.*	Silvery grey moth - produces caterpillars	The caterpillars mine through the tender leaves - severely damages new leaves.
Leaf and blossom weber	*Macalla moncusalis W.* and *Orthaga exvinacea H.*	There are two species of these leaf and shoot webbing caterpillars	These caterpillars web the shoots and inflorescences - remain inside and feed on them - the webbed portions eventually dry up.
Cashew nut weevil	*Mecocoynus lorlpes*	Dark grey crawling insect - lays eggs on the trunk of the tree	The larva tunnels beneath the bark of the tree and eats the sapwood - results in small holes on the trunk and main branches - also brown/black sawdust mixed with gum exuded by the tree - attacked trees have sparse foliage or dried wood.
Cashew stem girdler	*Paranaleptes reticulator*	Longicorn beetle - has dark brown head and thorax - has orange with large black patched wing cases	Girdling and egg laying take place only during the dry season - the hatched larvae tunnels into the wood of dead branches for pupation in a prepared chamber - result is branches of the tree are damaged.
Thips	*Selenothrips rubrocinctus*	Dark brown insect	Sucks and scrapes the leaves - causes yellowish patches that merge and turn grey - seriously attacked leaves fall off.

Common Nam	Biological Name	Description	Symptoms and effect on cashew
Diseases			
Die-back or pink disease	***Corticlum salmonicolor*** and ***Pellicularia salmonicolor***	Prevails during the rainy season	Affected branches nitially have white patches on the bark - later the fungus develops a pinkish growth - the bark splits - and peels off - affected shoot starts drying up from the tip.
Damping off of seedlings	***Phytophthora palmivora***	Fungi attack of roots and collar region of tender seedlings Occurs in nurseries when drainage is poor and the soil becomes waterlogged	Affected seedlings become pale and show water soaked girdles of darkened tissue around the stems - the seedlings eventually droop and die.
Anthracnosis	***Colletotrichum gloeosporioides***	Caused by fungus and is also found on mango, citrus, avocado and papaya - high precipitation activates the pathogen	Infection occurs on tender leaves, twigs, inflorescence, nuts and apples - symptoms are reddish brown water soaked lesions, with brown exudate oozing from these spots - tender leaves crinkle, nuts and apples shrivel - can result in sudden death of the shoots.
Powdery mildew	***Oidium Sp.***	White or grey-whitish fungus	Attacks twigs, inflorescences and young nuts during the dry season - symptoms are grey-brownish spots on tender leaves, covered by whitish mould - surrounding leaves become yellowish and curled - if flowers are affected, the receptacle becomes grey - flower dries without setting fruit - growing fruit can become false fruit - the nut is depreciated by corky spots - and black spots on the kernel - can lead to total loss of production.
Inflorescence blight	***Gloeosporium mangiferae*** and ***Phomopsis anacardii***	Caused by fungi that are only saprophytic colonisers - not pathogenic	Characterised by drying up of floral branches - minute water soaked lesions appear in initial stages - lesions turn pinkish brown - affected inflorescences dry up and show a scorched appearance.

Sources; Horticultural Section, Kailasam et al., (1986) and Latis (1989).

cashew diseases in the Province. These diseases are particularly common in wet years, when early rains coincide with the flowering season. The ARPT (1991) also identified stem borers as the major pest that attacks cashew in the Province.

In the absence of effective plant protection, the result is severe losses in nut production. As one of the ways of controlling disease infestation, it is recommended that the basal branches and suckers of plants are pruned because they are the site of constant infection by powdery mildew. Integrated Pest Management Techniques (IPM) have to be used to control pests and diseases. This involves a combination of chemical spraying and effective management in terms of right spacing, pruning and weeding in order to control pests and diseases (National Research Council, 1986, 361). Besides pests and diseases, another bio-physical constraint cited by farmers is the long gestation period that cashews take before they start bearing nuts. This can result in some farmers being less than enthusiastic in concentrating most of their efforts on cashew growing and management at the expense of other income generating activities.

6.6.2 Institutional Constraints

Institutional constraints are mostly rooted in the undeveloped nature and relative government neglect of Western Province in comparison to other provinces in Zambia. In other

provinces such as Eastern, Northern, Luapula, Copper-belt, Central, Lusaka and Southern provinces almost all districts are linked to provincial headquarters and the rest of the country by all-weather roads.

In Western Province, However, by 1991, Kalabo, Lukulu and Sesheke were still not linked to Mongu by all-weather roads. In 1991 Extension Services of the Department of Agriculture in all the six districts of the Province did not have even a single vehicle. The poor road conditions in the Western Province combined with lack of financial resources to secure four-wheel drive vehicles results in acute transportation problems that hamper many development activities such as cashew growing.

As illustrated by Table 15, about 90 percent of all extension workers who responded to the questionnaire and interviews identified transportation difficulties as the most serious single problem. The sandy terrain combined with large geographical areas of coverage, makes the absence of four-wheel drive vehicles extremely difficult for agricultural extension services to function effectively. The lack of vehicles at district level makes it difficult to coordinate and implement extension service operations. Gils (1988) also identified inadequate transport as a serious constraint to the delivery of extension services. At Ward and Camp level, the lack of motor bikes and bicycles among Ward and Camp agricultural extension workers minimises their mobility. One

extension worker in Ushaa, Mr. Mubiana Mboo stated that, "the lack of transport combined with the wide dispersal of farmers makes it difficult for us to follow up on trained farmers and check on how they have put the training to practical use." Most of the camp officers travel on foot when carrying out their field work over large geographical areas (see section 6.3.4). Consequently access by farmers to extension services becomes limited.

As indicated in Table 15, about 30 percent of the farmers interviewed identified transportation difficulties as one of the major constraints. As mentioned in Chapter 4 (section 4.1.8), the lack of vehicles or some form of public transport combined with poor road conditions particularly during the rainy season makes it difficult for farmers to either obtain supplies or market their produce. One farmer in Nalusheke village (about 50 km from Mongu town), Mr. Frederick Katanekwa observed that, "the road leading to our area is not in a good condition so as to attract private transporters who can provide us with transport to have access to the market, especially for our mangoes." The transport problem is even more critical for farmers and other residents of Kalabo district further west who are separated from the rest of the Province and the country by the Zambezi River and its flood plain.

Another institutional constraint pertains to custom and tradition. As explained in Chapter 4 (section 4.1.5), the

land tenure system under practice is dominated by customary law. All land available for cashew growing in the Province falls outside the jurisdiction of district councils. The authority of district councils over land tends to be limited to the perimeter around district headquarters (Boma). The dominance of custom in land allocation undermines the expansion of cashew growing. Although only ten percent of the farmers interviewed identified the land tenure system as one of the constraints, senior agricultural officials expressed concern at the rigid manner in which land is allocated. The Cashew Development Officer, Mr. Akalemwa pointed out that, "the land tenure system under practice results in a problem of limited fields not only for cashew but also for cassava, bulrush millet and cow-peas."

The existing traditional land tenure system undermines the commercial expansion of the cashew industry. It only results in fragmented pieces of cashew estates on land owned by small holder farmers. In the absence of special waivers as in the case of ZCC, land is only allotted in small chunks and without title deeds. Unused land either belongs to absentee landlords or is under the custody of local traditional chiefs and is not easily accessible to potential cashew farmers.

Other significant constraints identified by both extension workers and farmers include; poor access to loans, untimely delivery of seedlings by suppliers and inadequate rains during the planting season. With regard to poor access

to loans, the Provincial Horticultural Officer at the time, Mr. Muhau Mataa stated that, "Lima Bank has a very indifferent attitude towards cashew farmers, they either reject the loan applications or reduce amounts applied for thereby frustrating the farmers." A farmer in Lusinde village, Mr. Mwakamui Lukama complained that, "stumping is very difficult and costly, loans should be provided for this purpose." Overall, however, transport problems as well as pest and disease infestation combined with the lack of sprayers and chemicals are the two most serious constraints. The net effect of these constraints is that cashew growing and development as well as yields are undermined. Consequently the prospects of enhancing cashew-based agroforestry systems also become undermined.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Review of Potential for Cashew Agroforestry: Conclusions

7.1.1 Bio-physical Potential

(i) The soil and other ecological conditions in the Western Province are suitable for the pursuit of cashew-based agroforestry. The potential for cashew-based agroforestry as a function of cashew growing was established by studies done under the auspices of the FAO. The feasibility of growing cashews in terms of suitability of soils and climate is supported by F.A.O studies (see Section 5.2.1). The feasibility of cashew growing and the fact that there are some food crops that can be intercropped with cashews offer scope for multi-cropping practices that can promote cashew-based agroforestry. Crops found suitable for intercropping with cashews are; bambarra nuts, cow peas, cassava, bulrush millet, soy beans and pigeon peas. Although these crops are few, they offer good potential for cashew-based agroforestry. This is supported by field trials (see Section 6.5.3).

(ii) Intercropping of cashews with cassava or some of the seasonal crops is the basis for cashew agroforestry practice. Intercropping can be practised for the first 7-10 years before the cashews out-grow the interspaces. Availability of the interspaces after about 10 years, can be achieved through

manipulation of spacing, early coppicing and the use of dwarf varieties for planting material. Extensive cattle rearing in Western Province also offers a base for a stable supply of cattle manure which can be used to supplement the organic and nutrient content of the soils. This linkage of the cattle industry to cashew growing in turn enhances the fundamental principles of agroforestry.

7.1.2 Institutional Framework

Existing government functionaries of the Departments of Agriculture and Forestry dealing with seasonal crops, horticultural crops, animal husbandry and forestry, provide the institutional set up through which cashew agroforestry can be promoted. These institutions provide an existing framework for government support and articulation of cashew-based agroforestry. The pursuit of cashew-based agroforestry does not require the establishment of any new government institutions. Branches of government that traditionally deal with crop husbandry and agroforestry, merely take up an added dimension by focusing part of their efforts on promoting cashew agroforestry.

The pursuit of cashew growing and agroforestry requires a reorientation of Extension Service goals and adopted techniques. Such a reorientation has to articulate practices entailing cashew intercropping as a top priority. More coordination is also required to ensure efficiency in

implementing activities. There should be stream-lining of functions and apportioned responsibilities among the branches of Agriculture Extension, Research and Forestry to avoid possible duplication and wastefulness. For instance, the role of each branch or unit in terms of achieving specific targets should be clearly spelled out.

7.1.3 Economic Potential

(i) Cultivation of cashew nuts in the Western Province is economically viable. The international market for cashew nut kernels offers export potential for cashew produce from Western Province. Given the fact that cashew cultivation is labour intensive relative to the use of capital implements, it offers more returns than the costs of establishing the cashew plantations (see Chapter 6, 6.4.1). Although kernel processing is a significant production cost, the high prices fetched by the kernels in the export market makes it economically viable for cashew nut cultivation in Western Province.

(ii) Cashew agroforestry through intercropping can lead to economic efficiency. When intercropping is introduced in the cashew fields it does not exacerbate investment costs since the fields have already been cleared for cashew cultivation. The same resources that would have been expended on the annual crops in separate fields are merely relocated to the cashew fields. Intercropping enhances the efficient use of resources

by enabling farmers to combine several crops on the same piece of land. The gross margins for combined cashew and cassava cultivation, illustrate the efficiency of intercropping (see Section 6.4.1). Intercropping practices enable the maximum use of labour and implements to produce more than one crop on a given piece of land. Efficiency is also realised through the recycling of nutrients.

7.1.4 Perceptions of Farmers

(i) Farmers have responded positively to cashew growing. The majority of the 10,000 farmers, who are taking up cashew cultivation are emergent small scale farmers (semi-commercial farmers). These are the type of farmers attempting to combine subsistence scale farming activities with semi-commercial farming operations. These farmers, as assessed from the interviews and the trend in cashew nut production as well as cashew trees planted, have shown a lot of interest in cashew nut cultivation. From 1986 to 1991, cashew nut production in the Western Province increased from 2 mt to 116 mt. This represents an increase of 5,700 percentage points or 58 times within a period of only five years. In 1985/86 there were only 16,000 cashew trees. In the 1990/91 growing season the number of cashew trees planted by small holder farmers had increased to 643,000. Thus in a period of five years, cashew trees of small holder farmers had increased by about 4,000 percent or 40 times. This interest is a result of perceived

rational expectations of the high returns to be generated from cashew nut production. Public information campaigns have aroused a lot of awareness and interest among farmers regarding the prospects offered by cashew nut growing.

(ii) Farmers are capable of switching from cashew monoculture to intercropping. Most of the farmers who have ventured into cashew nut cultivation have taken up cashew growing as a supplementary economic undertaking. These are subsistence farmers who have been growing cassava, millet, sorghum, bambarra nuts, maize, pumpkins and vegetables as their main source of subsistence. Others also rear traditional livestock such as cattle and chickens and under these circumstances it is possible to reorient some of the practices of these farmers from cashew monoculture to intercropping with seasonal crops. Intercropping itself is not a new practice to the farmers. Traditional crops such as maize are intercropped with pumpkins, watermelons, and groundnuts while cassava is usually intercropped with millet, sorghum and bambarra nuts. In this regard, the pursuit of cashew-based agroforestry will be introducing some familiar practices to the farmers.

7.2 Zambia Cashew Company (ZCC): Conclusions

(i) The Zambia Cashew Company (ZCC) plays a very significant role in the development of the cashew industry in Western Province (see figures in Section 5.3.4). Besides offering

extension services to farmers during the initial years of its inception, ZCC continues to be the only commercial enterprise that purchases cashew nuts from farmers, processes the nuts and exports the kernels to international markets. The ZCC's Agricultural department conducts independent agronomic research on improving the genetic attributes of cashew planting material. It has a grafting programme and selects its own planting material. The Company sells 75 percent of its seedlings to small holder farmers (ARPT, 1991).

(ii) If the ZCC switches from cashew monoculture to intercropping, its intercropping practices would be emulated by farmers. Apart from specific activities, ZCC has also exerted a lot of influence on existing and emerging cashew farmers through its activities on the ground as well as its public information campaigns. The large scale nature of ZCC plantations go a long way to reassure cashew farmers that the cashew industry can offer lucrative business opportunities. The practices applied by ZCC in its plantations are keenly followed by many farmers. Given the prominent role that the ZCC continues to play, adoption of intercropping of cashews with other crops on the part of the company could also help in promoting cashew-based agroforestry in the Province. Negotiations between the government and ZCC as well as fiscal policy could be used to induce ZCC to adopt intercropping.

7.3 Recommendations

1) Cashew should be grown as an agroforestry crop rather than as a monoculture. This is in line with the bio-physical potential for cashew agroforestry, and more consistent with sustainable development objectives.

7.3.1 Research

2) Research should be directed at developing cashew varieties and planting methods that can fit well into intercropping practices, and appropriate moisture conservation techniques. Research undertaken by the Regional Research Station of the Department of Agriculture plays a vital role in cashew cultivation. Agronomic research on cashew has mainly focused on developing progenies or cashew varieties that are best suited to the conditions in Western Province, are capable of producing maximum yields without compromising the quality of the nuts and are resistant to pest attack and disease infestation.

Because of rainfall seasonality and low overall precipitation, intercropped species can also help retain soil moisture. "Green mulching" with nitrogen-fixing species such as bambarra nuts can also help increase soil nitrogen and organic matter. Research should focus on finding more appropriate species and techniques that can enhance green mulching.

Cashew research should continue to be supported by government and other private institutions. This is because of the need to have cashew varieties with improved genetic qualities that offer more returns and less risks to the farmer. However, the criteria followed to develop suitable progenies should be expanded to include the selection of dwarf varieties that offer high yields and at the same time are disease resistant; dwarf varieties also offer more space for intercropping. Research should also continue to investigate the best spacing and combination of crops that can be intercropped with cashews. Technical details of the correct timing for planting and spacing of specific crops in the intercrops should be worked out.

7.3.2 Extension Services

3) **Extension Services should concentrate on cashew growing methods that emphasize intercropping practices.** Extension Services play the most critical role in disseminating new and improved practices to farmers. Cultivation methods embodied with innovations from research and reflecting both government policy and strategies are conveyed to farmers through Extension Services. The articulation of extension practices and methods as well as the efficiency with which they are implemented, in turn determine the extent to which farmers adopt farming innovations.

If Extension Service approaches focus on making cashew growing a form of agroforestry intervention through intercropping, then this goal can be passed on to farmers. Extension Service is the only government institution, apart from primary schools, well placed to be able to extensively reach all farmers within the shortest possible time. It is thus the institution best suited to reorienting farmers from undertaking cashew cultivation as a monoculture, to intercropping cashews with other crops.

In order to encourage farmers to adopt cashew intercropping, all forms of extension services including mobile courses (training sessions by mobile extension service teams), residential courses, training and visit (T and V), field days as well as demonstration fields should emphasize cashew intercropping as a basic message that runs parallel with technical messages on cashew planting and management. The stages in the growth of the cashew plants at which specific types of crops can be introduced, as intercrops, should be explicitly conveyed in the extension messages.

7.3.3 Transport

4) Transportation problems constitute a major constraint and therefore there is need to address them in future studies. Transportation in terms of road infrastructure and vehicles play a vital role in the delivery of inputs as well as the collection of produce in the agriculture sector as a whole.

Consequently transportation has a very significant impact on the effectiveness and success of cashew growing and marketing operations. In order to promote cashew based agroforestry, transport has to be accessible to cashew farmers in all the out-lying remote areas.

5) **Future studies on transportation problems should focus on improving routes linking up producer communities with district centres and marketing centres.** The most isolated and cut-off farmers are those located in Kalabo district across the Zambezi flood plain. Priority should therefore be given to linking up Kalabo with Mongu district by an all weather trunk road. This should be followed by improving major routes on sandy terrain such as the one linking Mongu to Ushaa. Apart from constructing a raised tarmac road across the Flood Plain between Mongu and Kalabo, all the other major roads and routes could merely be improved by using gravel.

7.3.4 Pest and Disease Control

6) **Pest and disease infestation of cashews should be controlled by integrated pest management techniques.** While there is on-going research to propagate cashew species that are more resistant to pest attack and disease infestation, there is need for short term solutions that can help alleviate the current set backs imposed by pests and diseases. As Latis (1989) also recommended, a combination of appropriate management in terms of correct pruning and weed control as

well as chemical spraying, the IPM approach, need to be used extensively to combat pests and plant diseases. Pest and disease infestation is mainly caused by stem borers and mildew, respectively. Just as the ARPT (1991) also recommended, applying white wash on the tree trunks of the cashew can help eliminate the stem borers. Five treatments per year of organic sulphur can reduce infestation by mildew to tolerable levels (ARPT, 1991). White wash and organic sulphur are natural products which, unlike insecticides and fungicides, are not harmful to the environment. Organic sulphur is mixed with water and applied using sprayers. This method is much safer and uses less organic sulphur than the dusting method used in Tanzania (ARPT, 1991).

7) **It is recommended that cashew farmers form an association whose mandate would be to represent the interests of the farmers with regard to institutions that market agricultural inputs and produce.** Although many cashew farmers are prepared to use chemical sprayers to control pest and disease infestation, sprayers and chemicals are not available from the regular stockists and suppliers of agricultural inputs. As indicated in Chapter 6 (Section 6.7.1) and Table 15, farmers complained of the lack of sprayers and chemicals for use against pests and diseases. The proposed cashew association would adopt strategies aimed at encouraging agricultural cooperative shops and other suppliers to stock chemical sprayers and the right type of chemicals. If financial

resources are inadequate for purposes of procuring chemicals and sprayers, the association should devise means of generating funds both from potential beneficiaries and any other forth coming sources such as loans, donations and grants.

7.3.5 Credit Provision

8) The government should offer some loan guarantees to cashew farmers through the local financial institutions. Part of the loans should be available to the cashew farmers as monetary disbursements to cover labour costs and cashew seedlings.

Accessibility to credit is vital for the cashew farmers in order to enable them to finance the acquisition of some of the inputs. As explained in Chapter 4 (Section 4.1.6), credit is not easily accessible to farmers, particularly for non maize crops. Government financial support to the cashew industry would be justified in the long-run by the vital role that the cashew industry would continue to play in terms of employment generation and overall economic growth.

9) Criteria should be worked out for determining eligibility for cashew loan schemes. In order to ensure that the proposed cashew loan scheme is accessible to committed cashew farmers who also have the potential capacity to repay the loans, a criteria has to be established for determining eligibility to the scheme. Such a criteria should be

developed jointly by the government, the local financial institutions as well as representatives of the cashew farming community, both medium and small scale. The fundamental principle that the criteria should be embodied with is the identification of potential capacity for an individual farmer in terms of previous efforts and performance, size of prepared land and recorded performance in related undertakings as the basis for determining collateral security. Computations should be made for such potential capacity so that equivalent monetary values are attached to all the factors that count as indicators of collateral security.

7.3.6 Delivery of Inputs

10) As Eijnatten (1984) recommended, cashew tree-nurseries should be established at all Primary schools in areas earmarked for cashew growing. The Regional Research station should involve the Extension Services branch, who have field workers in all the camps, to establish and operate cashew tree-nurseries. Delivery of inputs, specifically cashew seedlings distribution was cited by most of the farmers as an undertaking that is currently being done very inefficiently (see Table 7). Some farmers complained of the seedlings being delivered late, while for others insufficient quantities of seedlings were delivered. Some remotely located villages have no access to the distribution of cashew tree-seedlings.

Although poor road conditions and other transport problems are a major factor in causing the poor delivery of inputs such as seedlings and chemicals, poor planning is also a major contributing factor. In the long-run alleviation of transport problems would help improve the distribution of inputs. Cashew tree-seedlings are raised at nurseries located at district headquarters, with the exception of Namushakende and Simulumbe in Mongu. Lukulu, Kalabo and Senanga (Itufa) have one nursery each. Therefore, from a management perspective, distributional problems could be eased by mere decentralisation of the cashew tree-nurseries. Nurseries should be started in each Agricultural camp, with some of the big camps establishing more than one nursery.

7.3.7 Land Tenure

11) To enable existing cashew farmers and potential cashew farmers to obtain land title deeds, the Land Tenure Act (1970) and other statutory laws such as the Land Acquisition Act (1960) as well as the Land Reform Act and the Township and Country Planning Act (1979) should be strictly enforced in the Province. In order to encourage the expansion of cashew growing and consequently cashew agroforestry, land should be easily accessible (see Chapter 4, Section 4.1.5). Both cashew farmers and potential cashew farmers should be able to acquire any idle land and obtain title deeds for such pieces of land. The title deeds should be transferable to a third party.

Land belonging to either the state or traditional chiefs should first and foremost be recognised as economic property that can be owned and sold. It should be made possible for land to be sold or leased out to a third party. Negotiations should be effected between the state and the traditional chiefs aimed at ensuring that land is leased out with title deeds. Lease rates on such land should be paid by the holder of the title deeds to either the state or the traditional chiefs, depending on the jurisdiction under which a particular piece of land belongs.

The Lands Department, the traditional chiefs, the District councils and the Judiciary should be the central players in working out ways through which the land tenure system currently under practice could be reformed. The subordinate nature of customary law in relation to statutory law should be reasserted through enforcement and education of the Local Courts' Judges, Traditional Chiefs and the Public.

7.4 Concluding Note

The literature research and 1991 field surveys showed that there is good potential for undertaking cashew-based agroforestry. However, this potential is limited to the initial 7-10 years or so of any cycle before the cashew trees outgrow the interspaces. Despite this limitation, this potential should be exploited to the full.

The ecological benefits from cashew-based agroforestry include, improved nutrient cycling (see Sections 6.3.3 and 6.5.3), provision of green manure and organic matter, prevention of soil erosion, provision of shade to reduce weeds for the intercrops and provision of biologically fixed nitrogen when legumes such as bambarra nuts are used as intercrops.

However, the conventional farming practices of monoculture and agricultural intensification under which cashews are cultivated have the net negative effect of soil degradation. In order to promote sustainable agriculture, government support services such as Agriculture Extension should seize the opportunity already offered by the cashew nut growing and development industry. Cashew-based agroforestry practices should be promoted. To this end it is recommended that the Permanent Secretary in the Ministry of Agriculture and Fisheries, should consider the findings of this study and institute appropriate measures that would promote and enhance cashew agroforestry in the Western Province of Zambia.

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Appendix

ISSUES AND QUESTIONS USED IN DATA COLLECTION

Appendix A

(A) **Interviews**

(1) Interview Guide for Officials and Technical Experts

The following issues constituted the basis for interviews with government officials and agricultural experts.

(A) Extension Practices

1. General Agricultural goals and policies.
2. Goals and targets of extension services.
3. Objectives of Extension services regarding cashew growing and development.
4. Agricultural goals and Policies pertaining to cashews
5. Strategies for meeting (stated) objectives.
6. Administrative structure of cashew extension services.
7. Areas of focus in research on cashews.
8. Socio-economic conditions in the Project area.

(B) Farming System

1. Population densities
2. Number of cashew farmers.
3. Factors of production/inputs necessary for cashew growing.
4. Agronomical features of the cashew crop.
5. Cashew field or plantation sizes.

6. Number of cashew trees per field area. (acre/Hectare)
7. Constraints to cashew growing.
8. Cashew production figures.
9. Medium term and long term impact of initiated cashew programs on cashew prices.
10. Intermediate and Long-term viability of cashews in terms of market availability and ability to produce.
11. Agriculture contribution to GDP, share of cashews in total agricultural production.
12. Cashew impact on other crops, land management farmers socio-economic conditions e.t. c.
13. Cashew demand patterns and sustainability of production and marketing conditions.

(C) Agronomical Features of Cashews

1. Categories/break down of agricultural workers involved with cashews.
2. Cropping systems - traditional and those propagated by extension services.
3. Farming methods in the project areas.
4. Methods and activities of general agriculture extension services.
5. Methods and activities of agricultural extension services specific to the growing of cashews.
6. Cropping systems specific to cashew.
7. Number of demonstration fields and sizes.

8. Types and frequency of field days.
9. Land use systems - traditional versus those promoted by extension services.
10. Constraints to extension services.

(D) Cashews and Conservation

1. Ecological degeneration - draught, soil degeneration and related problems in the project area.
2. Soil and land conservation aims and practices.
4. Strategies for soil conservation.
5. Set aims or goals regarding Agroforestry in the project area.
6. Links with agroforestry research.
7. Crops competing with and complimentary to cashews.
8. Potentials and prospects for other crops.
9. Role and significance of vegetative regeneration of soils in the project area.
10. Role and significance of crop residues in the farming systems of Western Province.
11. Specific strategies on land management.
12. Forestry goals and programs in the project area.
13. Programs and practices on afforestation.
14. Uses of forest and wood products.
15. Impact of wood fuel and charcoal in project area.
16. Impact of cashew schemes on natural forests and bush land. Extent and magnitude of forest displacement.

17. Potentials and prospects for cashews.

(F) Major Environmental Factors

1. Distinct physical and agro-ecological features of the project area.
2. Natural problems in the Project area; soil erosion, leaching, permeability, drought, flooding e.t.c.
3. Forestry - sizes/ types e.t.c.
4. Agro-ecological conditions of the project area.
5. Perceptions of agroforestry.

(2) Standardized Interview Questions For Extension Workers

(A) Extension Practices

1. How large is your area of jurisdiction?
2. What is the total population in your area?
3. How many cashew farmers do you service in your area?
4. What is the total area planted with cashews in the area you oversee?
5. How many cashew trees do you have in your area?
6. What kind of services do you offer to cashew farmers?
7. What type of farming methods do you encourage cashew farmers to use?
8. How frequently do you have contact with your farmers?
9. Do you have Demonstration fields?
10. How do farmers respond to your activities?
11. Are you satisfied with the current methods of growing

cashews?

12. Is your work different in any way from that carried out by other workers in your area, if any?
13. What kind of problems are faced by cashew extension services in general?
14. What main problems do you face as a cashew extension worker?

(B) Conservation Options

1. Has your area ever been affected by draught over the years?
2. Do you have any problems related to soil degeneration?
3. Are you satisfied with the way the land is used in your area?
4. Are there any ways that cropping systems in your area can be improved to help soil conservation?
5. Are the uses of tree and wood products well balanced with natural replenishment?
6. Role and significance of crop residues in farming systems of Western Province
7. How do cashews relate to other crops in your area (in terms of competition and complementarity)?
8. Can cashews help in any way, regarding the productivity of the land?
9. How are trees and wood products used in your area of jurisdiction?
10. What suggestions do you have about land use in your area?

11. Should your work concerning cashews have any thing to do with soil conservation?
12. Are there any agroforestry practices in your area?
13. Should your work have anything to do with forestry?
14. Does the existing land tenure system have any effect on soil conservation?

(C) Major Environmental Factors

1. Have there been any noticeable changes to the surrounding vegetation over the years?
2. Have the rainfall patterns been consistent over the years?
3. What other observations do you have concerning cashews?

(3) Standardized Interview Questions For Cashew Farmers

(A) Farming system

1. How long have you been growing cashews?
2. What methods of cultivation do you use?
3. What factors of production or inputs do you use for cashew cultivation?
4. How many people offer labour services to your cashews per day/week/month/year?
5. How large is your cashew stock, field size / number of trees?
6. How old are your cashew trees /fields?
7. How much cashew do you harvest per tree/ year?

8. Do you have problems in selling your cashews?
9. Do you get enough for your cashews?
10. How much does it cost you to grow and manage your cashews per tree or land size?
11. What do you do to improve the fertility of your fields?
12. What other crops do you grow? Range ? Land size? Output?
13. Can your cashews be intercropped with other crops? if any, Does this affect your produce in any way?
14. What problems do you face concerning cashew growing?

(B) Extension Practices

1. Do you get help from agricultural extension workers? In what ways? How often?
2. What methods of cultivation and land management do you learn from extension workers?
3. Have you attended field days in the past? How many? What were they focusing on?
4. Have you attended any workshop or similar activity to learn about farming methods? If any, what was it about?

(C) Cashews and Conservation

1. Have you suffered from drought over the years? if any, how did it affect your crops?
2. Do you have problems of soil degeneration? erosion? leaching?, e.t.c.
3. Have cashews changed the way you use the land in any way?

4. How are trees and wood products used in your area?
5. What do you think can be done to balance up the needs of people and the growth of vegetation in your area? How, if any?
6. What other benefits or uses do you think you can get from cashews?
7. What do you do to help conserve the soil?
8. What do you do to help conserve trees?
9. What other observations do you have concerning cashews and the land?

(D) Major Environmental Factors

1. Have the soil conditions in your fields changed over the years? In what ways?
2. Have you observed any linkage between drought and the vegetation in general? Explain?
3. Have there been any effect of cashew growing and other cultivation activities on the natural vegetation?
4. Are there any other concerns with regard to the environment?

Appendix (B)

(B) QUESTIONNAIRE FOR CASHEW EXTENSION WORKERS

PLEASE KINDLY FILL IN THIS QUESTIONNAIRE AS BRIEFLY AS POSSIBLE.

WHERE NECESSARY USE THE BLANK SPACE ON THE BACK (FLIP) SIDE.

NAME:----------

RANK:----------

LOCATION (NAME OF CAMP OR BLOCK/WARD):----------

NUMBER OF MONTHS OR YEARS EMPLOYED AS AN EXTENSION WORKER:----

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(A) Extension Practices

1. How large is the area you oversee?

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2. What is the total area (size) under cashew cultivation in your area of jurisdiction (area you oversee)? ---------

3. What size of area is earmarked to have cashew trees?----

4. What is the total population in your area of jurisdiction?

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5. How many cashew farmers do you oversee?----------

6. Approximately, what is the total number or range of cashew trees in your area of jurisdiction?----------

7. How many forms of extension activities do you carry out? Mention them?----------

8. What are your day-to-day duties regarding cashews?------

9. Indicate if there are other field workers in your area of jurisdiction carrying out similar activities to the ones you do? Mention variations (differences) if any?---------

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10. What methods of farming/cultivation do you encourage cashew Farmers to use?----------

11. Are you satisfied with these methods?---------. Give reasons----------

12. How many demonstration fields do you have if any?--------

What are there sizes?----------

13. Approximately how many times per year or month, on average, do you come in contact with a cashew farmer(s)?-

14. How often do you have cashew field days if any?----------

15. What major problems concerning your work, do you face as a field worker?----------

16. What other problems do extension services, towards cashews, face?----------

(B) <u>Cashews and Conservation</u>

1. What problems do you think, cashews cause on the land?

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2. Do you think the land is used properly in your area?----

3. If Yes, How?----------

4. If No, Why?----------

5. Do cashews affect the cultivation of other crops in your

area?----------. How, if any?----------

6. Is there a way cashews can help the surrounding vegetation and the soil in your area?----------. How, if any?------

7. Does your work relate to soil conservation?-------. If Yes, in what ways?----------

8. Should your work regarding cashews have anything to do with soil conservation?-------. Give some reasons if any?---

9. Does your work relate to forestry?------. If yes, How?----

10. Should your work have anything to do with forestry?------. Give some reasons if any?----------

11. Do you have any other comments?----------

(C) Major Environmental Factors

1. What is the rainfall situation like in your area? (is it sufficient?)----------. Explain?----------

2. Do you have problems in your area related to soil erosion, leaching, permeability or any others related to the soil?-

3. Has your area suffered from draught in the past?---------- If Yes, Which years?----------

4. Has there been any noticeable change to the surrounding vegetation in your area?------. Do you think it is still growing as well as it used to in the past?----------

5. In what ways do the people in your area use trees and wood products?----------

6. Do you have any suggestions on how these should be used?

7. Do you think enough is being done in your area to balance

up the growth of surrounding vegetation and the activities of local people that affect the vegetation? Explain.----------

8. Do you have any other comments concerning cashews?---------