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AGRO-PASTORAL ACTIVITIES AND ENVIRONMENTAL DEGRADATION IN BOYO DIVISION, NORTH WEST REGION - CAMEROON

A Dissertation defended publicly on the 2nd of August 2024 in partial fulfilment of the requirements for the awards of a Master of Arts (M.A) Degree in Geography

Specialization: Marginality, Strategies of Development and Globalization

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DEDICATION

To my parents, MR and MRS. CHIATOH for their unwavering support and desire to see me attain this level.

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ABSTRACT

Agro-pastoralism is a vital activity in Cameroons economy. It is the main economic booster in Boyo Division as the number of people involved in this sector keeps increasing. Agro-pastoral activities provide employment to the local population and its end product (meat) provide nutrients necessary for the growth and maintenance of the human system. Notwithstanding, the growth of agro-pastoral activities in Boyo is at the detriment of environmental protection as some of the methods and technics used by crop farmers and pastoralists are rather agents of environmental damage. Besides environmental degradation such as water, air and land pollution caused by agro-pastoral activities, the sector is equally faced with a series of challenges ranging from crop failure and diseases. This work seeks to investigate the effects of agro-pastoral activities in Boyo Division.

Three hypotheses were constructed to guide this study. The collection, processing and analysis of data necessary for this study was done through the adoption of feasible research methods and technics. Data was gotten from the review of published and unpublished documents and internet sources, field surveys and questionnaire. Responses were gotten from 129 respondents from 16 villages selected from all the four sub-Divisions that make up the study area. Data was also collected through focus group discussions, interviews and direct field observations.

The verification of hypotheses for this study was done through inferential and non-inferential analysis, from where conclusions, suggestions and policy implementations were drawn. The analysis and interpretation of the collected data revealed that some methods of preparing the soil for crop cultivation such as the slash and burn and the spraying methods negatively affect the environment (table 7 and plate 2). The study equally portrayed livestock rearing as the major form of pastoral activity in Boyo with a total of 42% leaving behind negative footprints such as biodiversity lost, ecological pollution and savanisation. Methods such as extensive animal rearing (29%), small holder mixed farming in small nearby farms (49%) and small-scale ranching within the compound (22%). As concerns land conversion for the expansion of agro-pastoral activities, the study revealed that there has been a remarkable increase in the population of the study area and it's surrounding (plate 5) leading to the conversion of conservation land to accommodate the expansion of agro-pastoral activities. This has further aggravated the environmental conditions as there is continuous encroachment into forested land (plate 7) and changes in land use patterns as well as traditional agricultural patterns to techniques such as the slash and burn method of cultivation all in an attempt to increase output over a short period and also accommodate the increasing demand for land.

Key words: environmental degradation, environmental protection, agro-pastoral activities, agriculture, crop farming, animal rearing.

RESUME

L'agriculture agro-pastorale est une activité vitale dans l'économie camerounaise. C'est le principal stimulant économique de la Division Boyo, car le nombre de personnes impliquées dans ce secteur ne cesse d'augmenter. Les activités agro-pastorales fournissent des emplois à la population locale et son produit final (viande) fournit les nutriments nécessaires à la croissance et au maintien du système humain. Néanmoins, la croissance des activités agro-pastorales à Boyo se fait au détriment de la protection de l'environnement car certaines des méthodes et techniques utilisées par les agriculteurs et les pasteurs sont plutôt des agents de dommages environnementaux et parfois même des conflits agro-pastoraux au sein et autour de la communauté, d'où d'autres dommages écologiques. Outre la dégradation de l'environnement telle que la pollution de l'eau, de l'air et des terres causée par les activités agro-pastorales, le secteur est également confronté à une série de défis allant des mauvaises récoltes aux maladies. Ce travail cherche à étudier les effets des conflits agro-pastoraux dans la Division de Boyo.

Trois hypothèses ont été construites pour guider cette étude. La collecte, le traitement et l'analyse des données nécessaires à cette étude ont été réalisés grâce à l'adoption de méthodes et techniques de recherche réalisables. Les données ont été obtenues à partir de l'examen de documents publiés et non publiés et de sources Internet, d'enquêtes sur le terrain et de questionnaires. Les réponses ont été obtenues auprès de 129 répondants de 16 villages sélectionnés dans les quatre sous-divisions qui composent la zone d'étude. Des données ont également été collectées via des discussions de groupe, des entretiens et des observations directes sur le terrain.

La vérification des hypothèses pour cette étude a été effectuée au moyen d'une analyse inférentielle et non inférentielle, à partir de laquelle des conclusions, des suggestions et des mises en œuvre de politiques ont été tirées. L'analyse et l'interprétation des données recueillies ont révélé que certaines méthodes de préparation du sol pour la culture, telles que les méthodes sur brûlis et les méthodes de pulvérisation, ont une incidence négative sur l'environnement (tableau 7 et planche 2). L'étude a également dépeint l'élevage comme la principale forme d'activité pastorale à Boyo avec un total de 42% laissant derrière lui des empreintes négatives telles que la perte de biodiversité, la pollution écologique et la savanisation. Des méthodes telles que l'élevage extensif (29 %), l'agriculture mixte de petits exploitants dans de petites exploitations voisines (49 %) et l'élevage à petite échelle dans l'enceinte (22 %). En ce qui concerne l'implication de l'augmentation de la population et la récurrence des conflits agro-pastoraux, l'étude a également révélé qu'il y a eu une augmentation remarquable de la colonisation et donc de la population (planche 5) conduisant à l'empiétement des forêts alors que la population se bat pour l'acquisition de nouvelles terres agricoles, un changement dans les pratiques agricoles dans le but d'augmenter la production (ex. méthodes de brûlis par les agriculteurs et brûlis de brousse par les éleveurs) et dans quelques cas (18%), une relocalisation complète vers des villages ou des villes plus prospères.

Mots-clés : dégradation de l'environnement, protection de l'environnement, activités agro-pastorales, agriculture, agriculture, élevage.

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LIST OF ABBREVIATIONS AND ACCRONYMS

ACEFA :	Amélioration de la Compétitivité des Exploitations Familiales Agropastorales
BUCREP:	Bureau Central de Recensement et d'etude de la Population au Cameroun
CAMVENET:	Cameroon Vetiver Network
FALSS:	Faculty of Arts, Letters and Social Sciences
GMT:	Greenwich Mean Time
HH:	Households
IFAD:	International Fund for Agricultural Development
IPCC-SRCCL:	Intergovernmental Panel on Climate Change Special Report on Climate Change and Land
KM:	Kilometres
MINADER:	Ministry of Agriculture and Rural Development
NECOFAC:	Network for Eco Farming in Africa
NGO:	Non-Governmental Organisation
ONCPB:	Office Nationale De Commercialisation Des Produits De Base
SDGS:	Sustainable Development Goals
UN:	United Nations
UNCCD:	United Nations Convention to Combat Desertification
UNDP:	United Nations Development Program
UNEP:	United Nations Environmental Programme
UNISDR:	United Nations International Strategy for Disaster Reduction
VOGASPAD:	Volunteer Group for Agro-Silvo Pastoral Development
WHINCONET:	Western Highlands Nature Conservation Network
WOCAT:	World Overview of Conservation Approaches and Technologies
WWF:	World Wide Fund

GENERAL INTRODUCTION

0.1 BACKGROUND TO THE STUDY

Agro-pastoral activities in most rural areas of sub-Saharan Africa have become very intensive, triggered by rapid population growth, urbanization and economic growth. This has posed a serious threat to the environment. This environment is being pressured and over exploited to meet the food needs of the rapid growth in world's population (FAO, 2015). In densely populated areas, farm sizes have reduced and even become closer to forest zones and areas, which were never being cultivated, leaving farmers to fend for themselves on a more reduced area, which requires agricultural intensification in order to increase yields.

Agro-pastoral activities are dynamic and change over time and space. They englobe all ventures related to agricultural production such as crop cultivation, livestock rearing, apiculture, poultry farming and fish farming with the aim of sustaining livelihood and ensuring food security. Products from agro-pastoral activities are of great importance to the world as it sustains not just rural livelihood but also helps move closer to achieving the Sustainable Development Goals of ending hunger and ensuring better living conditions (SDG number 1 and 2). In Cameroon, apart from achieving these goals, they also contribute enormously in the growth and strengthening of rural economies. More than 70% of the country's working population are engaged in agro-pastoral activities either directly or indirectly as it contributes 44% to Cameroon's GDP, and 30% to its export revenue (ZEF, FAR and IRAD, 2017).

Products from agro-pastoral activities also serve as a source of nutrients to households involved and the entire community at large. Products gotten from animal husbandry such as cattle, fish, and goats and by products including eggs, milk are a great source of proteins to the body. Crop cultivation on the other hand provides the body with nutrients such as carbohydrates, vitamins, proteins and minerals through food stuffs like huckleberry, plantain, maize, cocoyam, potatoes, beans and fruits.

The techniques and methods of exploiting natural resources related to agricultural production are mostly unsustainable and a driver of environmental degradation in most developing countries and rural areas in particular. These activities are practiced in different ways using different methods like intensive crop farming, intensive livestock rearing, slash and burn methods, ranching and many more. Although agro-pastoral activities play a vital role in poverty eradication and food security, their contribution to environmental degradation are as well alarming and a call for concern.

0.1.1 Justification of study

The rural population of Boyo depends largely on crop cultivation and animal rearing for livelihood. Environmental degradation is a cause for concern in these recent times when the world is struggling to conserve, restore and implement the sustainable use of terrestrial ecosystems including forests and land resources, combat desertification, end hunger and alleviate poverty level. From field observations, farmers and livestock rearers have very little knowledge on the environment, how it functions and consequently the effects of their activities on the environment. This piece of work is therefore necessary; to educate the local population on the negative effects of their activities and propose different methods of doing the same activities sustainably.

The local population, administrative authorities and local NGOs are not very much aware of the pressure of agricultural activities on the environment of Boyo. This study analyses the methods of soil preparation and animal rearing methods practiced and how population increase is manifested in Boyo Division. It also brings out the effects of these activities on the environment of Boyo Division. The excess and uncontrolled use of chemical fertilizers coupled with poor agricultural methods like the slash and burn shows there are limited training of the various stakeholders and even agricultural personnel on the field. The findings in this work will create awareness to the stakeholders involved on how to better organize and train farmers and animal rearer on sustainable methods of farming and livestock rearing. It is hoped that the results put forth by this study will serve as a basis for sustainable agricultural practices, which will not just be beneficial to Boyo Division alone but to the entire North West Region and Cameroon at large.

To the ministry of agriculture and Rural Development, the ministry of Livestock, Fisheries and Animal Husbandry together with the ministry of Environment, Nature Protection and Sustainable Development, this work gives detailed analyses on the different agro-pastoral practices and how these activities negatively affect the environment of Boyo such as land degradation, air pollution and watershed depletion. The poor farming methods and techniques used by crop farmers and methods of pasture regeneration by livestock rearer need to be given more attention. Much is still to be done by these ministries to reduce the negative impacts of agro-pastoral activities and put in place better methods to carry out sustainable agriculture while reducing poverty alleviation amongst the local communities. This study will also help stakeholders on how to monitor agro-pastoral activities in order to reduce its effects on the environment.

0.2 DELIMITATION OF STUDY

The study was carried out in Boyo Division. It focuses on the negative impacts of agro-pastoral agriculture on the environment. Focus will be laid on the following aspects: spatial, temporal and thematic delimitations.

- **Thematic Delimitation**

This study concerns agro-pastoral activities and its impacts on the environment. The study explains how agro-pastoral practices, mainly crop cultivation and animal husbandry provokes environmental degradation in Boyo Division.

- **Temporal Delimitation**

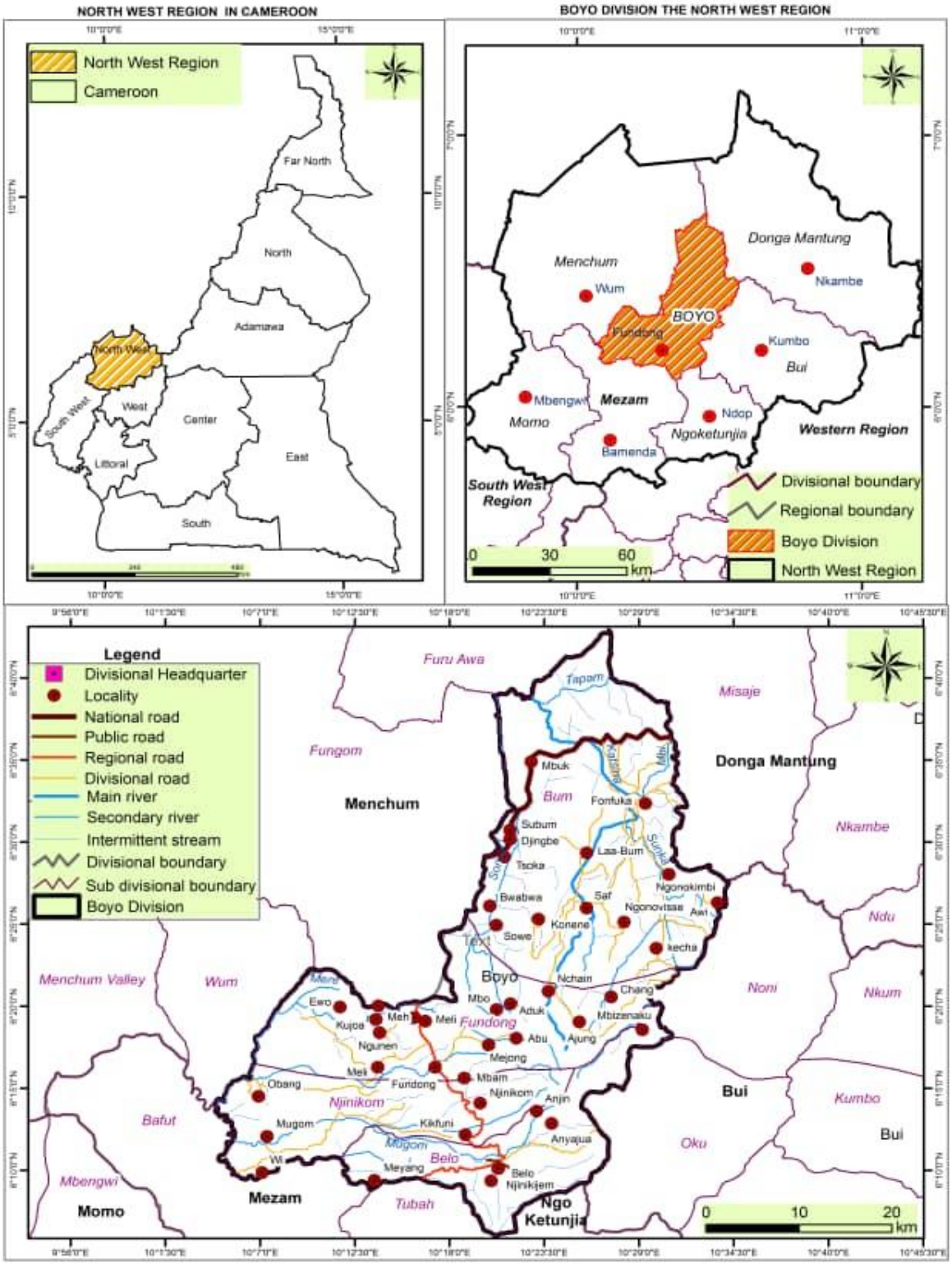
The study covers a period from 1985 to 2019. The year 1985 is chosen because it was during this period that Cameroon witnessed a fall in its economy (Baye et al, 2002). This crisis had many adverse effects on the economy including a sharp decline in the export earnings of major commodities (cocoa, coffee, and oil), an average recorded deficit of 7% in GDP between 1987 and 1993 (UNU-WIDER, 2014), a recorded deficit in public finance by ONCPB of about 30 billion (Achancho, 2013) without forgetting the agricultural credit policy which failed and was unable to adequately finance and guarantee the agricultural system. All of these led to increase rates of poverty as many people lost their jobs and remained unemployed (hunger period). Hence pushing young high school and university students to migrate back to rural areas and take up agricultural practices for survival.

- **Spatial Delimitation**

Boyo Division lies between longitude 10^0 14' and 10^0 17'east and latitude 6^0 07'and 6^0 20' north of the equator (ENGREF/CUDS, 1987). Boyo is located about 80.5km away from Bamenda, the regional capital of the North West Region.

It is found in the mountainous stretch of the western highlands of the agro ecological zone of Cameroon (North West region). Out of the seven Divisions in the North West region, it is the second smallest in terms of surface area. It covers a total surface area of about 1,592km^2 and is home to a population of about 124,887 people (BUCREP 2005). Boyo is bounded to the North east by Donga-Mantung Divisions, to the West by Menchum Division, to the South by Mezam Division and to the East by Bui and Ngo-Ketunjia Divisions. Boyo has four Sub-Divisions; Njinikom, Fundong, Belo and Bum sub Divisions with Fundong being the administrative capital of the Division (Mbile et al, 2004).

Our study area will cover all the four subDivisions taking 4 quarters from each subDivision. These quarters include: Tinifoinbi, Bobong, Wombong-itin and Balikumato in Njinikom sub-Division, Ngwah, Achain, Mentang and Mbongkisu in Fundong sub-Division, Aboh, Njinikijem, Anyajua and Anjin in Belo sub Division, Ngunakimbi, Laka bum, Kimbi and Bua-bua in Bum sub-Division. The people of Boyo also called the Kom people speak *Itaing IKom* as their native language. They are the only unique people in the North West Region who practice the matrilineal line of descend in both succession, marriages and enthronements (Ngong Chufi,2013). A Fon rules the people of Kom. The current ruler, ***foyn Ndzi Clement II*** succeeded the throne from his pre-decessor ***foyn Vincent Yuh II*** in 2017.



Source: *Adapted from the administrative map of Cameroon, INC, Yaounde, Mairomi, H. 2020*

Map 1: Location map of Boyo Division

As concerns its topography, Boyo is highly mountainous, found in the mountainous stretch of the western highlands of the agro ecological zone of Cameroon with undulating

escarpments, valleys, plateau and plains. More than 70% of the land is situated above 1400metres in altitude with many hills. Notwithstanding, this Division is blessed with a rich hydrographic network. Like in all other parts of the North West region, Boyo has many waterfalls and rivers, which take their rise from the hills. An example of such a river is the Kimbi River in Bum. There are also streams and springs in valleys and depressions. The water network contributes in moisturizing the atmosphere rendering temperatures favourable for continues farming.

According to Hawkins and Brunt (1965), the soils found in the forested region of Boyo are humified ferralitic soils with a very high organic matter content put in place by the humid climatic conditions. Boyo Division is dominated by the tropical sandy clay, ferruginous and sticky reddish-brown soils (Ngong Chufi, 2014). These soils are well drained and are very permeable. The Fundong, Belo and Njinikom sub-Divisions are dominated by ferralitic and volcanic soils with laterites, sand and loams in depressions. Bum sub-Division on the other hand has more of alluvial soils in the lowlands, wetlands and plains that favour agricultural activities (Funfuka council development plant, 2011)

The climate of Boyo is cold with two distinct seasons ideal for both agricultural and pastoral practices. The dry season begins from November to mid-March while the rainy season begins from mid-March to October. The dry season lasts just for 4months and is characterized by harmathan with very dry but cold nights. During this period, mean annual temperatures fall between 14^{o} C and 30^{o} C. The rainy season on the other hand lasts for 8 months and is heaviest during the months of August and September with annual rainfall exceeding 2000mm. Generally, the total amount of rainfall received in Boyo varies from 1800mm to 3000mm yearly with an average temperature varying from 22^{o} C at 1800 meters to about 16^{o} C or less at higher altitudes (Kimbum, 2002).

In terms of vegetation, Boyo is blessed with green savannah, which is made up of grass and plants. In spite of its rugged mountainous nature, Boyo Division has many vegetation types amongst which we have the montane forest dominant in Belo sub-Division, the gallery forest in the western part of the region covering Fundong and Njinikom, the dense forest covering the south western part of Fundong, Njinikom and Belo respectively, the herbaceous forest spotted in part of Fundong and Belo sub-Divisions and finally the shrub savannah covering a greater part of Bum sub-Division (Samba, 2000).

The Ijim Mountain Forest ecosystem provides a suitable milieu for many endemic plant species. Aside from the Ijim mountain forest, Boyo has other protected areas like the Kimbi Game Reserve in Bum sub Division, and sacred forests for cultural practices. Studies carried out by a team from ENGREF, Montpelier and the Dschang University Center (CUDS) in 1987 and other works by the Center for International Research, CIFOR identified 19 species of different kinds of plants in the Ijim forest distributed according to altitude. Bird life International brought out over 150 bird species from the Ijim Mountain Forest ecosystem during the Kilum-Ijim forest project, out of which 53 were endemic to the montane and sub alpine forest zone. Threatened species like Tauraco bannermani, Platysteiria laticincta were also identified.

0.3 Statement of the problem

Agro-pastoral activities are dominant in most parts of sub-Sahara Africa and constitute the main source of income for most developing countries. These activities have recently been identified as the main human activity in rural areas that greatly damages the environment. The methods and techniques used to cultivate in most rural areas are very unsustainable and unfriendly to the environment. The nature of the terrains together with the limited availability of arable lands makes the practice of this activity very competitive, which in most cases lead to devastating conflicts. The land use and land tenure systems together with the methods of pasture regeneration, methods of drainage in low lying areas and valleys of most rural communities are not friendly to the environment. Rather such systems are usually the cause of conflicts while the methods, are agents of environmental degradation. This is usually the case in regions with hilly slopes and limited arable land such as those in Boyo Division.

Farming methods and techniques of cultivation employed in this part of the country are unsustainable and very unfriendly to the environment. Farmers mostly practice the slash and burn method of cultivation, which exposes the soil to wind and soil erosion when it rains. Some farmers on the other hand still practice cultivation along the slope due to limited cultivable land hence increasing the degree of soil erosion in the slopes. In addition, the continuous cultivation on the same piece of land all year round renders the soil loose and vulnerable to all forms of degradation. This is due to the natural topography of the area which is made up of more hills that do not favor the tilling of the soil than valleys meanwhile other areas closer to the forest which could serve as cultivable land have been set aside for conservation for ecological reason. The use of chemical fertilizers, pesticides and fungicides come in as a measure taken by farmers to increase their yields due to the already infertile nature of their over cultivated soils. Most

often the use of these fertilizers and chemicals is uncontrolled and in excess due to ignorance as the majority of those practicing crop farming are old and cannot read and follow instructions properly. The excess use of these chemicals in farms not only affect the crops but it also affects the soil and the environment in general causing devastating consequences on the environment.

Similarly, pastoralists in Boyo Division have witnessed an increase in the number of animals especially in Fundong area over the years. As the size of the herds increase, pastoralists keep expanding their grazing lands towards the forest and restricted areas which have been demarcated for conservation instead of using intensification grazing practices. The destruction of this forest and conservation areas by pastoralists particularly those in the enclaves is causing deforestation and affecting the volume of water sources that take their rise from the Ijim montane forest. This encroachment into the forest and the continuous grazing on the same piece of land has adverse effects on its immediate environment. The most common of them is the loss of biodiversity as there is the cutting down of woody trees to give way for savannah vegetation, exposure of the soil caused by over grazing which most often leads to soil erosion and other forms of land degradation and also air pollution from the rampant burning of bushes by these pastoralists. Pastoralists also practice poor methods of pasture regeneration, like the felling of trees and setting bush fires for fast regeneration. These methods are equally very unfriendly to the environment as they are the primary cause of air pollution, soil depletion and savanisation. There is also the persistent problem of poor drainage noticed mainly in valleys when animals go on transhumance and in areas where there are fishponds. Animals on transhumance in the valleys tend to pollute the streams with their waste. This goes a long way to destabilize the water bodies hence causing water pollution.

The growing population of Boyo Division between 1990 and 2005 (BUCREP), has pushed farmers to keep seeking potential farming areas in order to increase production that can sustain the population. The increase in both human and animal population exerts pressure on the natural landscape of Boyo as farmers see a need to extensity their activities. Other factors such as the constant rise in the demand for food crops and animal products together with problems rising from the degradation of existing lands for agricultural activities has triggered the population of Boyo to seek new and more fertile lands to expand their activities. To get this increase in food supply, the local population sets out to find new farmlands either in the forest by clearing or in marginal lands such as hills while those who are do not have access to these areas engage in land conflicts between themselves. The effects of a growing population against

a stable arable land has left farmers in Boyo Division to seek for the expansion of their activities through the conversion of lands meant for conservation and other uses.

It is therefore very important for the above-mentioned problems to be addressed properly so that crop cultivation, livestock rearing and other pastoral activities can be practiced adequately in abit to reduce the its effects on the environment.

The main problem identified here put in simple terms is the use of poor farming method and techniques by farmers, excess use of fertilizers, uncontrolled grazing, poor methods of pasture regeneration, the expansion of agro pastoral activities towards lands/areas meant for conservation . The problem is thus simplified and presented in a visual and easily understandable form.

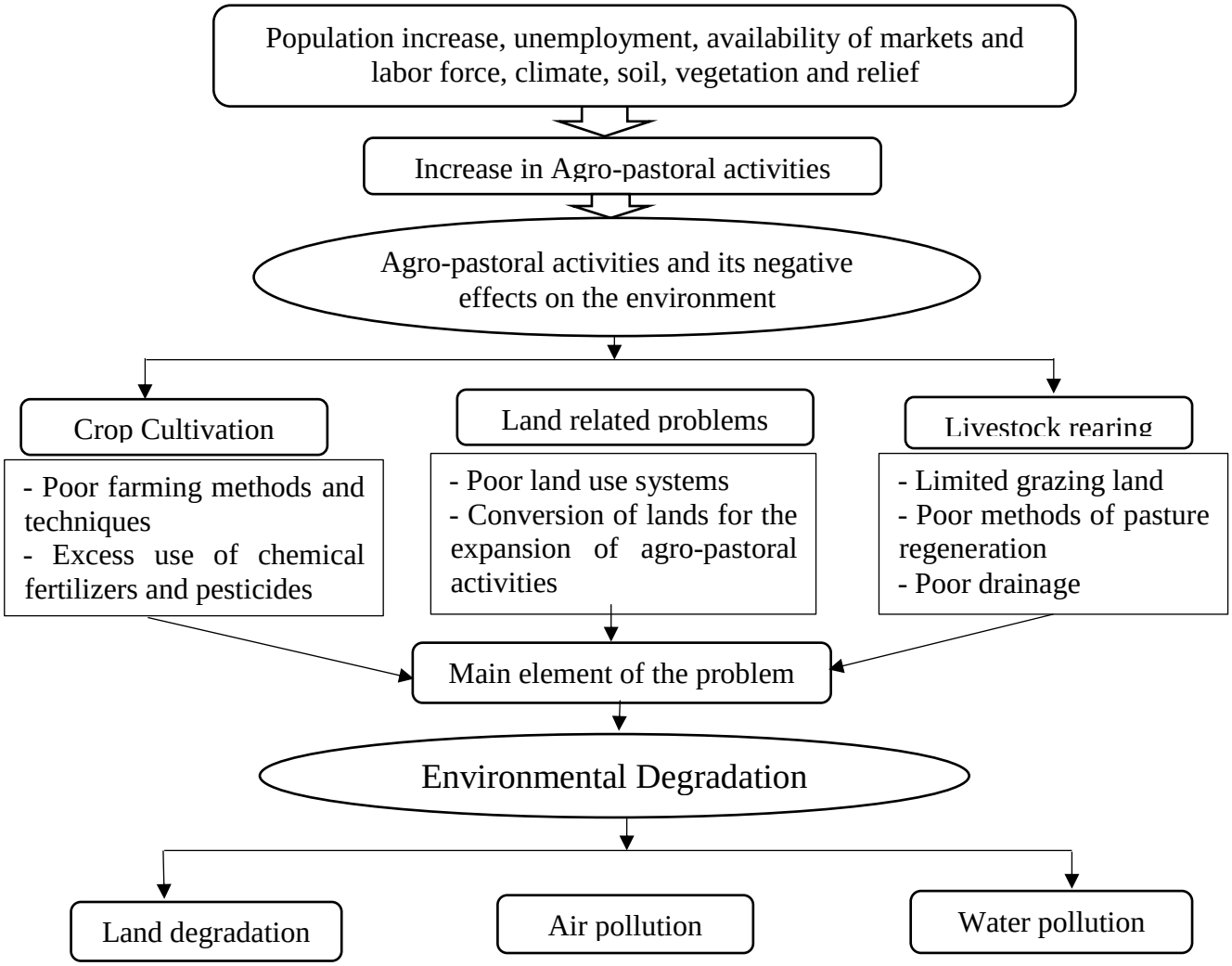


Figure 1: Diagrammatic presentation of problem statement

Source: Researcher, 2020/2022

0.4 Research Questions

General research question

To what extent do agro-pastoral activities provoke environmental degradation in Boyo Division?

- **Specific research questions**

1. How far do the methods and techniques of crop cultivation contribute to environmental degradation in Boyo Division?
2. To what extent does livestock rearing and other pastoral activities influence environmental degradation in Boyo Division?
3. What are the environmental implications of land conversion for agro-pastoral expansion in Boyo Division?

0.5 Research Objectives

- **General research objective**

To examine the extent to which agro-pastoral activities contribute to environmental degradation in Boyo.

- **Specific research objectives**

1. To find out how the methods and techniques of crop cultivation in Boyo contribute to environmental degradation
2. To investigate how livestock rearing and other pastoral activities affects the environment of Boyo
3. To find out how land conversion for the expansion in agro-pastoral activities negatively affects the environment

0.6 Research Hypotheses

The following hypothesis have been formulated to guide this research;

1. The methods and techniques of crop cultivation largely influences environmental degradation in Boyo
2. The methods of livestock rearing in Boyo largely influences environmental degradation

3. Land conversion for agro-pastoral expansion in Boyo Division has adverse effects on the environment

- **Operationalization of variables**

From critical observation of the research questions, objectives and hypotheses, we can identify three independent and three dependent variables which we need to operationalize.

Hypothesis 1: The methods and techniques of crop cultivation largely influences environmental degradation in Boyo

Independent Variable: methods and techniques of crop cultivation

Dependent Variable: Environmental degradation

Table 1: Operationalization of variables for hypothesis 1

Independent variable	**Indicators**	**Dependent variable**	**Indicators**
Methods and techniques of crop cultivation	-Slash and burn -Till and cover -Spraying -Use of chemical fertilizers -Use of animal dung	Environmental degradation (deforestation and erosion)	-cutting down of trees and vegetation -loss of top soil -destruction of soil micro- organisms -Air and water pollution -Soil infertility -increase in the release of GHG

Source: Researcher, inspired by masters 2 classes

Hypothesis 2: The methods of animal rearing in Boyo largely influences environmental degradation

Independent Variable: methods of animal rearing

Dependent Variable: environmental degradation

Table 2: Operationalization of variables for hypothesis 2

Independent Variable	**Indicators**	**Dependent Variables**	**Indicators**
Methods of animal rearing	- transhumance - ranching - large extensive farms -small holder farms nearby	Environmental degradation	- loss of vegetal cover - deforestation - loss of habitat - Environmental pollution (water, air and land

Source: Researcher, inspired by masters 2 classes

Hypothesis 3: Land conversion for agro-pastoral expansion in Boyo Division has adverse effects on the environment

Independent Variable: land conversion, agro-pastoral expansion

Dependent Variable: environmental effects

Table 3: Operationalization of variables for hypothesis 3

Independent Variables	**Indicators**	**Dependent variable**	**Indicators**
-Land conversion -Agro-pastoral expansion	-types of land conversions (conversion of forested land, conversion of grasslands, conversion of wetlands) -drivers of agro-pastoral expansion (rising global demands for food and livestock, population	Environmental effects	- deforestation and habitat loss -soil degradation from erosion and soil compartment - water pollution

	growth, degradation of existing lands)		

Source: Researcher, inspired by Masters 2 classes

0.7 Literature review

In order to come up with a valid scientific work, it was important for us to go through other works to gain more knowledge and avoid duplication. It is in this light that we studied both past and on-going works related to our study theme evaluating their orientations and contributions. A wide range of dissertations, PhD theses, journals, conference papers, published and unpublished documents were consulted to build a rich and befitting literature for this study. This section permitted the researcher to have a better mastery on different agro-pastoral activities and the impacts they have on the environment.

- **Methods and techniques of crops cultivation and its effects on the environment**

Crop cultivation for the past years has contributed to environmental degradation in various ways.

According to Ngwatezeh (2018), agriculture is the main activity that transforms the physical landscape of an area. The researcher laid emphasis on the impacts of agricultural pressure on land explaining that an increase in the pressure exerted by agricultural activities on the physical landscape has both human and physical causes, which results, to erosion, deforestation and pollution as its negative effects. The author concluded by pointing out the fact that the negative impacts of agricultural pressure on land are more alarming and cause greater problems than the benefits that come from it.

Engwali et al (2019) in their work titled “Contributions of phytosanitary products to the revenue of market garden farmers in Mezam Division, North West Regionof Cameroon”. They focused their findings on the revenues generated from the sales of market gardening products in the framework of ACEFA (Amelioration de la Competitivite des Exploitations Familiales Agropastorales) observatory in the North West Regionof Cameroon. The study looks at farmers’ perspectives of phytosanitary products and evaluates the extent to which farmers

handle and use these products while assessing the contributions of ACEFA towards reducing the excessive use phytosanitary productsand estimates the effects of these products on the revenue of these farmers. On the other hand, this study will be looking at the impacts of the agricultural practices of farmers on the environment, and the agricultural related conflicts that spring up from these practices in Boyo Division.

Fonjong (2004) directed his study towards the state of agricultural infrastructure in Cameroon from the forgotten story of agricultural shows after 1985 to the closure or near neglect of major agro-pastoral research and technical institutions in the country. According to the author, the future of agriculture in Cameroon was bleak and raised many questions. In this study, the author reiterates the fact that the ministry of agriculture, which holds one of the largest portions of the national budget, yet does not match the government's high-sounding policy of promoting agricultural development. In our study, instead look at the various forms agro-pastoral activities carried out in Boyo Division and how they bring about environmental degradation.

Kininla (2013) based her research on agricultural land use change and conservation efforts in Ngongbaa, Nso- Bui in the North West Region of Cameroon. This work aimed at determining the actual cause of the exhaustion of agricultural soil in Ngongbaa village. The author explained that humans were becoming dominant agents in land use change today through their activities such as deforestation, construction and agriculture. The study further assesses farmer grazier conflicts over land crisis in the forest. This work however, will be examining the different methods and techniques of cultivation and soil preparation. It goes further to assess the impacts of these methods and techniques on the immediate environment of Boyo.

Libisnyuy (2010) on her part examined how market women diversify their activities from mere foodstuff production to foodstuff marketing in the Bamenda fish pond and Nkwen annex markets. The author also examined how this diversification gave these women gender roles in their families and society. The researcher further categorizes the women involved in foodstuff marketing, the types of foodstuffs sold and their supply zones. Unlike her, our work will focus on the negative effects of the methods and techniques used in the cultivation of food crops.

Fomboh et al., (2016) stresses on the importance on agriculture to the Cameroonian economy. They also talk on how Cameroon has been able to sustain its population from agriculture and lays emphasis on the challenges faced by agricultural in recent years.

- **Methods of animal rearing and effects of the environment**

Mayanja et al., (2015) used pastoral and agro-pastoral activities together with the utility of a consumption coping strategy index to characterise and assess the factors relating to household food security in Uganda. In this article, they explained how pastoralist and agro-pastoralist contribute to ensuring food security in Uganda.

Sevidzem (2018) in his work titled "Urban-Pig Farming: Easy Gain and Danger to the Environment (Yaoundé-Cameroon)", examines the problems of pig breeding in the human environment. The author highlights the economic importance of pig breeding in income generation in the urban and suburbs of the city of Yaoundé. The study equally revealed that stakeholders in this activity focused on the economic importance while ignoring environmental problems. Our study on its part will be looking at all agro-pastoral activities that bring about environmental degradation and the conflicts surrounding these activities.

Renaud et al (2018) focused his study on apiculture. The author explained that beekeeping offered benefits, which could make it attractive to smallholder farmers as a possible strategy for making their livelihoods more sustainable. This author however states that the potentials of this activity remain largely unexploited and the lack of new entrants is thought to be one key reason for a decline in beekeeping. This paper reports on a study that examined the factors affecting beekeeping adoption in Baringo County, Kenya with a focus on three smallholder-farming communities. In our study, we will not just be looking at apiculture but all other agro-pastoral activities practiced in Boyo Division and how these activities and their different methods of practice impacts the environment.

Shegwe (2016), on her part looked at the dynamics of grazing lands and the adaptation of pastoralists in the Sabga-Bamuka area. according to this author, both anthropogenic factors such as population growth, agriculture and economic crisis and physical factors such as vegetation, soil, geology, climate have greatly influenced grazing land dynamics in the Sabga-Bamuka area. This work looked at the various groups of people that constitute pastoralists and how they adapt to changing patterns of grazing lands. The study went further to look at the various adaptation strategies that could be put in place. Our work will go a step further to look at how methods of raising animals contribute to environmental degradation in Boyo Division.

Mairomi H, (2011) in his book explained the reason for human encroachment into grazing lands. He also examined the causes and consequences of this encroachment phenomenon in Jakiri.

❖ **Agro-pastoral expansion and environmental degradation**

According to World Bank (1990-2000) a growing population leads to an increase in the conversion of forestlands for other land uses like land for agriculture and land for building and construction. The FAO estimated that about 13hec of forestland is permanently converted to agricultural land yearly especially in the tropics where population growth rate is high. They go further to say that poor policies from other sectors also contribute to rapid rates of deforestation.

Fombu (2006) in an investigative study on population dynamics and agricultural land use patterns in Pinyin clan in Santa sub Division, found out that the changes in agricultural land use in Pinyin was as a result of population growth. Agriculturalists reacted to this increase by adjusting their activities and adjusting to changing times. She however accepted the fact that traditional systems of agriculture and land management involving long fallow periods ensured natural regeneration of soil fertility.

Radoslava (2016) articulates his study around the effects of an ever-increasing population and agricultural activities on land-use, environment, and exosystemic services. Human expansion throughout the world has placed agriculture as a dominant form of land use globally. Human influence on the land is accelerating because of rapid population growth and increasing food requirements. The work stresses on the interactions between society and the environment, the driving forces, pressure sources, states, impacts and response framework approach that were all used for analyzing and assessing the influence of agriculture on land use, environment, and ecosystem services. The work goes ahead to elaborate on how these agricultural land use patterns bring about degradation of the environment.

Njoh et al (2018) sought to show that urbanisation was at an increase in major towns such as Bamenda. This urbanisation served as a major drive of unsustainable transformation of urban-rural relations and food systems. Their work looked at how urban and peri-urban agriculture links and interlinks urban issues and development objectives. Our study however deviates from his in that it instead looks at the types of agricultural practices and how these practices lead to environmental degradation and conflicts in Boyo Division.

Ndikintum (2000) studied population growth and pressure ascertained that a fast-growing population and its pressure on land contributes to environmental disequilibrium. His study goes further to propose ways to maintain productivity with improved strategies and techniques.

0.8 Conceptual and Theoritical Framework of the study

A number of approaches were highlighted and some carefully selected to be applied on the diverse agro-pastoral activities accounting for environmental degradation in Boyo. This work will be guided by fundamental theories and concepts and these frameworks will be applied and tested as they deal with environmental degradation and the effects of agro-pastoral activities on it.

0.8.1 Conceptual framework

Based on the importance of the research to the study area and the related works reviewed under this theme, some key concepts were selected then developed to suit the smooth understanding and context of this work. Some of these concepts include the concepts of agro-pastoralism, the concept of environmental degradation, the concept of land resource and land use and the carrying capacity concept.

1. **The Concept of Agro-pastoral activities**

Agro-pastoral activity is a mix of crop cultivation and animal rearing. According to the Merriam-Webster dictionary, it is a way of life or a form of social organization based on the growing of crops and the raising of livestock as a primary means of economic activity. FAO defines agropastoral systems as any production system that relies for more than 10% of its output on livestock but also include other production systems that rely on resources in their natural state such as hunting, gathering and fishing

Agro-pastoral activities in the context of this work is defined in simple terms as the integration of crop production and livestock production practiced amongst settled, nomadic communities and the local population. The types of crops grown by farmers and the animals kept by pastoralists varies and is greatly dependent on culture, climate, environment, geographic area and natural resource availability. Animals kept and crops grown in Boyo Division are not an exception to this preference. The types of animals domesticated here include cattle, goats, sheep, pigs, poultry and bees while the crops grown include maize, beans, huckleberry, cocoyam and sweet potatoes. Figure 2 below shows the conceptualization of agro-pastoral activities with two main dimensions, crop cultivation and animal rearing.

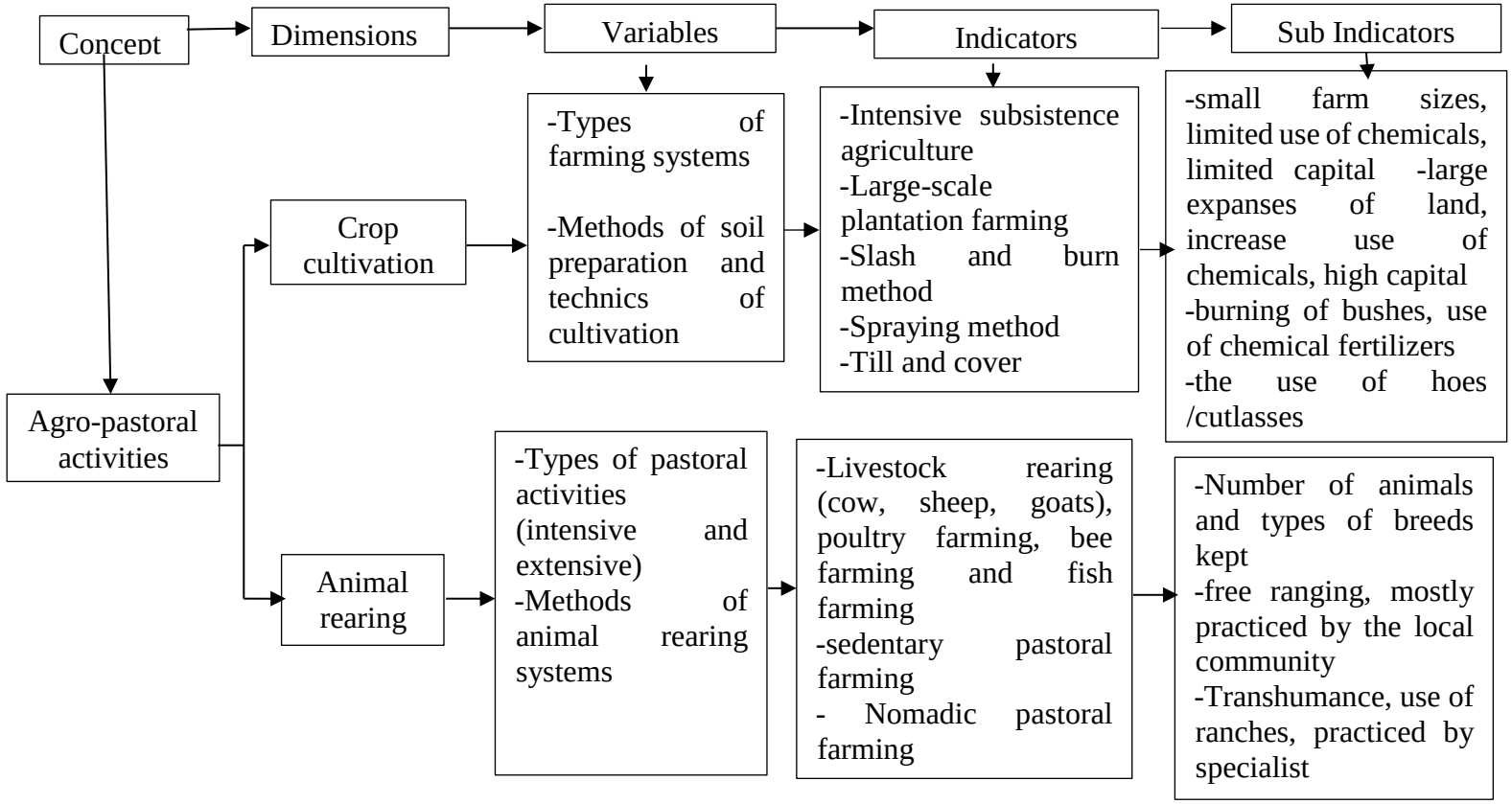
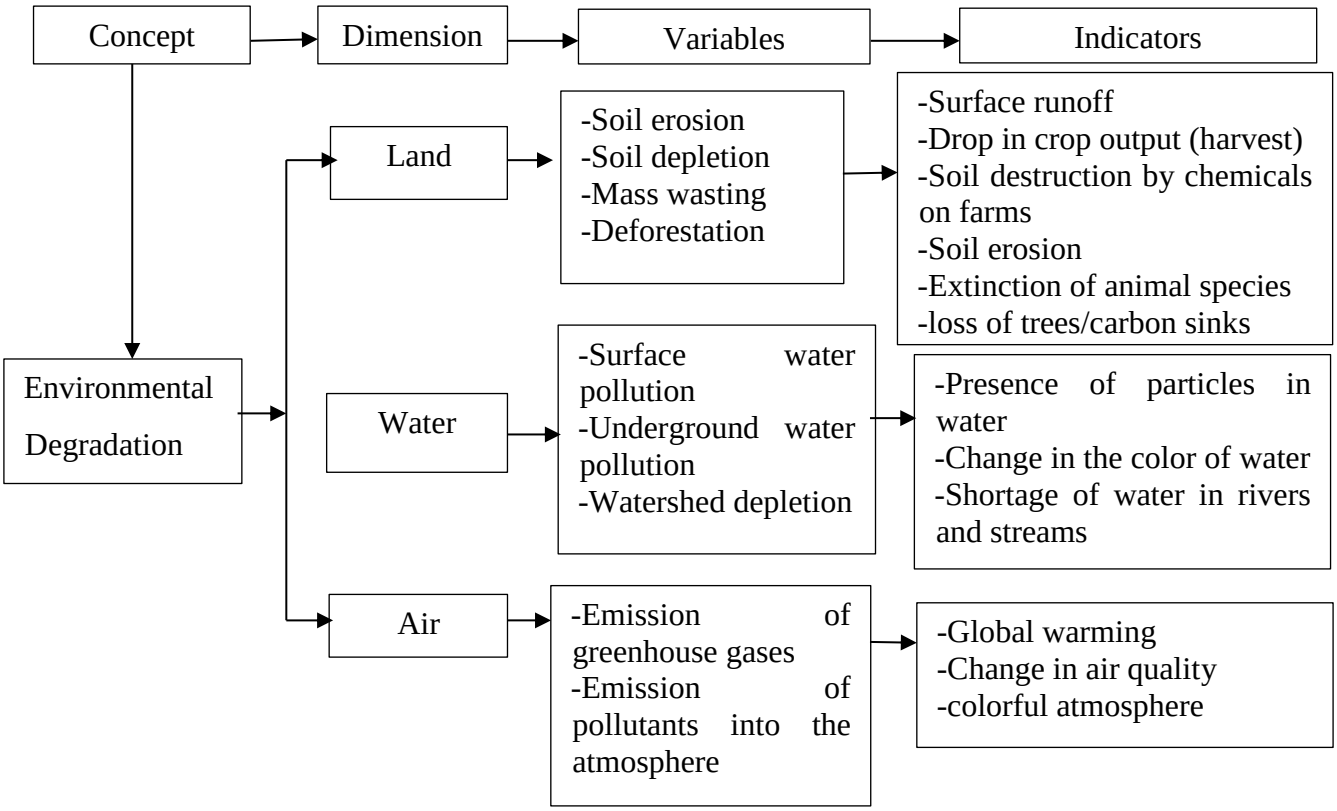


Figure 2: Conceptualization of agro-pastoral activities

Source: Researcher, inspired by Masters 1 classes

2. Environmental Degradation

Environmental degradation is the deterioration of the environment through depletion of natural resources (air, water, and soil), destruction of ecosystems and the extinction of wildlife (Swati Tyagi et al, 2014). According to a UN document on high-level threat panel, it is one of 10 serious threats of the world. The UNISDR defines environmental degradation as the reduction of the capacity of the environment to meet social and ecological objectives and needs. Within the context of this study, environmental degradation will be considered as any undesirable change or disturbance to the environment triggered by human actions on natural resources such as land, water, soil and air. These disturbances are manifested in the form of resource depletion, pollution, extinction of wildlife and destruction of ecosystems. The degradation of the environment caused by agriculture cannot be under looked especially in rural and forested areas which are often referred to as the cleaner space as compared to bigger cities. Environmental degradation in such rural areas as Boyo Division is not as a result of many industries and an active transportation system, but rather as a result of the frequent and consistent use of poor and uncontrolled farming practices. Fig. 3 below shows the conceptualization of the term environmental degradation as addressed in this study.

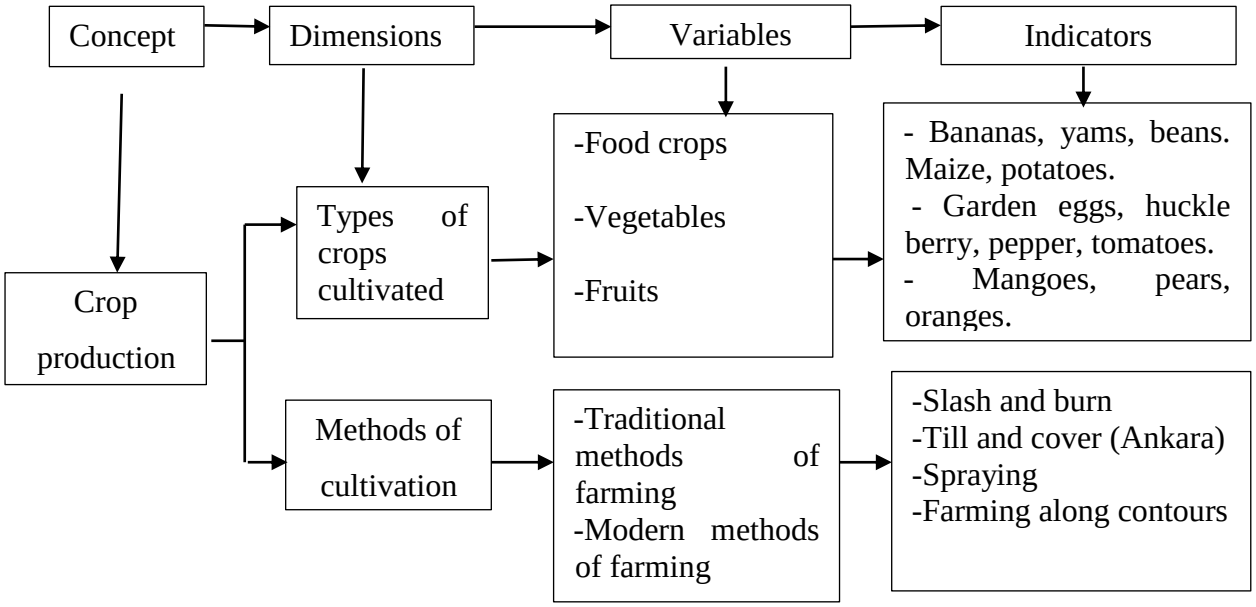


Source: Researcher, inspired by Masters 2 classes

Figure 3: Conceptualization of environmental degradation

3. The Concept of crop production

Crop production as defined by many scholars is a branch of agriculture, which deals with growing, and harvesting of crops for either food consumption or to satisfy our fibre need. The concept of crop production in this work will be tilted towards the types of crop production systems commonly practiced and the methods used in crop cultivation. Farming systems vary in Boyo Division vary with the most common being intensive subsistence agriculture otherwise known as intensive traditional agriculture. The methods of soil preparation for crop production include the slash and burn, where grass is cleared and burnt to increase short term soil fertility, the till and cover method also known as the Ankara method where grass is cleared and allowed to decay which is in turned used to form ridges. There exist other methods of soil preparation like the spraying method practiced mostly in small gardens. Whatever method of soil preparation being used depends on the type of farming system chosen and the destination of the final output. Below is a simplified diagrammatic representation of the concept of crop production (fig 4)



Researcher, inspired by Masters 2 classes

Figure 4: conceptualization of crop cultivation

4. The Concept of Carrying Capacity

Malthus evoked the concept of carrying capacity in his consideration of population and resources. Malthus considered carrying capacity as the capability of a given population to depend indefinitely on a given set of resources at acceptable levels of satisfaction without

stressing the environment. Ecologists went further and gave it a similar definition as follows; the population of a given species that can be supported indefinitely in a given habitat without permanently damaging the ecosystem on which it is dependent upon. By carrying capacity, there is need for sustainability as we always think of the future generation and the rate of resource regeneration.

The carrying capacity in this context is defined by the maximum number of herbivores that a rangeland can support on a sustainable basis. It is the maximum proportion vegetation (forage) that can be grazed without causing any damage of deterioration on the environment. The concept of carrying capacity here therefore works in the same line with sustainable agriculture.in this context, the carrying capacity is considered in the land to animal relationship. It is the maximum stocking rate that will achieve a targeted level of animal performance using a specific grazing method which can be applied over a defined period of time without deteriorating the environment (Mairomi Harry Wirngo). Carrying capacity changes from season to season and from year to year and can therefore be defined over fractional parts of the year. In this case we can talk of average carrying capacity which is the long-term average capacity over years and annual carrying capacity which is the carrying capacity of a specific year. Carrying capacity usually is changed by many measures of grazing managements either traditionally by bush fires or scientifically by degraded pastures (vegetation). In this case the land use will be dependent on the social and economic strength of local man and his economic unit. The carrying capacity within Boyo Division is associated with negative implications as there is continuous and uncontrolled grazing of livestock on a specific portion of land, giving the animals unrestricted and uninterrupted access throughout the grazing period. This situation is very common especially in the forested part of Boyo.

5. The Concept of Land Resource and Land use

Land is meant to serve a variety of human needs. According to FAO, the definition of land should include not only soil and surface topography, but also features like underlying superficial deposits, climate and water resources and the plants and animal communities which have developed because of the interaction of these physical conditions. It could be used for agricultural practices or infrastructural development or even industrial development all depending on the needs of the society and especially the land owner. When land users use this resource towards the development of different needs, the land is susceptible to change producing desirable and undesirable impacts that affect the environment in different way. Because about 2.5 thousand ha of land in the developing world has potentials of agriculture,

(FAO, 1997), about two-third of this land is rated as having significant constraints due to its topography or soil condition and not all of this land is even available for agricultural production. The scarcity of land as a resource is very clear nowadays especially land available for the primary production of biomass and for conservation purposes as the land is undergoing stress from degradation of arable land.

Analyzing land resources and land use is very important as it shows us the relationship that exists between land which is the resource and the people occupying and surrounding this land (land users). Analyzing land use directs us towards finding out why and how land use changes over time and identify the areas which are susceptible or have already experienced land use change.

According to the FAO (1997) land use involves the management and modification of the natural environment or the wilderness into building environments such as fields, pastures and settlements. It is also defined as the arrangements of activities and inputs by people to produce, change or maintain a certain land cover type.

The economic research service of the United States department of agriculture, identifies and classifies the different types of land use to include crop land, grass land for grazing, farm steads, water and wetlands.

Land in Boyo is mainly used for agricultural activities- crop cultivation and pastoralism. Areas close to the forest boundaries are used for crop cultivation while demarcated areas in selected parts of the forest in the Ijim site are used for grazing. In general, crop cultivation in this area is carried out on fertile lands around the forest while livestock rearing is done in forest lands, and grazing land where we have animals such as cattle and goats.

In the context of this study therefore, a land is a resource while land use refers to the activities carried out on land which leads to a change in the original form or structure of the environment and is pioneered by man in order to satisfy his needs.

0.8.2 Theoretical framework

Theories are principles that explain a fact. Various theories have been used to support and validate the hypothesis raised in the problematic. This study is integrated in the problematic of relations between man's activities with the natural milieu and is therefore based on possibilism and determinism amongst others. They deal with natures varying control human and agricultural activities.

1. The Theory of Environmental Determinism and Possibilism

The theory of determinism explains that it is the environment that influences man's behavior. This theory was proposed by a German geographic school pioneered by Von Humboldt and Carl Ritter. They argued that the environment is largely responsible for man's comportment, his adaptations and activities. On the other hand, the theory of possibilism was an idea which originated from the French and was propounded by Vidal de la Blanche (1898). The theory is more of cultural geography and seeks to explain that it is the environment that sets constraints or limitations, but culture is otherwise determined by social conditions.

The maim idea behind the theory of determinism is that even though the environment offers choices, man's life is still determined by him, according to his means and capacities he possesses but the theory of possibilism states that it is the environment that sets condition and limitations for cultural development, but it does not completely define culture. Instead, culture is defined by the opportunities and decisions that man makes in response to dealing with such limitations.

Thus, with an increasing human number and pressure on natural resources, man has persistently had an opportunity to transform the environment according to his present and future needs. In other words, there exist possible ways for man to alter the forest as a natural resource to fit an alternative land use that falls within man's priorities. Man, therefore, sets control on the state of the environment hence creating a continuous changing base for subsequent reactions to ensure adequate exploitation of forest resources. The possibilities made by man are through his numerous activities, technology and his behavior, which continuously shapes the use and exploitation of natural resources. In our study, this study will be used to examine the various adaptation methods used by crop farmers and pastoralist to adapt to the dynamics in Boyo Division.

2. The Tragedy of the Commons

This theory states that, when a resource is collectively owned by a group of people each will exploit the resource, overusing it and ignoring the group's collective interest. This theory is said to have its conventional origin in the mid 1950's. However, Hardin in 1968 came up with the idea of the tragedy of the commons (Hardin, 1968). The article he wrote mainly focused on overpopulation, but the author was well known for his idea on the over exploitation of common resources. Hardin's article was based on supposition where he argued that a herder is likely to increase his herds until the point of overgrazing because the profit of extra animals

goes to the herder, but the cost of over exploitation is felt in common and thus the herder pays only a fraction. He concluded by saying that freedom in the commons would lead to a common ruin.

In relation to the theory, the land is the common resource while degradation and farmer-grazier conflicts are tragedy. This theory will therefore be used to demonstrate the changes that occur on grazing lands because of increase in the livestock population, which leads to pasture shortage and all the related environmental problems.

This theory reflects in Boyo as crop farmers and in a bit to increase their yields use bad farming methods, which only aggravates the fertility of the soil leading to soil degradation. Pastoralist on the other hand increase their animals exerting pressure on the communal grazing lands.

3. Malthusian Population Growth Theory

The relationship between population growth and resources is a very crucial study in geography. Researchers have developed theories to explain why population changes and the possible problems likely to be faced in the future if the population changes. Thomas Malthus (1789) and Esther Boserup are the most renowned authors who wrote on the effects of population changes. These authors developed these theories after haven foreseen the problems related to population growth on the environment.

The Malthusian theory of population growth (1789) seeks to explain the relationship that exists between population growth and changes in food production. Malthus realized that population grew at a geometric progression rate. That is; 1, 2, 4, 8, 16, 32 … while food production rather increased at an arithmetic rate. That is; 1, 2, 3, 4, 4, 6 …

From the above analysis, Malthus predicted there would come a time when population growth will outsmart food production rate, implying the carrying capacity of land will be surpassed.

The ideas of Malthus were opposed by Esther Boserup in her book *"The condition of Agricultural growth; the economics of agrarian change under population pressure"* in which she advanced points to show that population growth will lead to the growth of better agricultural techniques and innovations to increase food production and be able to live with the prevailing circumstances. To her, agricultural innovation could only come if there is population growth.

These population theories when adapted to the context of this study, helps show the implications of an increase in the population of Boyo on the environment. An increase in population means more resources will be required to satisfy the available population. This will lead to over exploitation of resources and the encroachment of arable land into forested areas of Boyo. Increase in population in Boyo and especially in and around the KIMF has led to farmer and pastoralist over exploiting the land and rangelands. Some other farmers go further to think of innovative techniques to increase their yields.

0.9 Research methodology

A method is defined as an intellectual conception coordinating an assembly of operations in general with different techniques (Madeleine Grawitz 2001). It is a means of getting to the truth that is responding to a particular question of how which is linked to the problem to be solved. It is in response to this that this study makes use of the hypothetico-deductive method, which was first proposed by Christian Huygens (1629-1695), where scientific inquiry is followed by the formulation of hypotheses. The methods and techniques identified for this study have as integral part, a description of the schema in order to avoid ambiguity. This approach will make use of inferential techniques to test how far our stated hypothesis fit and a logical systematic sequence of steps will be employed to include data collection and the evaluation of evidence for data analysis and conclusions to be drawn from it in order to attain our specific objectives. We also made use of the proposal of Paul D. Leedy (1989) where we identified the data needed and their locations, then the means to collect them clearly spelt out and how they will be treated and interpreted to attain each of the specific objectives.

This section presents the research design used in this work, the methods of data collection and treatment. The instruments used to collect primary data and the sample size of the study area. The problems encountered during the research process are equally identified in this section.

The methodology applied to carry out this research is directly linked to the research questions and objectives in order to verify the hypotheses and attain the objectives set at the beginning of this work. Various research methods and techniques were used and were largely composed of data collection, treatment and analysis. Empirical data and materials for this study were drawn from a wide range of sources.

0.9.1 Research Design

The research design used in this work is that used in human geography for the spatial analysis of geographic phenomena. Agro-pastoral activities and environmental degradation in Boyo Division are therefore analyzed in time and space. The relationship between agro-pastoral agriculture and its impacts on the environment of Boyo were analyzed. To attain the objectives set at the beginning of this study and test the hypothesis, both qualitative and quantitative research methods were used. This was in order to provide global standards of research, using qualitative data to show how much in depth the topic has been researched and quantitative to define the scope of the topic. Based on both qualitative and quantitative methods of study, recommendations and results of the research were not based on the subjective approach but rather on the objective approach. Results included reflections and understanding of the problem at a deeper level, data analyzed in an interpretative and statistical manner.

The quantitative method was facilitated by the use of questionnaire. Questions were asked to 129 respondents, which required them to answer some of the questions with figures, these results were further analyzed using adequate statistical techniques. As concerns the qualitative method, it was facilitated by semi-structural questions and interviews targeting different people and zones. The interviews were structured using open-ended questions regarding agro-pastoral practices and the impacts they leave on the physical environment. The semi-structured open-ended questioning approach was very important as it gave respondents the opportunity to discuss question not originally included in the interview questions formulated nor the questionnaires. It aimed at providing unique insights into the phenomenon of agriculture and the environment of the study area. Observations were also part of the qualitative method in this research work.

The techniques adopted in analyzing the findings of this research are inductive, descriptive and inferential.

Deduction involved an assumed premise as a starting point, which is then applied to real world conditions. Logical hypotheses were made concerning environmental conditions. These hypotheses were then tested against particular instances so that the truth of the supposition was gauged. Depending on the application to the real world, the original hypotheses were proven, modified or disproved. It is in this framework that hypotheses were generated for this work, which we set for verification.

The descriptive techniques were used in analyzing the data obtained. These techniques were used to simplify data into manageable proportions. Such techniques involved the use of definitions, averages and percentages. The calculation of percentages of results from questionnaires was also an important part of the research.

The inferential techniques were used to list how far samples represent wholes and how far hypotheses fit reality. At the heart of this work was the probability theory, which brought this researcher into realms of statistics.

0.9.2 Data Collection

In order to achieve the objectives of this study, appropriate instruments for the measurement of variables were used. Primary and secondary methods of data collection were used. The study made use of tools, methods and techniques in Geography. The main tools used were questionnaires, interview guides and focus group discussion guides. The methods used were field trips, observations and surveys. These methods facilitated the collection of the necessary data, which would not have been possible with just questionnaires.

The study relied on the quality of data. Secondary data was collected from internet, MBOSCUDA, BUCREP, regional delegations of Agriculture, National Institute of Cartography, Newspaper articles, WHO reports and journals, Municipal councils amongst others

The internet was a vital source of data for this study. Some statistical data were also collected from archives from the study area and from the rich review of research material from around the world, through theses and dissertations. This study was able to compare agro pastoral activities in and around Boyo and the impacts these activities have on its surrounding environment. We were able to get this from different perspective in order to come up with a more relevant analysis and conclusion for this work.

Data for this study was also collected from libraries. The libraries visited include The Department of Geography, University of Yaoundé I, Faculty of Arts, Letters and Social Sciences. In these libraries, dissertations, journals, articles and textbooks were consulted for literature in the related field of study, published and unpublished scientific research works provided literature from general to specific issues on agro-pastoral activities and environmental degradation added to the rich list of bibliographies and web links that provided a pathway for further research.

The researcher collected data from audiovisual sources such as Televisions and Radios. National Television programs, documentaries and life coverage of talks during agro-pastoral shows. Cameroon Radio and Television (CRTV) and Equinox Pidgin News was very Informative to this respect. They provided us with necessary data on the dynamics of agriculture in our nation and how it is related to the study area. Data from these national stations complemented those from foreign television programs on National Geography. Following programs like ''*inside Africa'* and other programs on climate change and its impacts on man's activities and the environment also provided us with reliable information.

Newspapers also constituted a rich archive. Newspapers consulted include: Cameroon Tribune, The Post and Le Messager, which were all very informative. These multimedia sources were indispensable for this work as they provided data that the researcher could not record using other channels.

The theories advanced above helped us to confront empirical realities through data collection from the field. After operationalizing the variables in the research questions, research objectives and hypotheses, we were able to identify the data needed for this study. The collection of primary quantitative data was done through questions formulated in questionnaires. The collection of primary qualitative data on the other hand was done through questions formulated in the interview guide, and during field observations. In order to collect the primary data for this work, field trips were made to the study area where a number of data gathering activities took place.

a. Field Trips

As concerns primary data collection, three field visits were made. These field trips permitted us to carry out field observations, collect quantitative and qualitative data, and carry out an appraisal of relevant phenomenon and to administer questionnaires. The first visit to the study area was for familiarization purposes. Firstly, a general observation of the agro-pastoral practices was carried out to familiarize with methods used in livestock keeping and crop cultivation. During the first visit, a pilot questionnaire was administered to 20 individuals randomly selected. We equally made contacts with some elders, leaders of cooperatives, and farmers and grazer associations directly concerned with the activity so we could easily identify environmentally related problems.

After the first visit, there was a second visit. It was during this visit that questionnaires were administered to a chosen sample population of the study area and field observations of

the various variable identified were also done during the field trip in all the four sub Divisions of Boyo.

The third visit to the field was for verification in order to confirm the facts gathered during the earlier field trips. Again, during this phase interviews were conducted, and questionnaires given out to some leaders and agricultural practitioners in order to be sure of the consistency of their responses. Observations were also taken seriously in abit to notice the slightest modifications in the field. As a tool, a digital camera, a notebook, pen and pencil were kept handy, ready to take pictures and notes at each stage of the field trip.

b. **Focus Group Discussions**

There were three main focus group discussions held in our study area. This was done with a mix of farmers, graziers and local authorities. This exercise had as main objective to get the different views of all the actors involved and was done during the second field visit.

c. Interviews

Apart from questionnaire administration, interviews were also done in order to get first-hand information. Because of the crisis in this region, our interviews were mostly informal with leaders of cooperatives, administrative officials, farmers, graziers, non-farmers and graziers and landlords. The different groups were contacted in order to have broader information on the impacts of agricultural and pastoral activities on the surrounding environment of Boyo. These land users comprised of; crop farmers and livestock rearers. The various agricultural initiative groups and NGOs while administrative officials were made up of the *chi ndoh's* in Kom, the Mayors of Belo and Fundong Sub-Divisions and the Sub-Divisional Delegate of Agriculture and Rural Development. Other influential people like the ardors and quarter heads were also interviewed. All the above groups of people were contacted to have firsthand information on agro-pastoral activities in their various zones and how these activities adversely affect the environment.

- **Interviews with local authorities and head of farmers cooperatives**

Local authorities were interviewed to get an in-depth information of issues related to agro-pastoral conflicts while the head of major farmer's cooperatives were interviewed to have a general view point on the different types of agricultural practices, the farming season and how farmer's activities impact the environment.

- **Interviews with Farmers and graziers**

Being the main actors in the field, farmers and graziers were interviewed to get first-hand information on their respective activities. The different methods used for cultivation and grazing, the types of crops cultivated and animals reared, the reasons why they choose their respective activities, the choice of methods used and the impact they leave on the environment of Boyo.

- **Interviews with land owners**

This set of people were interviewed in line with hypothesis 3 to find out how population increase affects them. This enabled us to evaluate the relationship that exists between population increase, agro-pastoral conflicts and occupation of marginal lands.

Direct field Observation

Burgess (2002), Denzin (1989), and Patton (1990), noted that direct observation gives the researcher a valued recourse and tool to relate information obtained from questionnaire, to crosscheck information gathered from interviews and relevant institutions. Fieldwork involved keen observation of the researcher on the reality of the responses gotten from the administration of questionnaires and interviews. This included recording of the types of crops cultivated, the types and number (scale) of animals reared per site, the methods, techniques and tools used for soil preparation, techniques used in raising animals and the land use patterns in Boyo.

First-hand information, which could only be gotten through observation, were collected, to get this data, the researcher boarded vehicles to the different sub Divisions and in most cases bikes to get into the quarter from where we continued on foot.

It was observed that poor farming methods and techniques like the slash and burn methods were used almost on all farms around the forest areas. In these areas when the farmlands were being prepared for cultivation, grass and some trees were burnt down and the leaves and branches of the trees gathered in a specific spot and burnt to increase the soil fertility of the farm. Others used sprays as a method of farm preparation while some others just ploughed the soil and planted immediately. In the case of the animals, we observed that most of the animals were reared at home except for those in Fundong and Belo sub Division. Here a greater part of the natives took their animals to the forest fridges while the mbororos preferred their animals to graze just within the enclave.

In addition, we observed that the agriculture practiced in our study area was mainly subsistence agriculture where the excesses were sold to meet up with household needs. Commercial agriculture though not very popular was noted in some areas with particular

crops involved. Crop cultivation was carried out in small patches of lands owned by different individuals. They practiced joint labor as they jointly went to one person's farmland to work and in the next week worked in another member's farmland. Some families with many plots of land practiced shifting cultivation mainly because of the far distance of some of their farms. For animal rearing, cattle and cows were mainly reared for commercial purposes while goats and fowls were mainly for cultural purposes.

The population of the study area

The population for this study constitutes the total population of 16 selected villages from the four sub Divisions that make up the Boyo Division, taking 4 villages from each sub Divisions. According to the results of the 2005 population and housing census published in 2010, the sum of the population of the selected villages stands at 31,548 inhabitants. This population is spatially distributed as shown on the table that follows.

Table 4: Population of study area

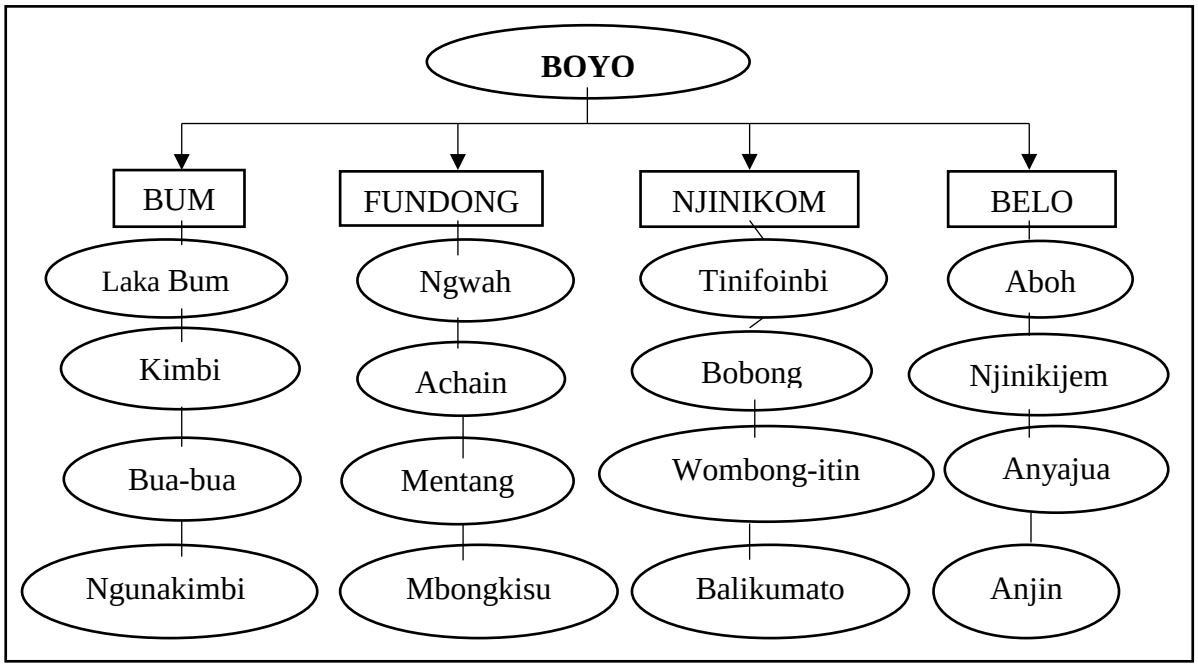
Sub-Divisions	Selected quarters/villages	Village/ quarter population	HH population	Total village pop	Total HH pop
Fundong	Ngwah	4516	593	9248	1225
	Achain	2065	302		
	Mentang	2061	242		
	Mbongkisu	606	88		
Njinikom	Tinifoinbi	1236	211	4359	737
	Bobong	1476	207		
	Wombong itin	492	113		
	Balikumato	1155	206		
Belo	Aboh	2204	236	13042	1620
	Njinikijem	4114	690		
	Anyajua	4152	335		
	Anjin	2572	359		
Bum	Laka Bum	345	51	4899	785
	Kimbi	2643	382		
	Bua Bua	1542	289		
	Ngunakimbi	369	63		
Total	**16**	**31,548**	**4,367**	**31,548**	**4,367**

Source: adapted from census 2005

0.9.2.1 Sample size of the population of the study area

The study metrix was divided into 4 main zones according to the different sub Divisions as shown on figure 1.

- Zone A: Bum Sub-Division (Laka bum, Kimbi, Bua-bua, Ngunakimbi)
- Zone B: Fundong Sub-Division (Ngwah, Achain, Mentang, Mbingkisu)
- Zone C: Njinikom sub-Division (Tinifoinbi, Bobong, Wombong-itin, Balikumato)
- Zone D: Belo Sub-Division (Aboh, Njinikijem, Anyajua, Anjin)



Source: Researcher, inspired by Masters 2 classes

Figure 5: Diagrammatic presentation of the study area

0.9.2.2 Sample Frame and Sampling Procedures

The sample size of the population for this study was selected from the 4367 households in the study area following the 2005 national census. The rationale for using the households is that it is much easier to administer a questionnaire in terms of households than the actual individuals in the population. In effect, 4% of the households made up the sample population for this study. The reason for choosing a 4% sample size is in accordance with the postulation of Nwana (1982), which stipulates that:

-If the population of the study is in a few hundreds, a 40% or more samples will do,

-If the population is in many hundreds, a 20% will do,

-If the population is in a few thousands, a 10% will do and,

-If the population is in several thousands, a 5% or fewer samples will do (Nwana, 1982).

The four percent sample size for this study is selected from the total number of households in each village using the formula:

$\frac{X * 4}{100}$ Where X: number of households,

4: sample size chosen and

*: multiplication sign

Table 5: Administration of questionnaires and effective respondents

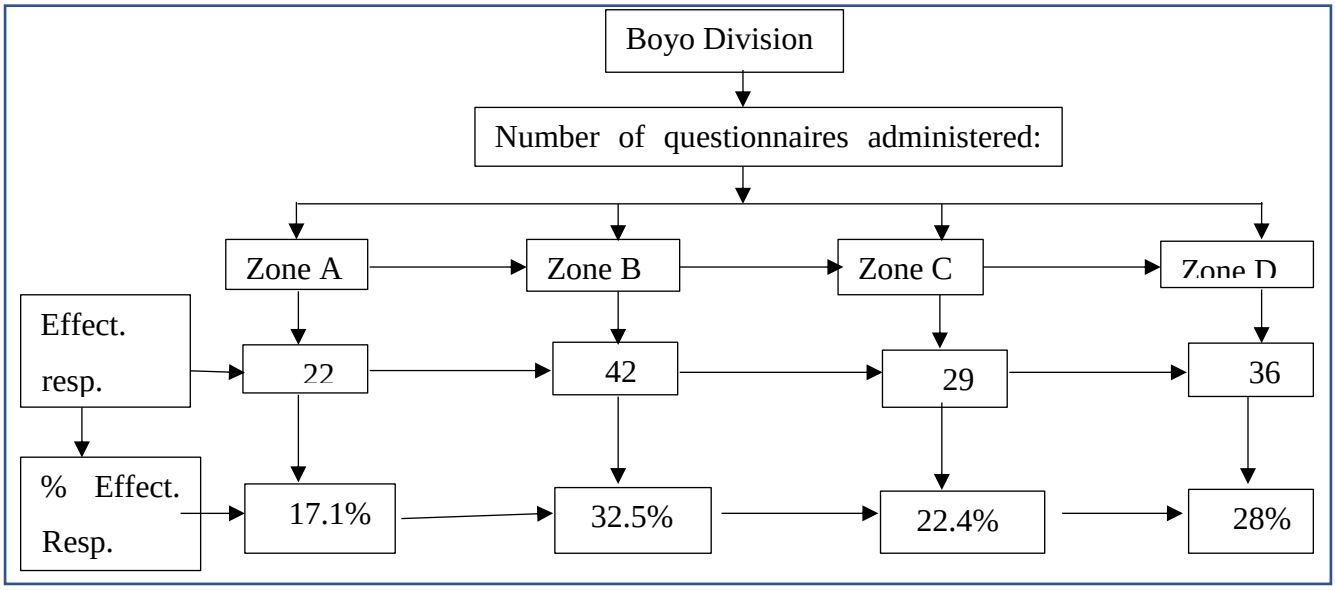
Communities/ quarters of Boyo Division	**HH**	**4% Sample size**	**Effec. Resp.**	**% of Effect. Resp.**
Zone A : Bum	785	31	22	17.1%
Zone B : Fundong	1225	49	42	32.5%
Zone C : Njinikom	737	29	29	22.4%
Zone D : Belo	1620	65	36	28%
Total	**4367**	**174**	**129**	**100%**

Source: BUCREP, 2005 population data, organized by author.

The 174 questionnaires taken to the field for administration in the villages/quarters of Boyo Division. In the field following our 4% sample size of 4367 households, we used the systematic random sampling approach to administer questionnaires. Due to the almost deserted nature of the villages because of the recent Anglophone crises, we could only administer 129 copies of our questionnaires in 129 households where we were fortunate to meet the occupants.

The researcher read and filled the questionnaires when the respondents could neither read nor write. Her assistance being a son of the soil and a fluent speaker of the native language helped to interpret the questions to the local people especially the old as the researcher herself

had slight difficulties in communicating with them. These questionnaires were administered in 2020. From table 5 above, we observe that with a sample size of 4367, 174 questionnaires were taken to the field but only 129 were answered. It is with this sample size that all the analyses in this study were done. Also, we observed a 100% response rate in zone C (Njinikom) where all the 29 questionnaires taken to the field were answered while zone D (Bum) recorded the lowest response rate as we had only 36 effective respondents out of 65 as proposed by our sample size. Fig 6 below shows a diagrammatic representation of the spatial distribution of effective respondents in the study area.



Source: Researcher, inspired by Masters 2 classes

Figure 6: Spatial distribution of effective respondents in Boyo

0.9.2.3 Administration and Sampling Procedures

Administering questionnaires and conducting interviews was done in stages. To begin, the researcher introduced herself, stating the institution she came from. The research assistant was also presented to the interviewees or resource persons. Next, the researcher narrated short histories on the evolution of agro-pastoral agriculture and its negative impacts on the environment. For instance, to the government, a short history on the evolution of agro-pastoral agriculture in Cameroon, in the North West and Boyo in particular was narrated. This was done in order to involve them in the exercise and also helped to attract the official's interest and increased their desire to respond to the questions asked. Finally, during the exercise, the researcher encouraged the respondents making them to understand that every opinion counted and no response was wrong.

0.9.3 Data Treatment, Presentation and Analysis

In this research, several types of data were collected that accorded different types of treatment before presentation, analysis and interpretation. The data collected were principally qualitative and quantitative data. The data collected embodied interview data focus group discussion data, questionnaire data, cartographic data and observation data. These different sources of data were treated and presented in form of graphics, tables and sketched maps according.

The treatment of quantitative data began with data coding where we used Strauss' grounded theory method of open system data coding. In this case, categories of responses from different respondents and the major themes were identified, assigned and classified. These categories were manually recorded on a prepared note book per objective of the study.

Observed phenomena were captured with a digital camera. These data were put in a Photoshop software where the photos were enhanced through enlightening and cleaning off impurities found in the photos to make them very clear and visible.

PROBLEMS ENCOUNTERED

The study area was too risky to walk through, observe, conduct interviews, administer questionnaires and carry out field exercises. This was due to the relief constraints and the social upheaval resulting from the Anglophone crisis, the researcher had to work in fear. This made it very difficult for the researcher to collect data from some villages in the interior especially those in the Bum sub Division. In addition, the hilly nature of the terrain made the search for data very tedious and tiring. However, the results were fulfilling for the study.

Structure of work

The general introduction is made up of the background of the study, justification of the study, delimitations of the study area, problem statement, research questions, research objectives and hypotheses, literature review, conceptual and theoretical framework, methodology and problems encountered.

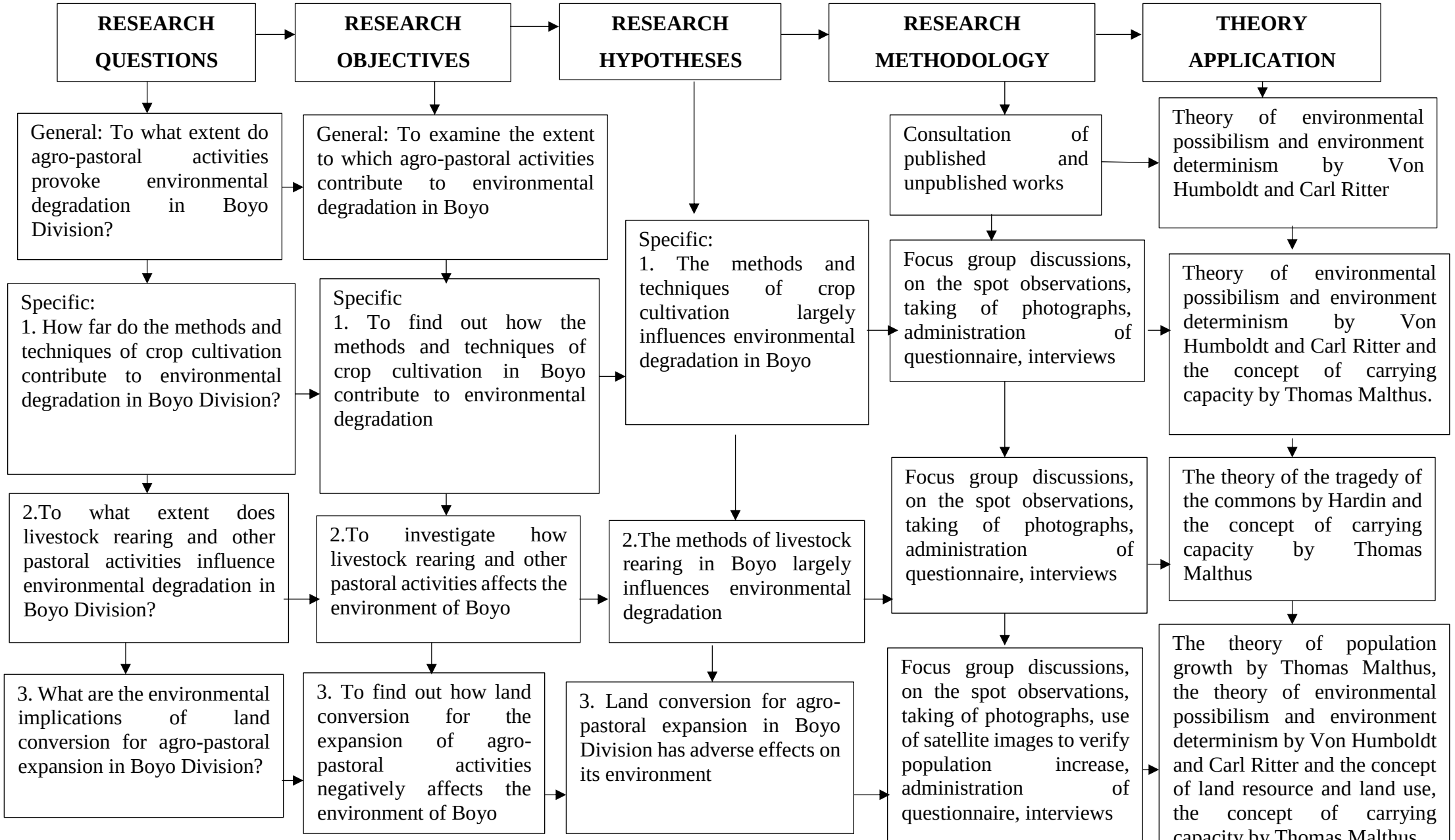
Chapter Layout

Chapter 1 focuses on the impacts of crop cultivation in the study area. It identifies the type of agricultural practices, types of crops, methods and techniques of soil preparation and the factors that favor crop cultivation in the study area. This chapter goes further to study the

forms of soil degradation in Boyo and identify those caused by poor agricultural practices, also this chapter brings out the negative impacts of such practices on the environment.

Chapter 2 focuses on the effects of livestock rearing on the environment of Boyo. It identifies the types of pastoral activities present in the study area, methods/ site of grazing, and the effects caused by grazing activities on the environment of Boyo and therefore validate hypothesis 2.

Chapter 3 looks at the negative effects of land conversion to accommodate the expansion of agro-pastoral conflicts in the study area. This chapter outlines the drivers of agrr-pastoral expansion, the types of land conversions practiced in Boyo and the environmental implications of such expansion on land use.



Source: conceived by the author, inspired by Masters Classes

Figure 7: Table of syntax

CHAPTER 1

CHARACTERISTIC OF CROP CULTIVATION IN BOYO DIVISION

Introduction

The continuous increase in agricultural activities over the years has been felt both at the local and global level, making it the most dominant land use on earth. The people of Boyo, like in other rural parts of the country and other developing countries depend on agriculture for their livelihood. In a study carried out by Ngwa (1989), about 50% of the world's population live in rural areas, of this number, 79.4% of them take part in agricultural activities especially crop cultivation. By the year 1991, agriculture in Cameroon accounted for 27% of GDP and employed about 59.3% of the labor force (Fonjong, 2004). This increase in agricultural activities has exerted much pressure on the natural environment. Moreover, the continuous cultivation by man coupled with his uncontrolled and often primitive agricultural methods and techniques of cultivation has damaged the natural environment in many ways. This chapter therefore elaborates on the negative impacts crop cultivation has on the environment of Boyo.

The raison d'etre of this chapter is to verify the first hypothesis, which states that; Crop cultivation and the methods used largely influences environmental degradation in Boyo. This chapter seeks to find out whether the different types of agricultural practices and the different methods employed during crop cultivation by farmers has a negative impact on the environment.

While in the field, we collected data related to the above stated hypotheses, which after treatment and analysis helped in the verification of this hypothesis. This chapter starts with an introduction and is sub-divided into three major parts; 1.1 brings out the characteristics of respondents,1.2 goes further to brings out the major agricultural systems practiced in Boyo (intensive and extensive agricultural systems) and the major agricultural hotspots in the study area while the last part examines the different methods and technics of crop cultivation practiced in the study area such as the slash and burn methods, the spraying method and the till and cover method and how these different methods individually affect the environment.

1.1 Characteristics of respondents

The study surveyed a diverse sample of respondents, including individuals from a range of ages, and employment statuses. This allowed for a comprehensive examination of the characteristics and perspectives of the target population.

❖ Age distribution of respondents

Crop cultivation in Boyo as per the time of this study is practiced mostly by the old and to a smaller extend the younger population as part timers. Most of the youths in this part of the country are rather engaged in other activities with fast yielding profits such as motorbike riding. According to field investigations, it was revealed that the outstanding age group of crop farmers in Boyo is 65 years and above while the lowest, 15 to 24 years presenting 3% of crop farmers in Boyo Division (fig. 8). It was also noted that generally, the youthful population (15-54 years) shy away from crop farming as they represent only 41% of the total respondents while the aging population (55 to 65+) represent more than half (59%) of the total respondence as shown on table 6 below.

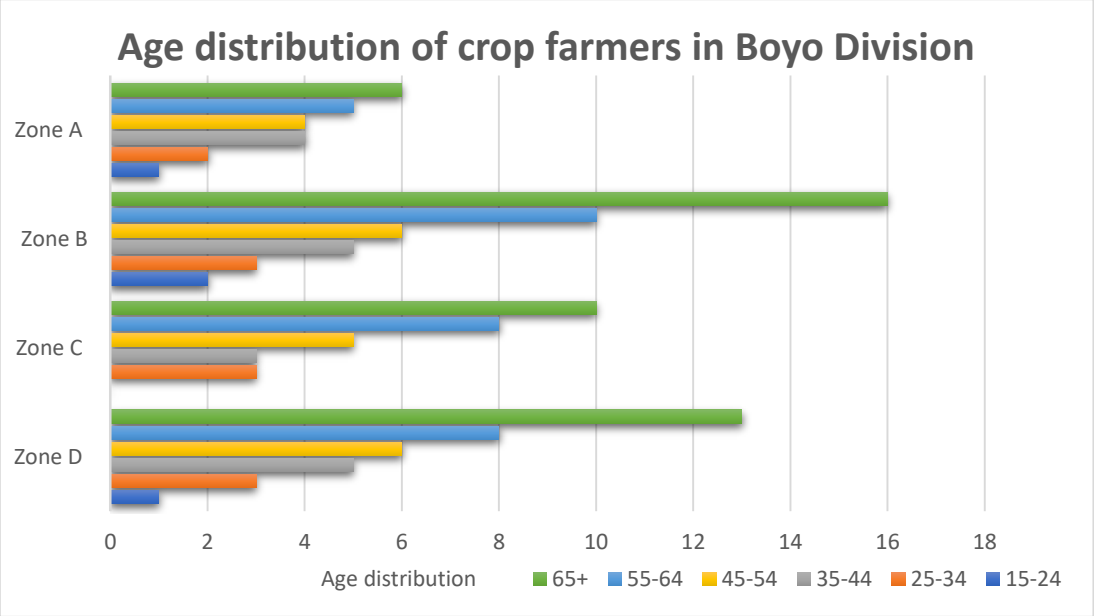
Table 6: Age distribution of respondents

Zones	**Total No of respondents**	**How old are you?**					
		15-24	**25-34**	**35-44**	**45-54**	**55-64**	**65+**
Zone A	22	01	02	04	04	05	06
Zone B	42	02	03	05	06	10	16
Zone C	29	00	03	03	05	08	10
Zone D	36	01	03	05	06	08	13
Total	129	**04**	**11**	**17**	**21**	**31**	**45**
Percentages	**100**	**03**	**09**	**13**	**16**	**24**	**35**

Table 5 depicts that the domineering age groups of crop farmers in Boyo Division is as from 55 years and above representing 59% of all crop farmers in this region. The dominant group however is made up of the elderly, 65 years and above. The age groups that come directly before it, 55-64 years and 45-54 years representing 24% and 16% respectively follow this. Field observations revealed that the younger ones especially the males between the ages of 25 and 35 years prefer other activities such as transportation (motorbikes). Some of them attested that they rather travel out of the rural areas to find greener pastures (better work opportunities and education) in bigger towns such as Bamenda, Douala and Yaoundé than give in their full attention to agriculture which according to them is not befitting enough, does not match their

educational status and above all the yields from agriculture alone cannot cater for all their needs. The youthful population shying away from agricultural activities has led to the continuous practice of old and rather degrading methods and techniques of cultivation by the older population as they can only practice what was transferred to them from generations without caring about the effects these methods could have on the soil. The youthful population not being there to transfer knowledge learnt in schools, institutions and even seminars about agricultural practices and how it can be done to avoid or reduce its negative effects on our already degrading environment is heart breaking.

Careful observation of fig 8 below shows a graphical display the age distribution of crop farmers in our study area.



Source: generated from table 6 above

Figure 8: Age distribution of crop farmers in Boyo Division

Crop cultivation in Boyo Division as already stated, is progressively becoming an occupation for the retired and aging population. This has gone an extra mile to implicate the agricultural sector in a rather negative sense since most educated youths shy away from agricultural activities and embrace other activities such as motorbike riding. According to field investigations from the field, it was revealed that the outstanding age group of crop farmers is 55 years and above representing 35% for farmers of 65 years plus and 24% for farmers between 55 years and 64 years. The lowest record being youths of between the ages of 15 years and 20years representing 3% as shown on fig 8 above. Field investigations revealed that age group between 15 and 20 years involved in crop farming are mostly those who have not attained any

formal education or school dropout who are left with no other options. This group of people are usually from less privilege homes and need to feed and cater for themselves and siblings reason why most of them are rush to crop farming. Analyzing these figures we can conclude that the younger generation are less interested in agricultural activities as they consider other options. They only turn back to this activity as they turn to get older.

According to key informants contacted on the ages of crop farmers in Boyo Division and the effects on farming methods implored, it was attested that the older generation who dominate this sector use old methods of farming such as burning which they learnt while growing up. It is very difficult to change these patterns at this stage as they are already used to it, have seen it work for their parents before, and is still somehow favorable to them even at this time. It is now the place of our educated youths to change these patterns by involving themselves more in agricultural activities and implementing what they have learnt. It is only by doing so that others will learn of the new and innovative methods of crop farming that degrade less.

- **Employment status of respondents**

A great percentage of people in Boyo Division claim unemployment status which is linked to the ongoing crisis in the region. According to field research, the majority of people left in the villages are either dropouts from school or unemployed individuals who have never attended formal school. The majority of this group of people rush into crop farming because they come from less privileged homes and must provide for their siblings as well as themselves. Table 7 below shows the employment status of respondents across Boyo Division.

Table 7: Employment status of respondents

Zones	**Total No of respondents**	**Are you actively employed?**		**If yes, which sector?**			
		YES	NO	**With the government**	**With the private sector**	**With an NGO**	**Self employed**
Zone A	22	06	16	05	06	03	08
Zone B	42	17	25	09	12	04	17
Zone C	29	14	15	05	08	03	13
Zone D	36	11	25	08	10	02	16
Total	129	48	81	**27**	**36**	**12**	**54**
%	**100**	**37.2**	**62.8**	**20.9**	**27.9**	**09.3**	**41.9**

Source: Researcher, field work data, 2021/2022

According to Table 7, the majority the respondents in Boyo Division are unemployed, accounting for 62.8% of all farmers in this area against 37.2% who are unemployed. Of those who are employed, 41.9% affirmed to be self-employed, closely followed by 27.9% of the population claiming employment status with the private sector meanwhile just a minority 09.3% are actively employed with the non-governmental organizations.

1.2 Major agricultural systems practiced in Boyo

In order to better utilize their space, farmers in Boyo Division practice varied agricultural mechanisms, which in all could be coined down as major agricultural systems. These farming systems in Boyo like all other places in Cameroon are determined by a combination of both physical and anthropogenic factors. Depending on the dominant physical and human factors available and the reasons for cultivation, farmers determine the system that best suits their needs. Based on this criterion, two main types of farming systems were identified: intensive and extensive agriculture. In order to find out the dominant agricultural system present in our study area, we set out to ask some pertinent questions to our respondents in the field. Table 8 below shows our respondents' views on the major type of agricultural system practiced in Boyo Division. This classification was done based on the types of farm tools used and scale of production in relation to the market amongst others.

Table 8: Major agricultural systems practiced in Boyo Division

Zones	**Number of respondents**	**What type of agricultural system is most practiced here?**			
		Intensive agriculture		**Extensive agriculture**	
		Intensive subsistence	**Intensive commercial**	**Extensive subsistence**	**Extensive commercial**
Zone A	22	10	05	05	02
Zone B	42	19	07	11	05
Zone C	29	16	04	06	03
Zone D	36	17	08	07	04
Total	**129**	**62**	**24**	**29**	**14**
Percentages	**100**	**48**	**18.6**	**22.5**	**10.9**

Source: Researcher, fieldwork, 2021/2022

From table 8 above, it can be observed that 66.6% of farmers in Boyo are engaged in intensive agriculture. It was equally observed that the land sizes were relatively small ranging from $200m^2$ to about $8000m^2$ mostly using tools such as cutlasses, hoes and axes and relied more on human labor from their immediate family, friends and njangi farming groups. Farmers here carry out such activities on small plots of land using primitive tools and only produces enough output to support the farmer and his small family.

In a quest for more information on how intensive subsistence agriculture was practiced, we had an interview with Na Ntein in Achah, Belo, where she explained to us that farming in this area is very easy. They organize what she called njangi farming where they all agreed to work (clearing, planting, and/or sometimes harvesting) in one person's farm for a day or more and move to the next member's farm during the same agricultural season. The process continues until every member's farm is being cleared, planted and/or harvested. According to her this was effective and worked for her entire family. However, she regrates the fact that this solidarity farming is gradually dying down due to the on-going crisis causing out migration in this area. Out of the 66.6% of farmers who practice intensive agriculture, a greater part (48%) was subsistence intensive and their main aim of cultivation is to feed their immediate families. In an interview with nawain Margaret Keh, she explained to us as thus;

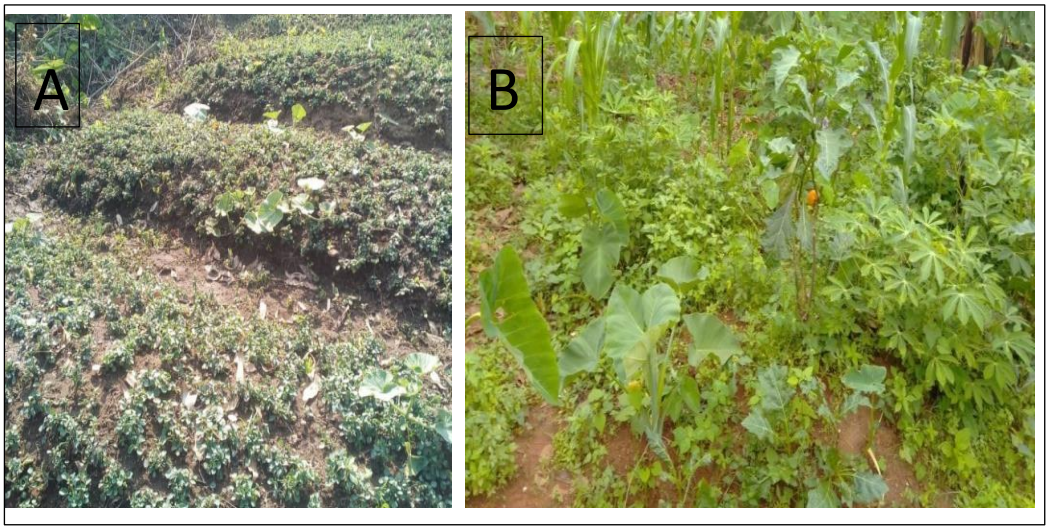
"*I do not cultivate to sell. I only cultivate because I want to feed my children and grandchildren. I may only sell in years when my harvest is in excess and use the money to acquire some basic household needs or purchase seedlings for the next farming season".*

Farmers who practice intensive subsistence agriculture in this part of the country mostly make use of the mixed cropping system otherwise known as inter cropping where they cultivate many different types of crops on a single piece of land. Crops grown include maize, beans, cocoyam, Irish potatoes, sweet potatoes and vegetables like huckleberry and bitterleaf. An interviewee from the "Mboini Women Association" was of the opinion that the mixed cropping system gave them more yields and a variety to choose from. It also helped them to maximize their lands while minimizing the risk of crop failure. The picture that follows is an image of an intensive subsistence farm in Njinikijem (fig. 9)

Source: Researcher, fieldwork, 2021/2022

Figure 9: Intensive subsistence agriculture in Njinikijem

Intensive commercial agriculture on the other hand represented 18.6% of our total respondents. It was observed that this proportion practiced mainly market gardening with crops such as huckle berry, pumpkin leaves, garden eggs, ibwang cultivated amongst others. An average family in Boyo has just about one to two farmlands and most rural farmers practicing intensive commercial agriculture in Boyo have limited resources. Plate 1 below is a vegetable farm in Bwa-bwa in Bun sub-Division clearly showing the aspect of intensive commercial agriculture.



Source: Researcher, fieldwork, 2021/2022

Plate 1: Intensive commercial agriculture in Belo sub-Division

In a bit to increase their income and output, most of them seek rentals from other wealthier families and are given just small portions of land for farming. They then tend to used excess fertilizers and pesticides to fight crop failure and increase yields.

With regards to extensive agriculture, we identified two entities; those who were into extensive subsistence agriculture and those who carried out extensive commercial agriculture. This type of farming requires large amount of labor, capital and large extensive land. The former represented 22.5% of the total respondents and was characterized by vast pieces of land ranging from 1 to about 10 hectares but not meant for commercial purposes. This was the case with bobe Yonghabi of Atuilah in Njinikom sub-Division, proprietor of about 6 hectares of maize not dedicated for commercial purposes. Farmers practicing intensive subsistence agriculture usually cultivate only a single crop in a piece of land like maize, cocoyam, beans or whatever crop they chose to and the farm turns to be referred to by the crop type cultivated there. For instance, farmers will often refer to their farms as the maize farm at Bochain or the beans farm at Anyajua depending on the crop that is being cultivated there.

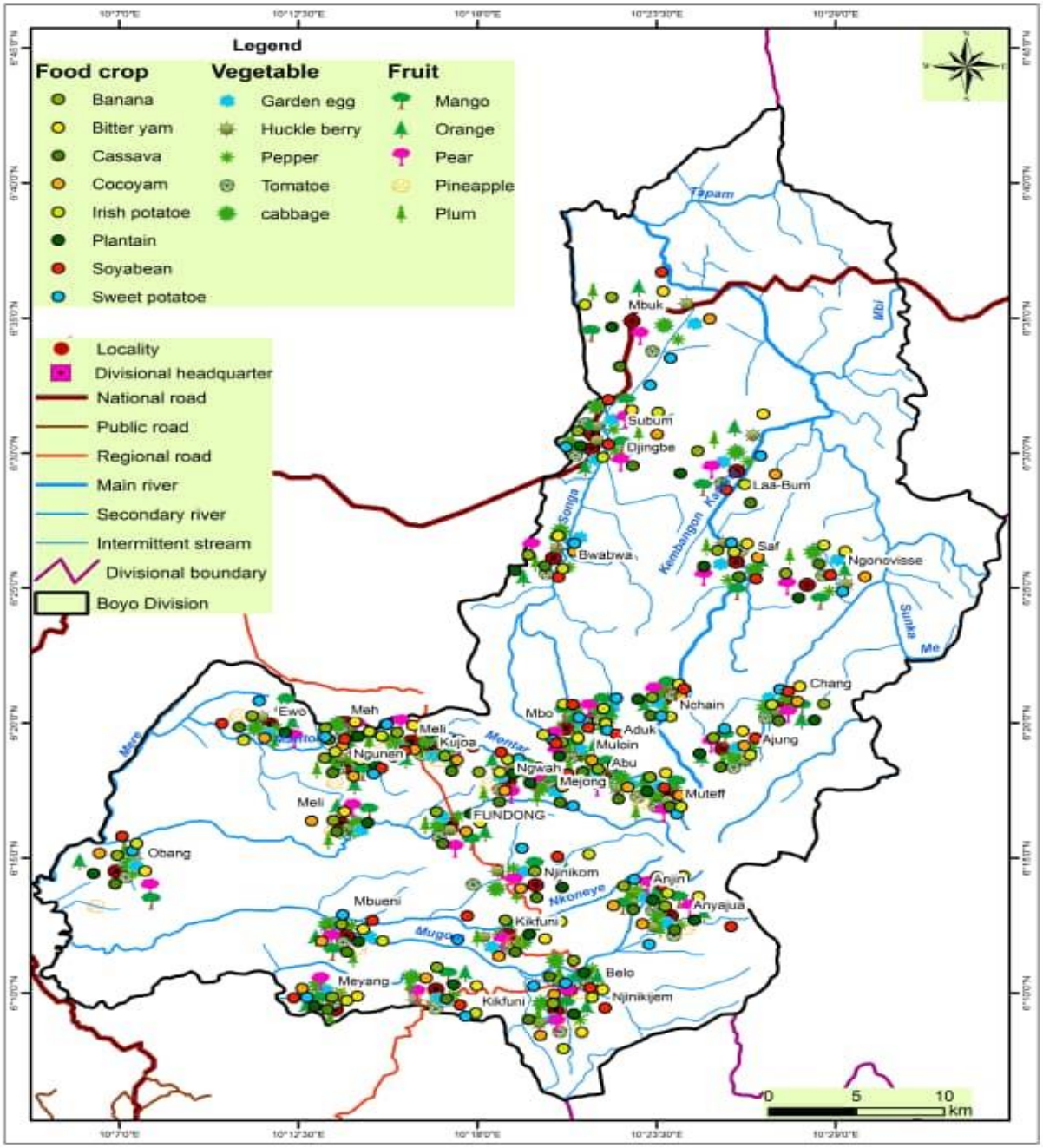
Source: adapted from Cameroon Association of Responsible Tourism (CAMAST), 2010

Figure 10: Extensive agriculture in Boyo

Figure 10 is an example of extensive agriculture practiced in Boyo (Ndawara tea plantation) we notice the crops are well aligned following a straight line. This eases the farmers work during weeding and even harvesting as they only have to walk along these open paths.

From careful observations, detailed analysis together with prompt responses from our respondents about crop types, choice of crops to be planted and plant domination in each

subDivision, we identified some agricultural hotspots in well-defined geographic zones as shown on map 2 below.



Source: *Adapted from the administrative map of Cameroon, INC, Yaounde, Mairomi, H. 2020*

Map 2: Agricultural hotspots in Boyo Division

From indications on the map above, we notice that beans and potatoes are extensively cultivated in areas like Anyajua, and Mbueni. Maize in Mbueni, Mbahyam that is being exported to other parts of the North West Region while the rest is consumed locally. As concerns intensive farming we noticed crops like yams, cassava, cocoyam, plantain While

some other crops were cultivated intensively in the form of small gardens with crops such as pepper, tomatoes, cabbage and other vegetables.

1.3 Methods and techniques of crop cultivation practiced in Boyo Division and their effects

Fieldwork statistics confirmed the existence of several different methods of soil preparation practiced by farmers in Boyo Division to prepare their farms for the planting season. We noted methods such as the slash and burn methods, the ankara method and the spraying method. Data related to the different methods of soil preparation used by farmers in this part of the country was collected, analyzed and presented on the table below (table 8)

Table 9: Respondents view on the methods of soil preparation practiced in Boyo Division

Zones	**Total No of respondents**	**How do you prepare your farmland for the agricultural season?**			
		Bush burning (Slash and burn)	**Spray and plant**	**Till and cover (Ankara)**	**All of the above**
Zone A	22	09	04	08	01
Zone B	42	15	09	14	04
Zone C	29	12	05	09	03
Zone D	36	16	06	12	02
Total	129	**52**	**24**	**34**	**10**
Percentages	**100**	**40.3**	**18.6**	**33.3**	**07.8**

Source: Researcher, fieldwork, 2021/2022

1. Slash and burn method

The methods of farming in the Boyo Division are mainly traditional and entails the use of crude tools such as hoes, cutlasses, axes, etc. In preparing the soil, some farmers prefer to allow the grass for at least two weeks after clearing to start decaying before it is gathered into heaps and covered with soil to form ridges. This is a popular method of soil preparation in the tropics

and the North western region of Cameroon in particular. It involves the cutting and burning of trees and / or bushes to create a suitable field for cultivation. The bush is cleared using rudimentary tools such as hoes, cutlasses and axes, the grass is then gathered into mounts and the ridges covered with soil and then burnt to produce a mix of burnt soil and ashes. The ashes produced is rich in potassium which is very fertile for crop cultivation at the moment but tend to gradually decrease with time as the nutrients are being taken up by plants and some of them leached below the reach of plant roots.

Source: Researcher, fieldwork, 2021/2022

Plate 2: The slash and burn method of soil preparation in Boyo Division

Photo A shows farmers gathering patches of grass to form a bunch before burning unlike in the second farm (photo B) where a vast portion of land and sometimes the entire farm is set ablaze.

In the case where it is a new farmland, trees of small and medium sizes are cut down, allowed to get dry and subsequently fire is set on it. This is the most widely used technique of cutting down trees in this region especially as it is characterized by a rugged and rough topography. This is a very old method of farm preparation in Boyo Division and is very much cherished by farmers. This is because it is the easiest form of preparing farms for cultivation despite its damaging effects on the environment.

Analyzes from table 8 above shows that 40.3% of farmers in our study area practice the slash and burn method to prepare their soils for the subsequent agricultural season. From information gotten from an interviewee in the field, after the harvesting season, they leave their

farms without cutting the stalks and woody plants and only return prior to the next planting season when the place is dry; they gather the plant residue then burn the rest. The farmer went further to explain that the ash produced after burning was used as a natural fertilizer to boost crop growth especially in areas like Ayanjua where there was a noticeable drop in crop output during the previous years. The potash gotten from burning however only works for a very short period and is soon exhausted leaving the soil fragile and empty, void of nutrients and hence less fertile than before. This farming activity usually takes place in the heart of the dry season between the month of December and March when the bush is very dry.

The widespread use of fire for preparation of land for farming has caused a lot of damage to the entire ecological system. Not only are the trees are burnt but thousands of soil organisms are also burnt in the process. These soil microbes and bacterial play a vital role in soil fixation and goes a long way in increasing the fertility of the soil. After setting the farm ablaze, there is depletion in soil moisture as the intensity from the fires only help to dry up the soil, destroy the microorganisms present and hence rendering the soil even more fragile and less fertile making this method of soil preparation a threat to soil nutrients. Aside the destruction of soil microorganisms, seeds of trees are equally burnt and make natural regeneration of the forest to be difficult.

Another adverse effect of the slash and burn method in the ecological system is its great contribution to greenhouse gas emission and air pollution causing climate change and global warming. When trees are burnt down, there is excess release of carbon dioxide, which remains in the atmosphere contributing to global warming and ozone layer depletion. Fire from the burning destroys natural habitat and scares away animals, birds and insects from their natural milieu.

Healthy soil is the result of a good relationship between the moisture in the area, insects, and native trees. The vegetation and trees in the area provide shade appropriate for the growth of younger plants while also protecting the general health of the soil. After burning the soil, structure becomes less suitable and crop roots can no longer anchor well in it. Soils from such farms are vulnerable to wind and water erosion plant roots cannot hold the soil firm. This is the case with farms in rocky and hilly areas especially those along the slopes of Boyo hill. Therefore, slash and burn agriculture disrupts the natural balance of the ecological system, dramatically affecting the soil.

2. Spraying method

In other situations, it was observed that some farmers use chemical sprays to prepare their farms for the planting season. This is a more advanced method of soil preparation and is only practiced by 14% of farmers in Boyo as seen on table 8 above. In Boyo Division, chemical spraying is mostly done in vegetable farms, gardens and very large farms to easily get rid of unwanted herbs.

The most common chemicals used here are *round up* which works for a duration of 12 hours before being washed out by rain, *green gobbler* has a duration of 24hours, *compare-N-Save* has a duration of 2-4 hours, and *spectracide* with a duration of 15 minutes. After the farm is sprayed using a back pump, it is allowed for about 5 days so the grass dies down and planting follows immediately without necessarily tilling the soil. The image below shows farmer Samuel preparing his farm for planting by the spraying in Bahnyam.

Source: Researcher, fieldwork, 2021/2022

Photo 1: Spraying as a method of soil preparation in Boyo

In an interview with Mr. Samuel, he confirmed to us that these chemicals can be used either before or after planting to kill the herbs. The increasing use of chemical fertilizers in this region accelerates the expiration of organic substances hence destroying the balance of nutrients in the soil and result to a rise to a variety of plant diseases. The chemicals present in the fertilizers end up as pollutants in water bodies such as rivers and streams around farming areas through runoff. The chemicals found in fertilizers are highly soluble and are absorbed by

the ground more rapidly than they are absorbed by the intended plants as plants have the capacity to absorb only a given level of nutrition at a time leaving the rest of the fertilizer to leach.

Leaching is not only hazardous to groundwater sources but also to the health of subsoil where these chemicals react with clay to create hard layers of soil known as hardpan. As a result of chemical fertilizer use the health of soil and water is jeopardized, not to mention the waste of money and nutrient deficient plants. The synthetic chemicals in the chemical fertilizers adversely affect the health of naturally found soil micro-organisms by affecting the soil pH. These altered levels of acidity in the soil eliminate the micro-organisms beneficial to plant and soil health as they help to increase the plants' natural defenses against pests and diseases. These helpful micro-organisms consist of antibiotic-producing bacteria and mycorrhizal and other fungi which are found in healthy soil. The use of chemical fertilizers also jeopardizes the health of bacteria that fix the nitrogen balance in the soil. These nitrogen-fixing bacteria are responsible for converting the atmospheric oxygen into a form of nitrogen that can be used readily by plants.

The application of chemical fertilizers in farms also contributes to the release of greenhouse gases as most fertilizers consists of substances and chemicals like methane, carbon dioxide, ammonia, and nitrogen, the emission of which has contributed to a great extent in the quantity of greenhouse gases present in the environment.

3. Till and cover method

Another method of preparing the soil for cultivation we observed was the till and cover method commonly known as ‘ankara’ system of farming. This is a more sustainable form of preparing the soil than the slash and burn method and involves the tilling of soil using crude tools such as hoes and cutlasses.

From the analysis of data presented on table 7 above, 16% of our respondents prefer to till the soil. From direct field observations, we noticed that the soil in some zones were soft and easy to dig and till. This was seen especially in areas in Bum subDivision where most of their soils are soft alluvial soils, low-lying areas and depressions in Fundong, Njinikom and Belo. This method of farming however loosens the soils and makes it liable to erosion after heavy rainfall. Photo 3 below shows a farm in Ashing, Kom prepared by tilling the soil.

Source: Researcher, fieldwork, 2021/2022

Photo 2: The till and cover method as a method of soil preparation in Boyo

During focus group discussions with farmers, they explained that they mostly practice this method in areas with soft soils. In areas where the soil is rocky and hard, they go for other methods like burning or spraying which makes the work lighter for them.

The hoe practice remains predominant though the manner in which farms are tilled has greatly evolved. From mass tilling during which the soil was simply softened and seeds sown to ridge tilling. Tilling techniques evolved to those involving the construction of soil mounds and further to the construction of ridges along the slopes. As a result of low productivity associated with these techniques, construction of ridges became across the slope, terrace that is contour wise in order to reduce the effect of erosion by rainwater, thereby maintaining enough farm soil in place, capable of supporting plant growth

This technique of tilling has equally undergone a series of modifications like from narrow short ridges to gradually broad and longer ones. Presently, farmers in several villages especially in the Mbam valley restrict the amount of soil in the construction of ridges during tilling. This allows for considerable decay of grass and the remaining soil reserved in furrows. When this soil is introduced under the plants during weeding, it revitalizes plant nutrients, contributes to increased crop productivity and boosts the year's yields. Several methods of farm preparations exist in the Sub-Division and these include slash and burn and slash and mulch.

Conclusion

The use of poor/inadequate farming methods and technics of farm preparations plays a great role in degrading the environment of Boyo Division. It is even worsened by the limited involvement of educated youths in the agricultural sector to transfer knowledge learnt in schools and seminars resulting to the continuous transfer of old and unsustainable methods and technics by the older generation. The methods of soil preparation such as the slash and burn often employed by these age groups (55^{+}) are those their grandparents and great grandparent taught them which have proven nowadays to be unsustainable and promote environmental degradation.

There is however beginning to be a shift as more and more farmers are encouraged to practice the till and cover method, which is more conservative. Although it is not very much used as expected, the presence of farm cooperatives, small farm groups and the trainings and seminars organized to throw more light on the dangers of unsustainable farming technics is slowly changing the narratives.

CHAPTER 2

CHARACTERISTICS OF ANIMAL REARING IN BOYO DIVISION

Introduction

Increasing agricultural production and improving the quality of milk and meat are key to combatting poverty and increasing food security in Africa. Two-third of all livestock is found in developing countries (Katrien, V. H et al, 2008). Countries such as Cameroon are increasingly turning to innovative techniques to control and prevent diseases among livestock, increasing their production over time. Unlike arable farming/ crop cultivation, pastoral farming is a form of agriculture that involves the production of livestock and its related products. Boyo Division is particularly known for its rich pastoral tradition and livestock rearing due to the presence of Fulani pastoralists in Fundong and Belo sub-Divisions.

Pastoral activities in this region have both positive and negative impacts on the environment. On the positive side, they contribute to the economy by providing food and income for the local population. However, the negative impacts of this activity on the environment is of growing concern as it often leads to overgrazing of pasture which in the long run generates to soil erosion, burning and land degradation.

In recent years, concerns have been raised about the environmental impacts of livestock rearing and other pastoral activities on the environment. It is therefore very crucial to understand the effects of these activities on the environment in order to develop sustainable solutions to promote economic development while protecting the regions natural environment and resources. This chapter aims to portray the negative effects of livestock rearing on the environment of Boyo Division through the different methods implored in the rearing process. To achieve this, we will look at the different types of pastoral activities practiced in this region, how animal rearing and pastoralism is perceived amongst the population and conclude with how the different methods of animal rearing affect the environment.

2.1 Types of pastoral activities practiced in Boyo

Pastoral farming in Boyo Division just like crop cultivation can be intensive or extensive depending on the farmers' preferences. From field observations and interviews conducted, it was noted that farmers preferences on the type of pastoral activity practiced was largely dependent on the farmers capital, farm size and their availability in order to cater for the animals they choose to raise.

Generally, those with relatively little capital but with the aim of getting higher outputs and profits turn to engage more in intensive methods of animal rearing such as poultry farming and fish farming where they focus on increasing the number of animals rather than the size of the farms where these animals are kept. It is a form of animal husbandry that involves keeping large numbers of animals in a confined space by maximizing production efficiency and increasing yields of animal products.

In intensive animal rearing, animals are mostly fed with specially formulated diets that are designed to promote rapid growth and high productivity. As a result, these animals usually reach maturity much faster than those raised in their natural environment do. While intensive animal rearing can result in higher yields and lower costs, it is greatly criticized for its negative impact on animal welfare, human health and the environment at large. The concentrated animal waste produced by animals in this system greatly contributes to water, air and land pollution when mishandled.

Extensive animal farming systems on the other hand is practice on large extensive lands with relatively small inputs of human labor. This farming system is generally practiced in areas where there is low agricultural productivity due to the number of animals and the amount of land these animals have to occupy. Usually, these farmers in an attempt to reduce their costs unconsciously aggravate our environmental conditions as they most often engage in frequent burning of bushes to enable fast regeneration of pastures for their animals which have exceeded the carrying capacity of the land. This is partly the case around Boyo hill where livestock farmers use the notion of no man's land to increase their number of livestock at will because they feel that because it is a communal land, they have equal rights to own any number of cattle they want hence working beyond the carrying capacity of the land. Aside burning, these pastoralists in an attempt to increase soil productivity go in for fertilizers to boost the soil, increase soil productivity and get results over a shorter period. This extensive livestock farming rather exerts too much pressure on the land/ grazing land leaving it bare and vulnerable and at this stage; the grazing lands are exposed to agents of erosion, specie exhaustion and environmental pollution.

One of the people interviewed in the field, Bobe Nges attributes this type of farming system to the rich and wealthy people. According to him a local man like him cannot afford a large piece of land like that for grazing only. He adds that these people have other sources of income as compared to them who depend solely on agriculture. His argument being that concentrating only on raising animals requires much capital but all they have is a small piece

of land from their family inheritance to feed themselves and their families. Bobe Nges went further to ask us that in case they even decided to start raising animals only, where will they have food to feed themselves?

Aside intensive and extensive pastoral farming as the two main rearing systems identified in Boyo Division, there are many types of pastoral activities practiced by pastoralists in this part of the country to sustain their lives. After conducting interviews and field observations, we came up with a list of the most practiced pastoral activities in Boyo Division. Table 10 below shows the most dominant pastoral activities identified in Boyo Division.

Table 10: Types of pastoral activities practiced in Boyo

Zones	Total No of respondents	What type of pastoral activity do you practice?					
		Extensive animal rearing		Intensive animal rearing			
		Livestock rearing	Bee farming	Poultry farming	Fish farming	All of the above	None
Zone A	22	11	01	05	01	04	0
Zone B	42	18	04	09	04	05	02
Zone C	29	10	02	08	05	03	01
Zone D	36	15	03	07	04	05	02
Total	**129**	**54**	**10**	**29**	**14**	**17**	**05**
Percentage	**100**	**42%**	**08%**	**22%**	**11%**	**13%**	**04%**

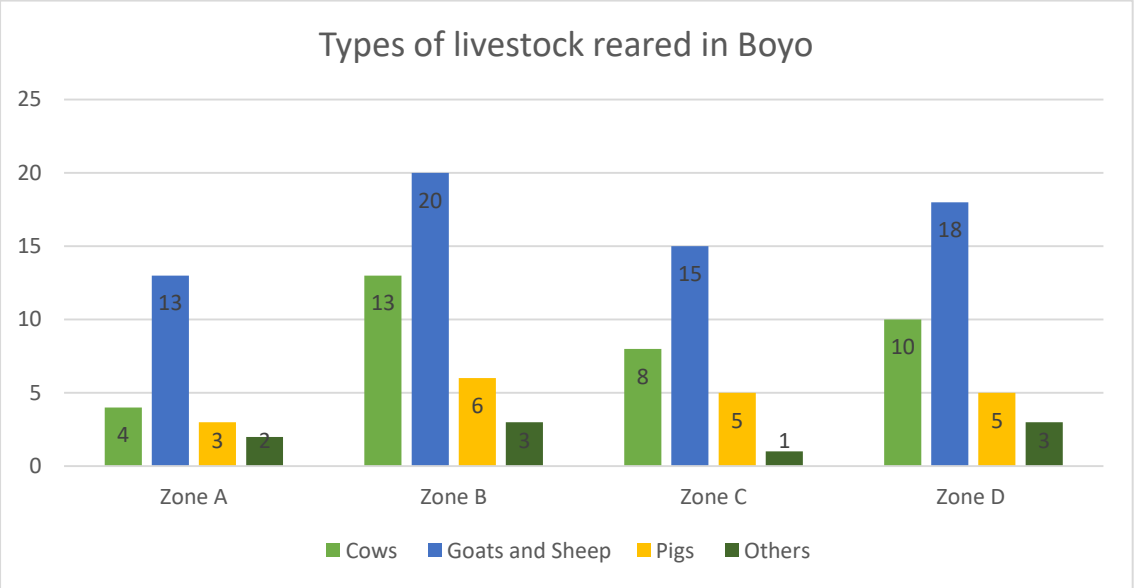
Source: Researcher, fieldwork, 2021/2022

From table 10 above, the most practiced type of pastoral agriculture in Boyo Division is livestock rearing which stands at 42% with animals such as cows, goats and sheep. This figure is closely followed by poultry farming with 22% featuring fowls and ducks as the most kept birds for poultry. These high values recorded for livestock and poultry as explained by an elder is due to the cultural attachment of the people of Kom to some of these animals as they serve as traditional requirement for almost all of their event, both happy and sad events. Also, the presence of the Fulani in Boyo especially the Fundong and Belo areas has greatly shaped the economic activity of these areas. The Fulani being very much inclined to their culture are associated with animal rearing and are seen carrying this everywhere they go. There were

records of other pastoral activities like fish farming and bee farming recording 8% and 11% respectively. Farmers little engagement in fish farming is due to the fact that this sector is still being integrated into the system and farmers do not master the dynamics involved in fish cultivation as they are versed with the other types.

I. Livestock rearing

Cows are the main livestock in Cameroon and this is not different with the case of Boyo. The country has 5.8 million cattle as compared with 4.6 million goats and 4 million sheep (IAEA, 2015). The Fulani herdsmen are the main cattle rearers in Cameroon, originating from the north but recently they have spread to occupy the grassland regions. The rearing of animals in Boyo is concentrated in Fundong sub-division around the forest area where it records the highest number of cattle in the region as compared to sheep, goats and pigs. The main by-products from livestock rearing here are meat although milk is also highly demanded. Cattle are also regarded as a symbol of wealth amongst Muslim settlers. In order to have more information on the different types of livestock reared, respondents across Boyo Division were questioned about the different types of livestock kept around them and the responses gotten were organized then presented on figure 11 below.



Source: Researcher, adapted from table 8

Figure 11: Types of livestock reared in Boyo

From figure 11 above, it is clear that the goats and sheep are the most reared animals in all the four sub-Divisions of Boyo Division. Goats are used in almost all occasions in Boyo from wedding celebrations to funeral celebrations and even during religious occasions. Almost

every household owns at least a goat in their compound for use if an emergency occurs. Cows were the second in the list of most common livestock reared in Boy Division. They had a cumulative total value of 27% against goats and sheep with the highest records of 51%. There exist other livestock in this area like pigs, which are kept by just a few people. The images on plate 3 below show the different types of livestock reared in Boyo Division.

Plate 3: Livestock rearing in Boyo

Source: Researcher, fieldwork, 2021/2022

Plate 3 above shows some of the different types of livestock reared in the study are. We have on photo A, cows grazing in the fields while photo B shows another type of livestock (pigs) reared in a confined environment.

II. Bee farming (Apiculture)

Beekeeping has become a very successful occupation in the primary sector of the Cameroon economy. It is a major integral component in the agricultural economy of our country yielding much more than crops when well managed. Apiculture is the maintenance of bee colonies, commonly in man-made hives, by humans. Apiculture products are mainly honey and wax with medicinal and cosmetic uses. They are consumed locally, nationally and internationally as a substitute for sugar. Bee farming is not a primary source of income to farmers in the North West but rather serves as an important secondary source. More than 80% of beekeepers derive 30% to 60% of their annual income from apiculture (Ingram and Mala, 2010).

The ecological environment and mountainous relief of Boyo Division serves as a breeding ground for bees. This has attracted bee farmers in taking up apiculture as a secondary source of income. It was only after the economic crisis that many people realized the importance of beekeeping in Boyo. Before this time, it was regarded as an occupation of the poor and unskilled laborers including women and farmers who had not attained a certain level of education. Apiculture in this part of the country is both traditional and modern.

Bee keeping activities can be spotted in the entire Boyo Division but most especially in the areas surrounding the Ijim mountain forest like Mbesinako and Mbongkisu. Honey gotten from beekeeping varies from the source of nectar. There are three types of honey in Boyo. Honey gotten from forest owers, bananas and coffee plants while the brown sticky and liquid honey is gotten from owers like Sun owers, roses and hibiscus.

III. Fish farming (pisciculture)

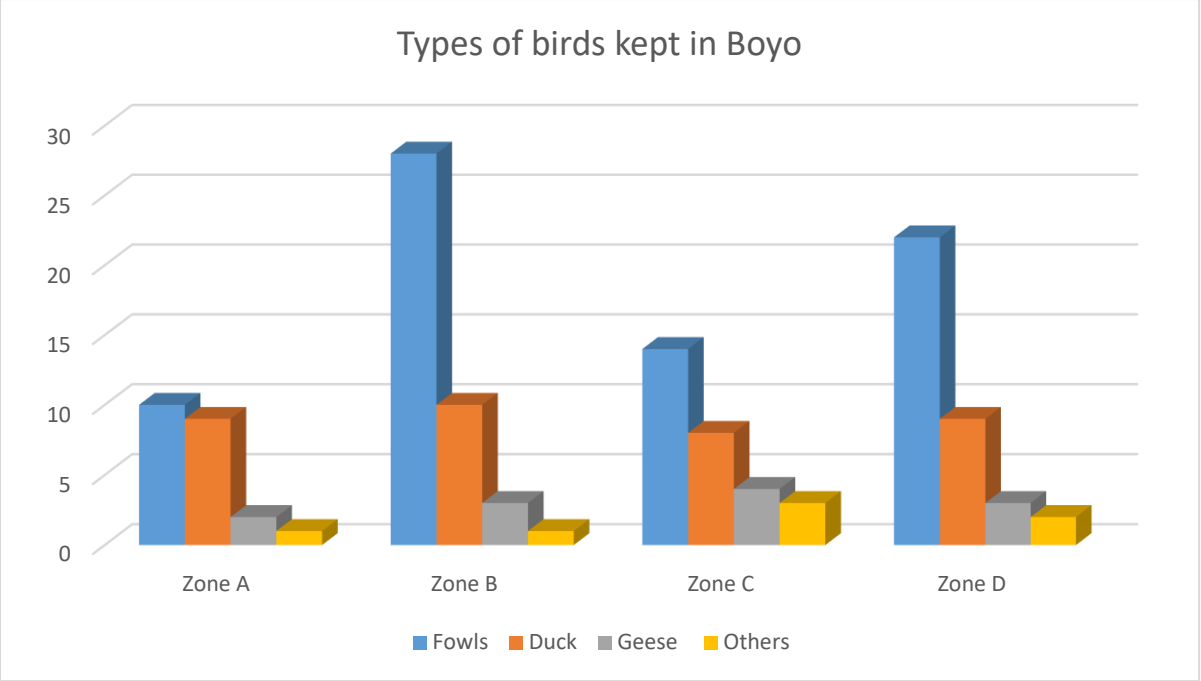
Fish farming is another form of pastoral agriculture which is still developing. From table 9 above only 8% of our total respondents practice pisciculture. In fact, in Fundong sub-Division, where it is most practiced with a total response of 4 out of 42 responses recorded, tilapia is the main type of fish kept. The harvest derived from this activity is either sold in the local markets or consumed by the farmer himself. From an interview with Dr. Tasah in Bochain, this activity is not highly practiced because it demands special training which is not easily accessible to the local population. Furthermore, the cost of starting up this activity is not affordable to most of the farmers. Photo 4 below is an example of what a fish farm looks like in a typical rural area such as Boyo Division.

Source: Researcher, fieldwork, 2021/2022

Photos 3: Fish farming in Tinifoinbi in Njinikom sub-Division

IV. Poultry farming

The poultry sector has emerged since the 2005 ban placed on the importation of frozen poultry products from Europe. Since then, it has been a source of employment to many youths as the demand for poultry products keep increasing. This is a form of animal husbandry, which deals with the breeding, rearing and managing of birds for food. It involves raising birds domestically or commercially primarily for meat and egg production and sometimes for their feathers. Today, the poultry sector alone accounts for about 4% of Cameroon's GDP (GIZ, 2018). Its products, (meat and eggs) serve as a source of protein while its feathers are used for decorations and cultural practices. Domesticated birds here include but not limited to chicken, ducks and geese. In Boyo however, poultry farming is predominant in raising chicken and to a lesser extend ducks. Figure 12 below shows data gathered in the field to estimate the spatial distribution of the different types of birds raised in Boyo Division.



Source: Researcher, fieldwork, 2021/2022

Figure 12: Respondents view on the type of birds kept in Boyo

According to respondents view on fig 12 above, fowls (chicken) are the main birds kept in Boyo Division. In Fundong sub-Division for example where we had the highest number of respondents, 28 out of 42 people affirmed that there were more of fowls than any other birds. It can also be observed that in Bum sub-Division even with the smallest respondent size, respondents confirmed to have at least 10 out of 22 people keeping fowls either for home consumption or for sale while the rest of the birds were just spotted within the community.

2.2 Perception of animal rearing in Boyo Division

Animal rearing is an activity cherished by a particular group of people (fulani) and detested by many others due to the inconveniences. According to data collected during field investigations, animal rearing is an activity resulting mostly from motivations such as cultural attachments, inheritance from parents or sponsors and to some extent, low literacy level and the inability get better paying jobs as presented on table 11 below.

Table 11: Respondents views on the perception of animal rearing in Boyo Division

Zones	**Total No of respondents**	**Are you comfortable (proud) when referred to as an animal farmer?**		**Why did you choose animal rearing as an economic activity?**				
		YES	NO	**Inheritance**	**Culture**	**Lack of jobs**	**Love for the job (animal)**	**To raise money for a better business**
Zone A	22	10	12	06	00	10	04	02
Zone B	42	24	18	08	10	12	06	06
Zone C	29	09	20	03	04	07	02	13
Zone D	36	20	16	09	07	10	04	06
Total	129	63	66	**26**	**21**	**39**	**16**	**27**
%	**100**	**48.8**	**51.2**	**20.2**	**16.3**	**30.2**	**12.4**	**20.9**

Source: Field data, 2021/2022

The 51.2% of respondents as depicted by table 11 above have a rather negative point of view on animal rearing activities as compared to 48.8% of respondents who admitted their love for the activity and are proud of it. As shown on table 10 above, zone B and D representing Fundong and Belo sub-Divisions respectively recorded the highest number of proud animal farmers.

Table 11 depicts that most people engaged in animal rearing because they lack good paying jobs and do not want to remain idle. This was closely followed by another group who confessed that they were into animal rearing only for a short period of time as they wanted to raise money for other lucrative businesses (20.9%). Most people in this group however expressed their desires to continue with rearing as it provides sufficiently for their needs. While others 20.2%, got involved because they had inheritance in form of animals, which later made them engage and love the activity.

2.3 Methods of animal rearing used in Boyo Division and their effects on the environment

Animal rearing methods in rural areas involve the production, control and management of different animals and their food (cattle, fish, poultry etc.). Generally, pastoralists here practice multiple-purpose, low-input methods of animal production. These rural families deploy a wide array of livestock-keeping strategies, based on locally available resources and opportunities as the animals are critical not only for sustaining their livelihoods, but also for cultural and social reasons. In order to serve their communities better with healthy and quality animal products, pastoralist and other agro pastoral farmers engage in different methods of pasture improvement methods to ensure the continuous and effective reproduction of their animals.

After several observations in the field and numerous interviews, we retained three main methods of raising animals in our study area depending on where the animals were being reared. Amongst these were; animal rearing in enclosed areas such as small farm huts or ranches and practiced stall feeding, animals reared in large extensive farms (especially cattle), and thirdly were animals reared within the compound especially at the back yard or in small farms closest to the compound and practiced free ranging. In a quest for more understanding on the different methods of animal rearing and why they were chosen, the following data was collected, analyzed and then presented on table 12 below.

Table 12: Respondents view on the different methods of animal rearing in Boyo

Zones	Total No of respondents	How do you rear your animals?		
		In enclosed area (stall farming)	Transhumance	Around the house (free range farming)
Zone A	22	02	06	14
Zone B	42	10	14	18
Zone C	29	08	07	14
Zone D	36	08	11	17
Total	**129**	**28**	**38**	**63**
Percentages	**100**	**22%**	**29%**	**49%**

Source: Researcher, fieldwork, 2021/2022

Analyses from table 12 indicates that more people in this region practice the free range farming system (49%) where the rear their animals around their living spaces. This method is used by both small farmers and commercial farmer as they also leave their animals feed in the fields and bushes around them (especially in enclaves). This was closely followed by the transhumance with a total respondence rate of 38 respondents representing 29% of the sample population. Rearing animals in enclosed areas such as stalls and animal pens is the least method employed by farmers in this region representing only 22% of the total respondent.

1. **Free-range animal rearing**

From the presentation on table 12 above, we observe that the most practiced method of animal rearing in the study area is done by small-scale farmers representing 49% of the sample population. This method of animal rearing is largely practiced by the indigenous small farmer relying mostly on his small family farm closest to the house. The small farmer incorporates animal rearing into his crop farming such that he does not need to spend much on pasture. This method of animal rearing although very common in rural communities such as Boyo, it is very much neglected by policy makers as there is very little or nothing done to improve farmers knowledge; farmer use local breeds and indigenous knowledge with basically no follow-up in the process. The most common animals identified with this method of animal rearing are goats, sheep, pigs and even fowls.

The free-range system is often referred to as a mixed farming system as it incorporates both animal and crop farming. Because the farmers focus is to get maximum output from his

small farm, they tend to leave their animals (goats, fowls, pigs etc) roam about in the farms after the crops have been harvested. This according to them lets the animals clear the farms thoroughly while feeding well and also helps in the soils fertility rate as their faeces are deposited straight into the soil. Bobe Bemsii further explained that during the rainy season when the crops are still in the farms, they find different ways of restricting the animals from entering the farms either by tying the animals around the boundaries of the farms or by tying them within the compound, hence protecting their crops from being eaten up by the animals.

While this free-range grazing can provide several benefits, such as allowing animals to graze on a variety of plants and reducing the need for expensive feed and labor, it can also have negative environmental impacts. Overgrazing and trampling of vegetation can lead to soil erosion, soil compaction, and loss of biodiversity. Additionally, animal waste can accumulate in water bodies, leading to water pollution and contamination. This method of animal rearing was observed especially in Belo sub-Division where animals (goats, pigs) were spotted in a family compound and some within the quarters with their faeces scattered everywhere.

2. Stall farming

Stall-feeding also referred to as zero grazing is the keeping of animals in confined areas, ranches or stalls and providing them with feed and water rather than allowing them to look for pasture themselves. This method of animal rearing is practiced by 22% of the population of our study area as indicated by table 11 above. It is mostly used for animals such as pigs as it allows for more precise control over the animals diets. However, in Boyo Division, we observed other animals such as goats and birds being reared using this method as shown on photo 4 below.

Source: Researcher, fieldwork, 2021/2022

Photo 4: Stall farming in Bum sub-Division

From field observations and information gathered from focus group discussions, this method of animal rearing occupies a relatively small portion of land as farming is intensive with a greater part of the feed bought from local markets. Stall-feeding can provide several benefits, such as allowing for better control of feed intake, reducing feed waste, and improving animal productivity. Additionally, it can reduce the negative environmental impacts of free-range grazing, such as soil erosion and water pollution. However, stall feeding can also have negative impacts on animal welfare if not properly managed. Animals can suffer from stress, disease, and poor ventilation if kept in poorly ventilated and overcrowded conditions.

3. Transhumance

Transhumance is a traditional practice of seasonal migration of livestock between different grazing areas. In Boyo Division, transhumance is a common practice among pastoralists who move their herds between highland and lowland areas depending on the availability of pasture and water. Pastoral farmers are concentrated in Fundong and Belo sub-Divisions closest to the forest where they can have easy access to pasture with the zebu cows as the main specie. A Fulani herdsman in Fundong area explained that maximum concentration on a particular animal and a well-selected specie gives them a better mastery of the animals and hence reduces their chances of mishandling a bunch of many different animal species due to little mastery, which could eventually lead to death of the animals and great losses.

This method has several benefits, such as allowing for the efficient use of grazing resources, reducing the risk of overgrazing, and providing an important source of income for pastoral communities. However, transhumance can also have negative impacts on the environment and local communities if not properly managed such as water pollution in drinking points, soil degradation and other disturbances as illustrated by plate 4 below.

Source: Fieldwork data, 2021/2022

Plate 4: Effects of transhumance in Boyo Division

Taking a close look at plate 4 above, photo A shows the animals at their point of rest with the herder preparing salt for the cattle. In the same spot we notice trampling of the soil by the cattle which leaves the surface prone to erosional and degradational forces. Overgrazing by livestock can lead to soil compaction, which makes it difficult for water and air to penetrate the soil. This can result to increased runoff and erosion, hence reduced soil fertility. The loss of soil can also contribute to sedimentation in nearby waterways, which can further degrade water quality and habitat for aquatic organisms. Livestock may contaminate water sources with their waste, leading to water pollution, eventually posing a health risk to humans and wildlife. This can also reduce the availability of clean water for drinking and irrigation.

The practice of transhumance can lead to overgrazing of fields by livestock which further lead to soil erosion, causing land degradation and reduce soil fertility which if not handled carefully could escalate further resulting to reduced crop yields and food insecurity for local communities.

To mitigate the negative impacts of transhumance, it is important to promote sustainable land use practices and to engage in dialogue between farmers, herders, and other stakeholders to find solutions that benefit both the environment and the local communities.

Conclusion

The uncontrolled use of inadequate methods of animal rearing such as transhumance is a driving force for environmental degradation in Boyo Division. With a larger population having a rather bad perception of animal rearing, has led to youths shying away from the activity hence non transferability of skills and knowledge. The methods of animal rearing such as transhumance and the free range system when not well managed are unsustainable as there are agents of pollution, erosion and soil infertility.

CHAPTER 3

LAND CONVERSION FOR AGRO PASTORAL EXPANSION IN BOYO DIVISION

Introduction

Boyo Division has experienced significant population increase in the past few decades with an estimated population of over 124.887 people (BUCREP, 2005). This increase in population has led to an increase in the demand for food, water and land resources, leading to frequent clashes between farmers, pastoralists and other land owners all of which reflects negatively on the environment as pressure is being exerted on the natural environment of this region.

Land use and land cover change is a major issue facing rural communities like Boyo Division. As the population has grown, there has been increasing pressure on land resources, leading to the conversion of natural vegetation and forests to agricultural and pastoral uses. This process of land conversion is driven by the expansion of agro-pastoral activities, as the local population seeks to increase food production and livestock grazing areas to support their livelihoods.

The pressure from agricultural activities has led to deforestation, soil degradation and loss of biodiversity, and the depletion of water sources. The negative environmental implications of land conversion for the expansion of agro-pastoral activities in Boyo Division are therefore significant and cannot be left unattended to. In this context, it is important to understand the underlying drivers of agro-pastoral expansions, the different types of land conversions practiced in this side of the country as well as the environmental implications.

In order to verify the hypothesis for this study, we collected data related to the expansion of agro-pastoral activities and its implications on the environment. This chapter starts with an introduction and is sub-divided into three major parts: the drivers of agro-pastoral expansion in Boyo Division, the types of land conversions practiced in Boyo Division and environmental implications of such expansions.

3.1 Drivers of Agro-pastoral expansion in Boyo Division

Pastoral activities are an important contributor to ensuring food security and economic development in Cameroon. Pastoral agriculture in Boyo Division has played a significant role in the economic and social development of the region, providing a source of income and food

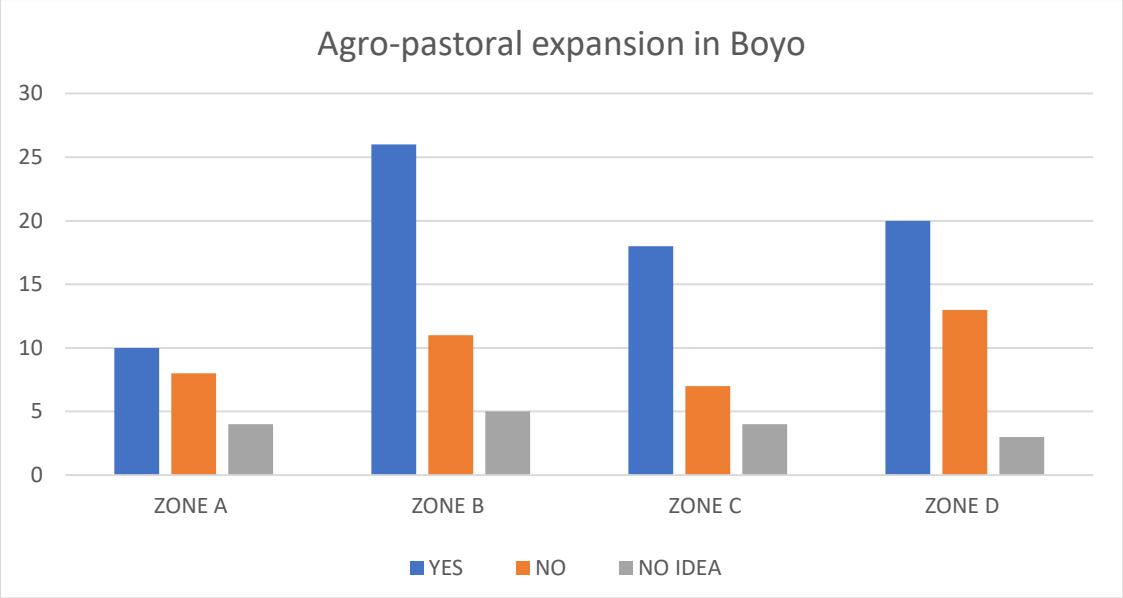
for many households. Understanding the factors that favor the growth of these activities over the years is essential for promoting sustainable development in the region. The pages that follow will explore some of the key factors that contributes to the expansion of agro-pastoral activities in Boyo Division. In order to confirm that there has been an increase in agro-pastoral activities in our study area, respondents' view on the expansion of agro-pastoral activities in Boyo was recorded and presented as follows (table 13).

Table 13: Respondents' view on the expansion of agro-pastoral activities in Boyo

ZONES	**Number of respondents**	**Have you noticed any recent increase in agro-pastoral activities in Boyo?**		
		YES	**NO**	**NOT REALLY**
ZONE A	22	10	08	04
ZONE B	42	26	11	05
ZONE C	29	18	07	04
ZONE D	36	20	13	03
TOTAL	**129**	**74**	**39**	**16**
Percentages	**100%**	**57.4%**	**30.2%**	**12.4%**

Source: Field Work, 2021/2022

As shown on table 13 above, 57.4% of responses from our respondents show that agricultural activities in Boyo in terms of expansion of both crop farming and animal rearing has increased over the years as oppose to 30.2% who think that there has not been any expansion. Out of the 129 people who answered our questionnaire, there were 16 people who were indifferent as to the subject matter of agro-pastoral expansion in Boyo, representing 12.4% of the total respondents.



Source: Adapted from table 13

Figure 13: Respondents view on the expansion of agro-pastoral activities in Boyo Division

Investigation from figure 14 above shows that people in zone B (Fundong sub-Division) are exceptionally much mindful of the increment of agro-pastoral activities around their environment. Out of 29 respondents as it were, 11 denied the reality that the activities around them had increased while more than half (26) people validated the assertion that agro-pastoral activities had truly increased. Belo sub-Division being another area with a high concentration of animal rearer recorded 20 respondents who attested to the fact that agro pastoral activities had increased around them while 13 respondents denied the fact and 03 respondents were indifferent. Globally, this gave us 74 respondents out of 129 respondents who attested to the expansion of agro-pastoral activities in our study area representing 57.4% of the total sample population. Thirty-nine other respondents representing 30.2% of the total population were in denial of the fact that there was an expansion of agricultural activities while the rest 16 respondents representing 12.4% of the population were indifferent

We went further to find out the reasons for this expansion. From the questionnaires administered, data was collected in regards to the reasons behind the expansion of agro pastoral activities, we were able to bring out some of the drivers of agro pastoral expansion in Boyo Division. After a critical analysis of the responses proposed by our respondents, we grouped and presented them as seen on table 14 below.

Table 14: Respondents view on the reasons agro-pastoral expansion in Boyo Division

Zones	Total No of respondent	What are some of the reasons for the recent expansion in agro-pastoral activities in Boyo?		
		Natural (vegetation and relief)	**Social (population increase and cultural practices)**	**Economic (increase in market demands and market opportunities)**
Zone A	22	04	09	09
Zone B	42	07	21	14
Zone C	29	05	15	09
Zone D	36	07	17	12
Total	**129**	**23**	**62**	**44**
Percentages	**100**	**18%**	**48%**	**34%**

Source: Field Work, 2021/2022

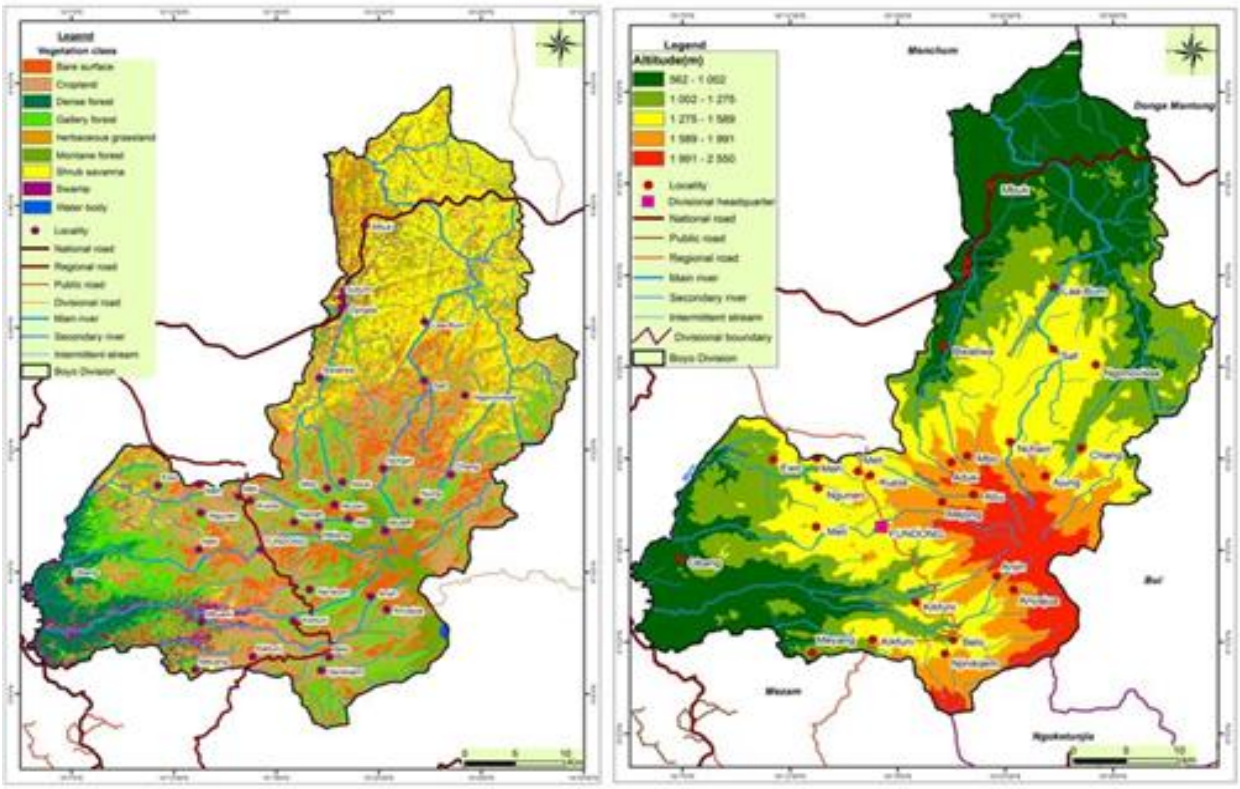
Table 14 shows some of the reasons advanced by farmers on why they decided to expand their agricultural activities in Boyo. 44 out of 129 people who were involved in farming said they got attracted to the activity because of favorable economic conditions such as ready and available markets, 23 people attributed the expansion to favorable natural conditions like good relief and climate conditions for their crops and animals. However, a greater number of people (62 people) attributed the growth of agro pastoral activities to social reasons like population increase and the need to produce more.

- **Natural drivers**

Agro-pastoral expansion in Boyo Division of Cameroon is significantly influenced by natural drivers such as vegetation and relief. This region, characterized by its diverse ecosystems and varying topography, provides an ideal environment for both crop cultivation and livestock grazing, supporting a range of agricultural practices, from subsistence farming to more intensive agro-pastoral systems, allowing farmers to cultivate crops and raise animals simultaneously. Additionally, the relief features, ranging from fertile valleys to elevated plateaus create microclimates that enhance agricultural productivity.

Boyo is blessed with green savannah, which is made up of grass and plants which serves as food for the many herbivorous animals in this region. The shrub savannah in Bum sub-Division, the gallery forest in Fundong and Njinikom together with the herbaceous forest in Fundong and Belo sub-Divisions serve as grazing grounds for animal like cattle and goats.

Boyo is highly mountainous, found in the mountainous stretch of the western highlands of the agro ecological zone of Cameroon with undulating escarpments, valleys, plateau and plains. This relief type is however very suitable for the Fulani graziers who have taken wondering as a part of them. This allows them to freely move around with their animals uphill for food and downhill for water (transhumance). There is a concentration of graziers in areas like as Anjin, Mejang, Anyajua, Aduk, Kikfuni, and Njinikijem. Below is a vegetation map together with the relief map of Boyo.



Source: Adapted from the administrative map of Cameroon, INC, Yaounde, Mairomi, H. 2020

Plate 5: Relief and vegetation map of Boyo

❖ Economic drivers

The rural communities of Cameroon have long relied on agro-pastoral activities as a key source of livelihood and food security. There has been a notable expansion of agro-pastoral practices in these areas, driven by a complex set of economic factors.

1. Increase in demand for food and animal products

An increase in the demand for food crops in Boyo Division has led to the expansion of agro-pastoral activities by encouraging farmers to diversify their production systems. As the market for food crops grows, farmers are motivated to not only cultivate a variety of crops but also integrate livestock into their farming practices. This diversification allows them to maximize their land use and increase overall productivity. By combining crop production with animal husbandry, farmers utilize crop residues as feed for livestock, creating a more efficient and sustainable agricultural system.

As the population grows, particularly in urban areas, the demand for animal-source foods like meat, milk, and eggs is expected to continue rising and even accelerate in the short to medium term. This is because as incomes rise and diets diversify, per capita consumption of animal-source foods typically increases. Also, the livestock sector in Cameroon is rapidly evolving towards a more market-oriented system. This long-distance, often cross-border, movement of livestock is central to the livelihoods of many pastoral communities, traders, and intermediaries. As the livestock industry becomes more commercialized, the demand for animal products from these rural production areas is likely to grow to meet the needs of the expanding urban population.

The expansion of agro-pastoral activities is further supported by the emergence of new market opportunities. As demand increases, local and regional markets develop, providing farmers with better access to buyers and competitive prices for both crops and livestock. This economic incentive encourages farmers to adopt agro-pastoral practices, as they can benefit from selling both produce and animal products.

2. Available markets and profit incentives

The growing population of Boyo Division and the neighboring towns such as Bamenda, Kumba and Douala, and even neighboring countries such as Nigeria and Gabon has provided markets for different food crops and animal products (meat, poultry, eggs, and fish) produced in our country. Cattles from Boyo Division are sold in the local and neighboring markets like Fundong market, Bambui market, the cattle market in Bamenda. Below is an image taken during a market day in the cattle market of Bamenda.

A key aspect of any good economy is the availability of markets where buyers and sellers can freely interact. The livestock sector in Cameroon contributes 13% to the country's GDP and employs over 30% of the rural population. However, the domestic production of

livestock products such as meat, milk, and eggs does not meet the growing national consumption requirements. This unmet demand provides a strong profit incentive for agro-pastoral communities to expand their production and access these lucrative markets. These infrastructural improvements have made it easier for the local population to transport and sell their crops, livestock and livestock products, thereby increasing the profitability and incentive for agro-pastoral expansion. Photo 5 below is a typical example of a cattle market in Bamenda.

Source: global press journal, 2015

Photo 4: Bamenda cattle market

The graziers move with their cattle from Fundong on foot and pass through Kikfuini in Njinikom where they take some rest. They later kick off again from Kikfuini to Biango and then to Mbingo in Belo before reaching their final destination in Banbui market for sales. It has become a frequent routine for cattle rearers as the market opens every Thursday for this particular purpose. However, instead of going to the market every week, some cattle rearers explore other markets such as the Fundong market and only go to the Bamenda cattle market once monthly or at specific intervals to maximize their sales.

Population increases and the need to eat and stay healthy provides a ready market for food crops and animal products produced in Boyo Division, such as milk, beef and skin (canda). The current political unrest and insecurity in this zone has drastically increased the

demand for food resources. This high demand for these animal products has pushed so many to this activity creating pressure on the physical landscape of the study area. The availability of profitable markets, supported by infrastructural improvements provides a strong incentive for the expansion of agro-pastoral activities in rural Cameroon. Overcoming the existing constraints will be key to ensuring the sustainable growth of this important sector.

- **Social drivers**

The people of Boyo Division have long relied on agro-pastoral activities as a primary source of livelihood and food security. However, in recent decades, there has been a significant expansion of agro-pastoral practices in this region, driven by a complex interplay of social factors. Understanding these social drivers is crucial for developing effective policies and interventions to support sustainable agro-pastoral development in Cameroon's rural communities.

1. **Population increase**

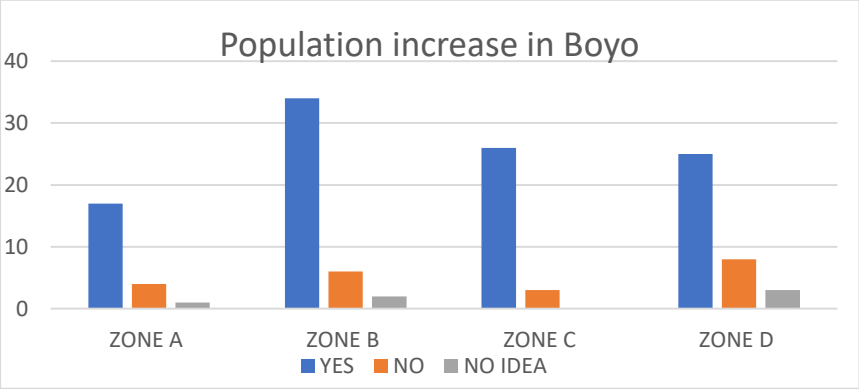
An increase in the population of an area is often because of changes in certain parameters. The conducted research showed that the human population of the villages in Boyo has increased in the past years. The respondents' view on the human population change in Boyo was recorded and presented as follows (table 15).

Table 15: Respondents' view on population increase in Boyo Division

ZONES	Number of respondents	Has there been an increase in human population in Boyo?		
		YES	NO	NO IDEA
ZONE A	22	17	04	01
ZONE B	42	34	06	02
ZONE C	29	26	03	00
ZONE D	36	25	08	03
TOTAL	**129**	**102**	**21**	**6**
Percentages	**100%**	**79%**	**16%**	**5%**

Source: Fieldwork, 2021/2022

As shown on table 15 above, 79% of responses from our respondents show that the population in Boyo in terms of human number has increased over the years as oppose to 16% who think that the population has not increased.



Source: adapted from table 14

Figure 14: Respondents view on population increase in Boyo Division

Investigation from figure 13 indicates that people in zone C (Njinikom sub-Division) are exceptionally much mindful of the increment of population around their environment. Out of 29 respondents as it were, 03 denied the reality that populace had increment and the rest validating to the truth that they have really taken note an increment in their populace measure. Essentially, Fundong sub-Division (zone B) being the being the region with the most elevated

number of respondents had 34 respondents who acknowledged there was an increment in populace estimate and 6 individuals who denied. This gave us 40 respondents in Fundong sub Division who taken note changes in their encompassing populace and as it were 2 individuals being clear approximately the subject.

Examination from figure 13 shows that people in zone C (Njinikom sub-Division) are especially much careful of the lively of masses around their environment. Out of 29 respondents, only 03 denied the reality that people had increase and the rest approving to the truth that they have truly taken note of an increase in their masses. Fundong sub-Division (zone B) being the being the locale with the foremost raised number of respondents had 34 respondents who recognized there was an increase in masses assess and 6 people who denied. This gave us 40 respondents in Fundong sub Division who taken note changes in their enveloping masses and only two people who were indifferent.

The 16% of respondents who denied that fact that there was population increase in the area was probably due to the ongoing socio-political crisis plaguing the region which has forced so many people to find settlements out of the region where it is calmer. This abrupt movement of people out of these risk zones has drastically brought down the population in most villages leaving only few youths and a dominating old aged population.

We went further to consult google earth images of Boyo Division of two different years (2009 and 2019) in order to compare the changes on landscape. Below are google earth images, which show the evolution of settlement in response to population increase in major towns in Boyo Division. The image shows evolution within an interval of 10 years (2009-2019).

Source: Google Earth images

Plate 6: google earth images of Boyo Division before and after

From the images, we observe that the concentration of built-up areas in photo B is more intense than that in photo A. photo A was taken on the 24th of March in 2009 while photo B was taken ten years later (2019). In the North of photo, A, Fundong sub-Division was a little concentrated around the center and Njinikom sub-Division with houses randomly scattered. Photo B on the other hand shows Fundong sub-Division ten years later with more concentration and more build up areas and an escalated increase in build-up areas in Njinikom.

From data collected in the field, we were able to bring out some of the reasons responsible for this increase in population in our study area. After a critical analysis of the responses proposed by our respondents, we grouped and presented them as seen on figure 15 below.

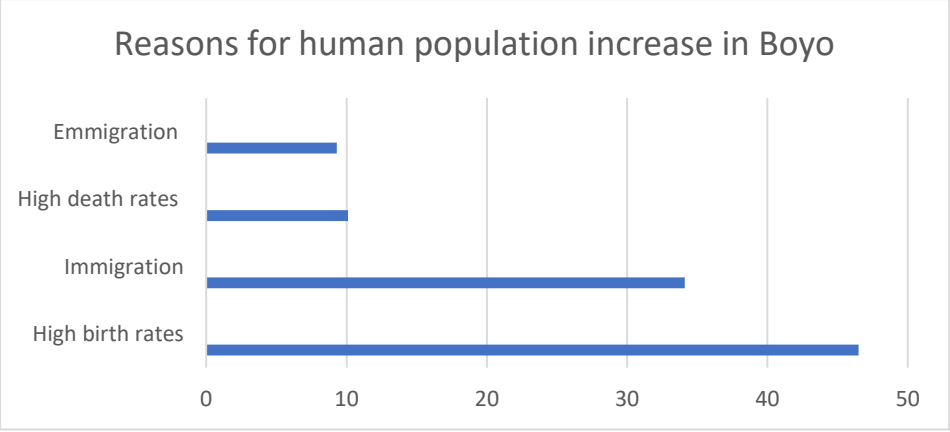


Figure 15: Respondents' view on the reasons for population increase in Boyo

Source: fieldwork data, 2021/2022

As shown on figure 15 above, it was observed that high birth rates stood out as the dominant reason for an increasing population in Boyo Division (46.1%), followed by immigration which was at 34.1%. on the other hand, respondents who believed that there has not been an increase in population blamed it on high death rates (10.1%) and emigration (09.3%).

I. **High birth rates**

As shown on fig. 15 above, high birth rates were the major cause for an increase in population in our study area. After a lengthy interview with some nurses from the Njinikom Catholic hospital, Mbingo Baptist hospital, they explained that giving birth in the early years of 1990 was difficult and even costly for women as there were not many health facilities to walk them through the process of childbirth. They further explained that only a few people enjoyed the health facilities (influential elites in the community and those who could afford it), a great number of people trekked and covered long distances to get to hospitals which made many women to give birth at home or by the road side. A percentage of those who managed to give birth in the hospitals never came back for follow up of the child and vaccinations, all of which contributed to the high infant mortality in the area. The sudden increase in the number of health facilities and health care centers like the Wombong sub-divisional hospital has greatly reduced infant mortality rates and increase the number of live births recorded on a monthly basis.

Polygamy is also a reason for the high birth rates recorded in this part of the country. Many families practice and encourage polygamy. Where they regard a man with many wives as a respectful man and a potential problem solver. In addition, the Muslim religion and the catholic faith frown at the use of contraceptives as a method of birth control. This has made the use of pills and other methods of birth control limited leading to easy conception and subsequently high births.

II. **Migration**

Migration is the movement of people or a group of people from one place to another. This movement is usually from a point of departure to a point of residence where the migrants settle either for a long period of time or for just a short period depending on the motive for the movement. People's movements are influenced by certain environmental and socio-economic condition that either push them to move out of a place or pulls them to settle in a given location. In the case on Boyo, after an investigative study to know if the population had increased in the

past year, 75% of our respondents accepted and of this percentage, 31% was as a result of immigration (table 13). We went further to find out some of the reasons why people choose to migrate and consequently settle in Boyo. The table below explains some of these reasons (table 16).

Table 16: Respondents view on the reasons for migration

Zone	**No of respondents**	**Why did you choose to settle in Boyo?**		
		Favorable climatic conditions	**Fertile soils and cheap land**	**Welcoming people**
Zone A	22	08	10	04
Zone B	42	12	18	12
Zone C	29	08	12	09
Zone D	36	11	18	07
Total	**129**	**39**	**58**	**32**
Percentage	**100%**	**30%**	**45%**	**25%**

Source: fieldwork data, 2021/2022

Table 16 above shows the reasons advanced by respondents for moving and settling in Boyo. As seen from the table, 45 % of responses attested to the fact that it was because of the fertile soils and availability of cheap lands, 30% was because of the favorable climatic conditions while the remaining 25% was due to the welcoming nature of the people.

Fertile soils and the availability of cheap and affordable land in Boyo especially in the suburbs stands as the major attracting factor for in migration in the area. The climate and relief of Boyo plays a great role in the formation of its soils. The dominant red ferralitic soils in our study area is because of the combination of this town main factors. The soils are relatively well drained which makes it good for agricultural practices hence plays as an attractive factor for settlement in the Kom land. A majority of immigrants settled immediately they got a stable land where they carried out their activities, this is the case with Baba Danpullo of Ndawara tea estate who settled immediately the Fon of Kom gave him a vast portion of land for his project. Just like Baba Danpullo, the Fulani pastoralists constitute another group of immigrants who found refuge in Kom land since the beginning of the 20th century where they have since then been.

Another reason advanced by our respondents for the increasing population of Boyo was the fact that the natives were nice and welcoming. They explained that the availability of many churches for evangelization, schools for education and hospitals to keep them healthy was not enough reason for them to move in and settle in a community where the people were not welcoming to strangers.

2. Cultural practices

For the Fulani grazers, it is part of their culture to keep animals and is a representation of wealth for families. This means that more animals (cattle) equal more wealth. The inheritance of animals and farmlands is a native culture of most communities of the world especially in Africa, and particularly in our study area. The land(s) owned by the father is divided between his children after his death, in rare cases when he is still alive. To keep the legacy of their father, the children are forced to engage themselves in agricultural activities to maintain their heritage. With the Fulani population, emphasis is more on the animals than the land itself. This is because of their inbound nature as wonderers. The Kom man cherishes his culture so much that they follow it to the least. In almost every occasion in Kom, there is the need to kill animals and use them for feasting. The commonly used animals here are goats and fowls used during funerals and other celebrations. In addition, all visits and settlements related to the palace requires goats and /or fowls, the feathers of fowls are used as chieftaincy titles, traditional performances like juju dances are rewarded with fowls. There is also very high demand of goat and cow meat during traditional weddings where the groom is expected to bring in buckets of meat for his in laws as part of the requirements.

In fact, the need for these animals is indispensable in our lives and it is only normal for us to keep some of them in order to reduce cost and free ourselves from embarrassment. I can assure you in every compound here you will find at least one to two fowls roaming around the compound and maybe a goat tied somewhere at the backyard irrespective of the economic situation or economic class.

3.2 Types of land conversions practiced in Boyo

Boyo Division in Cameroon is home to a diverse range of ethnic groups, including the Kom, Hausa, Mbororo, Fulani and Bum. Among these, the Kom people constitute the largest population. The region has seen an influx of Muslim cattle herders, known as the Mbororo and Fulani, who have settled in the area due to the availability of grazing land. Other ethnic groups have also migrated to Boyo Division for social and economic reasons.

The land in Boyo Division is primarily classified as "national land," which means it is not privately owned but rather managed by the government. This national land includes farmland and communal land held under customary law. The government has the authority to convert this national land into state land and allocate use rights, such as granting forest concessions, or convert it to private ownership, for example, for urban development.

In terms of land use, the region is known for its coffee production, which is organically grown in the dark, nutrient-rich volcanic soil at high elevations. However, since the 1990s, the Fundong municipality within Boyo Division has seen a shift towards alternative livelihoods, with a prominent sector being the commercialization of food crops. Farming is practiced in both rural and urban areas, with the majority of farmers engaged in subsistence agriculture using poor farming techniques on small land holdings of around 6 hectares. The region also has some protected areas, such as the Ijim Forest Reserve and the Kom-Bum Reserve, which are home to various plant and animal species, including chimpanzees, gorillas, and the Barnerman's Turaco bird. Additionally, the region is known for its basalt, a type of black stone that is commonly used for construction purposes.

To further understand land conversion types in our study area together with field observations, we sought to get our respondent viewpoints on how they manage the expansion of agro-pastoral activities. (Table 17).

Table 17: Respondents view on the types of land conversions practiced in Boyo Division

Zone	**No of respondents**	**How do manage the expansion of agro-pastoral activities in this region**		
		Search for new farms	**Move towards the forest**	**Search for new settlement**
Zone A	22	12	7	3
Zone B	42	24	12	6
Zone C	29	15	8	6
Zone D	36	18	10	8
Total	**129**	**69**	**37**	**23**
Percentage	**100%**	**53**	**29**	**18**

Source: Field Work, 2021/2022

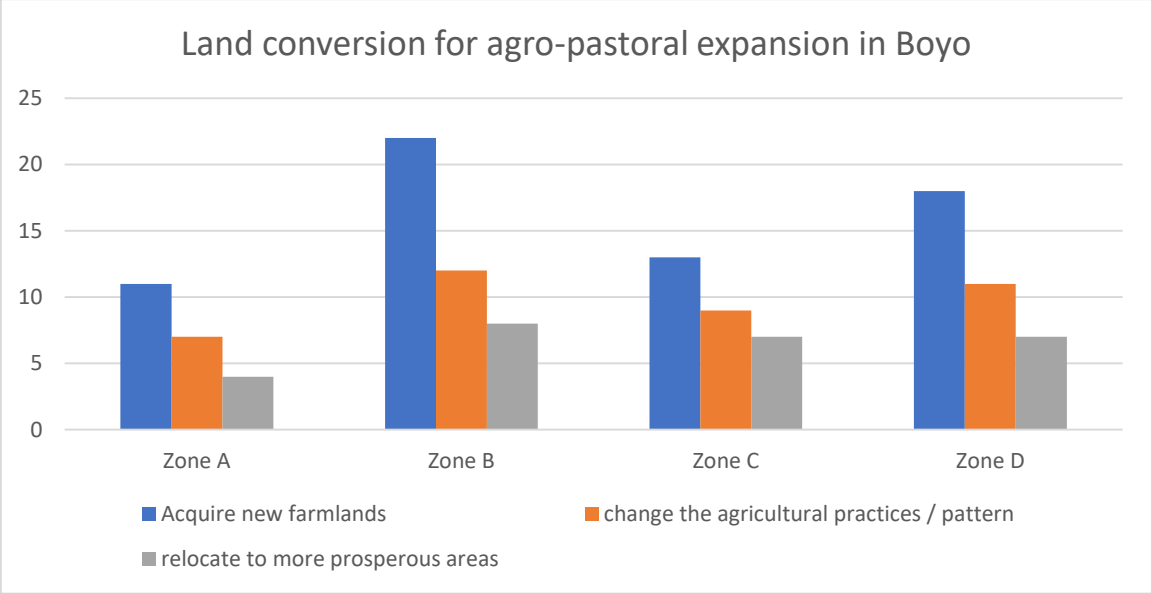
Table 17 depicts that the most noticed impact of the expansion of agro pastoral activities in Boyo Division is thee search for new farmlands for agricultural activities representing 53% of all respondents in this region. According to the information gathered, the greatest reaction to this expansion is for villagers to search for new farmlands; this includes moving back to abandoned farms, farms in distant places, farms along the hill side (Boyo hill), farms around swampy areas and river beds and even renting of farmlands from wealthier families in order to sustain their families and carter for their daily needs.

- **Conversion of forested land**

One of the principal means to notice the expansion of agro pastoral activities in this region is through the migration of agro pastoral activities toward the forest region especially crop farming and animal rearing (plate 6). This was represented by 29% of our total respondents with the highest impacts coming from Belo and Fundong sub-Divisions. Only a small fraction of the population resolved to finding settlements elsewhere (18%). Those who decided to relocate completely to new settlements either migrated to urban towns where they engaged in other lucrative activities, while others stayed within Boyo and sort for less expensive settlement. Those who stayed within mostly relocated to more risky areas along the hill.

Although many see the expansion of agricultural activities to be a good thing mainly because it's a source of income and more importantly because it's a pathway to food security,

its negative implications cannot be under looked as it not only modifies the environment in which we live but it also goes a long way to change or modify our actions as we have more mouths to feed but not more land to farm on. Figure 17 below shows the consequences of land conversion for agro-pastoral expansion in Boyo Division as solicited by the views of respondents



Source: Fieldwork, 2021/2022

Figure 16: Respondents view on land conversion for agro-pastoral expansion in Boyo Division

According to the views of respondents on the chart above, the greatest land conversion type for agro pastoral reasons in Boyo is the creation or search of new farmlands followed by forest encroachment and the search for new settlements. A 53% view by respondents' backup the fact that the population in a case of an expansion of its agricultural activities will most often tend to seek new farmlands in interior villages or high-risk zones such as steep hills and valleys. This was closely followed by forest encroachment with 29%.

The effects of agro-pastoral expansion in Boyo are primarily the creation of new farmland, forest encroachment, and the search for new settlements. A majority of respondents believe that when there is an increase in agricultural activities, the people will most often move to new farmland in interior villages or high-risk zones such as steep hills and valleys. This is inevitably followed by a rise in the rate of environmental damage.

The favorable physical factors in Boyo are characterized by humified ferralitic soils with a high organic matter content favored by the humid climate and cold. These soils are well

drained and of good permeability (Hawkins and Brunt 1965). This has led to the introduction and massive cultivation of several food crops such as maize, beans, plantains, potatoes and cassava. With the coming of the Irish potato innovation in the Northwest Region, and subsequent proves of its high yielding rates in Boyo Division, a mad rush for the acquisition of agricultural land in this region was sparked especially those around the forest zones such as Anyajua. The cultivation of this crop type contributes greatly to encroachment into the forest, leading to deforestation in the search for arable land. The map below (plate 7) illustrates the portion of the forest that has so far been degraded by agricultural activities in Boyo.

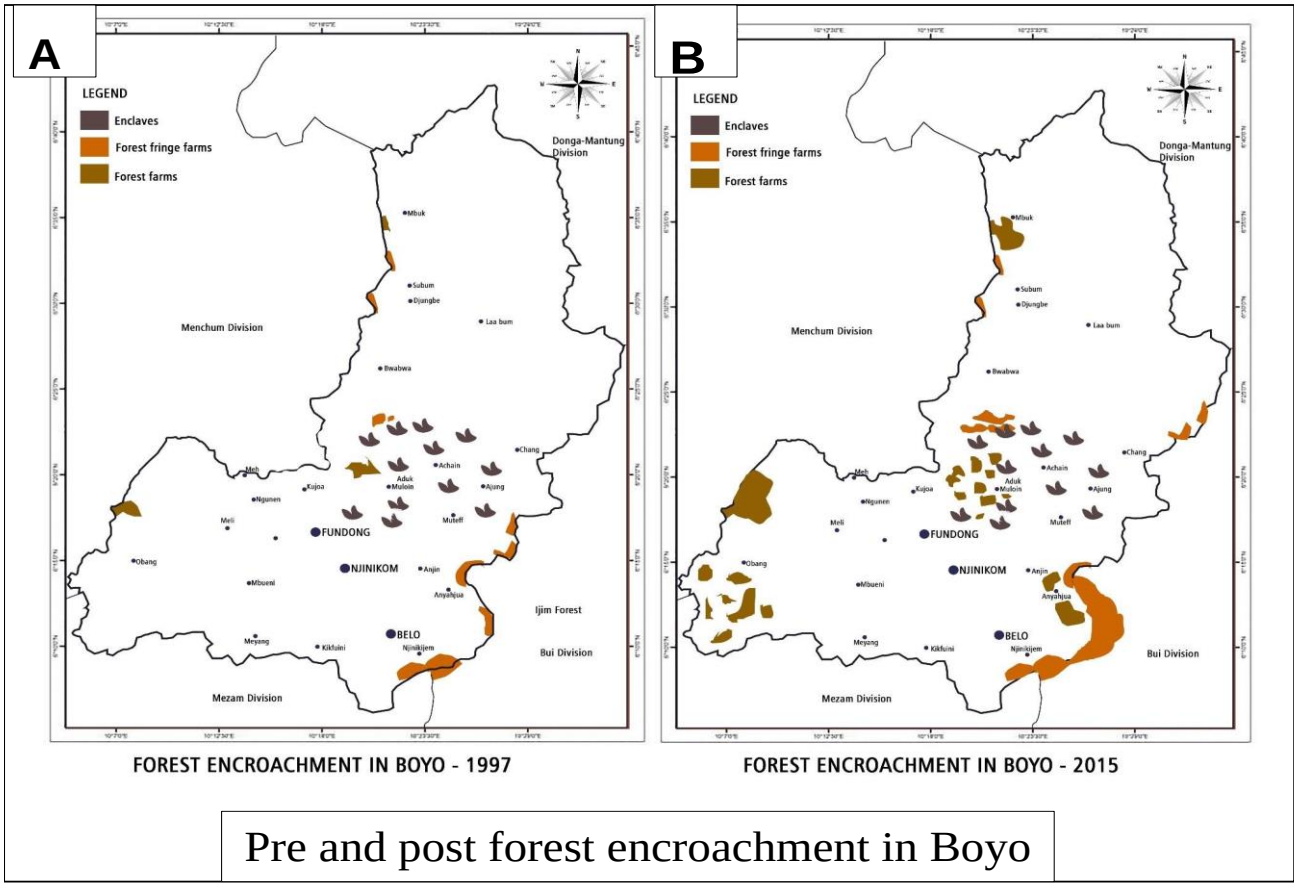


Plate 7: Forest encroachment in Boyo

Source: Fieldwork data 2022

Plate 6 shows forest encroachment in Boyo resulting from crop farming and animal rearing. This is clearly shown as the number of enclaves, forest farms and forest fridge farms have increased in quarters such as Muloin, Anyajua, Njinikijem and Ajung between 1997 and 2015.

Agricultural expansion does not leave behind herdsmen as their cattle herds are also bound to increase over the years. This increase in the number of cattle herds does not correspond to

an increase in the grazing space. As a result, the rearers are bound to go an extra mile to graze their animals after the carrying capacity of the enclaves is exceeded. Some of these grazers take their animals into the forest where they feed indiscriminately on the young regenerating herbs and the old ones too. As a result of their indiscriminate feeding habits, there is loss of biodiversity species as some of the plants die off (photo 5). The lack of autonomy over grazing land does not encourage any form of management of pasture by the pastoralists as everyone want to get the most out of the community land/ forests. Faced with this situation of selfishness and greed from pastoralist, this tends to exert so much pressure on the land which goes a long way in rendering the soil loss and consequently prone to erosion and loss of soil fertility.

Source: Fieldwork data, 2019/2020

Photos 6: Animal rearing in Boyo hill

The expansion of farmlands, grazing lands, and settlements has led to significant land use changes and deforestation in Boyo Division. The increasing human population has driven the demand for more land for agriculture, livestock, and housing, resulting in the conversion of forested areas. The conversion of forested lands to agro-pastoral uses has led to deforestation, loss of habits and even conflicts between different land user groups, such as farmers and pastoralists. These "agro-pastoral conflicts" have become perennial in the region, manifesting through fighting, loss of lives, destruction of property, and disruption of peace and development.

- **Conversion of grasslands**

Boyo Division is characterized by a diverse landscape, including grasslands that have traditionally been used for livestock grazing. However, the expansion of agro-pastoral activities has led to the conversion of these grasslands to other land uses, particularly crop cultivation and settlements. The growing human and livestock populations in the region have increased the demand for land and resources. As a result, farmers have been clearing and converting grasslands into croplands to meet the rising food production needs. This has led to a reduction in the available grazing areas for pastoralists, who rely on these grasslands to feed their herds of cattle, sheep, and goats.

The Tiwou Plateau in Boyo Division, part of the Bamenda Highlands of Cameroon, was historically an agrarian society dependent on subsistence agriculture, hunting, cattle herding by mbororo nomadic herdsmen, and small ruminant rearing. This highland environment, characterized by steep, rugged slopes and rainfall variability, posed significant challenges to agricultural production and human livelihoods. Also, the introduction of the Ndawara Highland Tea Plantation transformed this formerly desolate landscape into an economic hub. The tea plantation, the largest in the CEMAC region and West Africa, has led to the conversion of the former grasslands into an area of intense human activity.

This transition from a predominantly pastoral and subsistence agricultural system to an industrial tea plantation represents a significant land use change in the region. The expansion of the tea plantation has likely come at the expense of the grasslands and pastures that previously supported the agro-pastoral activities of the local population.

The conversion of grasslands has not only reduced the land available for livestock rearing but has also disrupted the delicate balance between the different land use systems in the region. Pastoralists who have historically used the grasslands for grazing now find themselves in conflict with the expanding agricultural activities, as they compete for access to the limited land resources. These conflicts between farmers and pastoralists have become a major challenge in Boyo Division. The destruction of crops, the encroachment on grazing lands, and the resulting violence have had significant impacts on the livelihoods and food security of both groups. The situation has been further exacerbated by issues related to land tenure, as the lack of clear demarcation and ownership of land has contributed to the escalation of these conflicts.

3.3 Environmental implications of agro pastoral expansion in Boyo Division

It was verified that the ever-increasing footprints of man through his activities (agriculture and animal rearing) in and around the borders of the Ijim forest has been intensively felt by this biodiversity over the years. Starting from the days of our ancestors, there has been a tremendous increase in the number of crop farmers and animal rearers (mainly the Muslim herdsmen). This continues increase in the occupation of land in these areas has brought about changes in land cover and even on biodiversity in Boyo Division.

- **Deforestation and habitat loss**

The expansion of agro-pastoral activities is a major driver of deforestation and loss of biodiversity. Deforestation, the clearing of trees and forests, is a major environmental issue in Boyo Division and many other regions in Cameroon. This practice often involves the conversion of forested areas into agricultural land, grazing pastures, or other uses. Habitat loss, a direct consequence of deforestation, occurs when natural habitats are destroyed or altered, leading to the decline or extinction of species.

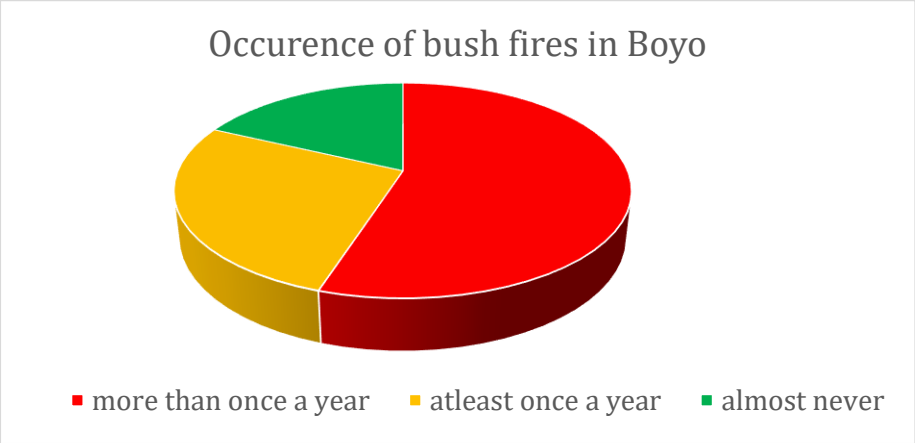
Deforestation also leads to a fall in the production of honey as the flowering plants needed by bees for nectar have been cut down. In some cases, the bees are even forced to leave hives due to the absence of nectar (Binyuy, 2015). Deforestation also brings about an increase in soil erosion on the slopes of Boyo hills given its steep nature, which leads to a fall in soil fertility along the affected parts of the forest as the soils become more exposed to denudational processes. The poor methods of cultivation also worsen the rate of soil nutrient lose, resulting in sterile soils. This causes farmers to go in the search for more fertile lands, further degrading the forest.

This process of deforestation has severe consequences for biodiversity as forests are home to a vast array of plant and animal species, many of which are found nowhere else on Earth. When these forests are cleared, the habitats of these species are destroyed, leading to the loss of biodiversity. In addition to the direct loss of habitat, the intensification of agro-pastoral activities can also contribute to the decline of biodiversity through the increased use of pesticides, the introduction of non-native species, and the depletion of water resources. These factors can further disrupt the delicate balance of ecosystems and lead to the decline of native species.

Land conversion for the expansion of agro pastoral activities also disrupts the delicate balance of ecosystems as forests play a crucial role in regulating the local climate, maintaining

soil fertility, and providing essential ecosystem services. The removal of these forests often leads to changes in precipitation patterns, soil degradation, and the disruption of natural cycles that support a diverse range of species. Climatic perturbations characterized by frequent dry seasons and other environmental stressors have contributed to the degradation of pastoral resources like pasture land and water sources in the Boyo Division. This has led to overgrazing, encroachment of grazing lands by crop farmers, and conflicts between farmers and herders. The expansion of agro-pastoral activities often involves the fragmentation of remaining forest patches. This fragmentation creates isolated pockets of habitat, which can be detrimental to many species that require large, contiguous areas to thrive. Forest fragmentation increases mortality of animals moving between habitat patches, reduce recolonization rates leading to smaller local population sizes that are more susceptible to extinction. In some cases, it increases the vulnerability of species to diseases and other threats.

Furthermore, the herdsmen usually set enclaves ablaze during the dry season in order to allow the quick regeneration of greener and fresher grass during the coming season. This dry grass burns easily and quickly when exposed to flames from hunters, farmers and even grazers. In the case of Boyo Division, bush fires we identified as one of the major problems plaguing the agro-pastoral landscape as seen on the chart below. (fig.17). When cattle rearers set the grass ablaze, they move down valleys to areas such as the *Mentang* valley and the Juafeff valley in Laikom. Some cattle rearers go as far as *Mejang* and only return during the rainy season.



Source: Fieldwork data, 2021/2022

Figure 17: The occurrence of bush fires in Ijim forest area

During the process of burning, the fire often goes out of control, consuming part of the forest revealed a hunter at Anyajua. The same is true for farmers who use the slash and burn method of cultivation. Their activities often lead to wild fires, which consume vast portions of the

forest, destroying biocenoses and biotopes, including endemic species. Bush fires are known for destroying years of investment in plant life and shrinking the honey economy in Boyo. These bushfires have mostly been responsible for the loss of biodiversity, water catchments, beehives and farmlands.

- **Soil degradation**

The conversion of natural ecosystems, such as forests or grasslands, to pasture land often involves the clearing of vegetation. This deforestation and loss of ground cover leaves the soil exposed and unprotected, accelerating erosion processes. Without the stabilizing effects of deep-rooted natural vegetation, the soil becomes more susceptible to being washed or blown away. Overgrazing on the other hand is also a major contributor to soil degradation in agro-pastoral systems. When livestock are grazed at stocking rates above the land's carrying capacity, it can reduce ground cover and vegetation, exposing the soil to erosion by wind and water. This loss of protective vegetation cover makes the soil more vulnerable to being washed or blown away, leading to a depletion of the fertile topsoil.

Additionally, the trampling of livestock compacts the soil, reducing its porosity and water infiltration capacity. Compacted soils are less able to absorb water, increasing surface runoff and further exacerbating erosion. The compaction also makes it more difficult for plant roots to penetrate the soil, hindering vegetation regrowth and recovery.

Another negative environmental effect is the intensification of agro-pastoral activities, such as the introduction of non-native forage species or the overuse of fertilizers and pesticides which disrupts the delicate balance of the soil ecosystem. This process usually results to a decline in soil organic matter, nutrient depletion, and a reduction in the diversity and activity of soil microorganisms, all of which are essential for maintaining soil fertility and structure.

Over time, the combination of overgrazing, soil compaction, erosion, and disruption of the soil ecosystem can result in a significant loss of soil productivity and quality, making the land less suitable for sustainable agricultural or pastoral use. Addressing these issues through the adoption of sustainable land management practices, such as rotational grazing, soil conservation measures, and the restoration of natural vegetation, is crucial for mitigating soil degradation in agro-pastoral systems.

- **Water pollution**

One of the primary ways is through the excessive use of fertilizers and pesticides. When farmers clear land to grow crops, they often rely heavily on synthetic fertilizers to boost yields.

These fertilizers, which contain high levels of nitrogen and phosphorus, runs off into nearby waterways during heavy rains. This influx of nutrients can lead to eutrophication, where algal blooms rapidly and depletes the water of oxygen, creating "dead zones" where aquatic life cannot survive.

CONCLUSION

The conversion of land for the expansion of crop cultivation and animal rearing can have significant negative on the natural ecosystem such as deforestation, habitat loss, soil degradation and even water pollution through the use of fertilizers and pesticides, the improper management of animal waste, soil erosion, and the overexploitation of water resources. Addressing these issues is crucial for protecting the health of aquatic ecosystems and the communities that rely on them.

Population increases in Boyo also indicates the need for more arable land for farming given that there are more mouths to feed. In areas where acquiring a new piece of land is difficult, farmers tend to change their agricultural practices and patterns in a bit to increase output per surface. This change in agricultural patterns coupled with poor agricultural practices such as farming across ridges has worsen environmental deterioration across Boyo Division. Given that, all inhabitants in the area own at least a portion of land for subsistence cultivation. This extension, coupled with poor farming practices, further worsens issues. The ever-increasing population has led to the eradication of farming practices such as shifting cultivation for the need of land. However, the practice of the *slash and burn* agricultural method and the implementation of bush fallowing in place of shifting cultivation is still a major cause of environmental damage in Boyo. The need for more agricultural land leads to the cutting down of forest for the opening of new farmlands. This brings about a reduction in the total surface area of the forest as farmland consumes the forest and it contributes to the reduction of species

GENERAL CONCLUSION

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This research focuses on agro-pastoral activities and environmental degradation in Boyo Division. In a bid to vividly examine the above problem, certain themes were circled out which included crop cultivation, the types and methods of crop cultivation, pastoral activities, the different types and methods used in rearing, population increase, agro-pastoral conflicts and its implications on the environment. A general objective and three specific objectives were set which helped assess how agro-pastoral activities provoke environmental degradation in Boyo Division while advancing strategies for sustainable agricultural practices in the region. The data collected was presented and analyzed in the three chapters above and will still be used for the testing and validation of the hypotheses conceived for this study.

Hypotheses testing, analysis and discussion of results

The testing of the hypotheses conceived to quantify respondents‟ views for analysis in this study was done with the help of the psychological theory of perception-action which states that people perceive their environment and events within it in terms of their ability to act. The notion of perception therefore guided the actions that were taken. The hypotheses for this study were verified with the use of the Chi Square for the analysis of data collected through interviews, questionnaires, focus group discussions and field observations. Research hypothesis 1, 2 and 3 were all tested, each followed by analysis and discussions of the obtained results as follows;

Research Hypothesis 1

The first hypothesis for this research served as a guide for the collection of data on how the methods and techniques of crop cultivation contribute to environmental degradation in Boyo Division.

The methods and technics of crop cultivation practiced in Boyo Division has a great impact on the environment. These methods (slash and burn methods, and the spraying methods) are great promoters of environmental degradation through soil exposure, erosion (especially water and wind), which all together exposes the environment to all forms of degradation such as biodiversity lost and pollution. In order to verify this hypothesis, data was collected for the key methods used by farmers to better prepare their farmlands for the agricultural season. The following tables were developed from the data collected through questionnaires;

Table 18: Respondents views on the methods of soil preparation in Boyo Division

Zones	Total No of respondents	How do you prepare you farmland for the agricultural season?				
		Bush burning (Slash and burn)	Spray and plant	Till and cover (Ankara)	Planting without tilling	All of the above
Zone A	22	09	04	05	03	01
Zone B	42	15	09	12	02	04
Zone C	29	12	05	07	02	03
Zone D	36	16	06	10	02	02
Total	129	**52**	**24**	**34**	**09**	**10**
Percentages	**100**	**40.3**	**18.6**	**26.3**	**07**	**07.8**

Source: Field work data, 2020/2022

In order to verify the link between the methods of crop cultivation and environmental degradation, we developed a contingency table and also stated the null hypothesis as follows (tab. 18);

Table 19: Contingency table for hypothesis 1

Observed Value (O)	**Expected Value (E)**	**O-E**	**$(O-E)^2$**	**$\frac{(O-E)^2}{E}$**
9	14.33	-5.33	28.44	1.98
4	32.25	-28.25	798.06	24.75
5	25.80	-20.80	432.64	16.77
3	43.00	-40.00	1600.00	37.21
1	129.00	-128.00	16384.00	127.01
15	8.60	6.40	40.96	4.76
9	14.33	-5.33	28.44	1.98
12	10.75	1.25	1.56	0.15
2	64.50	-62.50	3906.25	60.56
4	32.25	-28.25	798.06	24.75
12	10.75	1.25	1.56	0.15
5	25.80	-20.80	432.64	16.77
7	18.43	-11.43	130.61	7.09
2	64.50	-62.50	3906.25	60.56
3	43.00	-40.00	1600.00	37.21
16	8.06	7.94	63.00	7.81
6	21.50	-15.50	240.25	11.17
10	12.90	-2.90	8.41	0.65
2	64.50	-62.50	3906.25	60.56
2	64.50	-62.50	3906.25	60.56
129	708.76	-579.76	38213.66	$\sum$ 562.46

Source: Table 18 based on Chi Square statistics

$$X^2 = \frac{\sum(0-E)^2}{E}$$

Chi Square Value = 562.46

Degree of freedom (df) = (c-1) (r-1) = (5-1) (4-1) = 4x3 = 12

Null Hypothesis (Ha): Environmental degradation in Boyo Division is independent of the methods and techniques of cultivation.

Alternative Hypothesis (Ho): The methods and techniques of crop cultivation largely influence environmental degradation in Boyo.

Now, we have Chi Square value (562.46) as calculated from the contingency table above, the predetermined alpha level of significance (0.05) and the degree of freedom (12) situating the chi square value at 12 DF, we notice that X^2 (562.46) is far beyond the critical value 21.026. The null hypothesis proposing that environmental degradation in Boyo Division is independent of the methods and techniques of cultivation can therefore be rejected and that which says the methods and techniques of crop cultivation largely influence environmental degradation in Boyo retained.

Our first specific objective for this study was to find out how the methods and techniques of crop cultivation in Boyo contributes to environmental degradation. It was observed that there is a high demand for food crops from this area yet the educated youths are not into the agricultural sector leaving it to their aging parents and grand parents who are more attached to the old methods handed to them by their forefathers. These reasons coupled with the difference in soil types and altitudes only help in promoting the use of the slash and burn methods by subsistence farmers and the spraying methods by extensive farmers.

Research Hypothesis 2

Hypothesis 2 seeks to show how the methods of livestock rearing in Boyo influences environmental degradation. Through the responses provided by respondents, we were able to verify and validate this hypothesis.

The demand for animal meat and beef by-products has recorded an increase in the previous years hence encouraging pastoral farmers to increase animal production. To investigate how livestock rearing and other pastoral activities affects the environment of Boyo, respondents' responses were implored (table 20).

Table 20: Respondents view on the different methods of animal rearing

Zones	Total No of respondents	How do you rear your animals?		
		In enclosed area (small ranches)	In large extensive farms	Around the house
Zone A	22	02	06	14
Zone B	42	10	14	18
Zone C	29	08	07	14
Zone D	36	08	11	17
Total	**129**	**28**	**38**	**63**
Percentages	**100**	**22%**	**29%**	**49%**

Source: Fieldwork data, 2022

From the data above, the contingency table will therefore be as follows;

Table 21: Contingency table for hypothesis 2

Observed Value (O)	**Expected Value (E)**	**O-E**	**$(O-E)^2$**	**$\frac{(O-E)^2}{E}$**
2	64.50	-62.50	3906.25	60.56
6	21.50	-15.50	240.25	11.17
14	9.21	4.79	22.90	2.49
10	12.90	-2.90	8.41	0.65
14	9.21	4.79	22.90	2.49
18	7.17	10.83	117.36	16.38
8	16.13	-8.13	66.02	4.09
7	18.43	-11.43	130.61	7.09
14	9.21	4.79	22.90	2.49
8	16.13	-8.13	66.02	4.09
11	11.73	-0.73	0.53	0.05
17	7.59	9.41	88.58	11.67
129	203.70	-74.70	4692.73	$\sum$ 123.22

Source: Table 20 based on Chi Square statistics

$$X^2 = \frac{\sum(0 - \mathrm{E})^2}{E}$$

Chi square value = 123.22

Degree of freedom = (c-1) (r-1) = (3-1) (4-1) = 2x3 = 6

Null hypothesis (Ho): Environmental degradation is independent of the methods of livestock rearing in Boyo.

Alternative hypothesis (Ha): The methods of livestock rearing in Boyo largely influences environmental degradation.

Having X^2 =123.22 which is the calculated value for our Chi square statistic, and 0.05 as the predetermined alpha level of significance, and a degree of freedom (df) at 6, we note that the Chi square distribution table at 6 degrees of freedom when reading along the row is way above the critical value (12.592). As such, we then reject the null hypothesis (Ho) which states that environmental degradation is independent of the methods of livestock rearing in Boyo and we retained the alternative hypothesis (Ha) which states that the methods of livestock rearing in Boyo largely influences environmental degradation.

The second specific objective of this study focused on investigating how livestock rearing and other pastoral activities affects the environment of Boyo. From field surveys, it was observed that the methods implored by pastoralist during animal rearing are not sustainable as they engage in burning the bushes to ease regeneration.

Research Hypothesis 3

This hypothesis sought to show how agro-pastoral expansion in Boyo Division leads to land conversion.

The fertile soils and favorable climates coupled with the available markets have attracted pools of population influx who came in search for cultivable land, bringing about encroachment and destruction of the forest. The recorded increase in population over the years has pushed farmers and pastoralists to seek new areas for cultivation and rearing. Due to an increase demand for food crops and agricultural products, crop farmers tend to move towards hills and lowland areas which are not very good areas for cultivation, other farmers create new farmlands closer to the forest which leaves them moving inward as the years pass by. Pastoralist on their part move in and around the forest with their animals in search of green leaves while others leave their animals roaming and getting into farmlands all of which promotes conflicts between both farmers and pastoralist. To verify the negative impacts of agro-pastoral expansion on land conversion in Boyo Division. This was done with the help of the responses provided by the respondents.

Table 22: Respondents' view on the types of land conversions practiced in Boyo

Zone	**No of respondents**	**How do manage the expansion of agro-pastoral activities in this region**		
		Search for new farms	**Move towards the forest**	**Search for new settlement**
Zone A	22	12	7	3
Zone B	42	24	12	6
Zone C	29	15	8	6
Zone D	36	18	10	8
Total	**129**	**69**	**37**	**23**
Percentage	**100%**	**53**	**29**	**18**

Source: fieldwork data, 2022

Table 23: contingency table for hypotheses 3

Observed Value (O)	**Expected Value (E)**	**O-E**	**$(O-E)^2$**	**$\frac{(O-E)^2}{E}$**
12	10.75	1.25	1.56	0.15
7	18.43	-11.43	130.61	7.09
3	43.00	-40.00	1600.00	37.21
24	5.38	18.63	346.89	64.54
12	10.75	1.25	1.56	0.15
6	21.50	-15.50	240.25	11.17
15	8.60	6.40	40.96	4.76
8	16.13	-8.13	66.02	4.09
6	21.50	-15.50	240.25	11.17
18	7.17	10.83	117.36	16.38
10	12.90	-2.90	8.41	0.65
8	16.13	-8.13	66.02	4.09
129	192.22	-63.22	2859.89	$\sum$ 161.45

Source: table 22 based on Chi square statistics

$$X^2 = \frac{\sum(0 - \mathrm{E})^2}{E}$$

Chi square value = 161.45

Degree of freedom = (c-1) (r-1) = (3-1) (4-1) = 2x3 = 6

Null hypothesis (Ho): land conversion in Boyo Division is independent of agro-pastoral expansion.

Alternative hypothesis (Ha): Agro-pastoral expansion leads to land conversion in Boyo.

With our Chi square statistic (X^2 =161.45) which is the calculated value, our predetermined alpha level of significance (0.05), and our degree of freedom, df = 6, we observe that our calculated value (161.45) goes beyond 12.592 which is the critical value. We therefore reject the null hypothesis (Ho) which states that land conversion in Boyo is independent of agro-pastoral expansion and retains the alternative hypothesis (Ho) which states that; agro-pastoral expansion leads to land conversion in Boyo Division.

The third specific objective for this study focused on finding out how an expansion in agro-pastoral activities negatively affects the environment. It was observed that agro-pastoral expansion is triggered by population increase leading to the conversion of land to accommodate these activities.

CONCLUSION

For a long time now, agriculture as a whole has served as the backbone of rural economies in Cameroon, with Boyo Division inclusive bringing to them, a stream of importance ranging from economic, social and cultural values. Nonetheless, the practice of this activity has intensified with time due to an ever-increasing population, leading to an increase in the demand for these products, as there are more mouths to be fed. This increase in population, coupled with poor farming technics used by crop farmers and poor methods of grass regeneration used by pastoralists leads to devastating consequences such as pollution, erosion and all forms of degradation hence provoking scarcity of species (both plants and animals) and possible extinction. Poor agro pastoral practices by the local populations especially those inhabiting the fringes of the forest go a long way to boost the degradation of the forest.

Moreover, the use of poor farm preparation methods such as the slash and burn and the spraying method coupled with the poor methods of pasture regeneration and herds management by pastoralist has brought about the emergence of more agro-pastoral conflicts.

SUGGESTIONS AND POLICY IMPLIMENTATION OR RECOMMENDATIONS

Agro-pastoral activities are of significant importance in Boyo Division, both for the livelihoods of the local communities and for the general economy. Agriculture and livestock rearing are the main sources of income for most people in this region and the activities critical for food security and poverty alleviation. Although these activities are of great importance to both the local communities and the economy at large, it can contribute to environmental degradation if not managed sustainably as demonstrated in previous chapters. Promoting sustainable agro-pastoral practices can help to address these challenges and promote a healthier and more sustainable environment in the region. In order to achieve this, a couple of recommendations were made in line with this activity. These suggestions are addressed to crop farmers, animal rearers and the state as a whole.

To crop farmers

While crop cultivation is an important activity in Boyo Division and Cameroon as a whole, there is a need for increased investment in the agriculture sector to improve productivity, enhance food security, and promote sustainable agricultural practices. Several sustainable agricultural practices could be implemented in Boyo Division to enhance the productivity and sustainability of crop cultivation such as:

Crop rotation where farmers will be encouraged to grow different crops in a particular field in a specific sequence over time. This practice can help to reduce soil-borne diseases, improve soil fertility, and reduce the need for chemical fertilizers and pesticides. Also, organic farming, which involves using natural methods to manage pests and diseases, maintain soil fertility, and produce crops without the use of synthetic fertilizers and pesticides should be encouraged among farmers. This practice can help to reduce the environmental impact of agriculture and provide consumers with healthier and safer food products.

Conservation agriculture is another safe option when it comes to agriculture. This involves minimizing soil disturbance, maintaining soil cover, and rotating crops to reduce soil erosion and improve soil health. Conservation agriculture is a sustainable land use practice that emphasizes on the use of cover crops such as maize and reduced tillage with the aim of improving soil health and reducing erosion. Although this practice is already being used by some farmers to conserve soil moisture and reduce soil erosion in some areas, it would be great if more and more farmers could adopt this method.

Implementing these sustainable agricultural practices in Boyo Division could help to improve soil health, reduce environmental degradation, increase crop yields, and enhance the livelihoods of smallholder farmers in the region.

To pastoralist and animal farmers

The environmental effects of pastoral agriculture in Boyo Division depend on the management practices employed by pastoralists. Sustainable livestock farming practices, such as rotational grazing, agroforestry, and improved waste management, can help to reduce the negative environmental impacts of livestock farming while promoting soil health, biodiversity conservation, and carbon sequestration. Pastoral farmers in Boyo Division can implement sustainable livestock farming practices by adopting the following strategies:

Rotational grazing can be introduced to reduce over grazing. This involves dividing pastures into smaller paddocks and rotating livestock through them, allowing for periods of rest and recovery for the vegetation. This approach can help to prevent overgrazing, reduce soil compaction and erosion, and improve soil fertility. Farmers can improve grazing management by monitoring pasture conditions, adjusting stocking rates, and implementing rest periods for pastures. This can help to prevent overgrazing and promote soil health.

Farmers can improve waste management on their farms by constructing manure pits to convert animal waste into fertilizer. This can help to prevent water pollution and improve soil fertility. Farmers can integrate crop and livestock production on their farms through integrated crop-livestock systems. This approach involves using livestock to provide manure for crops, and using crop residues to feed livestock. This approach can help to improve soil fertility, reduce the use of chemical fertilizers and pesticides, and promote biodiversity.

Education and training programs can help to promote sustainable livestock farming practices among farmers in Boyo Division. This can involve providing farmers with information on sustainable land use practices, waste management, and animal health, as well as training on the use of new technologies and techniques.

Also, pastoralists should be encouraged to use watering points along transhumance routes. Making provisions for watering points along transhumance routes can reduce the need for livestock to graze near water sources thus reducing the risk of water pollution.

Promoting sustainable livestock farming practices in Boyo Division requires a multifaceted approach that involves promoting sustainable land use practices, improving waste management, and providing education and training to farmers. By adopting sustainable

livestock farming practices, farmers can help to reduce environmental degradation, improve soil fertility, and promote biodiversity conservation in the region.

The state

The state can encourage farmers to adopt sustainable agricultural practices and sustainable land use practices by providing them with the necessary resources and incentives to make the transition and reduce environmental challenges triggered by agro-pastoral conflicts in this region. Here are some ways to encourage farmers to adopt these practices:

Providing farmers with education and training on sustainable agricultural practices can help them to understand the benefits of these practices and how to implement them effectively. This could be done through workshops, demonstration farms, and extension services.

Education and training programs can also help to promote sustainable agro-pastoral practices among farmers in Boyo Division. This can involve providing farmers with information on sustainable land use practices, soil conservation, and waste management, as well as training on the use of new technologies and techniques. Research and innovation in the livestock sector can also be encouraged. This will bring forth the development of new technologies and techniques for sustainable livestock production, as well as the testing and scaling up of existing approaches.

The government can support farmers in Boyo Division to adapt to the impacts of climate change. This can involve the development of early warning systems for extreme weather events, the promotion of drought-tolerant crops for livestock feed, and the provision of insurance schemes to protect farmers against losses. The state could also facilitate multi-stakeholder partnerships between farmers, civil society organizations, the private sector, and other actors in the livestock sector in order to coordinate efforts, share knowledge and expertise, and mobilize resources to support sustainable livestock production. Providing financial incentives, such as subsidies and low-interest loans, can help to offset the initial costs of transitioning to sustainable agriculture and encourage farmers to adopt these practices.

Encouraging farmers to practice agroforestry and promote reforestation of already damaged zones will be a win for the state. Planting trees and incorporating them with farming systems can help to improve soil health, reduce soil erosion and provide shade and shelter for livestock. The planting of trees could be done round the farmland to serve as a boundary hence reducing conflicts over land use. As a substitute to agroforestry, farmers can also be encouraged to practice integrated crop-livestock systems already practiced by a few. This involves the

integration of crops and livestock in the same farming letting the animals feed on crop residues while the animal dung is used as fertilizers.

In addition, they can strengthen land use planning and management development by developing land use plans that take into account the needs of both farmers and herders. This will go a long way to help in reducing conflicts over land use and help in promoting sustainable land management practices.

Overall, encouraging farmers to adopt sustainable agricultural practices requires a combination of education, financial incentives, climate change adaptation amongst others. By providing farmers with the necessary support and incentives, farmers can help to reduce environmental degradation, improve soil fertility, and promote biodiversity conservation in the region while creating a more sustainable and resilient agriculture sector in Boyo Division and beyond.

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APPENDICES

1. QUESTIONNAIRE

Dear respondent, I am CHIATOH ELIZABETH NIHGWAIN, a final year masters student in the department of Geography, Faculty of Arts, Letters and Social Sciences of the University of Yaoundé 1. I am carrying out research on the topic ‘‘AGRO PASTORAL ACTIVITIES AND ENVIRONMENTAL DEGRADATION IN BOYO’’. This research exercise is solely for academic purpose and your response is strictly confidential.

Thank you in Advance.

Please tick the boxes where appropriate and briefly explain where necessary.

Section A.

Demographic characteristics

1. Nationality……..
2. Village ……...
3. Sex……..
4. Status. Married ☐ Single ☐ Divorced ☐ Widow/Widower ☐
5. Occupation. Civil servant ☐ Farmer ☐ Grazier ☐ Business ☐ Informal ☐ private sector ☐ NGO ☐
6. Level of education. Informal ☐ Primary ☐ Vocational ☐ Secondary ☐ BSC ☐ Masters ☐
7. Age group. 15-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ 65^{+} ☐

Section B

PART 1: **methods and technics of crop cultivation and its effects in Boyo**

1. Which crops do you mostly cultivate?
   a) Cereals - maize
   b) Vegetables – bitter leaf, huckle berry, green
   c) Tubers – plantains, coco yams
   d) Legumes – beans, potatoes

e) Cash crops – cocoa, coffee

2. Why do you choose to cultivate these crops?
   a) Fertile soils b) high demand c) favourable climate d) others
3. What type of agricultural system is mostly practiced here?
   a) Intensive subsistence b) extensive subsistence
   b) Intensive commercial d) extensive commercial
4. How do you prepare your farm(s) for cultivation?
   a) Burning b) till and cover c) spraying d) all of the above
5. Do you use fertilizers, fungicides and pesticides in the process of cultivation?
   a) Yes b) No
      i. If YES on which crops do you use them and why?
         ……..
         ……..
      ii. How often do you use them?
         a) Weekly b) monthly c) annually d) others, specify…..
      iii. If NO, what do you use to increase crop yields?
         a) Animal dung b) household waste c) crop residues
         d) others, specify….
6. Why do you choose to do agriculture?
   a) Meet up with daily needs/expenses b) old age – just to occupy myself
   c) availability of land d) lack of good paying jobs e) for business purposes
7. In the last 5-10 years, have you noticed any increase in the number of people practicing agriculture in your area?
   Yes ☐ No ☐
      i. If yes what do you think is the reason for the increase?
         a) High demand for agricultural products
         b) Scarcity in food crops
         c) Increase in population
         d) Increase in living cost
         e) Other, specify ……..
8. What are some of the problems you face as a farmer?
   a) Crop infection
   b) Unfavourable climatic conditions
   c) High prices of primary products – seedling
   d) Others ……
9. In your opinion, how can farmers increase their output and still protect their environment?
   ……
   ……
   ……

PART 2: **Livestock rearing and environmental degradation**

1. Which type of pastoral activity do you practice and what quantity do you rear?
   a) Cattle (i) 0-20 (ii) 21-40 (iii) 41-60 (iv) 61^{+}
   b) Goats (i) 0-20 (ii) 21-40 (iii) 41-60 (iv) 61^{+}
   c) Sheep (i) 0-20 (ii) 21-40 (iii) 41-60 (iv) 61^{+}
   d) Cows (i) 0-20 (ii) 21-40 (iii) 41-60 (iv) 61^{+}
   e) Pigs (i) 0-20 (ii) 21-40 (iii) 41-60 (iv) 61^{+}
   f) Fowls (i) 0-20 (ii) 21-40 (iii) 41-60 (iv) 61^{+}
   g) Fish (i) 0-20 (ii) 21-40 (iii) 41-60 (iv) 61^{+}
   h) Bees
2. When did you start rearing animals?
   a) 1985-1990
   b) 1991-1996
   c) 1997-2002
   d) 2003-2008
   e) 2009-2014
   f) After 2015
3. What type of birds do you keep?
   a) Fowls b) ducks c) geese d) others
4. Why do you choose to keep these animals?
   a) High demand for them b) favourable climate c) cultural benefits
5. How/Where do you rear your animals?
   a) Within the forest b) around the forest fridges c) at home d) in enclosed areas
6. How do you decide on the site where you rear your animals?
   a) Availability of water c) Good drainage
   b) Availability of free land d) Others ……
7. Do you practice transhumance?
   a) Yes b) No
      i. If yes, where do you move to and for how long? ……
      ii. Before leaving what do you do?
         a) Burn down the place to allow easy regeneration b) allow the place to regenerate on its own c) abandon the site and move to a new site
      iii. If no, how do you cope during the dry season?
         a) Cut grass from the forest to feed the animals b) buy food for the animals c) allow the animals to move around in farms
8. Have you noticed any increase in the number of livestock rearers and animals?
   a) Yes b) No
      i. If yes what do you think is the reason for this increase

a) High demand for animals and their products b) increase in general population c) other ……..

9. Why did you choose animal rearing as an economic activity?
   a) Lack of jobs c) to raise money for a better business
   b) I love taking care of animals d) I inherited the business
10. What are some of the problems you face while carrying out your activity?
   a) Bad roads b) animal infections c) others ……
11. Are you aware that some graziers around the forest intentionally extend into the forest with their animals?
   a) Yes b) No
      i. If yes, what do you think is the motive behind this extension into the forest?
         a) Enclaves/ ranches are no longer fertile b) increase number of cattle in the ranches/ enclaves c) more fertile lands are found in the forest
12. In your opinion, what can grazers do to protect their land without reducing their outputs?

……
……
……

PART 3: **Agro-pastoral land use practices and environmental degradation**

1. Is there a clear distinction between forested land, agricultural land and grazing land?
   a) Yes b) No
      i. If No, how is land allocated for different purposes?
         a) Individuals buy land and decide what to do on it b) the authorities tell you what to do on your land c)
2. Are you a land owner?
   a) Yes b) No
   i. If yes, how did you get your land?
   a) Inheritance
   b) Bought the land
   c) Other …….
3. How is land used here practiced?
   a) Land is kept for a specific purpose, either farming or rearing
   b) Farming land can also be grazing land
   c) Others ……
4. Have you noticed any increase in agro-pastoral activities around you?
   a) Yes b) No c) not really
5. What do you think is the cause of this increase?
   a) Social- Population increase and cultural practices
   b) Natural – good vegetation and relief conditions
   c) Economic – available markets and increase in market demand
6. Has there been an increase in human population recently?
   a) Yes b) no c) no idea
7. Why did you choose to settle in Boyo?
   a) Favourable climatic conditions
   b) Fertile soils and cheap land
   c) Welcoming people
8. How do you manage the expansion in agro-pastoral activities?
   a) Search for new farmlands
   b) Move towards the forest
   c) Search for new settlements
9. Are there any agro pastoral conflicts recorded here?
   a) Yes b) No
10. If yes what are some of these common conflicts?
    a) Farmer-grazier conflicts b) bee farmers and graziers c) forest coordinators and farmers conflicts d) Hunters and graziers conflicts
11. What do you think is the main cause of these conflicts?
    a) Limited land b) inheritance c) carelessness and mismanagement of space
12. What are some of the consequences of such conflicts?

a) Destruction of farmlands b) death of animals c)

In your opinion what measures can be taken to limit the occurrences of these conflicts?

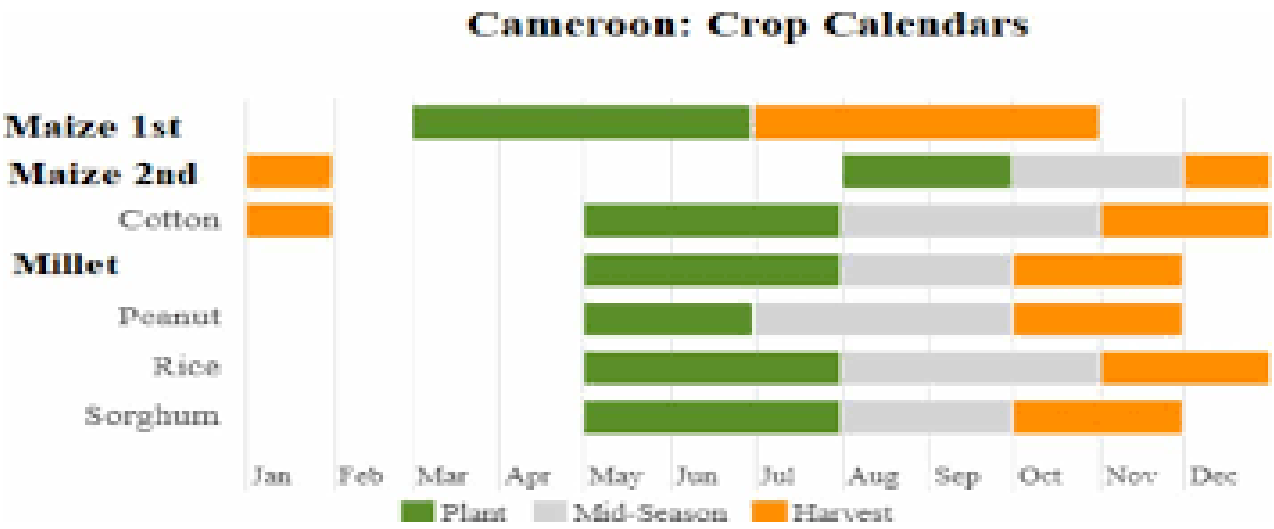
……

……

……

……

2. AGRICULTURAL CALENDAR

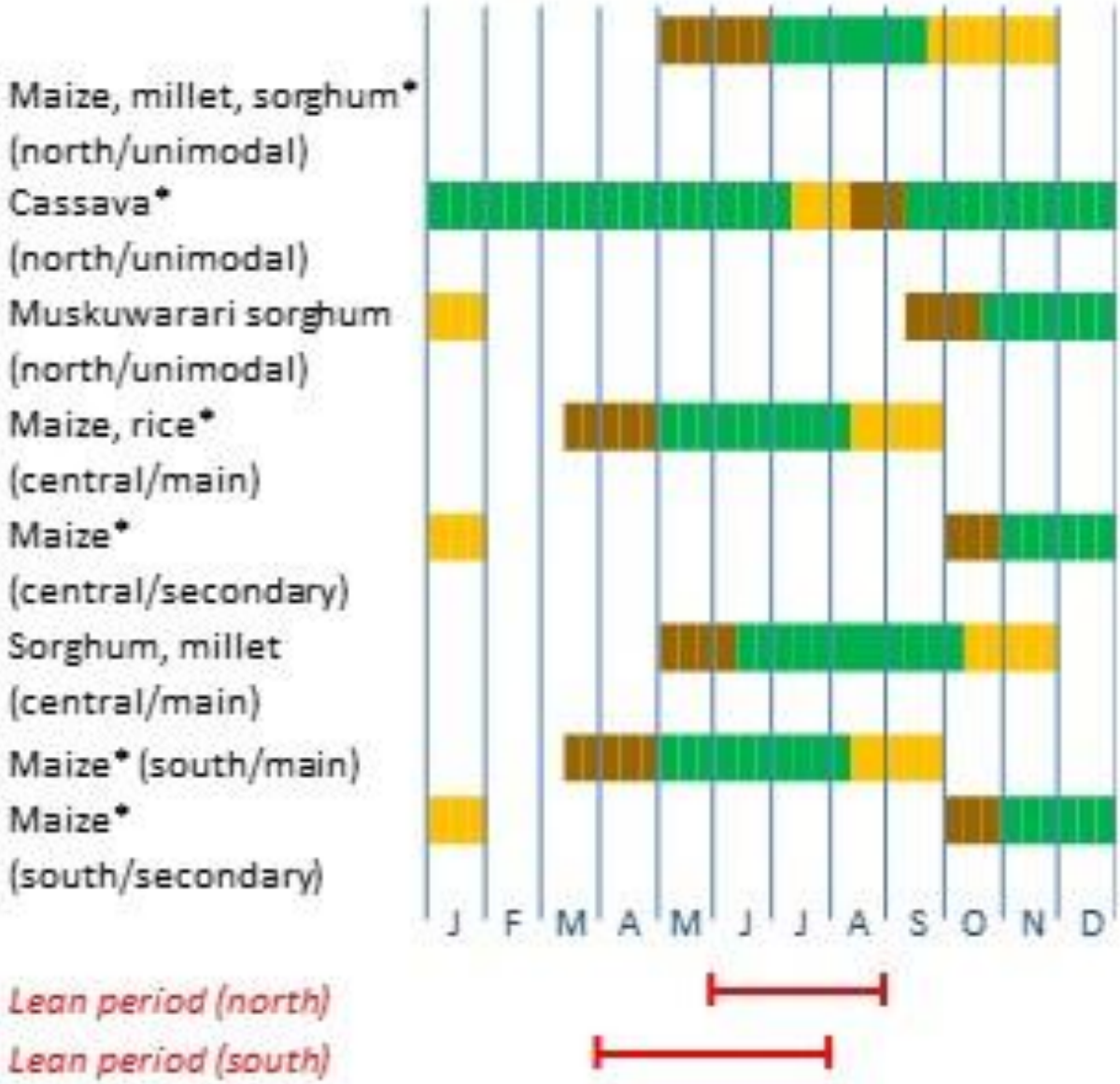


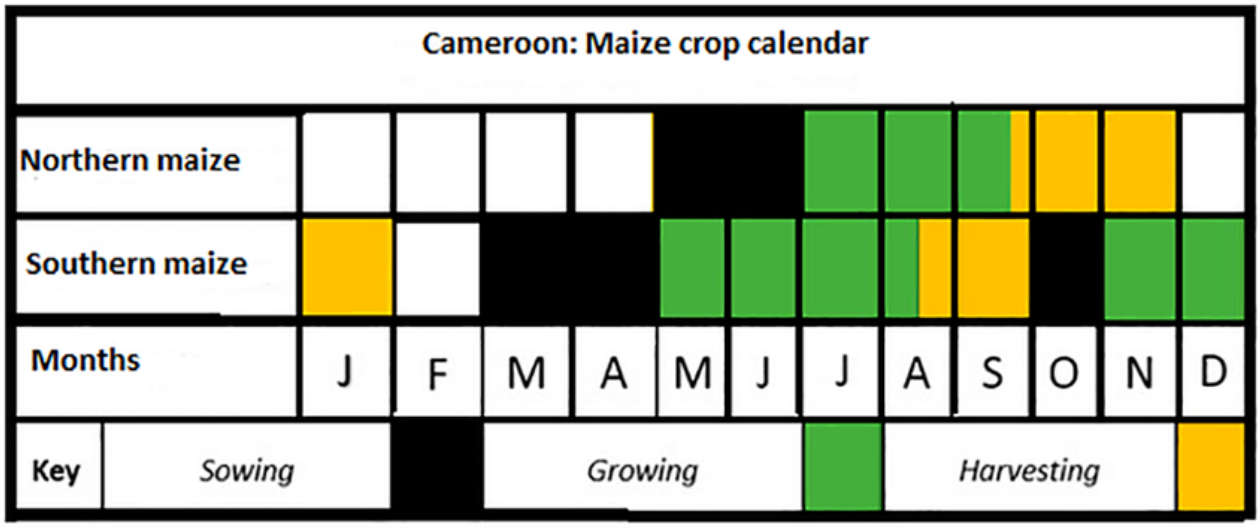
	Janvier	Février	Mars	Avril	Mai	Juin	Juillet	Août	Septembre	Octobre	Novembre	Décembre
Partie septentrionale/ Extrême-Nord et Nord		Récolte de contre saison					Soudure (1)			Semi de contre saison (2)		
						Semis				Récolte pluviale - principale		
Partie méridionale / toutes les autres régions			Semis	Période de moindre disponibilité (3)		Récolte pluviale - principale						
	Récolte							Semis – second cycle, petite saison des pluies (4)				Récolte

1 - selon les années, la soudure peut commencer en juin ou juillet.
2- pratiqués sur les terres hydromorphes, récolte moins abondante que la récolte principale.
3 - on ne peut à proprement parler de soudure dans la partie méridionale.
4 - l'importance des semis varie d'une région à l'autre et d'un agriculteur à l'autre.

Cameroon

Crop Calendar *(*major foodcrop)*




Cameroon: Maize crop calendar
Northern maize
Southern maize
Months
J
F
M
A
M
J
J
A
S
O
N
D
Key
Sowing
Growing
Harvesting

3. The Chi Square Statistics

Types of Data:

There are basically two types of random variables and they yield two types of data: numerical and categorical. A chi square (X^2) statistic is used to investigate whether distributions of categorical variables differ from one another. Basically categorical variable yield data in the categories and numerical variables yield data in numerical form. Responses to such questions as "What is your major?" or Do you own a car?" are categorical because they yield data such as "biology" or "no." In contrast, responses to such questions as "How tall are you?" or "What is your G.P.A.?" are numerical. Numerical data can be either discrete or continuous. The table below may help you see the differences between these two variables.

Data Type	Question Type	Possible Responses
Categorical	What is your sex?	male or female
Numerical	Disrete- How many cars do you own?	two or three
Numerical	Continuous - How tall are you?	72 inches

Notice that discrete data arise fom a counting process, while continuous data arise from a measuring process.

The Chi Square statistic compares the tallies or counts of categorical responses between two (or more) independent groups. (note: Chi square tests can only be used on actual numbers and not on percentages, proportions, means, etc.)

2 x 2 Contingency Table

There are several types of chi square tests depending on the way the data was collected and the hypothesis being tested. We'll begin with the simplest case: a 2 x 2 contingency table. If we set the 2 x 2 table to the general notation shown below in Table 1, using the letters a, b, c, and d to denote the contents of the cells, then we would have the following table:

Table 1. General notation for a 2 x 2 contingency table.

	Variable 1		
Variable 2	Data type 1	Data type 2	Totals
Category 1	A	b	a + b
Category 2	C	d	c + d
Total	a + c	b + d	a + b + c + d = N

Note: notice that the four components of the denominator are the four totals from the table columns and rows.

Suppose you conducted a drug trial on a group of animals and you hypothesized that the animals receiving the drug would survive better than those that did not receive the drug. You conduct the study and collect the following data:

Ho: The survival of the animals is independent of drug treatment.

Ha: The survival of the animals is associated with drug treatment.

Table 2. Number of animals that survived a treatment.

	Dead	Alive	Total
Treated	36	14	50
Not treated	30	25	55
Total	66	39	105

Applying the formula above we get:

Chi square = $105[(36)(25) - (14)(30)]^2 / (50)(55)(39)(66) = 3.418$

Before we can proceed we need to know how many degrees of freedom we have. When a comparison is made between one sample and another, a simple rule is that the degrees of freedom equal (number of columns minus one) x (number of rows minus one) not counting the totals for rows or columns. For our data this gives (2-1) x (2-1) = 1.

We now have our chi square statistic ($x^2 = 3.418$), our predetermined alpha level of significance (0.05), and our degrees of freedom (df =1). Entering the Chi square distribution table with 1 degree of freedom and reading along the row we find our value of x^2 (3.418) lies between 2.706 and 3.841. The corresponding probability is $0.10<P<0.05$. This is below the conventionally accepted significance level of 0.05 or 5%, so the null hypothesis that the two distributions are the same is verified. In other words, when the computed x^2 statistic exceeds the critical value in the table for a 0.05 probability level, then we can reject the null hypothesis of equal distributions. Since our x^2 statistic (3.418) did not exceed the critical value for 0.05 probability level (3.841) we can accept the null hypothesis that the survival of the animals is independent of drug treatment (i.e. the drug had no effect on survival).

Table 3. Chi Square distribution table.

	probability level (alpha)					
Df	0.5	0.10	0.05	0.02	0.01	0.001
1	0.455	2.706	3.841	5.412	6.635	10.827
2	1.386	4.605	5.991	7.824	9.210	13.815
3	2.366	6.251	7.815	9.837	11.345	16.268
4	3.357	7.779	9.488	11.668	13.277	18.465
5	4.351	9.236	11.070	13.388	15.086	20.517

Chi Square Test of Independence

For a contingency table that has *r* rows and *c* columns, the chi square test can be thought of as a test of independence. In a test of independence the null and alternative hypotheses are:

Ho: The two categorical variables are independent.

Ha: The two categorical variables are related.

We can use the equation Chi Square = the sum of all the $(f_o - f_e)^2 / f_e$

Here f_o denotes the frequency of the observed data and f_e is the frequency of the expected values. The general table would look something like the one below:

	Category I	Category II	Category III	Row Totals
Sample A	a	B	c	a+b+c
Sample B	d	E	f	d+e+f
Sample C	g	H	i	g+h+i
Column Totals	a+d+g	b+e+h	c+f+i	a+b+c+d+e+f+g+h+i=N

Now we need to calculate the expected values for each cell in the table and we can do that using the row total times the column total divided by the grand total (N). For example, for cell a the expected value would be (a+b+c) (a+d+g)/N.

Once the expected values have been calculated for each cell, we can use the same procedure are before for a simple 2 x 2 table.

Observed	Expected	$\|O - E\|$	$(O — E)^2$	$(O — E)^2 / E$

Suppose you have the following categorical data set.

Table . Incidence of three types of malaria in three tropical regions.

	Asia	Africa	South America	Totals
Malaria A	31	14	45	90
Malaria B	2	5	53	60
Malaria C	53	45	2	100
Totals	86	64	100	250

Appendix 1: Chi square statistical table

DF	0.995	0.975	0.20	0.10	0.05	0.025	0.02	0.01	0.005	0.002	0.001
1	0.0000393	0.000982	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.550	10.828
2	0.0100	0.0506	3.219	4.605	5.991	7.378	7.824	9.210	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.860	16.924	18.467
5	0.412	0.831	7.289	9.236	11.070	12.833	13.388	15.086	16.750	18.907	20.515
6	0.676	1.237	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.690	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.180	11.030	13.362	15.507	17.535	18.168	20.090	21.955	24.352	26.124
9	1.735	2.700	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	14.631	17.275	19.675	21.920	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	15.812	18.549	21.026	23.337	24.054	26.217	28.300	30.957	32.909
13	3.565	5.009	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	20.465	23.542	26.296	28.845	29.633	32.000	34.267	37.146	39.252
17	5.697	7.564	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.790
18	6.265	8.231	22.760	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312
19	6.844	8.907	23.900	27.204	30.144	32.852	33.687	36.191	38.582	41.610	43.820
20	7.434	9.591	25.038	28.412	31.410	34.170	35.020	37.566	39.997	43.072	45.315
21	8.034	10.283	26.171	29.615	32.671	35.479	36.343	38.932	41.401	44.522	46.797
22	8.643	10.982	27.301	30.813	33.924	36.781	37.659	40.289	42.796	45.962	48.268
23	9.260	11.689	28.429	32.007	35.172	38.076	38.968	41.638	44.181	47.391	49.728
24	9.886	12.401	29.553	33.196	36.415	39.364	40.270	42.980	45.559	48.812	51.179
25	10.520	13.120	30.675	34.382	37.652	40.646	41.566	44.314	46.928	50.223	52.620
26	11.160	13.844	31.795	35.563	38.885	41.923	42.856	45.642	48.290	51.627	54.052
27	11.808	14.573	32.912	36.741	40.113	43.195	44.140	46.963	49.645	53.023	55.476
28	12.461	15.308	34.027	37.916	41.337	44.461	45.419	48.278	50.993	54.411	56.892
29	13.121	16.047	35.139	39.087	42.557	45.722	46.693	49.588	52.336	55.792	58.301
30	13.787	16.791	36.250	40.256	43.773	46.979	47.962	50.892	53.672	57.167	59.703
31	14.458	17.539	37.359	41.422	44.985	48.232	49.226	52.191	55.003	58.536	61.098
32	15.134	18.291	38.466	42.585	46.194	49.480	50.487	53.486	56.328	59.899	62.487
33	15.815	19.047	39.572	43.745	47.400	50.725	51.743	54.776	57.648	61.256	63.870
34	16.501	19.806	40.676	44.903	48.602	51.966	52.995	56.061	58.964	62.608	65.247
35	17.192	20.569	41.778	46.059	49.802	53.203	54.244	57.342	60.275	63.955	66.619
36	17.887	21.336	42.879	47.212	50.998	54.437	55.489	58.619	61.581	65.296	67.985
37	18.586	22.106	43.978	48.363	52.192	55.668	56.730	59.893	62.883	66.633	69.346
38	19.289	22.878	45.076	49.513	53.384	56.896	57.969	61.162	64.181	67.966	70.703
39	19.996	23.654	46.173	50.660	54.572	58.120	59.204	62.428	65.476	69.294	72.055
40	20.707	24.433	47.269	51.805	55.758	59.342	60.436	63.691	66.766	70.618	73.402
41	21.421	25.215	48.363	52.949	56.942	60.561	61.665	64.950	68.053	71.938	74.745
42	22.138	25.999	49.456	54.090	58.124	61.777	62.892	66.206	69.336	73.254	76.084

43	22.859	26.785	50.548	55.230	59.304	62.990	64.116	67.459	70.616	74.566	77.419
44	23.584	27.575	51.639	56.369	60.481	64.201	65.337	68.710	71.893	75.874	78.750
45	24.311	28.366	52.729	57.505	61.656	65.410	66.555	69.957	73.166	77.179	80.077
46	25.041	29.160	53.818	58.641	62.830	66.617	67.771	71.201	74.437	78.481	81.400
47	25.775	29.956	54.906	59.774	64.001	67.821	68.985	72.443	75.704	79.780	82.720
48	26.511	30.755	55.993	60.907	65.171	69.023	70.197	73.683	76.969	81.075	84.037
49	27.249	31.555	57.079	62.038	66.339	70.222	71.406	74.919	78.231	82.367	85.351
50	27.991	32.357	58.164	63.167	67.505	71.420	72.613	76.154	79.490	83.657	86.661

We could now set up the following table:

Observed	Expected	|O -E|	$(O — E)^2$	$(O — E)^2/ E$
31	30.96	0.04	0.0016	0.0000516
14	23.04	9.04	81.72	3.546
45	36.00	9.00	81.00	2.25
2	20.64	18.64	347.45	16.83
5	15.36	10.36	107.33	6.99
53	24.00	29.00	841.00	35.04
53	34.40	18.60	345.96	10.06
45	25.60	19.40	376.36	14.70
2	40.00	38.00	1444.00	36.10

Chi Square = 125.516
Degrees of Freedom = (c - 1) (r - 1) = 2(2) = 4

Table 3. Chi Square distribution table.

probability level (alpha)

Df	0.5	0.10	0.05	0.02	0.01	0.001
1	0.455	2.706	3.841	5.412	6.635	10.827
2	1.386	4.605	5.991	7.824	9.210	13.815
3	2.366	6.251	7.815	9.837	11.345	16.268
4	3.357	7.779	9.488	11.668	13.277	18.465
5	4.351	9.236	11.070	13.388	15.086	20.517

Reject Ho because 125.516 is greater than 9.488 (for alpha □□□□□□□

Thus, we would reject the null hypothesis that there is no relationship between location and type of malaria. Our data tell us there is a relationship between type of malaria and location, but that's all it says.

Chi Square,