AGRICULTURAL PRACTICES AND ENVIRONMENTAL DEGRADATION IN SANTA SUB-DIVISION, NORTH WEST REGION OF CAMEROON

Abstract

Agriculture is the mainstay of Cameroon's economy, engaging an estimated 70 percent of the economically active population and accounting for an estimated 80 percent of the primary sector's contribution to the country's GDP. It also provides 1/3 of foreign exchange earnings and 15 percent of the country's budgetary resources. This study set out to investigate agricultural practices and environmental degradation in Santa Sub-division, North West Region of Cameroon. The major types of agricultural practices studied were food crop, market gardening and animal farming. The study made use of primary and secondary data sources. Primary data sources included field observation, interviews and questionnaires. A total of 170 questionnaires were administered using stratified random sampling technique and the data obtained was complemented by secondary sources from published and unpublished materials. Findings revealed that agricultural practices have precarious impacts on the environment in Santa. Climate change was seen to have a silver lining in the crop sector. Declining soil fertility and climate change were some of the major problems faced by farmers in Santa. Adaptation measures amongst others were mixed crop farming, crop rotation, soil management practices and mulching. The study recommended the need to determine the carrying capacity of various grazing, range lands and regulatory control of herd size. This study also proposes the adoption of climate-smart agriculture to minimize the effects of climate change on agriculture in Santa. Farmers in Santa should strengthen their economic security by adopting sustainable agricultural systems, and targeting their production to take advantage of new demands and consumption patterns.

Key Words: Agricultural Practices, grazing, market gardening, Environmental Degradation, Santa Sub-division

1. Introduction

Human beings have a contract with nature. It is an umbilical relationship between them and the environment on which they depend for their sustenance. All the beauty and bounty of nature combine to give mankind a natural reassurance and consistency that all will be well if we treasure and conserve the environment which is our common heritage through what is today known as sustainable development [1]. According to the online encyclopeadia of world problems and human potential [2], "the vast majority of humanity's agriculture is non-sustainable and in spite of the substantial increase in food production over the past few decades, the present model of agriculture has not solved the world's hunger problem. Industrial and chemical intensive agriculture systems have many damaging impacts. It degrades the fertility of soils, intensifies the effects of droughts and contributes to desertification, pollutes water resources, causes salinization, increases dependence on non-renewable energy, contaminates the food supply, and contributes to climatic change".

"Since the first United Nations Conference on the Environment, held in Stockholm in 1972, particular attention has been paid to the study of the quality of the environment and the overexploitation of natural resources. It is generally accepted in the literature that human activities and especially agricultural activities are one of the main causes of accelerating environmental degradation including climate change" [3]. "Over the past 50 years, human beings have changed the natural ecosystems (in the name of agriculture) more rapidly and profoundly than in any comparable period in history. In the developing countries, these changes have degraded the environment, provoking different responses from affected populations" [4]. There is, indeed, an overwhelming evidence to show that human activities today have drastically affected the earth's support system. In order to feed the burgeoning world population today, we may continuously invade the hills, the mountainous environments and the plains in search of agricultural lands [1].

“Agriculture is the backbone of most developing countries that practice rain fed peasant agriculture. This is evident especially in economies of sub-Saharan Africa given that besides ensuring the sustainability of rural livelihoods, it is also a major contributor to the Gross Domestic Product (GDP). In most countries of sub-Saharan Africa, 60% of the economically active population work in the agricultural sector” [5] and “over 85% of the rural population of sub-Saharan Africa continues to rely on agriculture for their survival” [6]. The agricultural sector continues to be critical in Africa as it provides employment for more than 50% of Africa’s labour force and a means of livelihood for over 70% of the poor [7].

According to Food and Agriculture Organization [8] and the United Nations Environmental Program [9], the number of hungry people in the world remains unacceptably high. The Food and Agricultural Organization remarked that 19 million people are hungry in developed countries because of crop failure resulting from extreme climatic conditions; flooding, droughts and storms. Its 2008 statistics revealed that a vast majority of hungry people live in developing countries, where about 850 million people are estimated to be undernourished. In this third world, Asia and sub-Saharan Africa are hardest hit by the changing climatic caprices of today’s climate change phenomenon where 239 million people are hungry in sub-Saharan Africa.

The growth of human population on the earth surface without a corresponding increase in the natural landscape that sustain life has called for the need to understand the trend of environmental problems caused by agricultural practices [10] . The population-agriculture-environment nexus is what Clark [11] termed the three basic concerns: that is population growth, agricultural performance and environmental degradation. For the past years, world population has been increasing with an associated acceleration of environmental problems. Consequently, mother earth is charged with the huge task of feeding the increasing world population and handling their wastes. The population-resource-environment nexus is therefore a strong base for environmental problems.

The agricultural situation in sub-Saharan Africa is often characterised as dire, needing immediate policy action if food production is to keep up with a growing population, famine averted and poverty reduced. The ten to twenty year record of agricultural performance in three countries in the region: Cameroon, Ghana and Mali, belies such bleak assessments. Cameroon found within the sub-Saharan African Region has also been affected by environmental degradation. “Agriculture is the mainstay of Cameroon’s economy, engaging an estimated 70 percent of the economically active population and accounting for an estimated 80 percent of the primary sector’s contribution to the country’s GDP. It also provides 1/3 of foreign exchange earnings and 15 percent of the country’s budgetary resources [12]. Despite this enormous potential, agriculture in Cameroon faces a plethora of challenges, thus compromising the country’s capacity to sufficiently nourish its expanding food needs”. In North Cameroon for example, signatures of environmental change are discernible; increasing drought and flood events.

Known as the paradise for food in Cameroon, the North West Region is now suffering from a drop in yield due to some physical factors like climate and decrease in soil fertility [13]. Variability in Climate is a cause for concern to residents in the region. This regional variability is associated with a global decrease in the amount of rainfall in the tropics of about 20 percent [14], which directly affects crop yields and causes livestock death, leading to hunger and triggering the need for a sustainable agricultural practice.

Santa Sub-division is located within the Western high land agro-ecological zone of Cameroon and has witnessed a great alteration in its environmental components as a result of unsustainable agricultural practices. These environmental systems have greatly affected the people of Santa in terms of farming and livestock keeping which are major activities of the inhabitants. Heavy reliance on chemicals (pesticide and fertilizers) has come with another set of problems to the environment and to the health of those involved. Pollution, environmental degradation water shortages and

waste problems are all problems being witnessed today as a result of unsustainable agriculture in Santa Sub-division.

The value and importance of the relation between humans and nature have been neglected during recent years especially in Santa Sub-division. Efforts to improve agricultural productivity in the short-term are often designed to succeed at the expense of long-term sustainability, whether this takes the form of ecological stress, loss of genetic diversity in standing crops, salinization and alkalization of irrigated lands, nitrate pollution of ground-water, or pesticide residues in food. The consequences of these changes do not only have environmental impacts (loss of agricultural landscapes and water pollution), economic impacts, and cultural impacts, but also affects the general nutrition, relationships, health and quality of life.

2. Research Problem

Santa Sub-division is one of the fastest growing Sub-divisions of the North West Region of Cameroon. About 80% of her population is engaged in agriculture. However, agricultural practices on the landscape have left a significant impact on the environment. These changes have been triggered by the over exploitation of the immediate environment by the fast growing population who depend on the landscape for their livelihood. While environmental problems are a global issue, their severity and consequences in Santa have been worsen by demographic, economic, social and cultural aspects.

Even though the application and use of advanced technology have led to agricultural improvements, poverty, hunger, and environmental degradation are still wide spread. Increasing soil depletion on the hilly landscape of Santa has reduced crop output and has forced farmers into unproductive marginal lands. This expansion which is aimed at having more farmlands to meet up with the food demand of their families and the local markets have failed because the soil has been exhausted and the indigenes and the people have resorted to the use of chemical fertilizers whose application have affected surface and ground water supply.

The alarming environmental problems brought about by agriculture have left a lot of untold effects on the agricultural activities of Santa. Hydrological droughts have manifested through food shortages and fluctuations in prices of most produce. The long fallow periods have been shortened to ensure food security which has never recorded a significant success. The pressure on pastoral systems has led to the fluctuation in prices for livestock on the market and variations in the cost and inputs. The return periods of livestock from transhumance especially cattle have been delayed because of the prolonged dry season. With the severe environmental problems, the population has adopted a number of mitigation measures to improve on agricultural yields. Unfortunately, these measures are inadequate because of poverty, limited information, low educational levels and inadequate technology.

3. Study Area

Santa is found in the North West Region of Cameroon and lies between longitudes $9^{o}58''$-$10^{o}18''$E of the Greenwich meridian and between latitudes $5^{o}42''$-$5^{o}53''$N of the Equator. Santa is located in the South of Mezam Division in the North West Region. It has a surface area of about 532.62 square kilometers. It is bounded to the North by Bamenda Sub-division, to the West by Bali and Batibo Sub-divisions, to the South by Mbouda Sub-division (West Region) and to the East by Galim and Balikumbat Sub-divisions (Figure 1).

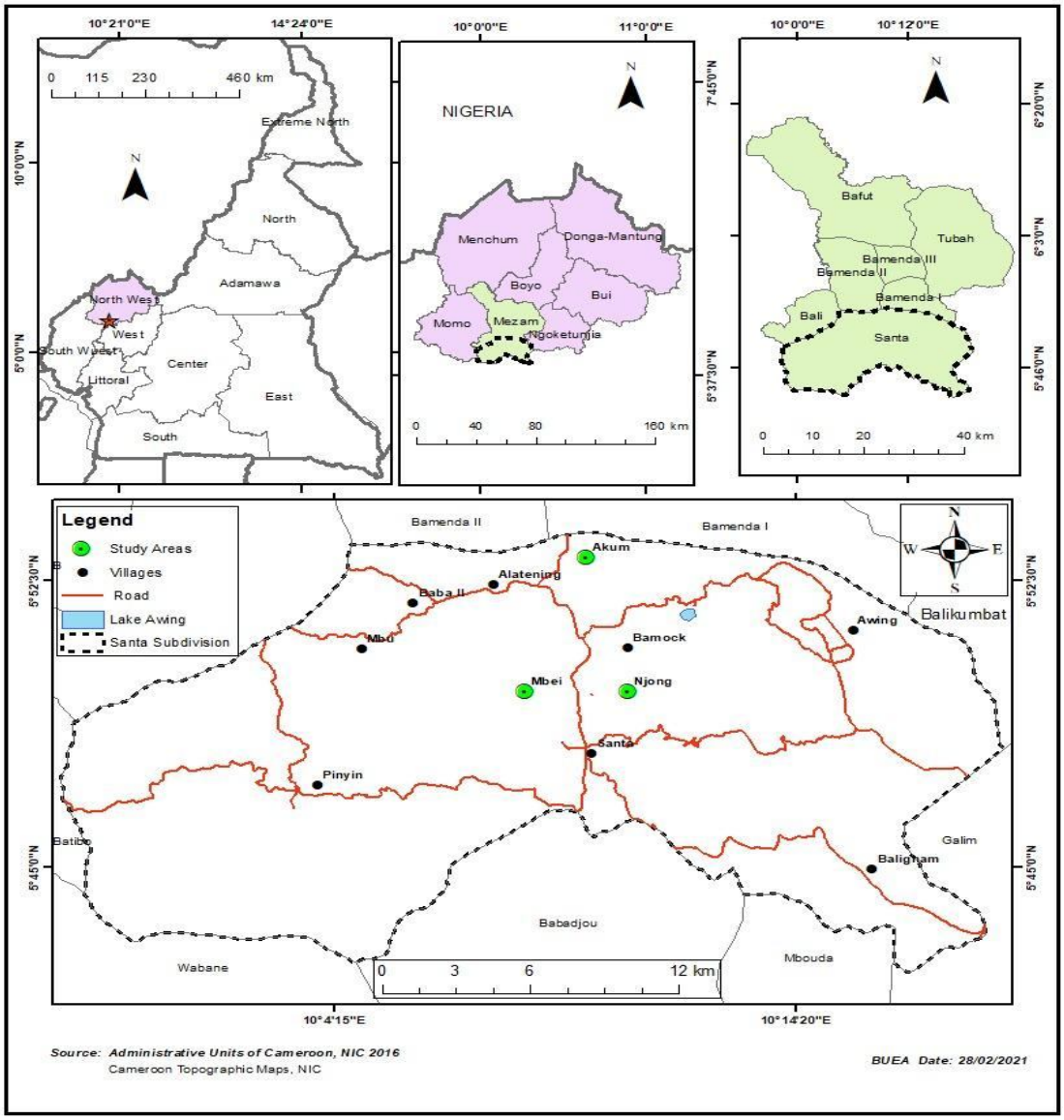

Figure 1: Location and layout of Santa Sub-division

The type of climate found in Santa is the Guinean climate. The climate is marked by two distinct seasons, the dry and wet seasons. The wet season usually begins around March to mid-October. The rainfall ranges between 2000 to 3000mm per annum. The dry season is usually from October to February characterized by very cold nights and very hot days. The annual average temperature in Santa hardly exceeds 19^{o}C. This temperature is favourable to crop and vegetable cultivation qualifying the Sub-division as the agriculture cornucopia within the North West Region. The highest

mean annual rainfall for 2012 stood at 2555.7mm while the lowest annual rainfall total was 1828.9mm in 2017.

As far as relief and geology are concerned, Santa is essentially characterized by mountains located on the North West and West Regions mountain chain, otherwise known as the Bamboutous ranges. The highest point in the area is Mount Lefo in Awing, which is about 2209m above sea level [15]. The relief ranges from about 400-2600m above sea level. Another outstanding peak is the Azope hill situated in Baba II and many other ranges.

The population of Santa in 1987 was estimated to about 57,477, and it was projected in 2015 to have a population of 319,870 [16]. This gives a density of about 108 inhabitants/km^2 in 1987 and over 10,989 inhabitants/km^2 in 2015. Since then, this heterogeneous population (Ngembas, Moghamos, Chambas, Bamilikes, Mbororos and Hausas) have grown rapidly. The surface area is about 532.67 square km [17]. The population is unevenly distributed with the highest densities found around the center of Santa.

4. Materials and Methods

This study adopted a survey research design. A field survey was carried out in the villages of Akum, Mbei and Ndzong because they are major havens for agricultural practices in Santa Sub-division. The research adopted both the descriptive and analytical methods of investigation and was further complimented by review from published and unpublished sources, interviews and focused group discussions, with agriculturalists, small farm holders, farming cooperatives, extension workers, some key persons from the agricultural delegation of rural development, environment and livestock sectors, and other resource persons in Santa Sub-division.

For field observation, vital primary data was generated by intuition based on longevity in the area. Under this, the following were observed; the various human activities and their intensities in the area; evaluating the potentials of the different

ecological functions as well as assessing the environmental distinctiveness and also investigating evidence of environmental degradation and taking note of their spatial intensities. The researchers also observed and evaluated the potentials of the different ecological niches as well as assessing the environmental peculiarities. An exploratory semi-directed method, use of focused group discussions at village/quarter level with the participants was also involved. Focused group discussion was conducted with some farming groups on their meeting days and other farming cooperatives, which are remarkable in Santa.

One hundred and seventy questionnaires were administered to farmers from the domains of food crop, market gardening and animal farming. Stratified random sampling technique was used to collect the necessary data on agricultural practices on the environment in Santa Sub-division. This was to provide equal chances of individuals to be selected as respondents. The target population was made up of food crop farmers, livestock farmers and market gardeners. The data were analysed using SPSS Version 21 statistical package to produce simple charts for the interpretation of each of the sections in the questionnaires answered.

5. Results and Discussion

5.1 Type of Agricultural Activity

Results revealed that market gardening (40%) is the dominant agricultural activity being practiced in Santa followed by livestock (37%) and finally food crop production with 23% (Figure 2). It was realized that majority of the respondents were into market gardening when compared with food crop because market gardening is more profitable than food crop. Food crop producers are mostly farmers who lack sufficient capital and other resources to carryout market gardening, as it is capital intensive and time consuming. Santa Sub- division is characterised by great ecological and climatic variations that influence the agricultural activities and systems. The altitudinal range (1000m to 2600m) and a mean annual temperature of 19^{o}C have favoured the growth of crops and the rearing of animals.

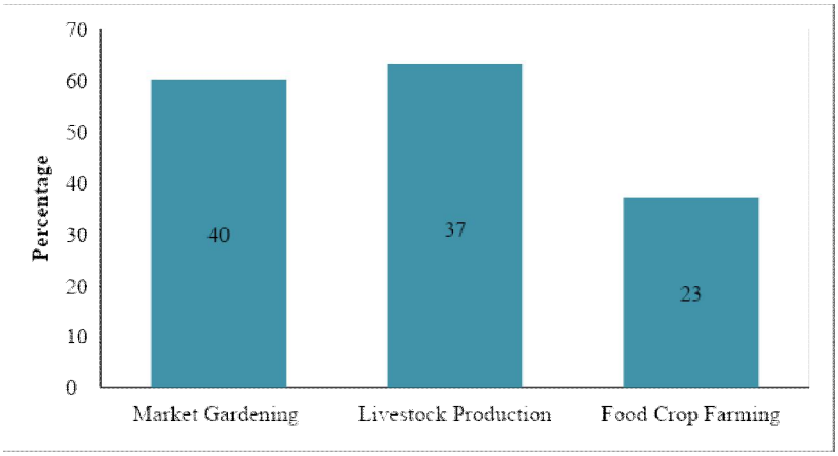

Figure 2: Type of agricultural activity

The common crops grown include Carrot, Cabbage, Maize, Beans, Cassava (mostly transformed into garri), Irish potatoes, green beans, Solanum potatoes, aroids, yams and a host of other garden crops cultivated over vast areas of land in the villages of Akum, Ndzong and Mbei. Figure 3 portrays some of the main market gardening crops and vegetables cultivated in Santa Sub-division.

Figure 3: Some of the garden crops cultivated in Santa; Cabbage under cultivation (a), Carrot under cultivation (b), Irish under cultivation (c) Irish under the process of harvesting (d)

Solanum potatoes and beans are fast becoming important economic crops in the area, but storage remains the major hindrance to the expansion of this activity to real commercial scale. Storage methods and infrastructure are still traditional and inefficient. Market gardening and food crop production are a wide spread practice in all the villages in Santa but livestock production is only carried out in particular villages making the impacts of unsustainable agriculture more severe with food crop production and market gardening.

Santa has rich fertile soils owing to its deeply weathered volcanic basalts that do not only enhance soil fertility but the area offers an ideal climate for the growth of pasture. This makes it possible for multiple agricultural activities such as market gardening, food crop production and livestock production to thrive with outstanding success. Table 1 presents the data for food crop production from 1995-2018 and it indicates that production has been on a decline with significant variations in some crops like Irish potatoes and cocoyam. The table also indicates that production has drastically declined from 2016 to 2018. Declining production is linked to declining soil fertility as a result of over cultivation and increasing pressure on land for settlement and agricultural expansion.

Furthermore, increasing effects of climate change and extreme weather conditions in recent years have greatly contributed in the decline of crop production in Santa. Increasing water shortages aggravated by extreme weather conditions especially prolonged dry season have also led to a decline in agricultural production in Santa. Prevalence of pests and diseases enhanced by changing climatic factors cannot be left out as it is also a contributing factor. However, lack of technology and sustainable agricultural practices have greatly slowed down the growth of this sector.

Table1: Food Crop Data in Santa Sub-Division (1995-2018)

Time	Cereals (kgs)	Legumes (kgs)	Tubers (kgs)	
Year	Maize	Beans	Cocoyam	Irish Potato
1995	10023	12102	1201	23151.41
1996	10203	12011	2145	26095.12
1997	10125	11230	920	18021.25
1998	9253	11025	812	15635.02
1999	9254	9124	812	10251.45
2000	9025	10254	2714	22013.23
2001	8352	11254	1452	15123.22
2002	9254	9123	1002	22235.44
2003	8241	9140	1024	23124.11
2004	7021	8562	952	23204.1
2005	9572	8471	945	20125.33
2006	10245	10032	1203	19205.11
2007	9740	9147	770	19145.22
2008	7235	9321	603	17045.11
2009	9753	9354	921	16142.21
2010	10235	8142	924	13221.01
2011	10123	9453	954	10213.44
2012	9142	7421	854	12154.11
2013	10145	7251	812	11445.51
2014	9240	6425	941	11223.21
2015	8231	7412	721	10721.12
2016	12031	8421	710	10720.14
2017	11042	8563	689	9650.10
2018	9240	6421	615	80142.23

Source: Ministry Agriculture and Rural Development, Sub-Divisional Delegation of Santa [18]

5.2 Type of Farming System

Based on the responses from farmers, shifting cultivation had 54%, slash-and-burn system of farming with 33%, while bush fallowing had a percentage of 8 and a total of 5% out of the total population did not give any responses on the various farming systems, as indicated on Figure 4.

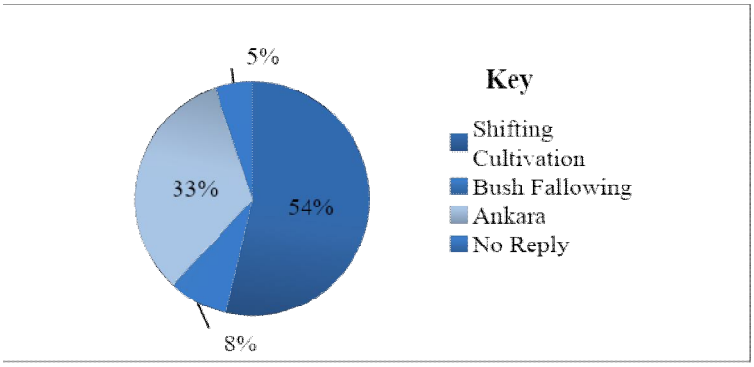

Figure 4: Farming Systems

Shifting cultivation was being practiced in Santa before the 1970s. As a result of population increase and the introduction of the Green Revolution in the 1980s, this practice became more unpopular, though not completely wiped out as some evidence of shifting cultivation can still be traced in Santa today. The practice of shifting cultivation is a very unsustainable practice given that the farmers do not care for the land, with the conception that in case of decline in output, he/she will move to a virgin land. Thus, the land is first deprived of it vegetal cover hence it becomes vulnerable to agents of erosion.

The slash-and-burn system of agriculture popularly known in Cameroon as "ankara'' is a widely used method of growing food in which wild or forested land is cleared, cut and any remaining vegetation burned. The resulting layer of ash then provides the newly-cleared land with a nutrient-rich layer to help fertilize crops. This system is mostly used by food crop farmers especially those that are into tuber cultivation. After several years of cultivation, fertility declines and weeds increase. Slashed and burned areas are experiencing negative impacts on biodiversity specifically on immobile, small species.

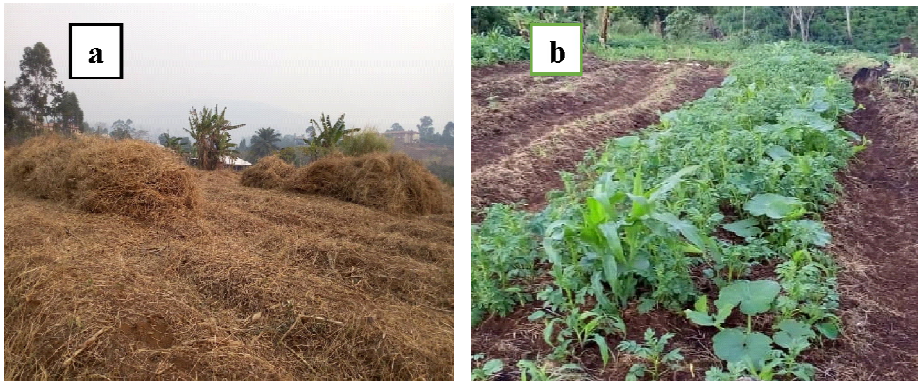

Figure 5 : Slash-and-burn system before "ankara" is being made (a) and after "ankara" has been cultivated (b)

From Figure 5, grass is first gathered and piled up in the form of a ridge and then it is left to dry for some time. Grass is usually cleared around the months of November

and December and then the ridges are formed with grasses. In the months of January and February, farmers then till and cover the grass with soil. After this process, the farmers then burn the already tilled "ankara" in order for their crops to do well. Figure 5(a) shows grass being gathered to prepare a ridge for the "ankara" and Figure 5 (b) shows the "ankara" after it has been burnt and cultivated. As seen on the Figure 5, a variety of crops are then planted such as Irish potatoes, maize and pumpkins.

It is worthy of note that these farming systems are however, not sustainable in practice. The high level of rural poverty in this area has hindered the ability of most farmers from affording chemical inputs and modern methods for permanent cropping. Since farmers have to depend on the natural processes for soil nourishment, they have embarked on this various farming systems which are not sustainable.

5.3 Livestock Production

Livestock production is another dominant agricultural practice in Santa. This study however was focused on cattle, piggery, goats and poultry production. A total of 63 farmers accounted for livestock production with cattle farmers taking the lead with 36% followed by piggery farmers with 29%, poultry farmers with 19% and finally goats with just 16% as seen on Figure 6.

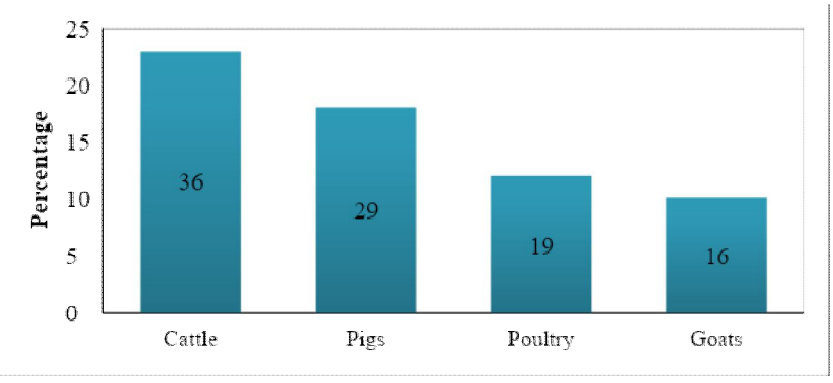

Figure 6: Distribution of Respondents Based on Livestock production in Santa

The great ecological variations in this area have spurred up the rearing of livestock production in Santa and some species being reared include cattle, horses, goats, sheep and fowls. Cattle rearing are the main market-oriented speculation in this domain. It is mostly carried out by the Mbororos who have settled in the area and transhumance is practiced during the dry season.

The rapid increase in livestock numbers since the 1980s have caused pasture lands in Santa to experience degradation. According to Fogwe [15], livestock growth rates and production are low because they are raised under extensive conditions using poor animal husbandry and animal health practices. A milk-processing factory has been established for processing local milk from cattle. This has boosted the livestock sector together with the provision of slaughterhouses in Mile 8 Akum, Santa and Mile 12. Purebred cattle have also been given to farmers by Heifer to boost the productivity of farmers.

Milk generated from these cattle is sold at the milk processing factory in Mbei to generate income while a good quantity is also consumed by households. The Fulani cattle herders exploit the mountain tops and slopes for grazing like on the Malabah hills and Mbeng hills in Akum and the Mafoumusong hills in Ndzong.

Cattle rearing are the most organized animal production activity in the area. Most cattle owners are the Mbororos who live in the grazing areas with their cattle and move to the marshes in the dry season in search of fresh grass. Graziers on transhumance in the area who move down to the Balikumbat Sub-division are mainly from Santa Sub-division. Most households however carry out small livestock rearing, which constitute an important source of supplement to income from agriculture. The Sub-divisional Delegation of Livestock, Fisheries and Animal Industries is organised into 5 zoo-technical and veterinary centers. Production in the 5 centers is presented in Table 2.

Table 2: Livestock production data for Santa Sub-division

Zootechnical & Veterinary Centres	Bovine		Ovine	Caprine	Porcine	Equine	Avian	Canine	Assine	Rabbits	Pigeon	Quail
	Beef	Dairy										
Awing	2250	0	759	1650	618	98	5625	974	0	22	0	0
Akum	1250	67	620	217	724	54	7018	645	1	49	34	0
Baligham	615	0	98	68	85	25	2450	1250	0	18	0	0
Pinyin	2340	0	350	127	485	70	3350	453	0	34	0	0
Santa	2500	202	525	459	618	88	6840	1250	2	64	265	243
Total	**8955**	**269**	**2352**	**2521**	**2530**	**335**	**25283**	**4572**	**3**	**187**	**299**	**243**

Source: MINEPIA, [19]

Cattle production is mainly restricted to the grassland areas. Cattle in Santa are grazed on the slopes of hills during the rainy season when there is abundant vegetation and drink from major streams and springs. The statistics on Table 2 are only indicative because there are difficulties in having real statistics. Most livestock breeders keep information away from government official in order to evade their due taxes.

5.4 Impacts of Agricultural Practices on the environment in Santa Sub-division

There are many impacts emanating from the unsustainable agricultural practices on the environment and how it has affected the livelihood of the indigenous population of Santa. Emphasis on this study will be laid on the environmental impacts.

Agriculture in Santa is as old as the first settlers in this locality. It provides countless people with sustenance and livelihood. With the presence of this activity in Santa, especially animal farming in particular come along with it great risk. Agriculture however increases carbon dioxide levels in a considerable amount making it one of the main sources of carbon dioxide emissions for decades. Animal waste from farms contains harmful pathogens which causes disease and infection. When these pathogens get into soil and water systems, they create irreversible damage to land and pose health risks towards humans. The use of fertilizers also brings about several complications. They contain harmful elements such as nitrogen and phosphates, both of which cause the release of ammonia and nitrogen runoff, all of which have undesirable effects on the environment.

Although agriculture is essential in sustaining human life, the practices associated with it have been known to have certain impacts on the environment.

The most notable of these effects includes climate change, deforestation, pollution and general environmental degradation.

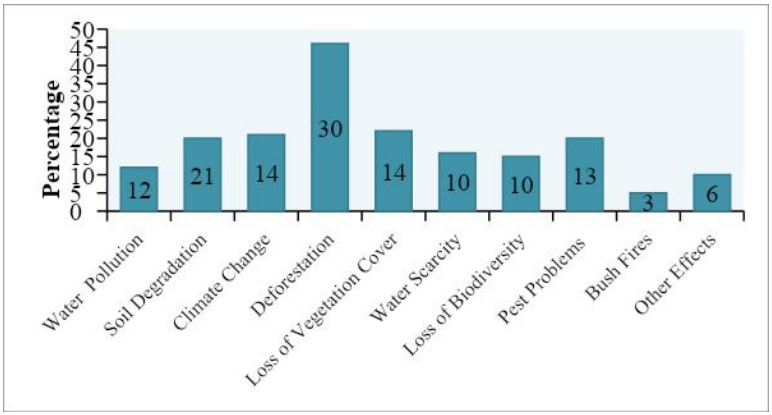

Figure 7: Effects of Agricultural Practices

Figure 7 indicates the various responses of farmers based on the effects of agricultural practices on the environment in Santa. It is evident from the Figure that the major effect felt by farmers in Santa is deforestation with 30%, followed by soil degradation 21%, climate change and loss of vegetation cover with 14% each, pests and disease problems with 13%, water pollution with 12%, water scarcity and loss of biodiversity with 10% each, other effects with 6% and bushfires with 3%.

This scenario in Santa Sub-division is similar to the research carried out by Shapiro [20] in which he found out that pressure to feed the Zaire's increasing population has resulted to changes in agricultural practices in which these changes in turn are leading to declining soil fertility, deforestation and degradation of the natural resource base. He added that given the state of Zaire's economy, the changes in agricultural practices that have emerged as a result of population growth, increased population density and growth in the demand for food production do not appear to be sustainable in the long run.

5.4.1 Deforestation in Santa Sub-division

Results from the field revealed that there has been a decrease in forest cover and increasing deforestation resulting from increase in population growth and increasing demand for fuel wood and timber for commercial purposes. Deforestation in this area is mostly done by graziers or farmers practicing slashes and burn system of agriculture and others who use fire as a means of clearing vast portions of land. Deforestation in Santa has resulted in much more destruction than simply creating an empty space for cattle and crop production. If the population of Santa continues tearing through the forests for their agricultural activities, it will bring an untold misery. The extreme removal of trees for agricultural purposes disrupts the carbon cycle, meaning that fewer trees are available to absorb carbon dioxide from the air.

Furthermore, when trees are cut, especially in large numbers, excess carbon dioxide is released into the atmosphere. As a result, more greenhouse gases are released which warm the planet and contribute to climate change and global warming. Without enough trees, soil is vulnerable to erosion and nutrient loss. The absence of roots can cause topsoil to be easily washed or blown away leading to decreased soil quality. Extensive deforestation affects the water cycle which results in interference with precipitation and the water cycle.

Figure 8: Deforestation in Santa: (a) for timber (b) for agriculture

Figure 8 (a) indicates the felling down of forests specifically eucalyptus for timber. Trees are also largely felled down for fuel wood and for the production of charcoal. Picture (b) shows an area that has undergone deforestation mainly for agricultural activities. More forests are increasingly becoming threatened as farmers are clearing down this forest land to extend their agricultural lands. Hence, forests in Santa sub-division has been severely degraded leaving patches of grass along the slopes and narrow valleys and this has also led to biodiversity loss as certain species of flora and fauna have become threatened and others are facing extinction

5.4.2 Water Pollution

Agriculture, which accounts for 70% of water withdrawals worldwide, plays a major role in water pollution. In order to enhance agricultural production both in quantity and quality in Santa, several soil additives are being used in farming. The widely used are pesticides, weedicides and fertilizers, which end up as pollutants in water run-off from the soil. This run-off adversely affects more people and animal. Farms discharge large quantities of agro-chemicals, organic matter, sediments and saline drainage into water bodies. Water pollution is an increasing global concern that damages the growth and the health of billions of people. Growth in crop production in Santa is achieved mainly through the intensive use of inputs such as pesticides and fertilizers which has serious ramifications on water bodies. Agriculture in Santa has polluted rivers and streams particularly surface-water pollution and this in return pollutes ground water. Agricultural pollutants move from farms through water to ecosystems and drinking water sources, which is not healthy for crops and human consumption.

Furthermore, cattle drinking upstream pollute water and those downstream are forced to consume polluted water which causes health issues. Agriculture is

mainly responsible for nitrate, phosphorus, pesticide, soil sediment, salt, and pathogen pollution of water from crop and livestock activities. Findings from the field indicates that unsustainable water use has harmed the environment by changing the water table and depleting groundwater supplies; this is evident by increasing water scarcity each year. Moreover, irrigation in Santa has also increased soil salinity and wash pollutants and sediment into rivers which causes damage to freshwater ecosystems and species as well as those further downstream. The use of pesticides, fertilizers, and other agro-chemicals has increased tremendously since the 1950s.

5.4.3 Climate Change in Santa Sub-division

Agriculture both contributes to climate change and is affected by climate change. Agriculture in particular releases significant amounts of methane and nitrous oxide, which are two powerful greenhouse gases. Methane is mostly produced by livestock during digestion and it is released through belches. It also escapes from stored manure and organic waste in landfills. Nitrous oxide emissions are an indirect product of organic and mineral nitrogen. Increase in food demand in Cameroon and Santa in particular has intensified agricultural activities which also increases the rate of the emission of greenhouse gases which are the major force of climate change**.**

Agriculture and climate change have a reciprocal relationship. Climate change affects agricultural production through precipitation levels and temperature variations. The most significant climate change associated with agriculture is brought about by methane, nitrous oxide and Carbon dioxide, all of which are greenhouse gases released into the Earth's atmosphere from farming and other industrial activities. Pesticides, weedicides and fertilizers application affects the quality of air through production of compounds like Phosphorous, Nitrate and Ammonia.

Increase in these greenhouse gases causes global warming, prolonged dry seasons, increased temperatures and increasing desertification why not a change in rainfall pattern. This affects agricultural yields seriously as farmers depend much on rainfall for their various agricultural activities. Climate change has a significant impact on the environment as it increases water demand, limiting crop productivity, and reducing water availability in Santa where irrigation is mostly needed during the dry season. Moreover, Climate change has brought about greater variation in weather extremes and new challenges requiring this sector to take mitigation and adaptation measures.

5.4.4 Water Scarcity

Water scarcity has a huge impact on food production in Santa and the entire population too. Clean drinking water is becoming scarce in Santa especially during the dry season and many people in Santa spend their entire day trekking over long distance in search of drinkable water. Without water, farmers will not be able to meet up with shortages accompanied by the growing population. According to the International Water Management Institute, agriculture, which accounts for about 70% of global withdrawals, is constantly competing with domestic, industrial and environmental uses for a scarce water supply. Agriculture is both a victim and a cause of water scarcity. Water is required in large quantities for the production of crops and livestock. Water is the lifeblood of ecosystems, including forests, lakes and wetlands on which the food and nutritional security of present and future generations depends. Agriculture is one of the sector consuming large quantities of water globally.

Garden crops require more water than any other crops. Much water is however needed throughout the year to sustain production. Since prices for these crops rise during the dry season, farmers irrigate water to grow their crops which contributes immensely to acute water shortages. Ephemeral and intermittent

rivers which flows most times only during the rainy season dries off in the dry season, forcing farmers to make catchments in the remaining few rivers that has not dried in order to tap water for irrigation to support plant growth. In addition, eucalyptus trees found in this area absorbing most of the water in the streams during the dry season also contributes to serious water shortages in Santa.

So far, the use of water has been growing at more than twice the rate of population increase in Santa because of intensified agricultural activities. Although water covers 70% of the planet, a rising number of regions are chronically suffering under water scarcity including Santa, drinking water supplies, as well as damage to ecosystems and recreational, and cultural values associated with rivers and lakes. During the dry season these water bodies quickly dries off and the little left is exploited by farmers for their farming activities. Agriculture through irrigation is one of the major causes of water shortage in Santa. Many households during the dry season face severe water shortages as a result of intensified irrigation activities and high rate of evapotranspiration.

Increasing water scarcity has led to decrease in the volume of rivers, streams, lakes and disappearance of wetlands, which are essential for animals, plants as well as the agriculture itself. Aside from this, ecosystems are in great danger because natural landscapes can dry out, change or be polluted. Additionally, the economy can decline without enough water. However, water used for agriculture in Santa is wasted as a result of absorbent irrigation systems, inefficient application methods as well as growing cultivation of crops. This inefficient use of water is drying out rivers, streams, lake and underground water aquifers. Never the less, water is needed and essential for crop growth in order to provide food for the fast growing population.

5.4.5 Vegetation Loss

Agriculture is a dominant form of land management globally. Human influence on the land is accelerating because of rapid population growth and increasing food demands. Increasing population growth and competitive land use have caused land scarcity, conversion of wild lands to agriculture and other uses. Consequently, there has been a drastic loss of vegetation in Santa. United Nations Environmental Program [21] noted that population increase and increasing climate change have led to vegetal depletion. Vegetation responses are further made complicated because of concurrent changes in livestock population and agricultural practices. Climate change remains a difficult situation to contain in Santa. It has led to a change in the farming calendar and the emergence of many pests which thrives in moist and warmer conditions.

Increasing agricultural intensity in Santa generates pressure not only on land resources but also across the whole environment. These factors make agriculture a top-priority sector for both economic and environmental policy. The extreme clearing of land especially for animal agriculture, results in habitat loss and subsequently a loss in vegetation cover. Animal agriculture requires space and nourishment, so thousands of acres untouched land is cleared every year to make room for food crops and grazing pastures. Again, forests are cleared to produce food for other animals. Livestock production occupies a significant percentage of the total surface area in Santa, and most of the arable land in Santa is used for cattle grazing alone. Forests in Santa sub-division are often faced with deforestation, including plan and animal species residing within them. Trees have been cut down for commercial use and the burning of bushes and hills during the dry season by graziers has greatly contributed in vegetal loss in Santa. In Santa for example, forests are set ablaze to clear space for cattle and crop cultivation. This causes animals and plant species to perish in flames. However, intentional agricultural fires in Santa are scorching the environment of Santa; killing endangered plant and animal species not only this but it also

threatens the vegetation of Santa. In this vein, Balgah [22] observed that there is a relationship between population growth and land cover change. This implies that land cover changes as population also increases. Santa has witness a transformation in its land cover because of increasing population, which has led to the intensification of agricultural activities, which greatly affects land use patterns, and cover.

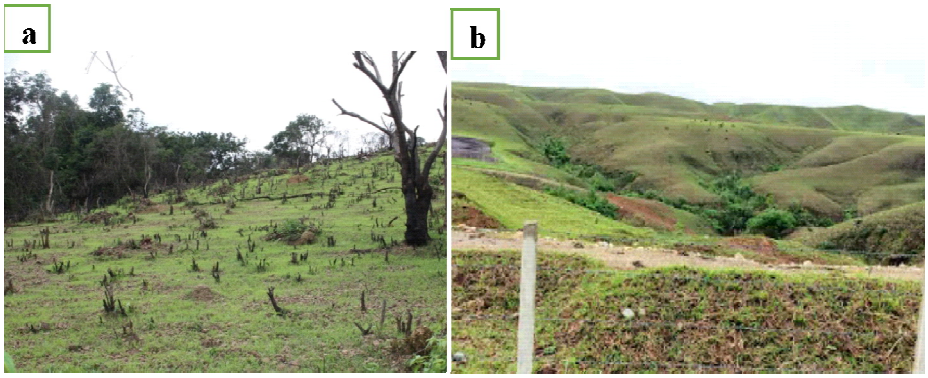

Figure 9: Vegetation degradation in Santa sub-division in Akum (a) and Mbei (b)

As seen on Figure 9, notice the widespread of vegetation degradation shown by the red and brown patches of land being exposed to the forces of erosion. Major causes of vegetation degradation in Santa are overgrazing due to high stocking rates and deforestation.

5.4.6 Soil Degradation

In all ecosystems, the biodiversity held in soil is massive. Healthy soils are vital to creating ample food production. Poor farming practices in Santa have aggravated the rate of soil degradation. Poor farming practices have been known to cause a considerable decline in the quality of soil. The Soil chemical test that was carried out in Akum and Mbei to determine whether there has been a decline in soil fertility reveals that most of the chemical soil properties that were tested have witnessed a decline most especially Phosphoric Acid, Magnesium

and Calcium, with higher variations in their calculated coefficient of variation (Table 3).

Table 3: Summary of soil test results and coefficient of variation

Soil Chemical Properties	Akum(Market Gardening)	Mbei (Food Crop)	Adjacent Plot	SD	Mean	Standard Error of the Mean	CV (%)
Total Nitrogen (N) %	0.661	0.384	0.508	0.1387528	0.5176667	0.080108966	26.80
Exchangeable calcium (Ca) cmol (+)kg-1	2.64	0.476	4.31	1.9222969	2.4753333	1.109838633	77.65
Magnesium (Mg) cmol (+)kg-1	0.758	0.185	1.047	8.6765028	12.86	5.009381227	67.46
Potassium (K) in cmol (+)kg-1	15.17	0.204	0.799	6.6400402	11.743333	3.833628997	56.54
Sodium (Na) cmol (+)kg-1	0.032	0.038	0.066	0.0181475	0.0453333	0.010477464	40.03
Phosphoric acid (P Ass(mg/kg)Bray 2	13.398	2.582	44.01	21.487824	19.996667	0.010477464	107.45
Exchangeable acid (AI*(cmol/kg)	0	0	0	0	0	0	0.00
AI*+H (cmol/kg)	0	0	0	0	0	0	0.00
Humidity %	16.55	4.71	7.05	6.2704492	9.4366667	3.620245534	66.44
Mat Org (g/kg)	52.892	53.927	54.443	0.7898399	53.754	0.456014279	1.47
Organic (g/kg)	30.68	31.28	31.58	0.4582576	31.18	0.264575149	1.46
Exchangeable bases T (CEC) (cmol/kg)	62.428	26.428	27.503	20.481338	38.786333	11.82490601	52.80
Acidity/Alkalinity Ph. (H2O)-1:5	5.37	5.63	5.53	0.1311488	5.51	0.075718795	2.38
PH(kci)-1:5	4.22	4.23	4.4	0.1011599	4.2833333	0.058404695	2.36

Laboratories of Inter Tropical Institute for Tropical Agriculture Yaoundé (2020) and Institute of Agricultural Research for Development, Santa (2020)

6. Conclusion and recommendations

Agriculture is regarded as the backbone of the population of Santa Sub-division. Over 80% of the population directly depends on agriculture for their livelihoods. The expanding population within this economic landscape has accelerated the need for more food to feed the many mouths added to the Sub-division every year. Unfortunately, the desires and effort to happily feed these mouths has been cut short by the deterioration of the environment due to unsustainable agriculture. There is a rapid depletion of the soils, shrinking of vegetation for livestock, decline in water supply during the dry season and worse of all the effect of climate change and variability as a result of unsustainable agricultural practices and systems such as the slash-and-burn system of farming. These adverse environmental conditions have constrained agriculturalists from meeting up with their desires and consequently food security becomes a major problem within the landscape. Shrinking vegetation and upland water scarcity in this Sub-division have spurred transhumance, conflicts, declining soil fertility, deforestation and climate change. The stubborn biophysical conditions in this area have also been aggravated by ineffective economic policies that encourage farmers in Santa to use their human and natural resources in unsustainable ways. Despite the increasing use of agricultural and arable land, the indigenous population of Santa dwellers are no better economically now than they were before. This study therefore recommends that:

- Farmers in Santa should strengthen their economic security by adopting sustainable agricultural systems, and targeting their production to take advantage of new demands and consumption patterns.
- The use of quality resilience seeds to climatic alterations and disease is highly recommended.

- Concerning transhumance, herders who take their animals especially to infested zones should always carry drugs for the control of ecto-parasites especially tsetse flies and ticks. This proactive planning is very essential for the livestock industry as prevention is better than cure.
- It is highly recommended that vegetation depletion should be augmented during the dry season through the planting of drought resistant species such as the Bracaria and Guatamala, in order to reduce the movement of animals.
- It is also recommended that graziers should construct water drinking points for their livestock to avoid scarcity of water during the dry season. This can be achieved through engineering work, whereby nearby streams and springs can be channeled to drinking points of livestock

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