EFFECT OF TEMPERATURE VARIATION IN LIVESTOCK IN KEFFI, NASARAWA STATE

BY

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NSU/PSM/ERM/0086/16/17

M.Sc ENVIRONMENTAL RESOURCE MANAGEMENT
(PROFESSIONAL)

JANUARY, 2019

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BEING A PROJECT SUBMITTRED TO THE DEPARTMENT OF GEOGRAPHY, FACULTY OF SOCIAL SCIENCES, NASARAWA STATE UNIVERSITY, KEFFI IN PARTIAL FULFILLMENT FOR THE AWARD OF M.SC IN ENVIRONMENTAL RESOURCE MANAGEMENT (PROFESSIONAL)

JANUARY, 2019

DECLARATION

I hereby declare that this project has been written by me and it is a report of my research work. It has not been presented in any previous application for Masters Degree (professional). All quotations are indicated and sources of information specifically acknowledged by means of references.

Ibrahim
....
Ibrahim Isyak

CERTIFICATION

The project "Effect of Temperature Variation in Livestock in Keffi, Nasarawa State" meet the regulations governing the award of professional Masters, Faculty of Social Sciences of Nasarawa State University, keffi.

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DEDICATION

I dedicate this project research work to Almighty Allah for who has given me the strength and wisdom to carry out this work.

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May I use this medium to thank my caring and friendly supervisor DR. Adamu T. Ogah who despite his tight schedule created time to supervise, visit and made possible corrections to my research work. I also particularly acknowledge the contributions of all my lecturers in the department for their words of encouragement.

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ABSTRACT

Livestock production refers to domesticated animals intentionally reared or kept for food such as meat, milk, or for use in labour or still for other products such as leather or wool. This work was aimed at determining the effect of temperature variations on livestock (cattle, sheep and goat) with respect to productivity measure. Data was acquired from primary and secondary sources. The primary sources included; personal interviews to the farmers, assessment of animal temperature, and yield in milk and meat production which were measured in jars graduated in liters and scale in kilograms respectively, diseases and death occurrence and animal feed. Secondary was from journals, published textbooks; Secondary data was also acquired from veterinary clinics, abattoirs (butchers), farm, Nigerian Meteorological Agency (NIMET) on temperature variation. Effects of temperature variability on livestock productivity are a global problem of concern and its impact are greatly felt by poor rural livestock farmers.

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INTRODUCTION

1.1 Background of the Study

Livestock production refers to domesticated animals intentionally reared or kept for food such as meat, milk, or for use in labour or still for other products such as leather or wool. Examples of such livestock include cattle, sheep, goat. pigs. buffalo and horses. Ruminant animals are mammals that are able to acquire nutrients from plant base by fermenting these in a specialized stomach before digestion through bacterial actions. This process requires regurgitation of fermented ingesta– popularly referred to as "cud" and later, chewing it again. The examples of such ruminants include cattle, sheep and goat. These animals can be reared in an agricultural setting like factory farms, family farms and cattle ranches. There are different systems or methods of rearing these animals, viz the *traditional or village system* which constitutes over 85% for all species (Tewe and Bokanga, 2001). For instance. under this system the animals are allowed to scavenge for food, the owner can decide to resort to "cut and carry" to feed the animals, and during a favourable weather seasoning tethering can be used, fattening and compound dairying is also used for these ruminants. Second, the *nomadic or pastoral system* allows for mixed farming and peri-urban and modern livestock husbandry.

Cattles are found throughout Nigeria but are most common in the northern two third parts of the country (Milligan, 1982). Seasonal transhumance – that is. the idea of moving livestock from place to place in search of greener pasture - does take place though to a limited extent. About half the total cattle population is permanently resident in the sub-humid zone. *Humped Zebu* breeds - including the *white fulani, Sokoto gudali* and *the red Boronu* - are by far the most common, however, limited number *of keteku, muturu* and *kuri* cattle species are available in the south-western, southern and north-eastern parts of the country respectively. *The zebu breeds* in Nigeria are mostly used for dual purpose rearing, that is., for both their milk and their meat. On the other hand, *the n'dama, keteku and muturu* species are strictly beef animal (Milligan, 1983).

Cattle. sheep and goats are found almost everywhere in Nigeria. They are estimated to be about fifty-one million heads of these ruminants with goats out-numbering the sheep. These animals are kept mostly for their meat and skins. There are three main breeds of goats in Nigeria: the *West African dwarf, the Sokoto red* and *the long-legged or Sahel* (Oyenuga, 1967; Bourn et al.1994). Goats are renowned for their hardiness and can survive in most environments. For instance, *the West African dwarf goats* are kept in the forest zones and in the middle belt; *the Sokoto-red* is more predominant throughout the north similarly *the Sahel goats* are mostly northern breeds and restricted to a strip along the frontiers with the Niger Republic. The most common production system for these species is that of seasonal confinement (Oyenuga, 1967: Bourn *et al*, 1994).

There are four main types of sheep native to Nigeria and these are *the balami, uda, yankasa and the West African dwarf.* Both *the balami* and *the uda* are common in the semi-arid region; the *West African dwarf* is common in the south while *the yankasa* can be found throughout the country (Bourn et al., 1994). These four breeds differ considerably in size, coat colour and other characteristics (Adu and Ngere, 1979).These ruminant livestock, under the extensive system, rely on natural grass and forage legumes for subsistence.

All things in nature have a diurnal or a daily pattern simply because they change throughout the course of a day. For instance, air temperature at any location is changed in the course of a day, a week, a month, or for even a year or for that matter, at any period. This is classified as *a periodic variation* which may occur as annual or diurnal temperature variations; it can either be a horizontal variation and vertical variation. Daily temperature cycle or diurnal temperature variation gives rise to daily maximum and minimum temperature levels.

The process of reaching a daily high or low temperature is a gradual one. It begins each morning when the sun rises and its rays extend and strike the earth's surface. Solar radiation directly heats the ground but because of the high land/ground heat capacity, that is., the ability to store heat - the ground does not immediately warm up. Just as a pot of cold water must first warm before coming to a boil so must the land/ground absorb a certain amount of heat before its temperature increases? On the other hand. daily low temperature commences in the afternoon when the sun begins its retreat. From that time until sunset the intensity of incoming solar radiation continually declines, that is, when more heat energy is lost to space than the incoming at the surface.

Temperature stress is a phenomenon that can impart physical and economical losses to livestock production in temperate, subtropics and tropical regions of the world. Temperature stressed animals undergo a series of metabolic and physiological changes (Christopherson *et al.,* 1983). Due to time constraints. this research is limited to the increase in environmental temperature with its effect on livestock productivity. Increase in temperature result in drought and water stress which cause heat stress and reduced quality of food supply to livestock productivity. The world's climate has continued to change at a rate that is projected to be unprecedented in recent human history on Intergovernmental Panel on Climate Change (IPCC. 2001).

The global average surface temperature increased by about 0.6°C during the twentieth Century (IPCC, 2001). According to the recent Fourth Assessment Report (IPCC, 2007), most of the observed increase in the globally averaged temperature since the mid-20th century is very likely due to the observed increase in anthropogenic (human) green house gas concentration. The IPCC climate model projections from 2001 suggest an increase in global average surface temperature of between 1.4 to 5.8°C by 2100: this range depends largely on the scale of fossil-fuel burning between now and the thousand on the different models used. At the lower range of temperature rise (1 to 3°C) global food production might actually increase however, above this range it would probably decrease (IPCC, 2007).

Nigeria is one of those countries that rely on livestock production as source of livelihood to make ends meet such that it lift people out of poverty and build sustainable livelihood. As reported by International Fund for Agricultural Development (IFAD, 2009), agriculture and livestock keeping are amongst the most climate-sensitive economic sectors and the poor rural communities are more exposed to the effects of climate change. The IPCC predicts that by 2100 the increase in global average surface temperature could be between 1.8 and 4.0 °C. When global average temperature increases by only 1.5 – 2.5°C degree, approximately 20-30% of plants and animal species are expected to be at risk of extinction Food and Agricultural Organization (FAO, 2007, IFAD, 2009).

Increase temperature has direct and indirect effects on livestock productivity. The indirect effects are linked to the changes on the availability of fodder and pastures. Some of the indirect effects for example will be brought about by changes in feed resources linked to the capacity of rangeland, the buffering abilities of ecosystems, increase scarcity of water resources, lower production grains. Other indirect effects are linked to the expected potential shortage of feed due to rapid increase in production competition between food, feed, fuel and land use systems. Alterations of temperature and precipitation regimes may result in a spread of disease and parasite into new regions or produce an increase in the incidence of disease. Mitigation and prevention of the environmental effects caused by increase in the concentration of atmospheric green house emissions as a result of increased

Anthropogenic activities require immediate and substantial changes in regulation production practices and consumption patterns.

1.2 Statement of Research Problem

The activities of man over time have contributed to increase in environmental temperature as a result of deforestation, burning of fossil fuel, vehicular emissions, aerosol sprays and agronomic activities. Increase in environmental temperature results in drought and water stress among others which inevitably affect livestock production in the form of heat stress and reduced quality of food supply through livestock production. Increase in temperature lowers animal performance as a result of alteration in the nutritional environment. It increases animal susceptibility to diseases and mortality. Particularly, climate change affect farm areas, agricultural output, prices of the agricultural products and directly or indirectly, the agricultural Gross Domestic Products (GDP).All animals have a range of ambient environmental temperature termed the *thermo neutral zone*. This is the range of temperature that is conducive to health and performance. The upper critical temperature is the point at which the effects of the heat stress starts to impact the animal. There are a number of environmental factors that contribute to heat stress. These include high temperature, high humidity and radiant energy (sunlight).However, livestock owners refused the researcher to have access to the animals because they assumed that she was a veterinary officer or a journalist that wanted to expose the health status of their animals and report to the appropriate authority. The researcher assured them that it was just for academic purpose, their names, farms and locations will not be mentioned. Based on this, she was able to convince them and had access to the animals and their feeds.

This research seeks to answer the question of *how much or to what extent temperature variation has affected livestock productivity in the in Keffi Local Government.*

1.3 Objectives of Study

The aim of this research is to assess the effect of temperature variations on livestock (cattle, sheep and goat) with respect to productivity measure. The objectives are to:

(1) Determine the temperature variation for a period of five years.

(2) Evaluate the yield in productivity livestock.

(3) Determine disease or death incidence as a result of temperature variation

(4) Establish the appropriate range suitable for effective production.

(5) Identify measures necessary to reduce the adverse effect of temperature variation.

1.4 Significance of Study

The findings and the recommendation of this research will assists farmers or livestock owners in the Keffi Local Government get accustomed to preventive and adaptive measures to reduce the effects of increased environmental temperature on livestock production. It will also assist other research students on further studies in the area of focus. It will equally help to emphasis the important role livestock plays in the agricultural sector. The negative impact of ruminants on green house gases emissions can be addressed through awareness on good animal husbandry specifically in the area of ruminant diets, animal stocking ration, farm animal waste, etc.

Adaptation and mitigation measures will contribute to boost productivity and conservation of fodder which can improve the supply of animal feed. reduce malnutrition, and mortality in herds. The need to improve food security and sustainability is of great importance to poverty reduction in Keffi Local Government.

1.5 Scope and Limitation

The study is limited to some strategic family farms and cattle ranches within the Keffi Local Government of Nasarawa State. This limitation is occasioned by time constraints and resource crunch as it is self sponsored. This notwithstanding. enough farms to give weight to this study, will be visited and the animals and their feeds will be assessed and analyzed. It is hoped that the outcome of this research work will assist other students of environmental resource management in their studies and further research work on the issue.

1.6.1 Definition of Terms

(i) Anthropogenic: This refers to man-made activities.

(ii) Hyperthermia: A medical condition in which the body temperature is much higher than normal.

(iii) Livestock Production: It is the domesticated animal intentionally reared in an agricultural setting to produce food or other products such as leather. wool etc.

(iv) Ruminant: Any animal that brings back food from its stomach and chews it again – in the form of cud.

(v) Transhumant: The practice of moving animals to different fields in different seasons. For example, movement to higher fields in dry season and lower fields during the rainy season.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Conceptual Framework

There is a substantial scientific literature examining the relationship between climatic characteristics (temperature, humidity, wind speed, and so on.) and animal productivity (NRC, 1981).

Fundamental to much of this literature is the concept of the thermo neutral zone – the optimal range of temperatures and environmental conditions in which the animals do not need to alter behavior or physiological function to maintain a normal body temperature.

At temperatures below the thermo neutral zone, livestock generally expence more energy and increase their voluntary feed intake in order to maintain their core temperature, resulting in lower feed efficiency (NRC, 1981). Maintaining an adequate temperature can be an important factor influencing design of housing and in husbandry decisions for cold susceptible animals such as poultry, swine, and young animals. Low temperatures resulting from particularly cold weather or loss of power to buildings housing confined animals, can cause economic losses from increased animal morbidity or death (Mader, 2003).

Above *the thermoneutral* zone, animals may experience heat stress and respond by reducing their voluntary feed intake, which reduces their weight gain and feed efficiency (Hahn, 1999; NRC, 1981; West, 1994; Cooper and Washburn, 1998; Yalcin, et al. 2001). Heat stress can also reduce fertility, milk production, and reproduction (Hansen et al. 2001, Drost et al. 1999; Renaudeau and Noblet, 2001). Extended periods of high temperature can be lethal for livestock, and a particular risk for feedlot cattle in some regions (Hahn et al 1999; Hahn and Mader, 1997).

Global warming is likely to increase temperature levels and the frequency of extreme temperatures – hotter daily maximums and more frequent or longer heat waves – which could adversely affect livestock production in the warm season. In some regions, economic losses due to warmer temperatures in the summer may be offset by greater productivity in the winter (Hatfield, *et al.* 2008).

A limited number of studies have used agricultural engineering models of the relationship between climatic conditions and feed intake to estimate the effects of climate change on the performance of domestic animals. Frank *et al.* (2001) use a model relating climate to feed intake and weight gain and milk production to estimate the response of dairy cows to predicted climate changes in the Great Plains region. The study estimated reductions in milk production of 5.1% to 6.8% by 2090 in the absence of efforts to mitigate the effects of temperature changes (e.g. by using evaporative cooling in barns).

Using a broadly similar approach, St-Pierre, Cobanov and Schnitkey (2003) estimated the economic losses attributable to heat stress by all major US livestock industries. The authors did not simulate the effects of global warming climate scenarios, but instead compared animal performance, reproduction and mortality under current conditions to a hypothetical "ideal" climate scenario (in which livestock are in their thermo neutral zone). The authors found that heat stress has an economic cost of between $1.69 and $2.36 billion dollars, with approximately 40- 60% of these costs occurring in the dairy sector, and the remainder in the beef, swine, and poultry industries. Using cost parameters drawn from the agricultural engineering literature, the authors also estimated the optimal level of expenditures on heat mitigation efforts.

2.2 Literature Review

Many studies confirmed that animal health and welfare are integral to environmental sustainability. Breeding for health can create productivity and welfare benefits and results in lower emission. Robust breeds of animals reared in extensive systems often have longer productive lifetime and these systems often have lower reliance on fossil fuel and grain impact.

Most climate and other environmental engendered impacts on livestock production are closely related to the normal biological functions of animals, for instance, in the areas of their food intake, digestion and manure production. Therefore, any adaptation attempt by their natural biological functioning has significant impacts on animal welfare generally. Increase in global temperature has impacted dairy and meat production especially in vulnerable parts of the world where it is vital for nutrition and livelihoods.

Ensuring good animal welfare will be paramount to addressing these challenges. Breeds suited to the local environment are often more robust and resilient than industrially farmed breeds. A sustainable food production system is possible. that is. one which delivers environmental protection, reduces GHG emission and ensures good animal welfare, public health and meat quality. Therefore, biodiversity conservation in general, reforestation and sustainable utilization of natural resources in particular will be an added advantage in tackling climate change and reduction in population dynamics of livestock.

Several studies have reported that there exists a correlation between rainfall variability and livestock population dynamics (Solomon, 2001; Kgosikoma 2006; Abdeta, 2011). In southern Ethiopia, cattle numbers dropped by 37% after the drought of 1983 to 1985. The herd then quickly grew to about 85% of the previous peak size by 1990. Another crash occurred in the early 1990s with a 42% reduction in cattle numbers, but interestingly the corresponding change in annual rainfall was less apparent in the early 1990s compared to that observed in 1983 to 1985 (Solomon 2001; Solomon and Coppock, 2002). In this region, it was shown that cattle population dynamics resembled a "boom and bust" pattern where longer periods of gradual herd growth were punctuated by sharp crashes in 1983 to 1985, 1991to 1992, and 1998 to 1999 when 37 to 62% of the cattle perished (Solomon 2001).Another study in Borana, Ethiopia showed that rainfall variability greatly influences herd dynamics under the communal and ranch management in terms of herd die-offs and lower birth rates which also considerably affects their milk production for household consumption. Droughts of the 1980s and 1990s caused 49% herd losses under the communal land use, while 57% of the cattle mortality under ranch management was attributed to droughts of the 1990s (Abdeta, 2011). However, creating appropriate awareness on the effects of climate change on ruminant livestock population dynamics can provide needed management practices that will allow farmers cope with the problem.

According to Parks. (2004) study on the effects of temperature on dairy cow. when environmental temperature moves out of the thermo neutral zone (or comfort zone). dairy cattle begin to experience either heat stress or cold stress. Both of these categories of stress compel the cattle to increase the amount of energy it uses to maintain its body temperature consequently allowing for less energy for the production of milk.

Thermo neutral zone is the range of environmental temperature where normal body temperature of a ruminant is maintained and heat production is at the minimal level. Heat stress is the major cause of decrease in the production abilities of dairy cattle especially, in hostile regions or environments. In fact, most scholars are of the opinion that decline in the production of milk and fat by ruminants were as a direct result of high environmental temperature. This can be justified by the negative effect heat stress has on the secretory functions of the udder (Silanikove, 1992).

Heat stress does not have to last for months to have profound negative impacts. but can occur in days, even in temperate climates. For example, during a heat wave in 2006, California dairy producers lost an estimated $1 billion in milk and animals. In 1999. during a severe heat wave. Nebraska producers lost more than $20 million in cattle deaths and performances. Between July 11 and 12. 1995 a combination of heat and humidity caused the deaths of over 3,700 cattle in a thirteen country area of Western Iowa (Collier and Zimbelman, 2007). This economic loss is a direct result from heat stress reducing such things as milk production, reproductive performance. milk quality. heifer growth, and increasing cow and calf mortalities and health-care cost.

Embryo loss is another important factor that affects fertility and is increased during heat stress. Dairy cows conceiving with singletons or twins are 3.7 and 5.4 times more likely to lose their embryo respectively during the hot versus cool season (Lopez-Gatius et al., 2004). In addition, the likelihood of pregnancy loss has been shown to increase by a factor of 1.05 for each unit increase in mean maximum temperature – humidity index (THI) from 21-30 days of gestation Garcia – Ispierto et al.. (2004).

In dairy cows, when there is decline in conception and embryo death during the first two to four weeks of pregnancy, this is usually interpreted to mean typical example of the existence of the phenomenon of low fertility induce by heat stress. This is especially correct when severe hyperthermia occurs under heat stress conditions. (Wiersma and Stott, 1969; Thatcher, *et al.* 1986).

Heat stress can be simply defined as the point where the animal such as cow is unable to dissipate an adequate quantity of heat to maintain its body thermal balance. The Temperature-Humidity Index (THI) could be used as an indicator of thermal climatic conditions. THI is determined by equation from the relative humidity and air temperature and is calculated for a particular day according to the following formula (Kadzere et al., 2002): THI=0.72 (W +D) +40.6 Where W= wet bulb temperature and D= dry bulb temperature.

The principle of THI is that as the relative humidity at any temperature increases, it becomes progressively more difficult for any animal to cool itself.THI values of 70 or less are considered comfortable, 75-78 stressful, value greater than 78 cause extreme stress. Signs of heat stress includes : restlessness, crowding under shade, or at water tanks, panting (open-mouthed breathing), increased salivation; increased respiration rate(gasping), rates of gut and *ruminal* motility are reduced, decreased activity, reduced feed intake, rise of rectal temperature, increased water intake etc.

In Sheep production, this sign is indicated by a drop in feed intake and increase respiratory rate, drop in wool and milk production. In rams, it is made manifest with reduces sexual drive leading to temporary impotence (Butswati *et al.*.2008; Marai *et al.*,2003).There are few other studies available in respect of pork, however, organic and outdoor bred pig production (Williams, *et al.*,(2006) and semi-extensive indoor housing has been shown to reduce GHG emission (per kilogram of meat production) compared to conventional intensive production. Climate change also affects nomadic and transhumant livestock keepers. New routes and pastures will have to be discovered (F.A.O, 2007; Thomton *et al.*. 2008).

There is increase in the incidence of disease during changes in temperature and precipitation which in turn would reduce animal productivity and possibly increase animal mortality (Baker and Viglizzo, 1998).Lack of water and increased frequency of drought in certain countries will cause loss of resources. As in the case of many African countries, it will exacerbate existing food insecurity and conflict over scarce resources (Seo and Mandelsohn, 2006, 2007). There is possibility of livestock farmers shifting to any other species for production and this will be based on their indigenous skill to cope with such newly introduced species in their environment.

Rotter and Van de Geijn(1999) categorized the impact of climate change on animal production on : availability of feed grain; pasture and forage crop production; quality health growth and reproduction and disease and their spread. The climate change may result in decrease or increase in population of a livestock species in a region (Moss *et al.*, 2000; IPCC, 2007). Animals which are more hardy and adapted to reference climate condition may thrive well while others may either shift to more suitable region or suffer stressful environment.

Livestock adapted to hot environment will be preferred in hot semi-arid/arid region of the country over high producing and less thermal tolerant sheep. Thermal stress is known to influence more severely to non-adapted and high producing sheep. The production performance and survivability *of Bharat Merino sheep*- that is crossbred (75% exotic inheritance). Climate change is seen as a major threat to the survival of many species, ecosystems and the sustainability of livestock production systems in many parts of the world (Moss *et al.*, 2000).

According Schoenian,·(2010) sexual activity in sheep is primarily controlled by the ratio of daylight to dark. Estrus becomes more frequent as the days become shorter. In general, fertility is highest and most efficient when *ewes* are bred in September, October, and in November: ewes bred at this time generally produce the highest percentage of multiple births. High temperature is detrimental to fertility, embryo survival and fetal development. This is the biggest objection to fall lamb production. High temperature at breeding can reduce conception rate. Heat stress during gestation impairs fetal development and can cause lambs to be significantly smaller at birth. If temperature exceeds 90 degree freight for an extended period. especially if the humidity is high, fertility of most ram is reduced.

Goats with production demands are susceptible to heat stress in spite of heat resistant characteristics. Depression of feed intake and reduction in production are commonly observed in heat-stressed goats. Guidelines for nutritional manipulation attempting to alleviate heat stress in goats remain to be established. Balancing rations according to reduced level of production, reducing dietary forage to grain ratio, feeding fat, supplementing sodium bicarbonate and other minerals, and maximizing cold water intake may be beneficial for heat stressed goats.

According to Praks, (2004) in the effect of temperature stress on dairy cow, the breeding records and metrological data of cows with first services between July 1st, 1979 and June 30^{th}, 1980, in a large Florida herd were analyzed to determine the relationship between temperatures and breed efficiency. Seasonal high temperatures were associated with a low breeding efficiency. Increase maximum temperature from 29.7^{0} c during April to 33.9^{0} c during July was associated with a decrease in conception rate on first service from 25 to 7%. Also, the average number of insemination per conception, based on pregnancy diagnosis 6 to 8 weeks after breeding, was higher from May to August(4.5 to 5.3) than from September to April (2.3 to 3.5)

Temperature decreases of any magnitude for 3 days before or after the day of breeding, when maximum temperature on the day of breeding were 27^{0} c, were associated with high pregnancy rates. Also similar temperature decreases around the time of breeding, below the previously mentioned high maximum temperature for 20days before the day of breeding were accompanied by higher conception rate. Fertility was consistently lower under all temperature changes when maximum temperature on the day of breeding was 33^{0}C.

A study by International Livestock Centre for Agriculture (ILCA. 1976) showed that the *white fulani or bunaji* cattle, under traditional system of production. have calving intervals of 22 to 24 months or more. The age at first calving ranges from 48 to 50 months and their milk production – that is, milk drawn excluding that consumed by the calf, is 306kg, over a lactation period of 441 days. This amounts to 253kg per year. Similarly, according to Yahuza (2001) the calf mortality was observed to be as high as 28%.

Generally, most of the national herds are in the hands of the pastoralists and the ILCA (1976) study cited above which was conducted with herds in the traditional system seem to illustrate the productivity of national herds. Based on the productivity of the cattle population under traditional system of production, it was estimated that domestic milk production will reach 515.3 thousand tons in 2001.

The table below shows the predicted size of the cattle population and the magnitude of their milk production for the period between 2001 and 2005 according to Yahuza (2001).

Table 2.1. Estimated Cattle Population and Milk Production

Year	Cattle population	Milking cows (herd)	Milk production (tones)
2001	21,470800	3,435328	515291
2002	22,329632	3,572741	535911
2003	23,222817	3,715650	557347
2004	24,151729	3,864276	579641
2005	25,117798	4,018847	606827

Source: Yahuza (2001).

According to Larry, (2007) there is normally a decrease in milk production for cows under heat stress. This decrease can be either transitory or longer term depending on the length and severity of heat stress. These decreases in milk production can range from 10 to 7.25%. In the summer of 2005, many New York dairy herds reported decrease in milk production of 5 to 15 pounds per cow per day. If heat stress lowers milk production in early lactation dairy cows, potential milk production for the lactation will be decreased. Dairy cows in later lactation may recover slowly from the effects of heat stress.

Heat stress has also been reported to decrease reproductive performance in dairy cows. There are a number of changes in reproductive performance, for instance, the effects can be prolonged and impact the animal for months after the heat stress exposure. Some of these effects include the following:

(i) The length and intensity of the estrus period decreases;

(ii) Decreased conception/fertility rate;

(iii) Decreased growth, size and development of ovarian follicles;

(iv) Increased risk of early embryonic deaths; and

(v) Decrease in fetal growth and calf size.

On feed nutrient utilization, an increased loss of sodium and potassium is usually associated with heat stress. This is due to losses associated with the increased respiration rate. This can shift the acid base balance and result in a metabolic alkalosis. There can also be a decrease in the efficiency of nutrient utilization according to the study.

Americans consume more than 37 million tons of meat annually. This is according to a US Census Bureau report of 2011. This report also indicated that the US livestock production in 2002 was worth about USD100 billion. Earlier in 2002, a report by same body showed that changes in climate did affect the animals directly and indirectly. Increase in heat waves directly affected livestock in most parts of the country. Several of the states reported an average loss of 5,000 animals under such weather conditions – this situation was also buttressed by another US government report issued in USGCRP: (2009)

A prolonged heat stress situation has been known to increase vulnerability to diseases in animals, reduce their fertility rates and equally reduce their milk production levels. In a similar way, drought periods may equally threaten both pasture and feed supplies. For instance, drought reduces the amount of quality forage available for grazing livestock. Again, in some areas where prolonged and intense drought occurs, it eventually results in higher summer temperatures and consequently reduces precipitation. With regard to the animals. especially those that rely on grains for food, a change in crop production due to drought becomes a problem.

Worthy of note also, is that changes in climate may increase the prevalence of parasites and diseases that affect livestock. Early onset of spring and warmer winters in some countries, have engendered environments conducive for the existence of some parasites and pathogens. Similarly, in areas with increased rainfall moisture-reliant pathogens could also strive, according to a report by CCCSP (2008).

Increases in carbon dioxide (CO_2) may increase the productivity of pastures but may also decrease their quality. Increases in atmospheric CO_2 can increase the productivity of plants on which livestock feed. However, studies have shown that the quality of some of the forage found in pasture lands decreases with higher CO_2. As a result, cattle would need to eat more to get the same nutritional benefits.

Schoenian S. (2010) was of the opinion that extreme heat can have a profound effect on productivity, especially, if the onset of heat is sudden and not giving livestock ample time to adapt. Generally, the growth rates of livestock are reduced under hot weather conditions mainly because available forage is usually less and the livestock themselves have reduced appetite for food. Also, prolonged high temperature of about 90° f/32.2° C, according to this study, can affect livestock reproduction. For instance, over-heated rams may lack libido – sexual drive. Ideally, rams should be sheared six to eight weeks before the onset of the breeding season.

A ram or buck affected by heat stress takes about six to seven weeks to be able to produce semen capable of fertilization. However, fully developed sperms are less likely to be affected by heat stress unlike sperm at its developmental stage. High temperatures are also harmful to developing embryo and causes fetal developments. Undoubtedly, heat stress lowers the natural immunity of animals making them more prone to diseases. Therefore, during periods of high heat temperatures or humidity there is the need to frequently check the livestock for signs or symptoms of distress of any kind.

Graham, *et.*, *al* (1982) reported that shorn sheep exposed to cold stress during grazing increases feed intake by 20 to 40 % to compensate for the heat loss. Likewise. Baile and Forbes (1974) have reported an increase in voluntary intake of food in cold stressed animals. These responses are directly related to the activity of the thyroid gland of the animals according to Gale (1973). This increase in thyroid activity of the animals leads to an increase in ruminoreticulum motility and higher rate of passage of digesta according to the views of Westra and Christopherson (1976) and Gonyou. *et al* (1979).

In contrast and according to Adams, et al (1986), cows consuming only rough forage ate less at lower temperature when compared with those reared at warmer winter temperatures. In addition, the study observed that a 44% reduction in feed intake occurs between 2 – 5 days period when air temperature is averaged about -15° C and – 27° C.

Kartchner in a 1996 study found that the intake of cows grazing on winter forage was below the maintenance level during both a harsh or mild weather condition. If energy requirements for grazing and cold environments are jointly considered. the relationship between the intake and the requirements would be even less favorable according to Adams, (1987). In the views of Webster, (1974), a decrease in the intake of forage results in lower production of thermo neutral heat which consequently mobilizes the body fat to bridge the energy gap so as to maintain the overall body temperature. Similarly, during cold periods, Young, (1975), observed an increase in concentration of glucose and free fatty acids in the blood. While Baile and Della-Fera, (1993) reported that increased levels of free fatty acids in the blood are directly related to reduce intake of food by the animals.

The studies reviewed are all empirical studies carried out by different scholars in situation of varied temperature situations and in different parts of the world. Majority of these scholars have come to the conclusion that temperature variations, despite differences, affect Livestock production.

With regards to this particular study, the empirical approach adopted will show that temperature variations in Nigeria similarly affect both directly and indirectly the reproductive levels of the animals studied.

Dobson *et al* (2000) indicated that the process of reproduction is an important physiological system for the development of species, linked to stress, that (Coubrough *et al.* 1985) has classified into two groups: environmental stress and handling. Environmental stress includes room temperature, cold and/or hot and cold, wind and moisture. The stress management includes animal density, to handling procedures, the flow of animals, to the interaction between animals of the same or different species and the existing social condition, as nonspecific psychological distress, noise, physical trauma, and so on. The combination of both stresses, act as stressors, which compromise the homeostasis of the animals.

A review of the literature indicates heat stress generally causes lower milk production, decrease growth rate for cattle and lambs, but little effect on wool production. Breed and diet affect the degree of adverse response. Heat is caused primarily by high air temperature, but can be intensified by high humidity, thermal radiation and low air movement. Improving performance of animals under warm conditions involves breeding and management and modifying the environment. The former includes the selection of heat tolerance, use of crossbred animals, diet with low heat increment in relation to energy for production and control of diseases and parasites. Environmental modifications may include provision of shades, use of water for evaporative cooling and increased air movement.

If intensive system of developing countries such as Nigeria are to play a significant part in mitigation of GHG emission, then, there is need to invest in research on the agro- ecological settings in the country. Research on the impact of GHG emission on livestock production in Nigeria and globally are lacking therefore, will unveil and suggest ways to preventing activities known to contribute to global warming. Our indigenous breeds of livestock are hardy and adopt better to the harsh humid tropical condition prevailing in Nigeria. Therefore, genetic development of breeds which will be less sensitive to global warming will mitigate the menace of the prospective climate change. However, farmers are not quite aware about the impacts of increasing atmospheric green house emission on agriculture production especially the livestock sub-sector. Therefore, good research work is needed to help them take strategic and tactical decisions.

Since changes are relatively slow, there is need to rely more on continuous observation and experience of farmers and their local knowledge. The negative impact of ruminants on green house gas emission can be addressed through change in animal husbandry including ruminant diets, animal stocking ratio, farm animal waste, land degradation, fermentation digestion in ruminants and monogastric (FAO,2007;Osinbanjo et al.,2009; IFAD, 2009) avoid nitrous oxides emissions.

In Keffi Local Government, the incidence of low productivity and sudden death of animals during high temperature is a concern in animal welfare and ecological sustainability. Drought due to high temperature affects grains and forages which cause low milk production, lean or poor quality meat, low birth rate and increase in disease incidence and susceptibility. Poor quality and quantity of these products affect the market value and availability.

CHAPTER THREE

THE STUDY AREA AND RESEARCH METHODOLOGY

3.1 The Study Area

Keffi Local Government of Nassarawa state, central Nigeria . It was founded about 1800 by Abdu Zanga (Abdullahi), a Fulani warrior from the north who made it the seat of a vassal emirate subject to the emir of Zaria (a town 153 miles [246 km] north). Although Keffi paid tribute to Zaria throughout the 19th century, it was constantly raided for slaves; its war in the reign of Sidi Umaru (1877–94) with the nearby town of Nasarawa resulted in a further payment of slaves to Zaria. Keffi is located just west of a junction of local roads that give it access to Abuja, Nasarawa, the trunk highway at Akwanga, and the main railway at Lafia . Pop. (2006) local government area, 92,664. The local government has eleven wards.

3.1.1 Vegetation

The area is located within the Southern Guinea Savanna region. It is an area of hilly and dissected terrains and undulating plains; much of the area is characterized by varying degree of ruggedness (Balogun, 2000). The common vegetation in the study area is shrub savanna. It occurs extensively on interfluves and ridges, in a number of localities. The region is made up of shrubs, trees and grasses. The shrubs, provide the foliage layer while grassy elements in the shrubs are definitely more in number than trees or shrubs. Patches of the rain forest contain trees such as Antirisern Africana, Anthocleistanoblis, Ceibaperitandra, Celtisspp and Dracaena arborea. The dominant vegetation of the territory is classified in to the Savannah types as follows:

Park or Grazzy savannah: This occupies about 53% of the total area of the state. It is annual in nature and only a few are found among the just grasses, namely: Albiza, Zygia, and Pakiaclapperforniana.

Savannah Woodland: This covers about 12% of the total area and occurs mostly in the rugged and less accessible part of the territory, especially in the Nasarawa, Toto, Kokona half plains and surrounding hills. The commonest trees species found include; Afzela hen Africana and non- pterocarpuserinacens.

The main occupation is farming- livestock (Cattle, Sheep and Goat).

3.1.2. Location

Keffi (Keffi) is a populated place (class P - Populated Place) in Nassarawa State (Nassarawa), Nigeria (Africa) with the region font code of Africa/Middle East. It is located at an elevation of 338 meters above sea level and its population amounts to 85,911. Its coordinates are 8°50'55" N and 7°52'25" E in DMS (Degrees Minutes Seconds) or 8.84861 and 7.87361 (indecimal degrees). Its UTM position is LQ77 and its Joint Operation Graphics reference is NC32-14. Current local time is 19:56; the sun rises at 07:41 and sets at 19:48 local time (Africa/Lagos UTC/GMT+1). The standard time zone for Keffi is UTC/GMT+1 In 2016 DST starts on - and ends on -

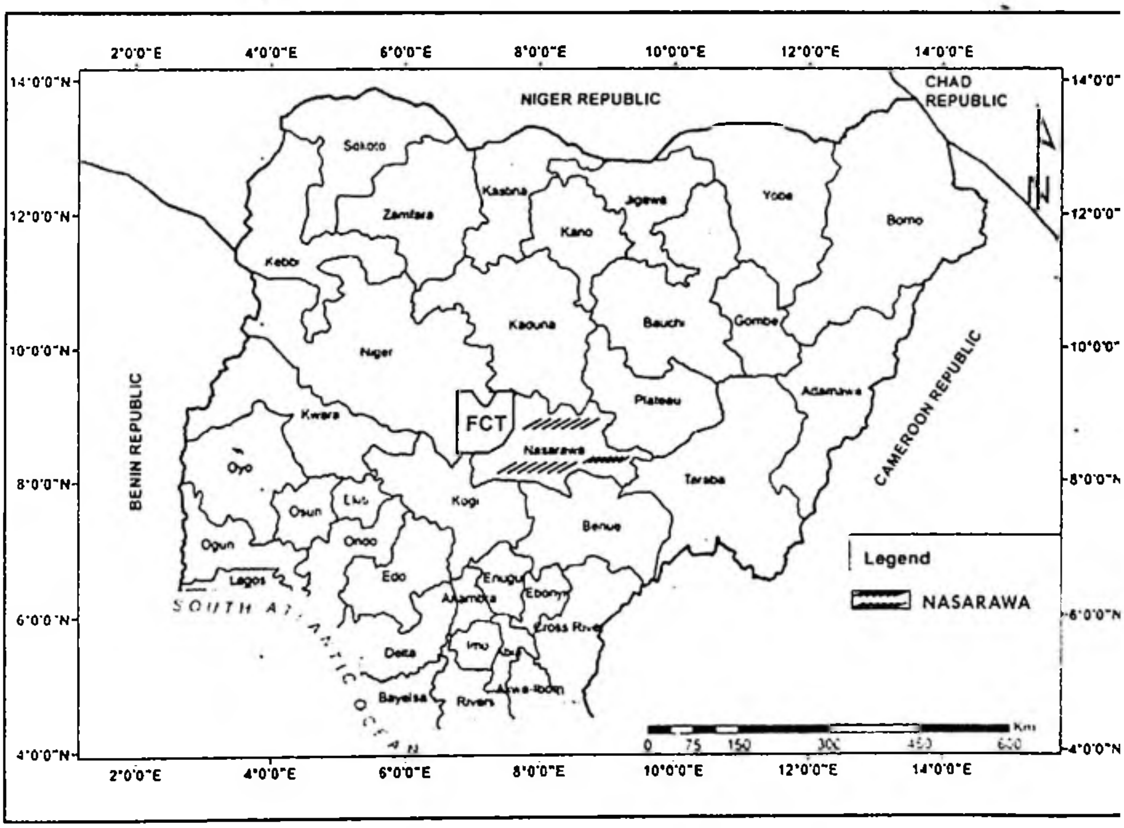

Fig. 3.1 Nigeria Showing Nasarawa State

Source: Geography Department, Nasarawa State University, Keffi (2015)

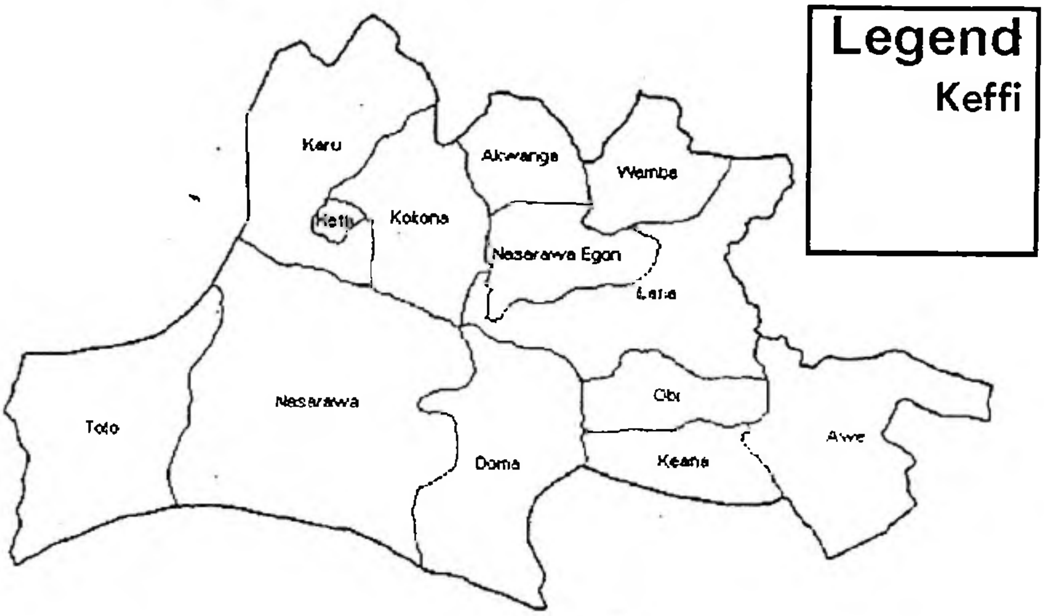

Fig.3.2 Map of Nasarawa State Showing Keffi
Source: Google

3.1.3 Climate

Nasarawa has a relative humidity at 2m above the surface of the earth according to weather forecast: Humidity 66%, Pressure OmmHg/hPa. Wind direction is west wind and its speed is 2.8ms/10km/h/6mph. The weather is also conducive for the rearing of Cattles, Sheep, Goats, Pigs, Rabbits, Chicken and Fishes. In fact, great opportunities abound for agro-allied industries in the locality.

Nasarawa experience three weather conditions annually. This includes a warm. humid rainy season and an extremely hot dry season; there is a short period of harmattan accompanied by the North East Trade Wind, with the main feature of dust haze, intensified coldness and dryness. The rainy season begins from April and ends in October when daytime temperature reach 20-30 degrees and night-time lows range around 22-23 degrees. In dry season, daytime temperature can soar reach 40 degrees and night- time temperature can drop to 12 degrees resulting in chilly evenings. Even the chilliest night can be followed by daytime temperatures well above 30 degrees. The high altitudes and rolling terrain of the Nasarawa State act as moderating influence on the weather of the state. Rainfall in the Nasarawa State reflects the territory location on the Wind ward side of the Jos Plateau and the zone of rising air masses. The annual total rainfall is in the region of 1100mm to 1600. The Nasarawa State falls within the Guinean forest-savanna mosaic zone of the West African sub-region. Patches of rain forest however, occur in the Gwagwa plains, especially in the rugged terrain to the South Southeastern parts of the territory, where a landscape of gullies and rough terrain found. These areas of the Nasarawa State form one of the few surviving occurrence of the mature forest vegetation in Nigeria.

On average, the temperatures are always high. Most rainfall (rainy season) is seen in May, June, July, August, September, and October. Abuja has dry period in January, February, November and December. On the average, the warmest month is March while the coolest month is August. September is the wettest month and January is the driest month copyright@2015www.weatherandclimate.com

3.1.4. Socio-Economic Activities

Keffi Local Government has one graded 1st class Chief. He is addressed as "Emi Keffi" respectively. The council with its ten wards and districts, all the village hamlet heads are answerable to the Emir.

The revenue base of Keffi is mostly derived from tax collection, farming such as livestock rearing; food crops (yam, maize, guinea corn,groundnut) commercial gardening, buying and selling as well as small scale businesses.

3.1.5. People and Culture

The homogenous intentions of the federal government could not hold due to none restriction of people from other parts of the country who sought domicile in Keffi Local Government. The present heterogeneous feature has introduced various new cultures from other parts of Nigeria into the area.

Today Keffi Local Government can boost of vibrant cultures from all the geo-political zones in the country. For instance, the Igbo, Hausas, Yoruba, Eggon, Mada, Afo apart from the original Fulani. The introduction has enormously added to the vibrancy of the present day Keffi Local Government. The culture of the people of Keffi Local Government is expressed in various languages, foods, festivals and so on. The dominant indigenous tribe in the Local Government is the Fulani, and Hausa ethnic groups. The people of Keffi believe in God, but like in many parts of the world have different ways of worshiping Him. God is known by different names in different parts of the Area Council.

The traditionalist on the other hand worship different gods, ancestors and believed in universal laws. It is therefore not strange to find churches, mosques and shrines in various parts of the council.

3.1.6 Veterinary Service

Keffi Local Government has only two governments owned veterinary outfits and numerous private veterinary clinics in addition to other mobile veterinary services.

3.2. Research Methodology

3.2.1 Reconnaissance Survey

This was undertaken before the real data collection. This was to enable the researcher identify the farms, sort for information, pre- test the instrument for data collection.

3.2.2 Sources of Data

Data was acquired from primary and secondary sources. The primary sources included; personal interviews to the farmers, assessment of animal temperature, and yield in milk and meat production which were measured in jars graduated in liters and scale in kilograms respectively, diseases and death occurrence and animal feed. Secondary was from journals, published textbooks; Secondary data was also acquired from veterinary clinics, abattoirs (butchers), farm, Nigerian Meteorological Agency (NIMET) on temperature variation.

3.2,3 Types of Data Required

The types of information required include:

(i) Data on temperature variation

(ii) Animal temperature

(iii) Animal feeds

(iv) Yield in milk and meat production

(vi) Disease occurrence

3.2.4. Study population

The population of livestock sampled in the study locations is presented in Table 3.1 below.

Table 3.1: Statistics of Livestock Population Sampled in the Four Farms

FARM NO.	TYPE OF ANIMAL			TOTAL NO. OF LIVESTOCK PER FARM
	CATTLE	SHEEP	GOATS	
A	60	15	*	75
B	43	7	*	50
C	70	10	20	100
D	38	12	10	60

Note * = **Goats not reared**

The study population was cattle, sheep and goats in four farms located in *Keffi Local Government*. Farm A has a total of 75 livestock comprising 60 cattle and 15 sheep; Farm B had 50 livestock comprising 43 cattle, and 7 sheep; Farm C had 100 livestock comprising 70 cattle,10 sheep and 20 goats; while Farm D had 60 livestock comprising 38 cattle, 12 sheep and 10 goats.

3.2.5. Sample selection and sampling technique

The study area was stratified in to the existing 14 districts. Thereafter, four districts were purposively selected namely; Kara, En-Awaki, Mayanka tsohon kasuwa and Jan farm, and a farm were selected in each of the selected districts.

3.2.6. Methods of Data Collection

3.2.6.1. Data on Temperature Variation

Data was collected from Nigerian Meteorological Agency (NIMET). The average maximum and minimum temperature for a period of five years was calculated from the data obtained. The changes in air temperature is a gradual one at any location, it may be high, low or normal.

3.2.6.2. Animal Temperature

The body temperatures of these ruminant livestock were collected by inserting a clinical thermometer through the rectum (Anus) of these animals. The temperature was taken and recorded when the ambient environmental temperature is normal/ standard, low (cold period) and high (hot period). It was also taken when these animals were exposed to sun (kept without shelter) for a longer period and when walked for some distance.

3.2.6.3. Animal Feed

Animal feed was measured by physical assessment- for plant materials and grasses whether it is fresh and greenish. Grains were assessed for moisture and mould which might cause infection to the animals. It was discovered that some these animals were reared under free range and scavenge for food while some in the ranch are tethered and fed with Plant material (grasses and branches) and grains. At times, some farmers feed these animals on coarse plant materials which are not easily digestible without knowing the implication to the environment. These ruminant animals digest these coarse plant materials that non ruminants cannot eat because of their "fore stomach". This is in line with what Environmental Protection Agency Inventory of US, GHS, (1990- 2005) reported on the enteric fermentation of the coarse plant material which results in manure with high methane emission (Green House Gases) in the atmosphere. Also, quality feed or feed that is easier to digest leads to manure with lower methane emission.

3.2.6.4. Yield in Milk and Meat Production

Rubber jars were used to collect milk produced and thereafter measured in graduated jars in liters. Oral interview with the farmers showed that dairy cow (milking cow) produce more milk during normal temperature than high or hot period. At the abattoir, live weight of animals were taken with weighing band and after slaughter, meats were measured with scale to determine the weight in kilogram. Oral interview held with the butchers showed that high temperature or hot period affect the quality and quantity of meat produced which are physically measured with weighing band and measuring scale.

3.2.6.5. Disease and Death Occurrence

With the aid of farm records from the farmers and clinical records from the veterinary services, the animals that were infected with diseases and treated were recorded. Also with farm records and oral interview with the farmers. the rate of infection and dead animals were recorded.

3.2.6.7. Field Assistants

Four field assistances were recruited and trained in animal restrain and handling. These field assistances restrain the animals while rectal temperatures were taken. They were also used to monitor the quantity of milk produced and measured in liters. Likewise, monitor the meat produced and measured with scale in kilograms.

3.2.6.8. Data Analysis

Data collected was analyzed using descriptive statistics (mean and standard deviation) and inferential statistical (ANOVA). ANOVA was used to determine variation in milk, meat and birth rate among cattle, sheep and goat.

Objective 1 was achieved through the record from NIMET showing temperature variation for a period of 5 years.

Objective 2 and 3 was achieved through measuring yield in production of milk and meat at variable temperature and also assessing birth rate, disease incidence and death during high, low and normal temperature.

Objective 4 and 5 was achieved through results on findings and recommendation.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results of temperature Records

Records from NIMET showed significant temperature variability in the last five years For instance, in 2012, the average maximum temperature was 27.9°C and the average minimum temperature was 21.8°C. And in 2013 the average maximum temperature was 31.9°C indicating a difference of 4°C increase. The average minimum temperature in 2013 was 21.2°C showing a 0.6°C decrease from that of 2012.

Table 4.1: Daily maximum and minimum temperature was collected from Nigerian Meteorological Agency (NIMET) from which the average annual temperature for a period of five years was calculated.

YEAR	AVERAGE MAXIMUM TEMPERATURE (° Celsius)	MINIMUM TEMPERATURE (° Celsius)
2009	28.0	21.6
2010	29.2	21.6
2011	27.9	21.8
2012	28.0	21.8
2013	31.9	21.2

Source: Computed from NIMET results 2014

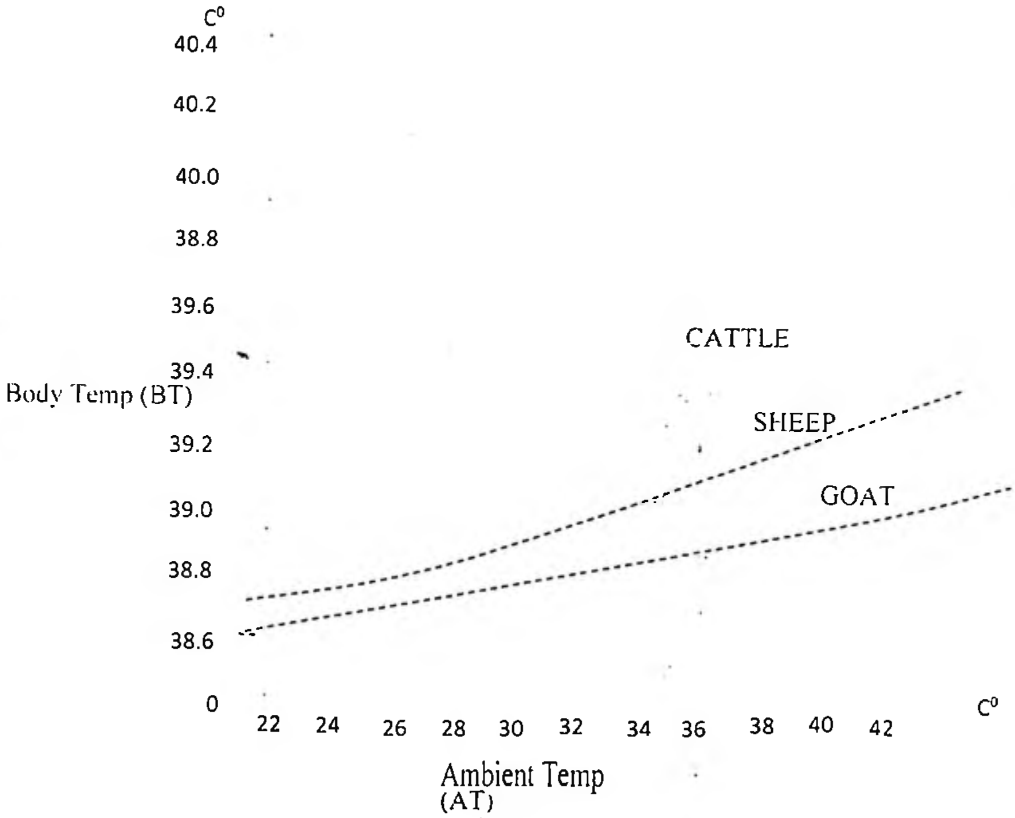

Figure 4.1 Contains Information on graph of body temperature in degree centigrade (°c) of livestock (cattle, sheep and goat) with respect to environmental (ambient) temperature in degree Celsius (°c). The rectal temperature of these livestock showed that as the environmental temperature increases, the body of the animals increased especially when reared without shade or shelter and exposed to direct sunlight, or walked for a long time and scarcity of water. These conditions result to heat stress and discomfort the animals. Rectal temperature is an indicator of thermal balance and may be used to assess the adversity of the thermal environment. In severe cases of heat stress, the rectal temperature rise, the effect on the animal increased when relative humidity is greater than 50%. A rise of 1°c or less is enough to reduce performance in most livestock species (Mc Dowell et al., 1976). According to FAO, 2007, IFAD, 2009, when global average temperature increases by only 1.5 -2.5^{0}c, approximately 20 – 30% of plants and animal species are expected to be at the risk of extinction.

Table 4.2 Temperature variation of cattle with respect to productivity measures (beef, milk and birth rate)

Farm	Production	Cold Period $\leq 38^oC$	Hot Period $\geq 40.5^o$ C	Standard/NormalPeriod38.5° C – 40.5° C
Farm A	Beef	118kg	107 kg	124 kg
	Milk	4.8 liters	4 liters	5.2 liters
	Birth Rate	1 or 2 calf birth per year	Lack of service, still births/abortion	1 or 2 calf per year
Farm B	Beef	126kg	112 kg	132 kg
	Milk	4.5 liters	3.6 liters	6 liters
	Birth Rate	1 or 2 calf births per year	Lack of service, still births/abortion	1 or 2 calf birth per year
Farm C	Beef	-	102 kg	120 kg
	Milk	-	4.2 liters	5.6 liters
	Birth Rate	-	Lack of service, still births/abortion	1 or 2 calf births per year
Farm D	Beef	126 kg	110 kg	128 kg
	Milk	4.8 liters	4 liters	5.4 liters
	Birth Rate	1 or 2 calf per year	Lack of service, still births/abortion	1 or 2 calf births per year

Source: Authors Field Survey, 2013/2014

Table 4.2 above contains information on temperature variation of cattle with respect to productivity in beef, milk and birth rate in four farms visited, measure in kilogram, liters and number of calf per birth. Farm C did not have any record on cold period. In farm A, during cold period of less than 38^0c, an average sized cattle has a beef weight of 118kg, hot period of more than 40.5^0c weighed 107kg and standard or normal temperature of between 38.5 – 40.5^0c weighed 124kg. Milk production in the same farm was 4.8liters, 4liters and 5.2 liters for cold, hot and normal temperature respectively. Birth rate during cold period was 1 or 2 calves per birth in 2 years, the same with normal period while hot period had no mating, still birth or abortion. Farm B had beef weight of 126kg, 112kg, and 132kg for cold, hot and normal period respectively. The milk production was 4.5liters, 3.6liters and 6liters for cold, hot and normal period respectively.

While birth rate for cold and normal period was 1 or 2 calves per birth in two years. Hot period recorded lack of service, still birth or abortion. Farm C had no record during cold period, however, the hot period showed beef weight of 102kg, and normal was 120kg. Milk production was 4.2liters and5.6liters for hot and normal period. Birth rate for hot period was same with other farms indicating lack of service or still birth while normal period had 1 or 2 calves per birth in two years. Farm D had 126kg, 110kg and 128kg for cold, hot and normal period respectively. Milk production was 4lit, 4lit and 5.4lit for cold, hot and normal period respectively while birth rate was same with cold and normal. Hot period recorded no with the other farms. The result revealed that hot period affected the beef production more than cold period. The quantity and quality of beef was affected measuring with scale and physical assessment. The beef looked pale and dehydrated. This is in line with what a U S Census Bureau (2011) reported concerning the quantity of meat they consume annually which drastically reduced due to climate change.

Milk production during cold period was slightly lower than normal or standard temperature while hot period showed significant low rate. Some scholars are of the opinion that decline in the production of milk and fat in ruminants were as a direct result of high environmental temperature. This can be justified by the negative effect heat stress has on the secretory function of udder (Silanikove. 1992).According to New York Dairy herds of 2005 which reported that in summer, there was a decrease in milk production of 5 to 15 pounds per cow per day due to heat stress. Also. Larry. (2007) says that decrease in milk production can range from 10 to 7.25%. This decrease can be transitory or longer term depending on the length and severity of heat stress. A heat wave in 2006, California dairy producers lost an estimated one billion dollar in milk and animal.

Birth rate of cattle production was also affected during high temperature where it was recorded mainly lack of service, still birth and repeated abortion. Birth rate was affected because there was reduced productive capacity and reduced sexual drive. According to Lopez, et al., 2004, embryo loss is another important factor that affects fertility and is increased during heat stress. Dairy cows conceiving with singleton or twins are 3.7 and 5.4 times more likely to lose their embryo respectively during hot versus cool season especially increased by a factor of 1.05 for each unit increase in mean maximum temperature. Wiersma and Stott; 1969; Thatcher, et al.. 1986 says that in dairy cows, there is decline in conception and embryo death during the first two or four weeks of pregnancy. This phenomenon of low fertility is induced by heat stress.

Table 4.3 Temperature variation of Sheep with respect to productivity measures (Beef, Milk and Birth rate)

Farm	Production	Cold Period ≤ 38°C	Hot Period ≥ 40.5° C	Standard/Normal Period38.5° C – 40.5° C
Farm A	Mutton	18 kg	16.8 kg	19 kg
	Milk	-	-	-
	Birth Rate	1 or 2 per birth	Still birth/abortion	1 or 2per births
Farm B	Mutton	18 .5kg	15.2 kg	19.8 kg
	Milk	-	-	-
	Birth Rate	1 or 2 births per	Lack of service, still birth/abortion	1 or 2per births
Farm C	Mutton	-	17 kg	19.2 kg
	Milk	-	-	-
	Birth Rate	-	Reduced Libido, still birth/abortion	1 or 2 per births
Farm D	Mutton	16 kg	15 kg	17.4 kg
	Milk	-	-	-
	Birth Rate	1 or 2 per births	still birth/abortion	1 or 2 per birth

Source: Authors Field Survey, 2013/2014.

Table 4.3 above contains information on temperature variation in sheep with respect to productivity measure in mutton and birth rate in the four farms measured in kilograms and number of kids per birth. However, there was no record of milk production because the farmers said milk was not in demand in the area of study. Farm C generally, did not have any record on cold period. In Farm A, mutton (meat) weight of an average sheep was 18kg during cold period, 16.8kg and 19kg for hot and normal period respectively. There was no record on sheep milk production because it was not in demand in the area.

Birth rate during cold and normal period showed the same results of 1 or 2 kids per birth while hot period showed a record of still births and repeated abortions. Farm B, mutton weight were 18.5kg, 15.2kg, and 19.8kg for cold, hot and normal periods respectively. Farm C did not keep record on cold period but had 17kg and 19.2kg for hot and normal period. Farm D, had mutton weight of 16kg, 15kg and 17.4kg for cold, hot and normal period. The birth rate was still the same with cold and normal period of 1 or 2 kids per birth. Hot period also showed record of still birth and repeated abortion. According to Susan, (2010). extreme heat can have a profound effect on productivity, especially, if the onset of heat was sudden and did not give livestock ample time to adapt. The growth rates of livestock are reduced under hot weather conditions mainly because available forage is usually less and the livestock themselves have reduced appetite for food. Over heated ram may lack libido (sexual drive). Furthermore, a ram or buck affected by heat stress takes about six to seven weeks to be able to produce semen capable of fertilization.

Table 4.4 Temperature variation of Goat with respect to productivity measures (beef. milk and birth rate)

Farm	Production	Cold Period ≤ 38°C	Hot Period ≥ 40.5° C	Standard/NormalPeriod38.5° C – 40.5° C
Farm A	Mutton	11.7 kg	10.8 kg	12 kg
	Milk	-	-	-
	Birth Rate	2 or 3 kids/birth per year	2 kids/birth per year	2 or 3 kids/birth per year
Farm B	Mutton	12 kg	11 kg	12 kg
	Milk	-	-	-
	Birth Rate	2 or 3 kids/birth per year	1 or 2 kids/birth per year	2 or 3 kids/birth per year
Farm C	Mutton	-	9.2 kg	10 kg
	Milk	-	-	-
	Birth Rate	-	1 or 2 kids/birth per year	2 or 3 kids/birth per year
Farm D	Mutton	11.2 kg	10 kg	11.6 kg
	Milk	-	-	-
	Birth Rate	1 or 2 kids/birth	Still births/abortion	1 or 2 kids/birth

Source: Authors Field Survey, 2013/2014.

Table 4.4 Contains information on temperature variation of Goat with respect to productivity in meat and birth rate in the four farms measured in kilograms and number of kids per birth. There was no record of milk production because milk was not in demand in the area.

Farm C did not keep record during the cold period. Farm A, recorded that an average size goat weighed 11.7kg,10.8kg, and 12kg during cold, hot and normal period respectively. Farm B had 12kg, 11kg and 12kg for cold, hot and normal period respectively. Farm C had 9.2kg and 10kg for hot and normal period respectively while Farm D had 11.2kg, 10kg, and 11.6kg for cold. hot and normal. Goats had not much difference in temperature variation on their productivity in respect to meat and birth rate. Goats are more adapted to hot period than cattle and sheep. Cattle are the worst affected in productivity with respect to beef, milk and birth rate. This is in line with Oyenuga, 1967; Bourn et al., 1994 – Goats are renowned for their hardiness and can survive in most environment. For instance, the West African dwarf goats are kept in the forest zones and in the middle belt; Sokoto red is more predominant throughout the north similarly the Sahel goats are mostly northern breeds

Table 4.5 Incidence of Disease of Livestock

Farm	Number of Livestock	Cold Periods (≤ 38° C) Disease (%)	Hot Periods (≥ 40.5° C) Disease (%)
A	75	4	8
B	50	4	12
C	100	5	9
D	60	5	10

Source: Authors Field Survey 2013/2014.

Table 4.5 above showed incidence of disease on the four farms in percentages.

Table 4.6 Incidence of Death of Livestock

Farm	Number of Livestock	Cold Periods (≤ 38° C) Death (%)	Hot Periods (≥ 40.5° C) Death (%)
A	75	-	2.6
B	50	-	4
C	100	1	3
D	60	-	1.6

Source: Authors Field Survey 2013/2014.

Table 4.6 showed incidence of death on the four farms in percentages

Tables 4.5 and 4.6 above contain information on incidence of Diseases and Deaths of ruminant livestock in four farms visited represented in percentages. Farm A with a total of 75 livestock indicates that 4% of the population was infected with various diseases such as pneumonia, *trypanosomiasis, dermatophilosis, mastitis, retained placenta, foot-rot and heat stress.* During cold periods, some of these animals were infected without any death recorded. On the other hand, during hot periods, there was an 8% disease infection recorded with 2.6% death rate amongst the animals. The infection was aggravated due to heat stress and at times, sudden death without severe clinical sign .Farm B with 50 livestock had a similar rate of infection of 4% with no death recorded during the cold period. However, during the hot period, there was a 12% rate of infection with 4% death recorded. In the case of Farm C with the highest livestock, there was a 5% rate of infection during cold period with 1% death rate. And during the hot period, there was a 9% rate of infection with 3% death rate recorded. Likewise, Farm D had a total of 60 livestock with 5% infection rate during cold period and no death recorded. Yet during hot period it recorded a 10% infection rate and 1.6% death rate.

Generally, the study observed that while there were disease occurrences during the cold periods, the death rate then was negligible unlike during the hot periods when infection rates and death rates were higher among the animals. According to Baker and Viglizzo, 1998, which says that increase in the incidence of disease during changes in temperature and precipitation which in turn would reduce animal productivity and possible increase animal mortality. Also report by CCCSP (2008) says that changes in climate may increase the prevalence of parasites and diseases that affect livestock. Early onset of spring and warmer winters in some countries, have engendered environments conducive for the existence of some parasites and pathogens.

However, cold periods do not have much effect on livestock productivity except where the cold temperature is below the thermo neutral zone. This causes cold stress which in turn, increases the maintenance requirements of livestock. Cold stressed animals have increased voluntary food in-take as a result of elevated thyroid gland activity. The elevation of thyroid activity results in increased ruminoreticulum motility and higher rate of passage of digesta (Westra and Christopherson. 1976; Goriyou, et al. 1976.) This causes decrease in the volume of rumen and dry matter digestibility. Some diseases, such as pneumonia are more prevalent during cold and moist weather. Young and fresh contaminated pastures cause gastrointestinal infections and diarrhea on animals.

However, to minimize the effects of temperature variation on ruminant livestock productivity, physical protection which includes; natural shades, such as trees, artificial shades to block the direct effect of solar radiation which is the main cause of heat stress. These shades could be permanent or portable shade structures according to shearer, et al., (2005). In addition, there will be need for adequate provision of clean water source, cooling and sprinkling of the animals, avoiding overcrowding and spending several hours in a holding pen. Breed or service animals in less hot period, Artificial insemination and synchronization of estrus period. Furthermore. Intensive farming which includes breeding for high yields, permanent indoor housing and concentrate feeding of animals is the best way to reduce livestock emission (World Society for the Protection of Animals Feb.2012).

4.2 Test of Hypothesis

Table 4.7 Measure of productivity with respect to temperature variation for Cattle

Measure of Productivity	Temperature variation	N	Mean	Std. Deviation
Beef Production (kg)	Cold Temperature (≤ 38°C)	4	118.00	11.31
	Hot Temperature (≥ 40.5°C)	4	107.75	4.35
	Standard/Normal Temperature(38°C – 40.5°C))	4	126.00	5.16
	Total	12	117.25	10.40
Milk Production (litres)	Cold Temperature (≤ 38°C)	3	4.70	0.17
	Hot Temperature (≥ 40.5°C)	4	3.95	0.25
	Standard/Normal Temperature(38°C – 40.5°C))	4	5.55	0.34
	Total	11	4.74	0.76
Birth Rate (per year)	Cold Temperature (≤ 38°C)	3	1.00	0.00
	Hot Temperature (≥ 40.5°C)	4	0.00	0.00
	Standard/Normal Temperature(38°C –	4	1.25	0.50

40.5°C))				
Total		11	0.73	0.65

Table 4.7 Contain Information on mean production in beef, milk and birth rate of cattle in four farms during cold, hot and normal period. The table shows that the mean beef production during cold period was 118kg, hot period was 107.75 and normal period was 126.It also showed that the total mean findings for beef was 117.25. For mean milk production the values are 4.70, 3.95, and 5.5 for cold, hot and normal respectively. The total mean milk production was 4.71 while birth rate was 1.00, 0.00, and 1.25 with a total mean birth rate of 0.73.

Table 4.8 ANOVA showing significance in temperature variation for Cattle

		SS	**Df**	**MS**	**F**	**Sig.**
Beef Production (kg)	Temperature	669.50	2	334.75	5.785	0.024*
	Error	520.75	9	57.86		
	Total	1190.25	11			
Milk Production (litres)	Temperature	5.125	2	2.563	34.170	0.000*
	Error	0.600	8	0.075		
	Total	5.725	10			
Birth Rate per year	Temperature	3.432	2	1.716	18.303	0.001*
	Error	0.750	8	0.094		
	Total	4.182	10			

*Significant

Table 4.8 ANOVA showed no significance difference for cattle in beef production since F value =5.785, df=2 and p=0.024 while there was significant difference for cattle in milk production and birth rate under varying temperature. Since the f=34.170, df=2, and p=0.000 for milk, and birth rate: f=18.3o3, df=2 and p=0.094.

Table 4.9 Measure of productivity with respect to temperature variation for Sheep

Measure of Productivity	Temperature variation	N	Mean	Std. Deviation
Mutton Production (kg)	Cold Temperature (≤ 38°C)	3	17.50	1.323
	Hot Temperature (≥ 40.5°C)	4	16.00	1.046
	Standard/Normal Temperature(38°C – 40.5°C)	4	18.85	1.025
	Total	11	17.446	1.618
Birth Rate (per year)	Cold Temperature (≤ 38°C)	3	1.667	0.577
	Hot Temperature (≥ 40.5°C)	4	0.0000	0.000
	Standard/Normal Temperature(38°C – 40.5°C))	4	1.500	0.577
	Total	11	1.000	0.894

Table 4.9 Contains Information on measure of productivity with respect to temperature variation for sheep in four farms. The mean mutton productions for the four farms are: 17.50, 16.00, and 18.85 for cold, hot and normal periods respectively. While the total mean was 17.446.

Table 4.10 ANOVA showing significance in temperature variation for Sheep

		SS	df	MS	F	Sig.
Mutton Production (kg)	Temperature	16.257	2	8.129	6.549	0.021*
	Error	9.930	8	1.241		
	Total	26.187	10			
Birth Rate per year	Temperature	6.333	2	3.167	15.200	0.002*
	Error	1.667	8	.208		
	Total	8.000	10			

*Significant.

- Table 4.10 ANOVA above showed significance in temperature variation for sheep productivity with f=6.549, df=2 and p=0.021.

The result from table 4.10 for sheep showed that there is significant difference in productivity (mutton and birth rate) under varying temperature. Since the p-value is less than 0.005 and reject the null hypothesis.

Table 4.11 Measure of productivity with respect to temperature variation for Goat

Measure of Productivity	Temperature variation	N	Mean	Std. Deviation
Mutton Production (kg)	Cold Temperature (≤ 38°C)	2	11.850	0.212
	Hot Temperature (≥ 40.5°C)	3	10.333	0.987
	Standard/Normal Temperature(38°C – 40.5°C)	3	11.333	1.155
	Total	8	11.088	1.049
Birth Rate (per year)	Cold Temperature (≤ 38°C)	3	2.333	0.577
	Hot Temperature (≥ 40.5°C)	4	1.250	0.957
	Standard/Normal Temperature(38°C – 40.5°C))	4	2.250	0.957
	Total	11	1.909	0.944

- Table 4.11 showed a measure of productivity with respect to temperature variation for Goat in four farms with mean mutton of 11.850, 10.333, and 11.333 for cold, hot and normal period respectively. The mean total for mutton was 11.088.

Table 4.12 ANOVA showing significance in temperature variation for Goat

		SS	df	MS	F	Sig.
Meat Production (kg)	Temperature	3.050	2	1.525	1.637	0.284*
	Error	4.658	5	0.932		
	Total	7.709	7			
Birth Rate per year	Temperature	2.742	2	1.371	1.779	0.230*
	Error	6.167	8	0.771		
	Total	8.909	10			

*Not significant

Table 4.12 ANOVA showed NO significance in temperature variation for goat in meat production and birth rate. Since f=1.637, df=2, and p=0.284

The p- values is more than 0.05 and accepts the null hypothesis.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

The study examined the effects of temperature variation on ruminant livestock productivity in Keffi Local Government. Temperature stress is a phenomenon that can impact physical and economic loses to livestock production. This stress exerts an influence on livestock productivity through an interaction between the animals' physiological changes and energy requirements. Data was sourced from primary and secondary. Primary source included personal interview with the farmers, assessment of animal temperature, and yield in milk and meat production, disease occurrence and animal feed assessment. Secondary data was from journals, published textbook, veterinary clinics, abattoirs (butchers), NIMET and unpublished materials. Purposively sample technique was used to select the four farms visited.

Descriptive and Inferential statistics were used in the analysis of temperature variation in livestock productivity. The study findings showed that as the environmental temperature increases, the body temperature of the animals also increases due to changes in the metabolic and physiological. Increase in animal body temperature results to heat stress, decrease in the quantity of milk and meat production and also reduction in birth rate. Incidence of disease occurrence and death are also on the rise due to low immune system.

During hot period, plant materials and grains fed to these animals are not fresh and greenish, in other words, they are not in good condition for consumption. They quantity that may be fresh and palatable may not enough for these animals therefore these animals were under fed which affect their productivity. These observations are common among all the four farms visited. On the other hand, during cold period, the animals do not respond much to environmental temperature as much as they respond to hot period. However, cold stress on its own causes an increase in voluntary feed in – take which increases the activity of the thyroid gland and result *in ruminoreticulum* motility and higher rate of passage of *digesta*. Animals exposed to cold or rains are more prone to diseases and infections.

However, intensive care and good feed management are necessary to reduce the effect of temperature variation on livestock productivity.

5.2 Conclusions

Effects of temperature variability on livestock productivity are a global problem of concern and its impact are greatly felt by poor rural livestock farmers. However. small scale livestock farmers contribute to green-house gas emissions but proper technology and adequate management can reduce the effect. Many studies have confirmed that animal health and welfare are integral to environmental sustainability. Breeding for health can create productive and welfare benefits, and result in lower emissions.

Temperature variability which result to heat stress have negative effects on dairy and meat production, birth and death rates. and incidences of disease occurrence especially in vulnerable parts of the world like Nigeria where they are vital for both nutrition and livelihood.

Ensuring good animal welfare will be paramount to addressing these challenges. Animal breed suited to local environments are often more robust and resilient than industrially farmed breeds. The effect of temperature on the productivity of animals can be prolonged for months if adequate measures are not taken. There should be increased awareness and understanding of possible anthropogenic contributing factors to temperature variability that result to heat stress. Strategic and tactical approach is necessary to mitigate the adverse effects on livestock productivity. However, it has been suggested that intensive animal farming – which includes breeding for higher yields, permanent indoor housing and concentrate feeding of animals – is the best way to reduce livestock waste by products that contribute to Green House Gases.

5.3 Recommendations

Effects of temperature variability on livestock production can be minimized through several measures. The two primary options are making some ration adjustments and altering the environment the animals live in. Interaction between nutrition and stress results to nutrient deficiencies which affects animal's ability to counter stress. The feed in-take in intensively managed livestock is less affected by the heat stress compared to the grazing animals in which reduction in grazing activity is to maintain heat balance (Beede, et. al., 1983).The strategies are to minimize heat gain by reducing solar heat load and maximizing heat loss by reducing air temperature around the animal or increasing evaporative heat loss directly from animals. Heat stress can occur nearly everywhere what varies is among locations is its duration. Negative effects of heat stress on production can occur within days.

Therefore, to minimize the effects of temperature variation on livestock production:

1. Physical protection and nutritional dietary manipulations are the main management practices. Physical protection includes, natural shades, such as trees, artificial shades to block the direct effect of solar radiation which is the main cause of heat stress. These shades could be permanent or portable shade structures according to Shearer, *et al* (2005).

2. There will be need for adequate provision of clean water source, cooling and sprinkling, housing and good ventilation, avoiding overcrowding and spending several minutes or hours in a holding pen. – All these would assist reduce the impact of heat stress. Wooly and hairy animals should be sheared prior to the onset of hot weather.

3. Breed or mate animals in less hot periods; Insemination with frozen semen in less hot time; Implement estrus Synchronization programs to schedule insemination or service; reduce the intake of fiber and protein and increase energy.

4. There are a number of factors that minimize the effects of cold temperature on animals, for instance, clean dry environment with minimal wind, hair depth and

dry hair coat of the animals are necessary to reduce cold stress. Feeding hay provides more heat during digestion than concentrate feeds. It is also necessary to use enough quantity of good dry bedding.

5. Some farmers are not quite aware of the impacts of increasing atmospheric green-house gas emissions on agriculture production especially in the livestock sub-sector. Adequate awareness and understanding is needed to help farmers together with proper management techniques and strategies. Thus, intensive animal farming which includes breeding for higher yields, permanent indoor housing and concentrate feeding of animals are among the best ways to reduce livestock emissions. Also the negative impact of ruminants on green house gases emission can be addressed through changes in animal husbandry including ruminant diets., animal stocking ratio, farm animal waste, land degradation, fermentative digestion in ruminants and monogastric to avoid nitrous oxide emissions (FAO,2007, Osibanjo et al., 2009; IFAD, 2009).

6. Generally, there should be public awareness on the human (anthropogenic) activities that contribute to increase in global surface temperature such as deforestation, burning of fossil fuel, aerosol spray, vehicular emission and agronomic activities.

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