Title

Effects of Climate Change induced electricity load shedding on small holder agricultural enterprises in Zambia: The case of Five Southern Province Districts.

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DECLARATION

I, the undersigned, do hereby declare that the work contained in the thesis is my own original work and that I have not previously in its entirety or part submitted it at any university for a degree.

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ABSTRACT

Zambia is currently facing electricity shortages, which affect the power supply throughout the country. Load shedding and power outages have had effects on agricultural subsectors, industries and household food security with negative implications for the productivity of the country's economy. This paper analyses the effects of climate change induced electricity power load shedding on smallholder farmers' agricultural productivity and production in Mazabuka, Monze, Choma, Kalomo and Namwala districts of Southern Province of Zambia for the 12 months period starting February 2015 through to February 2016 .

To gather the information needed to understand the effects and extent of load shedding and also determine whether there were differential outcomes on various enterprises, 149 structured sets of questionnaires were administered at enterprise level comprising of Dairy, Abattoir (beef), Crop irrigation, Feedlot and Poultry. Furthermore, to broaden and deepen the understanding of the effects and extent of load shedding on smallholder farmers, 17 focus group discussions were conducted with a total of 203 farmers from the same studied enterprises. Although ZESCO had released load shedding time tables for each district and for each different feeder, the study reveals that some enterprises in sample area were apparently either not aware of the scheduled power cuts or ZESCO had failed to follow their programmed load shedding time table. The findings show that Monze and Namwala respectively started experiencing power cuts as early as February 2015 and March, 2015, and were the top two districts having abrupt power cuts. Many enterprises experienced reduction in the estimated average level of production during load shedding. The production level reduced by 26.6% for cattle slaughtered in abattoirs, 19.3% for steers raised for market in feedlots, 13.5% for chickens raised for market in poultry and 34.7% for quantity of milk produced in dairy (milk collection centers). On the contrary, the quantity of irrigated crop harvested increased by 18.6% during load shedding. The effects and extent of load shedding

was profound in the extra costs incurred to sustain operations of the enterprise. More than half (64.71%) of Non sole proprietors (compared to Sole proprietorship (45.26%) agree to incur more costs due to power cuts. Further, there were delivery delays from suppliers (46.3%) and to customers (46.3%) due to load shedding. As they try to adapt and mitigate the effects of load shedding on the operation of the enterprise, majority of Sole proprietorship (49.47%) and 46.15% of Non-Sole proprietorship often times reduce the expansion of the enterprise. It is also significant that stocking and use of charcoal/firewood during load shedding was often used by Sole proprietorship (61.7%) compared to 26.92% of Non-Sole proprietorship. Similarly the majority Sole proprietorship (85.26%) and Non-Sole proprietorship (75%) resorted to renting alternative tools/equipment to back up power during load shedding, while the highest proportion of Non-Sole proprietorship (69.23%) often resort to buying alternative tools/equipments to back up power supply. Of the assets bought/rented in as alternative power sources, charcoal/breezier became very common among the poultry enterprise while generators were common among dairy, abattoir and feedlot.

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Finally all is possible with God and may His name be lifted up.

Amen and Amen

LIST OF ACRONYMS

ANOVA	Analysis of Variance.
ASFG	African Smallholder Farmers Group
CSO	Central Statistics Office
DACO	District Agricultural Coordinator
DRC	Democratic Republic of Congo
FASAZ	Farming System Association of Zambia
FGD	Focus Group Discussion
FND	Fifth National Development Plan
GWh	Gigawatt-hours
GDP	Gross Domestic Product
IPCC	Intergovernmental Panel on Climate Change
MAL	Ministry of Agriculture
MW	Megawatts
MDGs	Millennium Development Goals
PACO	Provincial Agricultural Coordinator
PRSP	Poverty Reduction Strategy Paper
SWASCO	Southern Water Sewerage Company
SPSS	Statistical Package for Social Sciences
TFP	Total factor productivity
UKAID	United Kingdom Aid
US$	United States Dollar
ZMW	Zambian Kwacha
ZRA	Zambezi River Authority

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1.0. INTRODUCTION

1.1. Background

Zambia is a politically stable democratic country with enormous economic potential embedded in its rich endowment of natural resources and its lovely people. The country is blessed with plenteous natural resources ranging from forests, arable land, minerals, water bodies, and the savannah climate to the amazement of the inhabitants charged to take care of it. The climatic conditions favour agriculture, which is the major employing sector in the country side. Also, the natural resources endowment favours the production of hydroelectricity because the country harbours huge sources of water in the Sub-Saharan region.

Accelerating economic growth and ensuring that the majority of the approximately 15 million people in Zambia benefit from it remain Zambia's central development challenges on the agenda. The national development goal of reducing poverty and reaching middle income country status by 2030 are articulated in the country's 'Vision 2030' (World Bank, 2009). The Government's strategy for inclusive growth and development is outlined in Zambia's National Development Plan. The Fifth National Development Plan (FNDP), which ran from the period 2006 to 2010, proposed a multi-sectorial strategy to increase Zambia's annual growth rate to seven percent (7%) and sustaining it at that level, thus making the growth more diversified as well as more inclusive. The primary theme of the strategy is "broad based wealth and job creation through citizenry participation and technological advancement" (World Bank, 2009).But the main challenge we face as Zambians is whether we are probably following our own set agricultural development agenda pathway. How as a nation we are committed to turning challenges such as the unprecedented load shedding, climate change, devaluation of the kwacha, low agricultural productivity(2.10 tonnes per hectare) among smallholder farmers (PACO's Office, 2016) who are the majority producers into favourable and thrilling opportunities to better our lives and that of the future generations matter most.

The current political, social and economic conditions present several challenges as well as opportunities for achieving the Government's development goals. Zambia needs to expand its economy faster than its current rate of 6 %(Zambia Economist, 2015) a year to achieve the national vision of becoming a middle-income economy by 2030. For Zambia to achieve the required growth acceleration, it needs to diversify its key economic sectors at all levels. It is important that revenue generated from the mines, which are the largest users of electric power, (59%) (World Bank, 2009) is used to build productive infrastructure and support the delivery of social services, thereby laying a more formidable and sustainable foundation for development. Despite almost a decade of growth, about two thirds of Zambians live in poverty, and rural people persistently lag behind the urban population in most measures of social welfare. Poverty in Zambia is mainly concentrated in rural areas, affecting 81 % of the rural population, and 34 % of urban dwellers (World Bank, 2009). Zambia is one of the most urbanized African nations (35 % of population live in urban areas) but two third of the total population are small scale farmers whose production and productivity is low (2.1tonnes per hectares) per unity area because of the various physical, economical, geographical and mental factors. When we look at urban dwellers, a good number are involved in some agricultural activities in their back yard such as poultry, feedlot, some back yard irrigation (vegetable production), and even dairy farming. The level of rural poverty has remained persistently high, as Zambia's growth over the past decade seems not to have been equally and sufficiently shared by the rural poor.

The adverse effects of climatic conditions to which the country is exposed overtly affect the resources such as water, land, animal, and energy production. The Agricultural sector is further constrained by low electricity connectivity by ZESCO, which further hinders the livelihood of the rural people. The World Bank (2009) asserts that agriculture consumes as low as about 2% of national electricity compared to mines, which consume about 59%. Climate-induced changes to the physical and biological systems are already being felt and exerting considerable stress on the country's vulnerable sectors. Already, the country's sensitive agricultural sectors, such as wildlife, forestry, water and energy, as well as human health are being adversely affected by climate change, thereby significantly affecting the economic, social, and environmental dimensions of our national sustainable development (Climate change Zambia, 2015). These, in turn, negatively impact the country's food security. In addition, the rise in extreme climatic events is negatively affecting the natural, physical, financial, and human resources that are crucial for people's livelihoods, and is leading to increased food insecurity and health issues.

As agriculture provides the main support for Zambia's rural economy, growth in the agricultural sector is one avenue through which poverty reduction can be achieved in Zambia. However, despite widespread recognition of the strong connection between agricultural development and poverty reduction, there is continuing under-provision of public investments (rural electrification and other infrastructure) for over a decade and small scale farmers have continued to wallow in poverty for a very long period. Zambia's primary policy objective of achieving accelerated growth and competitiveness in the agricultural sector cannot be achieved unless adequate public resources are committed towards catalysing the desired growth (Ngona, 2013).

Long-term public investment in research and development, extension services, rural infrastructure, and food safety and quality systems have high pay-offs and are among the most important drivers of agricultural growth and competitiveness. The small-scale farmers are highly affected by challenges inhibiting the commercialization of their production and productivity. In this regard, there is a need to understand the extent to which Zambia's agriculture development framework is evolving and helping small farmers and producers improve their production and eventually their livelihood.

Agriculture has been contributing positively to the national income and presently contributes about 21 % (Swain, 2012) to the gross domestic product (GDP). It is a concern that despite the country enjoying healthy rainfall in the recent past, the performance has been static compared to its potential. Having sustained growth in the agriculture sector enables the farmers to enjoy better incomes, and hence to improve their livelihoods. The majority of the population is involved in agriculture, but despite the agriculture sector being a positive contributor to the GDP, poverty levels still remain high (Ngona,2013).

Even though Zambia has abundant water bodies that favour hydro electricity generation and industrial development, the potential Hydropower remains largely untapped, at 27 % of the estimated 6,000 MW, while less than 5 % of arable land is under irrigation. The poultry, dairy, and beef sectors suffer from low access to water supply. Particularly in the rural areas, safe and drinkable water coverage is around 37 % (Kapika, 2013).

The widespread and growing phenomenon of power load shedding has emerged as one of the principal supply-side constraints to growth of the economy of Zambia. Not only has this led to significant losses of output, employment and exports but also during periods of high outages there have been loss of forestry due to high demand of charcoal in towns. As such, the economic return of reducing outages and of facilitating the process of adjustment to these outages is likely to be high.

1.1.1. Impact of rainfall variability on smallholder farmers

Most of the rivers and dams that support the agricultural activities in Zambia are replenished by natural rains, which start every season around end of October through to April. There is significant variance in the amount of rains received season from season, province to province, district to district, agricultural zone to another which has an effect on the hydro electricity generation and supply. Therefore, rainfall variability and unreliable power supply could keep 300,000 more Zambians in poverty over the next decade. Rainfall variability could greatly reduce food availability and accessibility, with drought-induced crop and animal failures registered in six of ten farming seasons between 1986 and 1996 (World Bank, 2009). World Bank (2009) believes that a severe drought event similar in intensity to the 1992 and 2015 could cost the country up to 6.6 % loss in its growth rate, or US$2.6 billion in GDP loss. This, in turn, would increase the national poverty rate by 7.5 %age points. Climate change if not well-mitigated can severely reverse the well spelt nation's development agenda. In its 2009 report, the World Bank indicates that the 2006/07 floods affected 1.5 million people and were estimated to cost over US$4.5 million in emergency operations and another US$80 million during the recovery phase. Rainfall variability, apart from its adverse effects on agricultural production and productivity, seems to narrow down to affect basic food security, impacts on households, incomes and poverty, reduced flow of water in rivers, such events also have significant impacts for the national focus. Rainfall variability probably results in recurrent water shocks such as droughts and floods which are likely to be exacerbated by climate change now and in the future. Global Circulation Models of climate change predict that over the next 20 to 30 years, Zambia will experience increasing temperatures with longer dry periods, more intense rainfall and increased storm events (World Bank, 2009). This will have important implications for hydropower generation systems and water resource management, as well as in the design, operation and development of infrastructure for the country. However, the key question is the extent to which this will affect agricultural productivity.

1.1.2. Energy Demands

It is worth noting that electricity plays an important role in all sectors including agriculture, energy, mining, industry, tourism, urban growth and rural development. The location of generation site, protection of distribution and supply networks is an essential prerequisite for growth and poverty reduction (Mukanga, 2015), especially for small scale farmers who are the majority. Electricity is a critical input for most production processes, particularly as technological advancements in production have increased the reliance on electricity-dependent technologies. However, in many developing countries, consumers are either not connected to an electricity grid, and when they are, the supply of electricity is fraught with outages. Zambia should undergo electricity rationing to avoid blacking the country completely. Given the reliance of production processes on electricity, such electricity shortages could potentially result in productivity losses for firms and agriculture producers (International Growth Centre, 2016).In other words, any disruption in the generation, transmission and distribution and supply of electricity power by ZESCO (Company tasked to manage generation, transmission and distribute of electricity in the country) to end-users entails disruption in the very production of products and services, which would in turn impact the ability of the country to overcome poverty. Therefore, in any growing economy, rise in population (demand is higher than supply), increased investments, and poor governance put a high demand on electricity generation. In the case of Zambia, the present installed capacity will not be able to meet the forecasted demand. Hence ZESCO has sought the use of power rationing mechanism to manage the deficit despite its negative effects on the economy and the marginalized poor.

The FNDP states that a considerable increase in hydropower generation is one of the priority development objectives of the country. A failure to meet the projected demands for energy, particularly of investments in major power stations over the past 30 years has resulted in a deficit in the national power system. Similar increases in national demand throughout the Southern African region have further undermined the availability of power through regional trade among the Southern African Power Pool. Zambia lies between the hydropower rich Democratic Republic of Congo (DRC) and relatively hydropower poor southern African region (World Bank, 2009), but has failed to harness its comparative advantage.

Therefore, everyone, not only utility providers, should take part in the planning for load shedding, the practice of distributing the available power to consumers by turning off one area and supplying another in an attempt to serve all the customers (Ahmed,2010). This practice is rare, but is a core part of the emergency management of all electricity networks. Load shedding can be required when there is an imbalance between electricity demand (customers' usage) and electricity supply (the ability of the electricity network to generate and transport the required amount of electricity to meet this demand) (Ahmed, 2010). Some argue that the mechanism only benefits utility providers and not producers, like smallholder farmers. This argument, however, ignores the important direct and indirect ways in which the smallholder farmers are affected by this scourge.

A dairy farmer should adopt mechanism to absorb unplanned ZESCO Load shedding any time because if he does not do so, the effects could severely negatively impact his productivity. A Poultry farmer should have also alternative mechanisms in place in case he/she faces power failure. Abattoirs should understand the extent of business loss that would be caused by load shedding and implement risk mitigation strategies. Irrigation farmers should be able to measure the impact that load shedding would have on their productivity too.

For example, smallholder farmers could lose trust in the abattoir if they brought the animals for slaughter and are not bought because there is no power at the plant.

1.1.3. Hydro Electricity Potential in Zambia

Zambia's endowment of water resources and topography provide significant hydropower resource potential, estimated at 6,000 Megawatts (MW) (Chitundu, 2014). The installed hydropower capacity represents only 27 % of the country's hydropower potential and accounts for 99 % of all electricity production in Zambia. The Kafue Gorge, Kariba North Bank and Victoria Falls Power Stations account for 96 % of the installed hydropower capacity and 92 % of the installed national energy capacity. Kafue Gorge and Kariba were both commissioned in the 1970s and represent the last large scale investments in power generation. Together they alone account for 99 % of all installed hydropower (Mukanga, 2015).

Hydropower has the potential to help countries reduce poverty, boost shared prosperity, and improve their energy security, but variable rainfall makes long-term hydropower planning critically important (Kozacek, 2015). It has long been acknowledged that the high dependency on two, geographically proximate power stations (Kafue Gorge and Kariba), exposes the national power system to significant risks and that there is a need not only to meet increasing generation demand but to diversify the base for such generation. With 96 % of the installed capacity produced within a 300 km radius (Kafue Gorge, Kariba North Bank and Victoria Falls Power Stations) there is an economic vulnerability to climate change (World Bank, June 2013). The drought in the early to mid 1990s depleted the water available to run the generators and turbine discharges between April 1992 and February 1993. Again, since May 2015, the low water problem has severely affected hydropower generation in these stations. During the period of 1992-1993, energy production was only 66 % of average production (World Bank, 2009) and as for 2015 it even worsened further to the extent of Zambia resorting to importing power from Mozambique and South Africa.

However, there could be a number of significant challenges that need to be addressed and overcome in order to realize this potential and the benefits that additional hydropower capacity could provide for the country. Zambia needs to invest in much more hydropower stations and increasingly also in other alternative source of energy. However, there have been no major investments in hydropower generation over the past 30 years despite various attempts by the government to obtain private and public funding for large hydropower projects. The current tariff framework does not provide for the necessary returns to encourage private sector development. This is because the current export prices are not cost reflective and would have to increase by about 15 % to cover their full cost, raising questions about the ability of ZESCO, the vertically integrated Zambian power utility, to invest in new and costly plants and sell into a competitive export market to cover its full costs of those exports, and to improve its financial performance (Nyamazanza, 2014).As such there is need to increase the tarrifs by ZESCO in order to compete regionally.

1.1.4. Climate Change affects electricity generation and agricultural development

Agriculture production and productivity do not only depend on the genetic characteristics of crops, fish, forests, livestock, soils, conducive climate and the availability of needed nutrients and energy (bio-physical) but also on the effective and responsive energy sector with effective and sustainable electricity supply (Gerry,2011). Agricultural production and productivity further depend on people (both male and female), values, goals, knowledge, available and affordable resources, monitoring opportunities and the decision-making processes within farming households’ management. Hydro electricity generation and supply depends on climate - a key resource in agricultural production. Climate refers to patterns of precipitation, temperature, wind, humidity and seasons. Regular and predictably patterned seasons, timely rainfall in the right quantities, and appropriate temperatures facilitate growth of food and cash crops and pastures on which livestock feed (James, 2015). Climate further determines availability of water for both human and livestock consumption for most farmers. Climate to a large extent determines hydropower generation which is a serious input in agricultural production and productivity. Climate therefore plays a fundamental role in shaping natural ecosystems (Forest, water bodies etc), human economies and the cultures that depend on it. Climate change alters ecosystems, impacting on humans and livestock that rely on a given landscape for food crops, pastures and water. Higher temperatures eventually could reduce yields of desirable crops while encouraging proliferation of weeds and pests. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. Climate change is already having a significant effect on agriculture, fisheries and forestry in Zambia. Some impacts are being felt over time including increase in mean temperatures, changes in precipitation patterns and water availability, sea level rise and salinization and severe disruptions to important ecosystems. Other climate change impacts present more sudden and extreme weather events such as desperate periods of droughts, extreme heat and/or floods (Nelson, 2009). Dairy, poultry beef, feedlot farmers that depend on intensification type of farming, may find it difficult to process their produce and inputs due to lack of access to reliable electricity power. Therefore, climate change is defined as a significant and lasting change in the statistical patterns of precipitation, temperature, wind, humidity and seasons over periods ranging from decades to millions of years (James, 2015).

The Inter-Governmental Panel on Climate Change (IPCC) forecasts that agricultural production; as well as access to food, in Africa, Zambia in particular, would be severely compromised by climate variability and change (James, 2015). The area suitable for agriculture, the length of growing seasons and yield potential, especially along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in these regions. In some parts of the country, yields from rain-fed agriculture and irrigated agriculture could be reduced by up to 50 % by 2020 (Nelson, 2009). With 95 % of agriculture dependent on rainfall, a 20 % decrease in length of crop growing season and a 50 % decrease in yields from rain-fed agriculture, the projected losses in potential for cereal production in Sub-Saharan Africa and Zambia in particular (SSA) are estimated at about 33 %. Local food supplies would be negatively affected by reduced productivity of livestock (feed and fodder availability) and decreasing fisheries resources in large lakes due to rising water temperatures, which may be exacerbated by continued over-fishing (Nelson, 2009)

Kapika (2013) reveals that ZESCO has continued offering lower tariffs in the region and as such the utility company has failed to raise enough funds to take advantage of its natural resource-water comparative advantage and high electricity demand. However, with tariffs below economic levels, investment in power system expansion and requisite refurbishments is being constrained, leading to a decline in power quality and reliability and making load shedding and even nationwide power blackouts an increasingly common phenomenon. It is against this backdrop that this study aims to ascertain the effects of electricity load shedding on the productivity of smallholder farmers in Southern Province of Zambia. This study will take five districts as a case study and these are:-Mazabuka, Monze, Choma, Namwala, and Kalomo. Furthermore the effects of load shedding will be determined on the following enterprises owing to the fact that they smallholder farmers use electricity on them as key production input; crop irrigation, poultry, feedlot, abattoirs, and dairy milk centres farming.

1.2. Problem Statement

1.2.1. Background of the research problem

Studies show that electricity remains a key driver of economic growth and major input in all economic sectors - agriculture, mining, manufacturing and tourism sectors. Perhaps one of the most pressing challenges facing the Zambian economy since 2015 is maintaining the structural integrity of its electricity generation network to sustain its economy, especially in agriculture. The country has witnessed deterioration in some key problem areas which attained unprecedented heights. It is clear those economic sectors such as mining, agriculture; processing and many others have faced severe energy shortages in electricity coupled with high devaluation of the local currency and high temperatures reaching alarming levels. The power system has come under severe strain due to maintenance backlogs and a failure to bring new generating capacity timeously online to match economic and social development in the country (Chitundu, 2014).

Drought induced reduction in hydropower generation has become a persistent feature in the country’s power sector. The adverse impacts of what is thought to be “climate change-related” power crises appear to have far reaching and devastating impacts on both the power sectors and the economic sectors of the country, especially the small scale farmers.

Zambia is in the middle of a crippling electricity crisis as the country grapples with a 560 MW power deficit, a situation likely to only get worse as demand for electricity grows 200MW annually (Zambia Economist, 2015). The year 2015 witnessed a major increase in the frequency and intensity of power load shedding or outages. National power blackouts, unheard of in the 1980s and 1990s have become annual events that occurred in 2006, 2007, 2008, 2009 and, more seriously, in 2015 (GsbZambia, 2010).

A manifestation of this problem has been seen in the large number of reports in both the private and public popular press of high incidence of outages (on average 8hrs daily). These outages affect domestic as well as commercial and industrial consumers (Hafiz & Saleem, 2013). We have also heard complaints by the various chambers of commerce and industry and Farmers associations such as Dairy Association of Zambia, ZNFU, Poultry Association of Zambia, and others in the country that the level of production in a number of industries has been reduced due to the persistence of outages which have fundamentally disturbed the normal rhythm of the production cycle in a large number of industrial units, especially in electricity-intensive sectors like textiles, non-metallic mineral products, basic metals, leather products, rubber and plastic products, paper and paper products, mines, irrigation farms, poultry, dairy processing, abattoirs, fisheries, etc.

Zambia has been experiencing daily 8-hour power-cuts since July 2015 (Engineering Institution of Zambia, 2015). Low water-levels at the main reservoirs for hydroelectric generation have triggered a power deficit of 34% of demanded electricity. With the country’s historically abundant power supply, the sudden crisis has caught households and businesses unprepared and without back-up sources of energy (Sladoje, 2016).

Left without electricity, low levels of available gas, and exceedingly expensive generators, many households have reverted to charcoal for cooking, causing a spike in prices and accelerated the rate of deforestation. While only 22% of the population has electricity access

(World Bank, 2012 data), everyone has been affected indirectly through disruptions to the municipal water supply (Sladoje, 2016).

On the other hand climate change has had a very strenuous effect on rainfall pattern in Zambia affecting smallholder agricultural production and productivity. In times of drought little water flows into hydroelectric dams, affecting electricity generation, which could be an input in enhancing smallholder farmers' productivity. Climate change is probably the biggest challenge the world is currently facing and Zambians have not been spared from its negative impacts. For millions of people across the globe, climate change has brought about higher temperatures (heat waves), reduced water levels, increased scarcity of food and increased risk of natural disasters such as earthquakes, floods, and severe droughts. Current research indicates that it will be people living in developing countries, like Zambia, that will bear the brunt of climate change (Media365 & British Council International Climate Change Champions Programme., 2010). As for rural communities, the greater frequencies and severity of droughts and floods caused by climate change lead not only to crop failure, dry pastures, livestock, health failure, etc., but also interferes with water supply technologies when, for example, the water levels in boreholes rise or fall beyond the specification of the pump. Thus climate change critically impacts the water-energy nexus (British Council , 2010). Extreme weather events are becoming more frequent and severe. Heat waves and drought plague many countries, destroying agriculture, drying rivers and dams that generate hydroelectric power, increasing the risk of wildfires and endangering lives (World Resources Institute, 2015)

ZESCO as the utility company that provides electricity has lost revenues in its daily operations and production. ZESCO's electricity generation currently is 99 % hydro and only

1 % thermal from diesel-powered generators located in most districts of North Western Province (ZESCO, 2015). This therefore means that if drought hits the country in a particular season, then production or generation of hydro power is affected amidst high demand for power by agriculture, mining industry, and other sectors that use it as source of input towards their production. Currently ZESCO's total installed capacity is 2,202.75Mega Watts (MW) while the available capacity is 2,169.75Mega Watts (MW) against a maximum national demand of 1,890MW (ZESCO, 2015). However, Zambia has potential to generate over 6000 MW but investments towards this full generation potential have never been achieved by ZESCO on behalf of the country. Failure by ZESCO to generate to its potential has led, at times, to electricity demands that outstrip supply. Consequently, this has resulted in the National parastatal supplier of electricity, ZESCO, implementing load shedding. It seems that ZESCO has embarked on a countrywide power rationing mechanism in order to preserve the limited water available for power generation until the 2015/16 rainy season. The shortage of electricity has been building up for some time, but has become more pronounced with reduced water levels at Kariba North Bank Power Station, Kafue Gorge Power Station, and Victoria Falls Power Station (Mukanga, 2015).This scenario is likely to introduce negative shocks in specific agricultural sectors that depend on the availability of electricity. According to ZESCO "Load shedding" is a planned rolling blackout on a rotating schedule throughout the country to avoid total power system failure and/or to safeguard the electricity infrastructure in the country. Therefore, load shedding is a planned safeguard for the utility company and does not take into consideration farmers' production program.

In Zambia, there are some researches that have been carried out to assess the impact of ZESCO power rationing on firm productivity and profitability (Sing'andu, 2009). Sing'andu, 2009) indicates that Agriculture, despite contributing 21% to National GDP, is the sector that least uses electricity, at about 2%, while other industries use over 50%. Access to electricity still remains low and is a key priority in Zambia's economic strategy. Just over 47% of the population in urban and peri-urban areas and only 3% in rural areas have access to electricity in the country. Overall 23% of the population has access to electrical power. The country is also currently experiencing power shortages and load shedding. Although electricity tariffs are amongst the lowest in sub-Saharan Africa, the high connection fees are seen as a considerable barrier to access. With less availabilty of power the agriculture sector is subjected to, load shedding could worsen or reduce the productivity of smallholder farmers, especially those with little or no means for alternative sources of power. Reducing electricity poverty among the smallholder farmers could be recognized as the 'missing development goal' for any country. Without access to electricity and sustainable energy sources (Boiling Point, 2008), communities have little chance to achieve food security and no opportunities for securing productive livelihoods that can lift them out of poverty. Additionally, basic services such as education and health care cannot be adequately provided.

Most parts of the country are facing energy (electricity) shortage and this could impact the social and economic development among the smallholder farmers negatively. Reliable electrical networks are absolutely necessary for energy supply. Unfortunately, access to electricity has become a major problem in our country. The productive districts of Southern Province such as Mazabuka, Monze,Choma,Kalomo and Namwala have not been spared from climatic induced ZESCO power cuts, power interruptions, and electricity rationing that the country is experiencing resulting in social tensions. Despite new generation projects, the modelling of different hydrology conditions shows that even in a wet (above average rainfall) scenario, current power shortages will continue through to at least 2018 (World Bank Group, December,2015).

The extent to which these power disruptions have affected the various agricultural production activities in the five districts have never been studied, to the best of our knowledge. Additionally there is limited research assessment on the negative effects of power loadshedding on the productivity and production of smallholder farmers in agricultural sector in the country.

This study used Exploratory research to assess effects of climate change induced load shedding on the following smallholder farmer agricultural enterprises: - Poultry (Broilers), beef (Abattoirs), dairy, feedlot and crop irrigation in Southern Province five districts of Kalomo, Choma,Mazabuka,Namwala and Choma. Exploratory research is a research study where very little knowledge or information is available on the subject under investigation (Sekaran, 2003). Hence, there is paucity of data to determine the extent of the effects of power-cuts on the Poultry (Broilers), beef (Abattoirs), dairy, feedlot and crop irrigation on smallholder farmers in Zambia's agricultural sector to date. This study sought to evaluate the effects of power load shedding on the productivity of smallholder farmers in five districts (i.e. Mazabuka, Monze, Choma, Kalomo and Namwala) of Southern Province.

1.3. OBJECTIVES

1.3.1. OVERALL OBJECTIVE

This research project aims to assist the Republic of Zambia to evaluate the effects of hydro electricity power load shedding on the productivity and production of smallholder agricultural enterprises (poultry, dairy, beef (Abattoirs), feedlot and crop irrigation) in selected five study areas of the Southern Province of Zambia.

1.3.2. Specific objective

(1) To determine the current levels of productivity and production among small scale agricultural enterprises

(2) To determine the extent of loadshedding in the affected study areas

(3) To measure the extent of the effects of load shedding on the smallholder agricultural enterprises.

(4) To determine whether there are differential outcomes on varius enterprises due to load shedding

(5) To explore climate change adaptation and mitigation strategies that smallholder agricultural enterprise have developed to cope with the effects of loadsheding

1.4. Research questions

1. What is the current level of agricultural productivity among smallscale enterprise before and during loadshedding?
2. What is the extent of loadshedding in the targeted areas where smallholder farmers reside?
3. To what extent has load shedding affected agricultural productivity of smallholder enterprises?
4. What climate change adaptation and mitigation strategies have smallholder enterprises developed to cope with the effects of load shedding?

1.5. Research Hypothesis

1.5.1. Null Hypothesis (H0)

Load shedding has no effect on smallholder agricultural enterprises in the five districts of Zambia.

1.5.2. Alternative Hypothesis (H1)

Load shedding has an effect on smallholder agricultural enterprises in the five districts of Zambia.

1.6. Rationale of the Study

There is limited research assessment on the negative effects of power loadshedding on the productivity and production of smallholder farmers in agricultural sector in the country. It is also noted that electricity deficit is one of the most serious contemporary issues facing Zambia's smallholder agricultural sector today, and it is worth studying. There are many causes of load shedding across the continent but as for Zambia, climate change, rising demand for power, poor power generation, transmission and supply are cited as the major cause of load shedding. Therefore, many countries in the region have insufficient generation capacity to meet rapidly rising demand and electricity shortages have become a binding and powerful constraint on the country's sustainable economic development. Therefore, this study seeks to evaluate the effects of electricity load shedding on the productivity of smallholder farmers in Zambia.

The findings of the study will help the government and its cooperating partners devise deliberate measures aimed at improving the agriculture sector in the country, particularly among the smallholder farmers. The study will specifically deal with the upshots of Climate Change induced 's load shedding on the agricultural efficiency among smallholder farmers in Southern Province taking Mazabuka, Monze, Choma, Namwala and Kalomo districts as case studies and with critical focus on beef (abattoirs and feedlots), dairy, poultry and crop irrigation enterprises being the main user of electricity supplied by ZESCO.

1.7. Research Area (Scope of Study)

Southern Province is one of Zambia's ten provinces, and home to Zambia's premier tourist attraction, Mosi-oa-Tunya (Victoria Falls), shared with Zimbabwe. The centre of the province, the Southern Plateau, has the largest area of commercial farmland of any Zambian province, and produces most of the maize crop and cattle. The province has the total area of 85,823 Km^2 (33,136 sq^2).The total Population of 1,853,464 with a density of 22/km^2 (56/sq mile) as of 2015. The province lies on latitude 16°30′South and Longitude 27°00′ East (World Bank, 2016).

Climatic pattern of Southern Province with respect to precipitation is ranging from 700 to 900 mm while atmospheric temperatures range from 16 to 40 degrees Celsius. The province receives the rains in the months of October through to April every year with varying amounts from district to district and month to month. The Plateau and the Kafue flats receive higher rainfall than the valley due to climate variability.

Choma is the capital of Southern province and lies in the midst of the province. Southern Province has a population of 1,589,926 out of national population of 13,092,666 but the projection indicates that population could be 1,907,784 out of country population projection of 15,933,883 (Central Statistical Office, 2010). In 2010, the population density for Southern Province was 18.6 persons per square kilometer. The population density increased from 14.2 persons per square kilometer in 2000 to 18.6 persons per square kilometer in 2010, representing an increase in density of 4.4 persons per square kilometer (Central Statistical Office, 2010; Central Statistical Office, 2010). As of the 2010 Zambian Census, Choma (including Pemba) district had a population of 247,860 , with area of 7296 km squared and population density of 38.7 inhabitants per kilometer squared, Kalomo (including Zimba) 258, 570 with area of 15,000 Km squared and 22.4 inhabitant per kilometer squared, Mazabuka (including Chikankata) 230,972 with area of 6,242 Km meter squared and population density of 40.6 inhabitants per kilometer squared,Monze,191,872 with area of 4,854Km squared and population density of 44.2 inhabitants per kilometer squared and Namwala,102,866 with area of 5,687 Km squared and population density of 20.9 inhabitants per kilometer squared .They are famous for their large herds of cattle with livestock farming, not surprisingly, their main economic activity (City Population, 2016; Central Statistical Office, 2010).

However, the projected population for Choma is 282,127,Kalomo is 335,539, Mazabuka is 253,518, Monze is 214,557 and Namwala is 118,933 (City Population, 2016; Central Statistical Office, 2010).

The Zambezi River is the province's southern border, and Lake Kariba, formed by the Kariba Dam, lies along the province's south-eastern edge. The eastern border is the Kariba Gorge and Zambezi, and the north-east border is the Kafue River and its gorge, dividing it from Lusaka Province. The Kafue Flats lie mostly within the province's northern border with Central Province. In the North West lies part of the famous Kafue National Park, the largest in Zambia, and the lake formed by the Itezhi-Tezhi Dam. The south-western border with Western Province runs through the teak forests around Mulobezi which once supported a commercial timber industry and for which the Mulobezi Railway was built.

The Batonga are the largest ethnic group in the Province. A rail line and the Lusaka-Livingstone road form the principal transport axis of the province, running through its centre and its farming towns: Kalomo, Choma, Pemba, Monze, and Mazabuka. In addition to maize, other commercially important activities include sugar cane plantations at the edge of the Kafue flats, and cattle ranching.

Livestock production is not only a major preoccupation of the rural population of Southern Province; it is at the centre stage of production, productivity and livelihood thereof. The province is the custodian of approximately one third of the national cattle herd. The highest concentration of cattle population owned by indigenous farmers is found in around the Kafue Flats along Namwala and Mazabuka Districts. There are equally high cattle numbers on the Tonga Plateau which also happens to be the maize belt in the province which is, in the main, propelled by animal draught power (Chibinga, 2013). Poultry and pig populations are fairly evenly spread out across all the ecological zones. Table 1 below shows the livestock population in the province. The bulk of which is owned by small scale farmers (Southern Province Veterinary office, 2015)

Table 1: Livestock census for southern province -2015

District	**Cattle**	**Goats**	**Pigs**	**Poultry**	**Dogs**	**Donkeys**	**Sheep**
Namwala	140 005	21 769	12 350	127 053	13 237	475	1 005
Monze	147 602	70 496	18 328	136 050	16 136	438	1 946
Mazabuka	105 209	15 161	9 801	110 221	8 149	1 462	5 377
Kalomo	113 700	56 692	5 220	227 326	16 109	809	8 018
Choma	139 301	63 923	65 218	296 718	13 481	182	6 238
Gwembe	72 103	42 341	11 214	111 082	13 483	169	715
Siavonga	17 665	21 415	3 459	29 184	-	-	2 931
Kazungula	79 000	29 918	9 349	87 334	-	-	-
Zimba	43 500	4 550	7 300	61 500	-	-	310
Livingstone	10 623	4 109	1 982	16 123	-	-	-
Chikankata	32 000	12 750	-	43 000	-	-	-
Sinazongwe	65 000	62 200	-	87 856	9 796	-	-
TOTAL	**1 125 753**	**436 574**	**367 053**	**1 333 447**	**(90 391)**	**(3 535)**	**(26 540)**

Southern Province Veterinary office, 2015 Provincial Livestock Annual Report, Choma.

In 2015, total livestock and livestock products export from the province were as follow; 4, 701 breeding animals (Bovine), 19, 464 Feedlot Bovines, 64, 314 Bovine carcasses, 60 658 Goats and Sheep, 22 217 Pigs and 194 714 Poultry (Southern Province Veterinary office, 2015).

According to 2015/2016 crop forecast survey, despite the prolonged drought the region experienced in 2015/2016 season, southern province planted 301,771 hectares of land for Maize crop and was expected to produce 448,187 tonnes with an average yield of 1.49

metric tonnes per hectare second from eastern province with 500,920 tonnes. The national land planted is 1,364,977 hectares and expected yield is 2,873,052 metric tonnes. Southern Province maize land planted represents 22% and 16% of yield production national wide respectively. However, the five districts selected for research, represents 75% of land cultivated for production of maize and 80% yields as for 2015/2016 season in the province making them very productive districts for the province (PACO's Office, 2016).

Choma planted 42,965 hectares with 73,643 tonnes of expected yields, Kalomo planted 96,544 hectares and expected production of 148,391 tonnes, Mazabuka planted 20,224 hectares and expected production of 43,869 tonnes, Monze planted 34,213 hectares and expected production of 48,881 tonnes (PACO's Office, 2016)

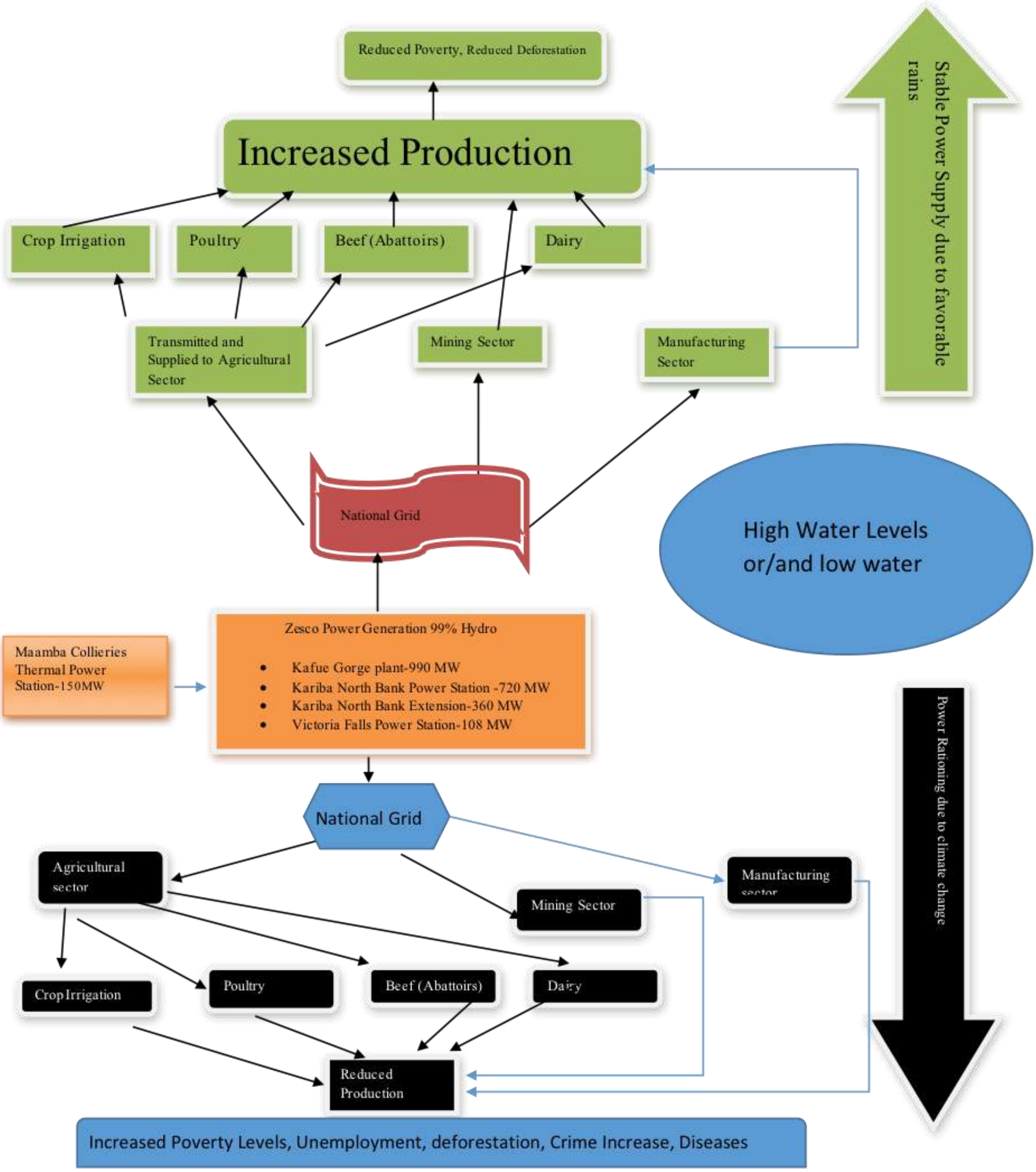
The study was conducted in Southern Province of Zambia. Five (5) districts were considered in this study. The districts are Mazabuka, Monze, Choma, Kalomo and Namwala. The newly created districts of Chikankata were considered under Mazabuka while Pemba under Choma and Zimba under Kalomo.

1.8. The Conceptual Framework

Theoretical Framework is a logically developed, described, and explained network of associations among variables of interest to the research study (Sekaran, 2003).

It is undeniable fact that contemporary agricultural related activities need modern energy. These two are concomitant elucidating that they go hand in hand. For many agrarian countries like Zambia, agriculture is the dominant sector in developing the economy and the largest employer. Energy input to modern and sustainable agricultural production, be it at small or large scales respectively, and processing systems is a key factor in moving beyond subsistence farming towards food security, added value adding activities in rural districts such as Mazabuka, Monze, Choma, Kalomo and Namwala. The evaluation of the effects of power load shedding by Zambia Electricity Supply Corporation (ZESCO) on agricultural productivity among smallholder farmers in the mentioned districts is illustrated in the research framework on the next page.

Diagram 1: Conceptual Framework depicting the effects of load-shedding on agricultural productivity of smallholder farmers in the study areas.



Source: Author, 2016

The framework to some extent depict that climate change affects Energy (Electricity), water and land differently and these are intertwined. Climate change affects each sector directly and indirectly. For instance, climate change affects water supply, energy demand, and land productivity, all of which can affect sector-wide decisions.

At smallholder farmers' level, the load shedding has different impact on livelihood. Other mitigation options, such as afforestation (re-establishment of forests), forest management, agricultural soil management, and fertilizer management are also tied intimately into the interfaces among land availability, land management, and water resource quantity and quality.

Furthermore, conceptual framework indicates that stable power supply is key to poverty reduction while poor supply due to low water levels caused by serious drought entails high levels of poverty among many farmers. Poverty stricken farmers are a danger to sustainable peace. They cause deforestation, because a lot of diseases etc as indicated in the framework.

1.8.1. Definition of Key terms

Key Words: Effects, Load shedding, production, productivity, smallholder farmers, climate change, Sole proprietorship, Non-Sole proprietorship, Southern Province-Zambia.

1. **Effects**: Ammer (2012) defines effects as outcomes. Effects are something brought about by a cause or agent. An effect is that which is produced, usually more or less immediately and directly.

2. **Load shedding**: the deliberate shutdown of electric power in a part or parts of a power-distribution system, generally to prevent the failure of the entire system when the demand strains the capacity of the system. Load shedding is a measure of last

resort to prevent the collapse of the power system country-wide. When there is insufficient power station capacity to supply the demand (load) from all the customers, the electricity system becomes unbalanced, which can cause it to trip out country-wide (a blackout), and which could take days to restore (ESKOM, 2015). According to Ahmed (2010) Load shedding is designed to distribute the available power to consumers by turning off one area and supplying another in an attempt to serve all the customers. This practice is rarely done in Zambia, but is a core part of the emergency management of all electricity networks. Load shedding can be required when there is an imbalance between electricity demand (customers' usage) and electricity supply (the ability of the electricity network to generate and transport the required amount of electricity to meet this demand) (Ahmed, 2010). When there is a shortfall in the electricity supply, there can be a need to reduce demand very quickly to an acceptable level, or risk the entire electricity network becoming unstable and shutting down completely. This is known as a "cascade" event, and can end in a total or widespread network shutdown affecting very large areas of a country.

3. **Power or Electricity:** Electricity is a form of energy associated with the atomic particles called electrons and protons. In particular, electricity involves the movement or accumulation of negatively charged electrons in relation to positively charged protons. The world's modern economies, with their industrial, transportation, and communication systems, were made possible by electricity. Old energy forms, such as water and steam, imposed limitations on production-limitations on where goods could be produced and on how much could be produced. Electricity has few such limits: it can go anywhere, even far into space (Britannica

Encyclopedia, 2016). In this study the terms Power and Electricity are used interchangeably to mean the same thing.

4. **Climate** is often defined loosely as the average weather at a particular place, incorporating such features as temperature, precipitation, humidity, and windiness. A more specific definition would state that climate is the mean state and variability of these features over some extended time period. Both definitions acknowledge that the weather is always changing, owing to instabilities in the atmosphere. And as weather varies from day to day, so too does climate vary, from daily day-and-night cycles up to periods of geologic time hundreds of millions of years long. In a very real sense, climate variation is a redundant expression—climate is always varying. No two years are exactly alike, nor are any two decades, any two centuries, or any two millennia (Jackson, 2016).

5. **Adaptation** involves developing ways to protect people and places by reducing their vulnerability to climate impacts. For example, to protect against sea level rise and increased flooding, communities might build seawalls or relocate buildings to higher ground.

6. **Mitigation** involves attempts to slow the process of global climate change, usually by lowering the level of greenhouse gases in the atmosphere. Planting trees that absorb Carbon dioxide from the air and store it is an example of one such strategy.

7. There are many definitions of agricultural productivity. Agricultural productivity is measured as the ratio of agricultural outputs to agricultural inputs (Dharmasiri, 2009). Productivity is also termed as an index of economic output relative to input. While individual products are usually measured by weight; their varying densities

make measuring overall agricultural output difficult. Therefore, output is usually measured as the market value of final output, which excludes intermediate products such as corn feed used in the meat industry. This output value may be compared to many different types of inputs such as labour and land (yield). These are called partial measures of productivity. Agricultural productivity may also be measured by what is termed total factor productivity (TFP). Productivity is a measure of the efficiency with which inputs are used to produce output. There are a number of different productivity measures. Productivity levels are a measure of the ratio of output to inputs, for example, the number of litres of milk produced per dairy cow or crop yield per hectare (Zambia Economist, 2015). This method of calculating agricultural productivity compares an index of agricultural inputs to an index of outputs. This measure of agricultural productivity was established to remedy the shortcomings of the partial measures of productivity; notably that it is often hard to identify the factors cause them to change. Productivity is a critical determinant of cost efficiency. Increases in productivity are often seen as being due to improvements in technology but may also be due to other factors.

8. **Production**: The processes and methods used to transform tangible inputs (raw materials, semi-finished goods, subassemblies) and intangible inputs (ideas, information, knowledge) into goods or services. Resources are used in this process to create an output that is suitable for use or has exchange value (Business dictionary.com, 2016).

9. **Southern Province** is one of Zambia's ten provinces, the centre of the province, the Southern Plateau, has the largest area of commercial farmland of any Zambian province, and produces most of the maize crop and cattle. . In addition to maize,

other commercially important activities include sugar cane plantations at the edge of the Kafue Flats, and cattle ranching. Southern Province has the only large source of fossil fuel in Zambia, the Maamba coal mine in the Zambezi valley, served by a branch line of the railway. The Zambezi River is the province's southern border, and Lake Kariba, formed by the Kariba Dam, lies along the province's south-eastern edge. The eastern border is the Kariba Gorge and Zambezi, and the north-east border is the Kafue River and its gorge, dividing it from Lusaka Province. It’s the source of almost 99 percent of Zambia’s electricity generation. i.e. Kariba Dam, Kariba North Bank, Kafue George and Itezhi Tezhi Dam. The Kafue Flats lie mostly within the province's northern border with Central Province. In the North West lies part of the famous Kafue National Park, the largest in Zambia, and the lake formed by the Itezhi-Tezhi Dam.

10. **Smallholder farmers**: There are many definitions of smallholder farmers. Ethical Trading Initiative (2005) defines smallholder according to level of the grown crop, and to the social, cultural, economic, technological advance, and political context. The productivity of smallholder farmers is less than that of commercial farmers. As for this research smallholder and small scale farmers are used interchangeably and does include the emergent farmers. It include town based families that keep poultry in their backyards, keep fish in their back yard house and out grower(Smallholders in a more formal, managed relationship with an exporter or processor) farmers like the Kaleya and Mugoto small holder Development and cooperatives like the dairy cooperatives, irrigation etc

11. **ZESCO** (**known as Zambia Electricity Supply Corporation Limited**) is a state-owned power company in Zambia. ZESCO Limited generates, transmits, and

distributes electricity in Zambia. It also offers various vending options for customers to buy electricity units for customers using prepaid meters. ZESCO Limited was formerly known as Zambia Electricity Supply Corporation Limited and changed its name to ZESCO Limited in May 1994. The company was founded in 1970 after Zambia Electricity Supply Act was passed in Parliament and is based in Lusaka, Zambia. It has offices in Lusaka, Ndola, and Kitwe; and service outlets in Zambia (Chitundu, 2014)

12. **Sole proprietorship:** It is a business that legally has no separate existence from its owner. In other words it is an unincorporated business with one owner who pays personal income tax on profits from the business. Income and losses are taxed on the individual's personal income tax return (Business dictionary.com, 2016). With little government regulation, they are the simplest business to set up or take apart, making them popular among individual self-contractors or business owners. From this research the Enterprise categorized as Sole proprietorship was at least dominantly run by one person or uses more of family labour.

13. **Non-Sole proprietorship:** Corporations are the most common form of business organization, and one which is chartered by a state and given many legal rights as an entity separate from its owners. This form of business is characterized by the limited liability of its owners, the issuance of shares of easily transferable stock, and existence as a going concern. The process of becoming a corporation, called incorporation, gives the company separate legal standing from its owners and protects those owners from being personally liable in the event that the company is sued (a condition known as limited liability)Incorporation also provides companies with a more flexible way to manage their ownership structure. In addition, there are

different tax implications for corporations, although these can be both advantageous and disadvantageous (Business dictionary.com, 2016).For enterprises in the form of cooperative/association, company, public (Parastatal) and partnership, fell under the non proprietorship category.

14. **Electric Feeder**: In power distribution, a set of electric conductors that originate at a primary distribution centre and supply power to one or more secondary distribution centers, branch-circuit distribution centers, or a combination of these.

15. **A Steer.** In cattle sex and age of cattle is used to describe the animal. The male is first a bull calf and if left intact becomes a bull; if castrated he becomes a steer and in about two or three years grows to an ox

2.0. LITERATURE REVIEW

2.1. Introduction

Electricity is the most widely used and rapidly growing form of secondary energy supply in Zambia. Its generation accounts for about 40% of total primary energy supply (Adslive.com, 2015). Interestingly, it offers great flexibility of distribution and use, is relatively efficient, very safe for the consumer, and environmentally benign in end-use. Although overall energy intensity (energy per unit of GDP) fell 25% worldwide 1971 to 1997, electricity demand increased almost threefold over this period (James, 2015). The share of electricity in total energy consumed will rise from 16% in 2002 to about 20% in 2030 (World Bank,2011). A lack of electricity has devastating consequences for any economy. Since early 2015, Zambia experienced a 2,100 gigawatt-hours (GWh) power deficit triggering countrywide power rationing mechanism in order to preserve the limited water available for power generation until the 2015/16 rainy season. In the recent past ZESCO, the national electricity utility has heightened load shedding (electricity rationing) throughout the country. The shortage of electricity has been building for some time but has become more pronounced with reduced water levels at Kariba North Bank Power Station, Kafue Gorge Power Station and Victoria Falls Power Station (Zambia Economist, 2015; Badiani, 2011) due to "below average" rainfall experienced during the 2014/15 rainy season (Engineering Institute of Zambia, 2015). The load shedding averages 6-10 hours per day and affects the agricultural sector which has a backward and forward linkage to different industries which provides employment and food security to the masses in the country. This has led to a public outcry and anger against the national utility (Engineering Institute of Zambia, 2015).

The Intergovernmental Panel on Climate Change (IPCC) identified the Zambezi River as one of the two rivers in Africa that are sensitive to climate change and urges that effects of climate change should be taken into account in the planning and operation of hydropower projects. The Zambezi River is particularly sensitive to global warming. There could be a number of studies have been done to predict the behaviour of the reservoirs under climate change but so far the outcomes are yet to be considered in the operation of the hydropower power plants on the Zambezi River (Engineering Institute of Zambia, 2015)

2.2. Power- sector reform and regulation in Africa causes of Load Shedding

Most developing countries, especially in Africa, have been severly disappointing in the management and running of their Electricity subsector. The utility companies are an extension of government institutions whose leadership is appointed by leaders of the government who have proved to be poor at doing business when compared to private run utilities. Therefore Sub-Saharan Africa’s electricity sector is one such example that has been in the midst of a multifaceted crisis for more than two decades, the central challenge of which has been its lack of generation capacity caused by mainly climate change and poor institution management (NatCom, 2009).

Remarkably and notably however, according to Kapika (2013) Africa’s total installed electricity-generation capacity, is at just 122 GW, is equal to that of France alone (France is never affected by load shedding). If North Africa is excluded (that is, Algeria, Egypt, Libya, Morocco, Sudan, Tunisia and Western Sahara which are slightly doing fine in electricity management business), the figure for sub-Saharan Africa drops to 77 GW; and if South Africa is excluded, installed capacity is a mere 33 GW – equal to that of Sweden.

Therefore, in terms of generation capacity, Africa ranks poorly even when compared with other developing regions. Around 125 MW per million people (Mushwana, February2009), its generation capacity is lower than that of developing regions in Asia. Making matters worse, about 25 per cent of its capacity is unavailable due to poor servicing and maintenance (Leung, 2005). Somewhere around the 1980s, when sub-Saharan Africa's generation capacity per million was roughly equivalent to that of southern Asia, Africa has lagged behind impressive progress in this and other regions.

Like earlier stated, Zambia's challenges are mirrored in other African countries. Countries across the continent are grappling with the challenge of supplying reliable electricity to meet the needs of a growing economy and providing universal access to electricity in order to improve the quality of lives of citizens using daily productivity means. The key issues faced in the power sector include poor reliability,low access, and insufficient capacity to meet existing demand; some 24% of the population of Sub Saharan Africa has access to electricity versus 40% in other low income countries (Mukoni, 2012). Excluding South Africa, the entire installed generation capacity of Sub Saharan Africa is only 33GW, equivalent to that of Argentina when in size and population Sub Saharan Africa is far much bigger than Argentina(World Bank Group, December,2015).

Many times poor investment into generation of electricity has not been managed well by the utility companies in sub-Saharan African region. That is to say that the investment required to overcome the challenge of generation capacity in Africa is daunting and therefore it is estimated that to meet suppressed demand, keep pace with projected economic growth, and provide the additional capacity required to fulfil electrification aspirations, a staggering 7 000 MW in new generation capacity would have been required per annum between 2005 and 2015 (Beilfuss, 2012). It should be noted that this would cost around US$15 billion to build and that a further US$5 billion per annum would be required for the rehabilitation of existing generation and transmission assets (ZESCO, 2015, ZESCO Corporate Affairs and Business development Directorate, 2013).

A second feature of Africa's power crisis is that the supply of electricity is often unreliable. World Bank enterprise surveys of private-sector firms revealed that sub-Saharan Africa experienced 10 days of power outages in a typical month, each of which lasted an average of seven hours and Zambia alone it has moved from 5 hours/ 8hours to 10hours. Clearly this comes at great economic cost through loss of business and damage to equipment. As a result, numerous firms across the continent have had to install back-up diesel generators, the running costs of which may be three times as high as that of grid-supplied electricity (Kapika, 2013).

Climate change has never spared sub Saharan Africa's verge to providing good electricity services to its population. Climate Change causes low rainfall which in the end makes the dam dry. That is more reason it is said that the situation is further aggravated by the increasing incidence of drought in regions that are dependent on hydropower, as well as high oil prices and civil war. More recently, high economic growth in some countries has led to sharp increases in demand, and this has put further pressure on the need to expand generation capacity and to refurbish and build new networks (Kazunga, 2014).

Kapika (2013) identified the poor financial state of power utilities as a key problem, arguing that this prevented them from meeting the rising consumption demands of existing customers and from expanding access to electricity. The determinants of this poor financial performance are two-fold. Firstly, in terms of revenue, tariff levels are inadequate and tariff structures distorted and uneconomic. The problem is compounded by poor commercial practices such as inefficient meter reading, billing and revenue collection. Secondly, cost containment was weak, with overstaffing, inefficient corporate structures, managerial deficiencies, shoddy operations, and poor maintenance of plant and equipment all commonplace. As a result, utilities have insufficient funds to fulfil their operations and maintenance obligations, let alone the required revenue to invest in meeting rising demand from customers.

What is very interesting about the electricity generation capacity, transmission and distribution in these regions is the relationship it has on economic development of the region in line with electricity accessibility. However, the real gap that exists in the above literature is that there is no specific study done on the effects of electricity/load shedding on smallholder productivity.

2.3. Electricity power is key to Poverty reduction for small holder farmers

Smallholders have a key role to play not only in achieving food security, but also in generating poverty-reducing agricultural growth. They are also stewards of increasingly scarce natural resources and on the frontline of dealing with the impacts of climate change (ASFG, 2015).Therefore,the Government of Zambia recognizes the key role electricity energy plays in development. It´s aware of the fact that energy services are essential inputs to all three pillars of sustainable development - economic, social and environmental. Achieving the Millennium Development Goals (MDGs) in Zambia and the goals of the Poverty reduction Strategy Paper (PRSP) requires the availability of reliable and affordable electricity energy (Ministry of Energy and Water Development, 2006). Since poverty is more widespread in rural areas where most smallholder farmers reside compared to urban areas, the increased funding for rural electrification and the electrification of some farm blocks (USAID, 2005) should be noted as encouraging as it contributes significantly to the enhancement of quality of life in the rural areas.

Increased agricultural productivity is enabled through the use of machinery and irrigation (Deloitte, 2012) which in turn reduces the need to expand quality of land under cultivation, reducing pressure on the ecosystem conversion. It is well know fact that energy could be used to purify water or pump clean ground water locally,reducing time spent collecting it and reducing drudgery.It also a catalyst to rural energy services in enabling non-farm based enterprise and processing of non-timber forest products.On the other hand the efficient use of electricity energy helps to reduce local pollution and improve conditions for rural poor people (Ministry of Energy and Water Development, 2006).

2.4. Driving forces of load shedding in relation to smallholder farmers productivity

Load-shedding results in lost economic opportunities in productive sectors like agriculture and the cost of this opportunity loss is great. In this regard, power rationing has increased the costs of commodity production and processing, driven primarily by the acquisition and operation of back-up generators, equipment start-ups, and idle labour. With generators in place, production losses among the large agro-processing firms are likely to be minimal. In commercial crop production, the effect has been reduced yields. Power rationing has generally led to reductions in producer surpluses, especially for dairy and potato farmers. For other commodities, production costs passed on through price hikes are expected to increase the cost of living for consumers.

Therefore, climate change induced much of the load shedding which has affected the agricultural enterprises in the country and Southern Province mainly in 2015 .Poor seed technology , livestock and poultry breeds that are not suited for the region could have additionally reduced the productivity and production of the region. Improved genetics technologies the farmers use have a bearing in the climate change mitigation and adaptation for farmers increased productivity (Anderson et al, 2015, Cissokho, 2014, Mchopa andAlban, 2014). Therefore, Mill (2015) asserts that load shedding has been disastrous on the farming community in the country because they farmers were not well prepared to mitigate and adapt to the crisis. Politics took a lot of centre stage on information dissemination (Mills, 2015) which were not well packaged on the other hand .

2.5. Energy demands in the poultry subsector

Poultry is one of the major sub sector of the Zambian economy and has a membership strength of over 23,000 involved in poultry production country wide and has continued to grow impressively (Daniel, 2014). Electricity remains a vital input in poultry production from lighting, to heating, ventilation and cooling. Thus electricity is at the core of a productive poultry farm and, as a result, one of the most costly inputs of chicken rearing (ESKOM, 2015).

Poultry is very sensitive to light and heat hence power outages would negatively impact the laying of hens. Layers need sufficient light to come on point of lay and to continue laying eggs. Any disruption in the lighting system is disruption in the laying period of the layers inducing the reduction in the revenue of the farmers whilst broilers will need a lot of heat during 4 critical days as day old chicks, good light and warmth does help to induce feed intake by the broilers. Therefore, if power is not sufficient enough to give enough light and heat, the chicks can die from colds.

With power shortages and rationing, small-scale poultry growers are likely to be the most affected, as they cannot afford the available alternative sources of power such as generators. Effects in this industry are expected to work through rising input costs (e.g., feed and day-old chicks), as well as the direct and indirect costs mentioned earlier. For example, day-old chick prices increased from about ZMW 4.6 to about ZMW 5.45 per bird between June and

November 2015, while for operating alternative power sources like generators the costs rose by 15% (Bwalya and Mwanguhya, 2010).

Daniel (2014) further asserted that smallholder farmers involved in selling perishable poultry products like dressed chickens and fresh fish are facing challenges in terms of storability of the above mentioned products. Because of these challenges the farmers are now reducing their stocks so as to avoid wastage and consequently experience losses as these perishable products have to be kept cool and frozen in the refrigerators, especially when there are long hours of load shedding.

Equally small hatcheries using electrical powered incubators to brood eggs for quails are also being negatively impacted by load shedding. The abrupt changes in temperature in the incubators affects the hatchability of eggs (Dixon et al, 2015), which results in the spoilage of eggs consequently leading to loss of income on this investment (Hibbard et al, 2014) by farmers.Many farmers resort to using charcoal in providing heat to chicken in times when there is power outages more especially in the nights when it becomes cold (Kaseke, 2014, Kaseke , 2010).This increase the destruction ofthe forest (Kalantary, 2010) which is a source of their livelihood in many aspects.

2.6. Energy demands in the dairy Subsector

Dairy products like milk are perishable hence require stable refrigeration. Thus good power supply is very essential in the dairy operations for operating milking systems, cooling milk, and supplying hot water for sanitation (CRS Report for Congress,2004).

Therefore, reliable power is an incentive to farmers as they are assured of market for their milk from processors such as Parmalat who demand quality fresh milk. Because of load shedding the dairy plants are taking five hours to regenerate after eight hours of power cut, which equates to a loss of around 13 hours. This is affecting the dairy farmers because it means their milk cannot be bought as it has gone sour thereby compromising on the quality. With reduced milk production among small-scale producers, the supply of fresh milk is expected to drop. For instance Kabayi Farms Limited in Kabwe incurred losses worth $1.15 million due to a two-day power outage, and as a result the farm is now in debt with its funder (ZNFU, 2014).

Because of the constant power disruptions, productivity in the dairy industry among smallholder farmers has been compromised resulting in the dairy sector failing to perform to high expectation. This in due course has reduced income for the farmers whose livelihood hinges on the dairy industry. This does not even favour also the rural women who are engaged in dairy business. Most of them are tossed off the business because they cannot face the challenges that come with higher productivity and production costs. At the end of the day, even alternative power sources such as solar products and generators (Hartl, 2010) become very unaffordable and inaccessible to them too.

2.7. Supportive rural road network and electric power infrastructure are key to lowering the cost of doing business

Typically, infrastructure in the rural areas of Zambia is poor and this contributes to low electricity connectivity among the rural people. This makes the agricultural enterprises face untold challenges in doing business with rural communities. Long distances combined with limited road coverage and poor road conditions result in long transit times and high transport costs (due to expensive truck maintenance and diesel fuel). Electric power is essential to modern, competitive beef and dairy industries (Asian Development Bank, 2015), yet in Zambia, rural access is severely limited. For agricultural firms in Zambia, access to electricity is associated with 52 percent higher productivity; but even in provinces along the line of rail, only about 6 percent of rural entrepreneurs are connected (Msaki , 2015). Farmers in other parts of the province have even lower or no access to better roads and electricity. Outages are a concern and, in the absence of reliable access to grid electricity, processors and farmers must rely on expensive standby diesel generation (Clarke et al, June 2010).

On the other hand, beef processing enterprises (abattoirs) use electricity for both production and cold storage mainly, though also for lighting. Many studies have been done to ascertain how power outages have caused severe problems in this subsector in Australia. Delayed livestock slaughter, processing and compromised quality have been noted as main challenges that have been caused by power cuts. Also increased costs that go with generator acquisition (Punt, 2008) are some result of load shedding effects and impact (Austria Meet Proccessor, 2013). Worst part is the lazing around of workers because the processing plant comes to standstill in many cases. Electricity is a valuable input to produce most goods and services, therefore higher electricity price can affect the costings and prices in other sectors of the economy both directly and indirectly (Punt, 2008)

2.8. Energy demands in the irrigation subsector

In the area of irrigation, the primary cost of outages is the impact on output of crops due to decline in water availability arising from a reduction in the number of hours operated by electric tube wells. Hafiz & Saleem, (2013) observed that farms using electric tube wells lose about 27 % of the working hours in outages, meaning that load shedding has an effect on productivity of a farm more especially those using irrigation which is more of intensification type of agriculture. Most of irrigated crops are high value crops, thus a farmer would not want to lose his crop from power load shedding,but when it is beyond his control, he has no option but to give up.For those who have managed to invest in generators, the cost of running them is very high due to high cost of fuel thereby production costs are increasing. Generators again tend to contaminate the water sources and the crop due to the carbon they emit (Mikhail, 2011).

Chowdhury and Torero (2007) acknowledged the use of electricity in irrigation as it significantly contributed to the agricultural productivity growth. For instance in the green revolution which occurred in India in 1950, electricity was identified as one of the key catalyst to this growth. With the use of electricity the yield per hectare for food grains increased (Winkler, 2009 , Sawe , 2004) and more importantly the use of clean energy does not disturb the normal growth of the plant in any way due to none deposit of carbon on the plant emitted from the form of electricity in question.

Therefore, a strong association exists between the use of electricity in agriculture and the productivity in agriculture. However, despite this strong association, the use of electricity in agriculture had already shown the sign of diminishing marginal return starting from 1980s because of power cuts (Gilberto, 2012, GIMPA, 2013).

Grace Communications Foundation (2016) indicated that the water, power and food nexus is the intrinsic linkage of energy which is required to access water that is needed to grow food for mankind. The report is indicative that 40% of people are employed in the agriculture sector worldwide (about 80% in Zambia) despite living in poverty and failing feed themselves. Irrigation can help to increase output of the productivity of farming by 10% and increases socio-economic capacity by 7% in Africa and 5% in Asia. Fossil fuel based electricity and diesel generators are used to power the majority of irrigation pumps around the world, using annually the same amount of power as Singapore in a year - around 62 terra watt hours (Grace Communications Foundation, 2016). Therefore, solar power can be used as a replacement of fossil fuel based sources is more environmentally friendly and financially sustainable over a longer period of time. Implementing new solar powered pumps in areas where there is no grid infrastructure provides a way for communities to grow their own food, where once they had no access to water to grow crops.

2.9. Energy demands in labour subsector

Load shedding has cost implication in relation to labour, therefore farmers need to have some knowledge on how to deal or mitigate its impact and effects on agricultural productivity. Load shedding reduces the productivity of smallholder farmers who depend on electricity for their poultry and crop production, crop irrigation, meat and milk processing and production through a reduction in labour force. Wyk (2015) asserts that in Pakistan the loss of output due to outages was estimated to have resulted in a loss of employment of almost 1.8 million. Of this labour, 39 % of this loss was in agriculture, 25 % in the industrial sector and 36 % in services sectors respectively. However Wyk (2015) argued that despite the erratic power supply employers and employees should know their rights and duties during these periods of interrupted power supply to avoid exploiting each other.Wyk (2015) further argued that employers need to ensure that they comply with labour law requirements while at the same time, implementing measures to reduce the negative impact that load shedding has on their businesses.

2.9.1. The Hydro Electricity Challenge in Zambia

Economic progress since 2000, driven mainly by mining production and related services, has substantially increased the demand for electricity in Zambia. A growing shortfall in supply has been exacerbated in 2015 by a reduction in hydroelectric generation due to low water levels caused by climate change at the country's main reservoirs. This has increased power outages and impacted all aspects of the economy, contributing to slower economic growth in around 2015 and resulted in higher production costs.

Despite climate change impact, Zambia's economy has expanded by an average of 6.4% per year between 2010 and 2014, and 7.4% over the last decade. This economic expansion has increased the demand for electricity by 4% per annum over the same period (World Bank Group, December, 2015). With very little new generationcapacity being brought online in the past 30 years, Zambia has been experiencing a power deficit over the past 4-5 years, characterized by power outages commonly referred to as load-shedding (Engineering Institution of Zambia, 2015).

Approximately 95% of generation capacity is linked to hydropower plants (Kessides, 2014), hence the electricity supply is heavily dependent on hydrology. This puts the country at risk in the event of drought, more so recently as the gap between generation and demand has widened.

While installed capacity, measured in Mega Watts (MW), has been higher than existing peak demand, available energy generation, measured in Giga Watt Hours (GWh) and which has an approximate linear relationship to the water used, has remained below the country's total energy demand. This has been worsened in 2015 due to low water levels in the main reservoirs used for hydroelectric generation.

Despite plenty of warning about dependency on hydro power and rising power demand, there has been very little improvement in generation capacity. Until 2006, Zambia had surplus power and this partly explains why prior to the 360MW Kariba North Bank Extension that was completed in 2015, the last major plant to be commissioned was the Kariba North Bank in 1977 (Zambezi River Authority, 2015). The history of surplus has also contributed to low tariffs which have been one of several barriers to investment in the grid and new generation capacity to meet rising demand.

Load-shedding has been increasingly common since 2006, but it has got much worse in 2015 and beginning of 2016. The shortfall in energy supply has impacted on manufacturing and industry (including mining), increasing the costs of production, and is negatively impacting on the quality of life of Zambians with access to grid electricity. Zambia's power challenge adds to the list of negative shocks impacting on the Zambian economy in 2015.

2.9.2. Zambia's Modern Power Crisis

Since around July 2015, ZESCO opted to increase the extent of rolling black-outs (load-shedding) to at least 8 hours per day on a rotational basis for the majority of its household, as well as commercial and industrial consumers including agricultural enterprises.

Although they are not subject to rotational load-shedding, ZESCO had requested even the mining industry to curtail its load at around 30% which has a negative impact on the growth of agricultural sector too. This is in order to manage a power deficit of around 591 MW each month (September to December 2015), representing approximately 34% of demand as shown in Table 2 (World Bank Group, December,2015).

At the national level, the power crisis has already caused reduced output and redundancies across businesses in the services, manufacturing and industrial sectors such as those relying on agricultural products for them to function. Manufactures and other processing plants are reporting increased costs of production, as they are forced to run costly generators or switch shifts to when they have electricity (extra pay is often needed for night shifts) and many declare they are only meeting between 30 and 40% of scheduled production (Patil & Chavan, 2011, Winde, 2015). Firms like abattoirs,milk centres engaging in complex procedures (some machines are designed to run 24 hours and require 3-4 hours of heating before use) and those requiring refrigeration are suffering (UKAID and World Bank, 2011) particularly badly. The mining sector on which the agricultural sector depends on as output market, is already impacted on by lower copper prices and load shedding, due to this it has announced closures, laying off 7,700 workers and postponed investment (World Bank Group, December, 2015). This means that even the disposal income for workers reduced and the market of meat,poultry, andvegatable reduced and then women suffer more (WIEGO, 2015) being the one charged with every search for family food too.

Table 2 shows the current generation capacity of ZESCO (987.5 mega watts),Lusenfwa Hydro (22.0), Ndola Energy (41.0) with extra emegency imports the government is making to mitigate the scourge from Day Ahead market (38), Electrcity de Mozambique (27.0) and Aggreko (107.0).

Table 2: A Severe electric power generation deficits in 2015

September to December 2015	**MGW**
ZESCO Generation	987.5
Lunsemfwa Hydro	22.0
Ndola Energy	41.0
Emergency Import-Day ahead market	38.0
Emergency Imports-Electricity de Mozambique(EDM)	27.0
Emergency Imports - Aggreko (148MW for 16hrs daily)	107.0
Itezhi Tezhi Power Station	-
Total Generation	1,222.5
Transmission Losses	73.4
Total Demand	1,740
Total Deficit	590.9
Total Deficit	34.0

Source: World Bank Group, (December,2015)

The decision by ZESCO to limit electricity generation is due to the historically low water levels at the country's reservoirs (including Kariba, Itezhi Tezhi and Kafue Gorge) that store water for hydroelectric generation. Prior to the start of the increased loadshedding in July, ZESCO generation capacity was in the range of 1,800 – 2,000 MW (Neuberta, 2012). The reason for the low water levels is a combination of lower rainfall (during the 2014-15 rainy season) and increased water usage.

Zambia's and Zimbabwe's water allocation at Kariba dam is regulated by the Zambezi River Authority (ZRA) and in both 2013 and 2014, ZESCO exceeded its allocation by 5% and 22% respectively (World Bank Group, December,2015). The commissioning of the Kariba North Bank Extension project in 2014 contributed to increased water use at the Kariba reservoir and the reservoir has not reached its maximum retention levels since 2010. Water levels in the reservoirs will recover somewhat during the 2015 -16 rain season, assuming usage according to allocation, but it will take several years of rainfall and balanced usage for them to recover to maximum levels.

As of mid-November 2015, most areas of Zambia had experienced low rainfall and if this trend continues (the El Niño is expected to last into Q1 2016), there will be only limited recovery in 2016 (ZESCO, 2015, Robbins, 2016). If, however, reservoir levels continue to drop, ZESCO may be forced to curtail generation at the Kafue Gorge and at Kariba North Bank (including the extension) power stations even more. However, some relief lies in the just lauched Maamba Thermal plant by President Edgar Lungu in Sinazongwe District of Southern province generating and supplying about 150 megawatts of 300 Megawatts to the national grid to easeup this electricity deficit.

2.9.3. Agricultural productivity, food security and droughts

The economic impact of climate change on southern Province is compounded by its agriculture-based economies-the agricultural sector accounts for about 80 per cent of employment and probably more than 60 per cent of the gross domestic product (GDP), its reliance on traditional technology and its dependence on only a few agricultural exports. Climate change is expected to lead to a 50 per cent decline in agricultural output by 2020

(Swain, 2012). This would not only endanger the food security situation but also increase the vulnerability of 80% small-scale farmers in the province.This also endangers aquaticlife in water bodies and also reduces the production of hydro electricity for the country and the region. The chronic hunger situation is expected to worsen due to declining water resources, resulting in a 5-8 percent increase in arid and semi-arid lands by the 2080s (Swain , 2012).

The precarious food situation of the Southern Province region could be as the result of various factors, including: unfavourable climatic conditions (erratic rainfall, drought and floods), poor and depleted soils, environmental degradation, failed sectorial and macro-economic policies, and inadequate support systems (Swain etal , 2012 ,Beilfuss, 2012). The smallholder farmers in Southern Province are especially vulnerable when their annual crops,poultry and livestock fail them. This is because, first, locally produced food becomes unavailable or scarce. Second, they cannot purchase food available in the market due to the loss of agricultural income, which is their main source.

Analysing the food situation in Southern Africa and Southern Province, Swain (2012) identified some factors that contribute to the food crisis in the region. Two of these factors are directly related to climate change. Severe dry spells and droughts are causing problems for Mazabuka, Monze, Choma,Kalomoand Namwala. Reduced runoff aggravates existing water stress, reduces land quality, lowers the quantity of water available for domestic and industrial use, and limits hydropower production. Agricultural drought (inadequate availabilityof water for crops) causes 10 to 50 per cent of annual yield losses on 80 per cent of the area planted with maize in the region (Chibinga, 2013). Below-normal rainfall years also occur more and more frequently, resulting in poor harvests especially due to the lack of early-maturing and drought-tolerant varieties. The shortage of dry-season fodder has also become a major constraint for livestock production, further impacting the food and income security in the region. Even though the effect of climate change on water scarcity may be relatively minor, it has the potential to have international and national consequences and become a source of conflict (Econorisk, 2010). Environmental degradation caused by soil erosion, desertification, deforestation and inappropriate agricultural practices remains a major threat to agricultural sustainability due to power load shedding which institution tasked to generate and distribute and supply it do not seem to realize. Added to the economic costs are the social and environmental impacts of the power crisis. It becomes much harder to provide quality health care and education if hospitals, schools, clinics and universities are experiencing electricity power outages (World Bank Group, December,2015).This impact also the smallholder farmers households in the communities.

The load-shedding has typically been for 8 hours per day though due to other outages,it went to probably 10hrs. Between June and August, it was restricted to six hours on the Copperbelt, but since then the country has been without power for on average eight hours per day. The load-shedding aimed to reduce demand, but there is not a full saving as often consumers delay some of their consumption to times when power is available.

2.9.4. Summary of Literature Review and Identified Gaps

It can be deduced from the above literature that energy access is an important issue directly related to income and poverty. Apart from being a direct cause of lower economic growth, the lack of modern energy services is certainly a major impediment to confronting drought and raising smallholder farmers' productivity. Electricity has been one of the drivers of agricultural productivity not only among the commercial and emergent farmers but also among the smallholder farmers leading to their economical, social, and environmental development. It is undeniable fact that most smallholders, emergent and commercial farmers who have taken agriculture as a business have taken electricity as their source of input more especially around irrigation, poultry and feedlot, fishery trading business; banking and other small scale business ventures. Therefore, the smallholder farmers' demand for electricity in the era of mechanization and modernization is high.

There seem to be some empirical evidence indicating that there is a clear correlation between power-cuts and industrial performance. Looking at how the farmers appear to be struggling during this load shedding period a layman would not hesitate to claim that the productivity of smallholder farmers in Zambia are equally affected as a result of this ongoing power load shedding by the utility company ZESCO. This study as aforesaid, will evaluate the effects of load-shedding on the productivity of small scale farmers in the aforementioned districts in Southern Province. It is likely that the impact and effect of electricity blackout on the agriculture is enormous and it is hoped that the findings of this research will help in revamping the sector particularly among the small-scale farmers.

In short the above literature indicates that in general agricultural productivity depends on electricity for its growth but few statistics to show how smallholder farmers and even medium scale farmers depend on it are documented. However, it appears there is no single known cause of load-shedding in Zambia but there are confusing statements being heard from different stakeholders justifying to safeguarding their own position. Therefore, studying the effects of load shedding on smallholder farmers' productivity is necessary. The findings of such studies is hoped to be used as a basis for planning and implementation of load shedding interventions among many stakeholders that include smallholder farmers in Zambia. Energy, land and water are intertwined in their relationship. Studies show that any one of them if impacted by climate change would also affect the other. In Zambia there seem to be very limited studies done on smallholder farmers' productivity due to load shedding.

3. METHODS AND PROCEEDURES

3.1. Introduction

This chapter introduces the methods and procedures that were employed in sampling, data collection and analysis.

3.2. Study area

The case study was conducted in the Southern Province of Zambia, owing to the fact that most of the smallholder enterprise are involved in both livestock and crop production and use electricity for their production either direct and or indirectly. Five districts of Southern Province were identified and selected for the study, and these included; Mazabuka, Monze, Choma, Kalomo and Namwala. According to 2015/2016 crop forecast survey conducted ,these districts represent 75% of land cultivated for production of maize and 80% yields expected as for 2016 market season in the province making them very productive districts for the province (PACO's Office, 2016). These districts had been purposively chosen to represent all the districts across the province. The sampled districts were convenient for coverage by the researcher hence helped to reduce cost of administering the study.

Map 1: Study areas: Mazabuka, Monze, Choma, Kalomo and Namwala in Southern province

Source :(Author, 2016)

3.4 Research design

The study was based on a non-experimental research design and cross section data for a period of January 2015 to March 2016. The period was further divided into before load shedding period (from 1st February, 2015 to 30th June, 2015) and during load shedding period (from 1st July, 2015 to 1st February, 2016). A quantitative and qualitative approach was used and this included administering questionnaires to the respondents (owner/ representatives of the enterprise). This generated quantifiable and qualitative results making it quick to record the data and also made the analysis easier.

3.5. Study population and sampling procedure.

This study had a sample size of 149 agricultural enterprises. Since there was no official listing of many enterprises to provide a total population from which an optimal sample could be drawn, the researcher began with compiling a sampling frame of all enterprise that use hydro power. The main sources of data were Ministry of Agriculture and Livestock, Southern Water and Sewerage Company (SWASCO) and established shops for day old chick (we asked for customers). Table 3 below elaborates the total population that we managed to identify in the sample areas.

Table 3: Population and sample size of studied agricultural enterprise

Enterprise	Total population	sample
Poultry	420	72
Crop irrigation	45	32
Dairy(milk collection centre)	36	29
Abattoir	14	12
Feedlot	4	4
Total	519	149

Table 4: The selected sample agricultural enterprise from studied districts

Type of enterprise	Mazabuka	Monze	Choma	Kalomo	Namwala	Total
Dairy(milk collection)	4	10	5	2	8	29
Beef(Abattoir)	2	2	4	1	3	12
Crop (irrigation)	5	1	12	1	13	32
Feedlots	0	0	3	0	1	4
Poultry	9	12	21	23	7	72
Total	**20**	**25**	**45**	**27**	**32**	**149**

According to Sekeran (2003) randomness begins with total population of 15 and above. We thus followed the generalized scientific guideline for sample size decisions, to determine the sample size for dairy, beef (abattoir), crop irrigation and poultry at the margin of error of less than 5%. We used excel random sampling function to draw the required sample. However, since the total population for feed lots was below 15 (according to Sekeran (2003), Krejcie and Morgan (1970), we purposively selected all feedlot enterprise. The selection of the samples used the following formula:

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where

n_0 Is the sample size

Z^2 Is the abscissa of the normal curve that cuts off area desired at 95% confidence level.

P is estimated proportion of population with desired characteristic (affected by climate change)

q is 1-p

e is the error desired to be tolerated is 5%

3.5. Quality Control

Quality control was a continuous process throughout the study to maximize validity and reliability of the findings of the study.

3.6. Validity and Reliability of Research Instruments and Pre-test

Best and Kahn (2010) explain that validity is the quality of a research instrument tool or procedure of data collection that enables it to measure what it is required to measure. Prior to conducting the survey, a one full day orientation session was organized by the team leader to brief the Research Assistants on the process, objectives, methods and data collection tools for conducting the research. The team members were also familiarized with the questionnaires to be used. The session included a segment of a classroom session and later pilot fieldwork at one of the selected respondents in Choma town to pre-test the questionnaire. This exercise was very useful as it helped fine tune the questionnaires and provided feed back to the research team at the end of pilot field work. The study tools were presented to the University for Validation by the supervisors and research panellists before data collection.

Reliability is the consistency of results over time under similar research methods and the consistent results after repeated trials as described by Bryman and Bell (2003). If the research tool was administered to other respondents, it should yield the same results; the results from similar questions should be related to indicate reliability. Cronbach's alpha coefficient is a statistical method in research that was used to test reliability. The test splits all the answers to a given question into two section or groups then the scores obtained are summed up. The researcher worked out the correlation between the two (a 'split-half test). An alpha (α) score of 0.70 or higher was considered satisfactory and ascertains reliability.

3.7. Logistical and Ethical considerations

The study was guided by following the ethical obligations pertaining to human research, hence, the need for approval from the research and ethics committee (Duffy, 1985 ,Ellsberg & Heise, 2005). The study complied with the following:

3.7.1. Ethical Approval

Informed consent from the research subjects was acquired and research participants were informed on the aims, methods and privacy of the research. This was done in simple and well-articulated languages such as Tonga and Nyanja. In other words, the ethics of confidentiality was highly observed. To this end, names of smallholder farmers were not revealed to ensure anonymity. Therefore, no individual piece of information, fact, idea, principle, truth and attitude towards electricity load shedding were considered as valid or invalid and/or worthy of acceptance or rejection.

3.8. Data Analysis

The data collected from questionnaires was entered and analysed using the Statistical Package for Social Sciences (SPSS), Stata and Microsoft Excel. Descriptive statistics and other relevant frequency distributions and graphs were run to analyse the socio-economic and demographic characteristic of the enterprise and respondents respectively. In addition, the Chi-square, t-test and cross tab were used to test the relationships between the variables in our hypothesis and also help the decision whether to accept or reject a hypothesis. In addition, 17 focus group discussions were administered which included a particular enterprises and participation of its direct beneficiaries (farmers). Farmers participating in the focus group discussion were (1) farmers that supply milk to dairy (milk collection centres) (2) Farmers that supply beef animals to abattoir or buy beef product (3) Farmers that are doing gardens using hydro power or were connected to Southern Water and Sewerage Company (SWASCO), (4) farmers that do poultry and finally (5) suppliers and buyers of animals to feedlot enterprise.

3.9. Study duration

The study duration was 12 months (February – June 2015) termed as preload shedding period and from July 2015 to February 2016 as during load shedding period.

4.0. RESULTS AND INTERPRETATION

4.1. Introduction

This section consists of the findings of the study as well as their interpretation and discussion. The section starts with a descriptive analysis followed by the Chi-square test.

4.2. Descriptive Analysis

4.2.1. Specialization of Agricultural enterprises

Figure 1 below shows the composition of the sampled enterprises. Of the sample enterprises, 48.32% were involved in Poultry, 21.48% in Crop irrigation, 19.46% in Dairy (milk collection centres), 8.05% in Beef (abattoir) and 2.68% in Feedlots.

Figure 1: Distribution of the studied enterprises

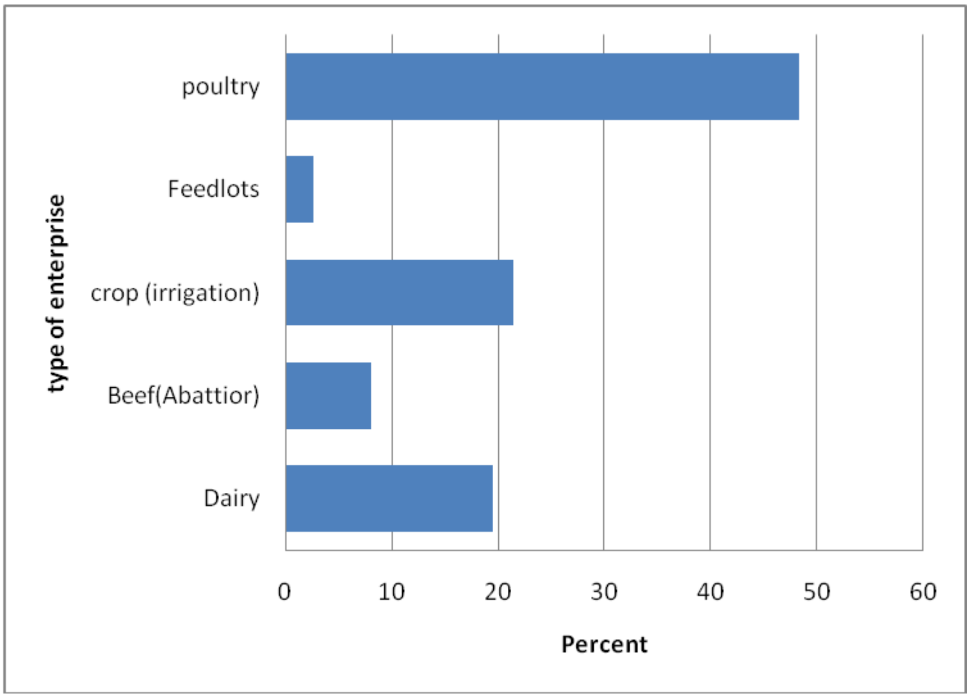
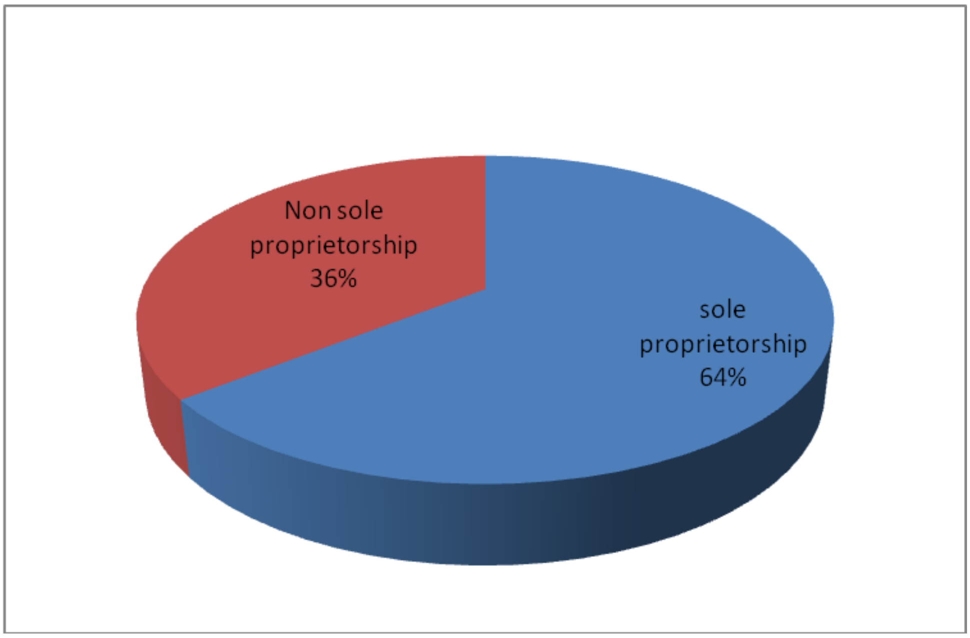


Figure 2 presents the type of proprietorship in the study area. The results indicate that the majority of the enterprises were run as Sole proprietorship[1] (64%) and while 36% were Non-Sole proprietorship[2]

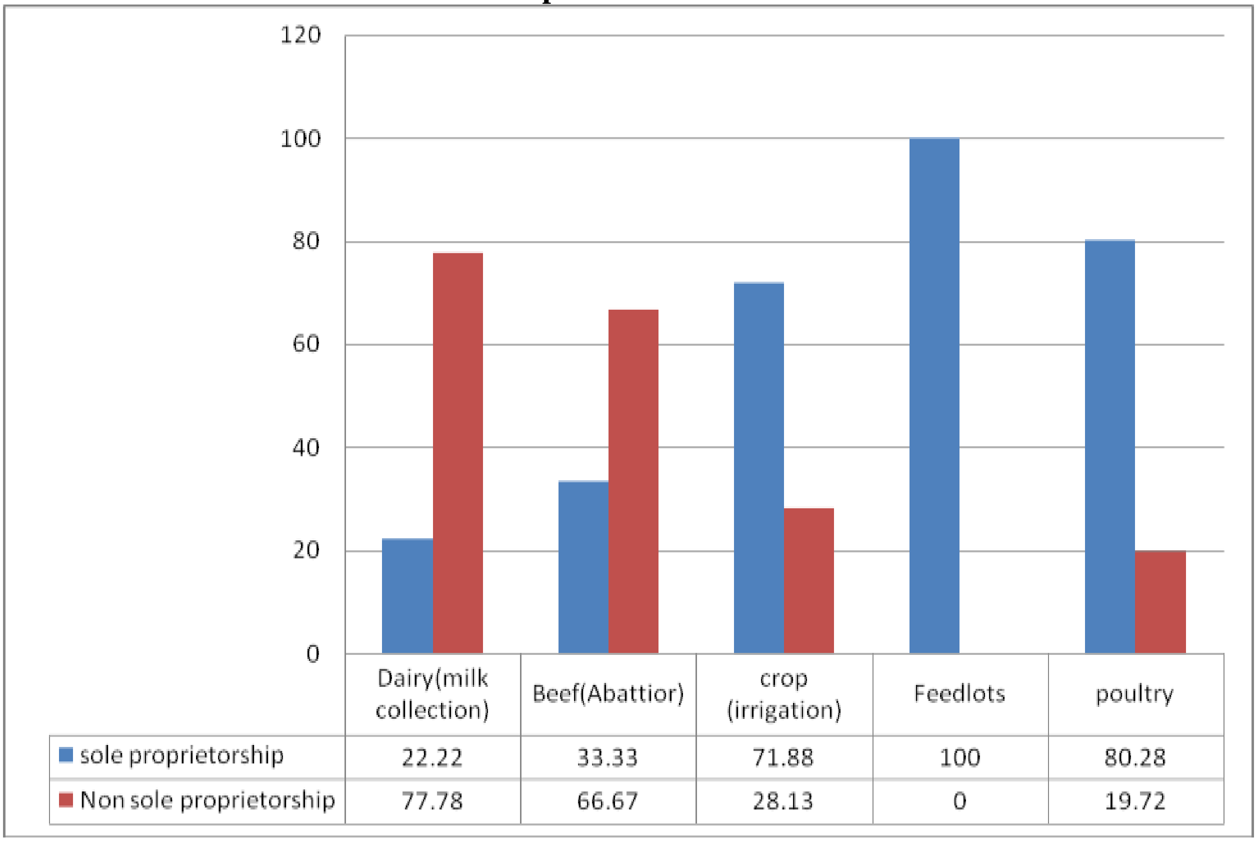
Figure 2 : Distribution of the type of proprietorship in the study



The Figure 3 below presents the type of proprietorship and agricultural enterprise of specialization. Enterprises run as Sole proprietorship included 100% of feedlots, 80.3% of poultry enterprise and 71.9% of crop irrigation. Meanwhile, 78% of dairy-milk collection centres and 66.7 % of beef abattoirs were run as Non-Sole proprietorship.

[1]Enterprise categorized as Sole proprietorship was at least dominantly run by one person or uses more of family labor.
[2]For enterprises in the form of cooperative/association, company, public (Parastatal) and partnership, fell under the non-proprietorship category.

Figure 3: The relationship between type of proprietorship and Agricultural enterprise specialized



4.2.2. Demographic Characteristics of sole proprietors

Table 5 shows the selected demographic characteristics of the Sole proprietorship in the study. More than half (57%) of respondents were males and 43% were females. Meanwhile 70 % of respondents were married, 17% single, 10.7% widowed and 1.8% divorced. The size of the household ranged from 1 to 20 household members; however the mean size was about 7 people per household.

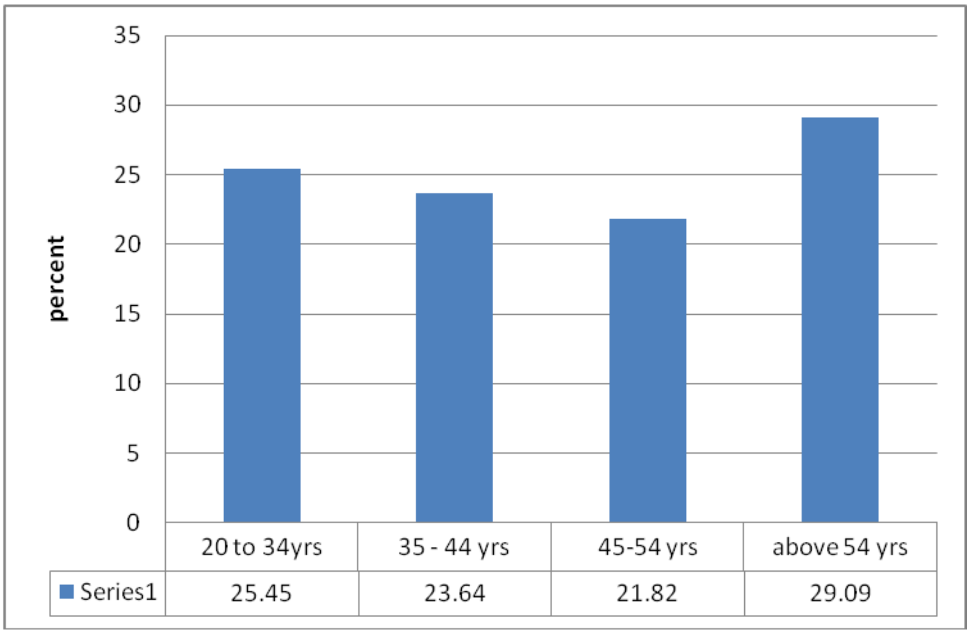
Table 5: Demographic characteristics of Sole proprietors

Variable	Observation	percent
Gender		
-Male	32	57
-Female	24	43
Marital status		
-Single	10	17.9
-Married	39	69.6
-Widow	6	10.7
-Divorced	1	1.8
Education level		
-No formal education	3	5.4
-Primary	8	14.3
-Secondary	18	32.1
-Tertiary	27	48.8
Employment status		
-Full time farmer	15	28
-Part time farmer	24	44
-Formally Employed	7	13
-Pensioner	8	15
Mean Age	55	45
-*Range*	(20-70)	
Mean household size	56	6.9
-*Range*	(1-20)	(1-20)

About 94% of the sole proprietors interviewed had some formal of education. Of these, 48.8% had attained tertiary education, 32.1% attained secondary education and 14.3% attained primary education. Only about 5.4 % had no formal of education at all. Further, 44% of respondents were part time farmers, 28% were full time farmers, 15% were pensioners and 13% were formally employed. The estimated mean age in the sample was 45 years, ranging from 20 to 70 years.

In Figure 4 below, the active age of respondents who were running enterprise as Sole proprietorship ranged from 54 years to 70 years representing 29 % of sampled age, closely followed by 25.45% of age between 20 and 34 years.

Figure 4: Distribution of Age of the Sole proprietors



4.2.3. Hydro Electric Power and Usage in sample enterprise

Figure 5 presents the relationship between hydroelectric power usage and the type of enterprise. Overall, 42% of the enterprise needed electricity for production purposes, 32% for display (lighting) purposes and 24.32% for storage purposes. All Feedlot enterprise used electricity in production. In crop irrigation, much of hydroelectric power (96.8%) was used for production purposes and 3 % in display (lighting).The reported main use of electricity in dairy (milk collection center) was storage (86.2%) and production (13.79%). Poultry enterprises used electricity for display/lighting (66.8%), production (26.39%) and storage (6.94%). The main use of electricity in beef (abattoirs) enterprise was production (50%) and storage (50%).

Figure 5: The relationship between hydroelectric power usage and the type of enterprise

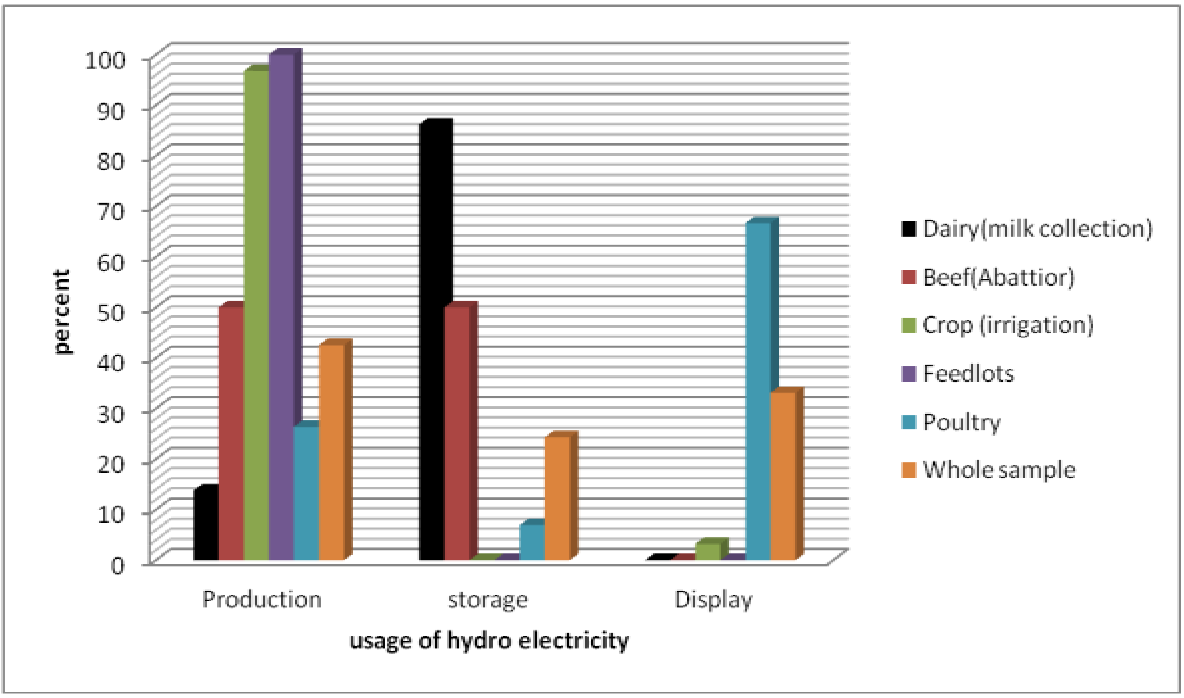


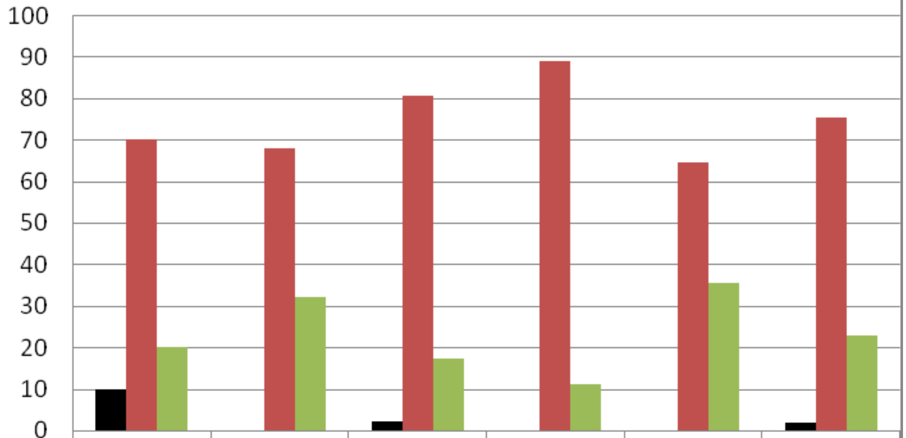
Table 6 indicates the duration of a typical electrical power cut/load shedding experienced by respondents in the studied districts. Overall, the mean hours of load shedding was 7.6 hrs during the day and ranging from 5 to 8 hours, while during the night time power cuts ranged from 1 to 8 hours with mean of 7.3 hours.

Table 6: Duration of a typical electrical power cut (hrs) in the sample districts

	whole	**Studied areas**				
Power cut	**sample**	**Mazabuka**	**Monze**	**Choma**	**Kalomo**	**Namwala**
Daytime(hrs)	7.64	6.8	7	7.9	8	7.8
- *Range*	(5-8)	(5-8)	(5-8)	(6-8)	(8-8)	(6-8)
Night time(hrs)	7.31	6.6	4.8	7.7	8	7.8
- *Range*	(1-8)	(3-8)	(1-8)	(2-8)	(8-8)	(1-8)
Observation (Daytime)	145	18	24	45	27	31
Observation (Night Time)	125	5	18	45	27	30

Results shown in figure 6 present the experience of hydroelectric power supply in the studied districts from July 2015 to February 2016. Overall, 75 % enterprises reported scheduled/ planned power cut, 23% experienced unscheduled power cut and 2% had consistent power supply. Of these, Kalomo enterprises reported experiencing load shedding that was scheduled (88.89%) and 11.11% unscheduled power cuts. Choma enterprises reported experiencing load shedding that was scheduled (80.43%), 17.39% unscheduled power cuts and 2.17 % had consistent power supply. Furthermore, Namwala enterprises reported experiencing load shedding that was scheduled (64.52%) and 35.48% unscheduled power cuts.

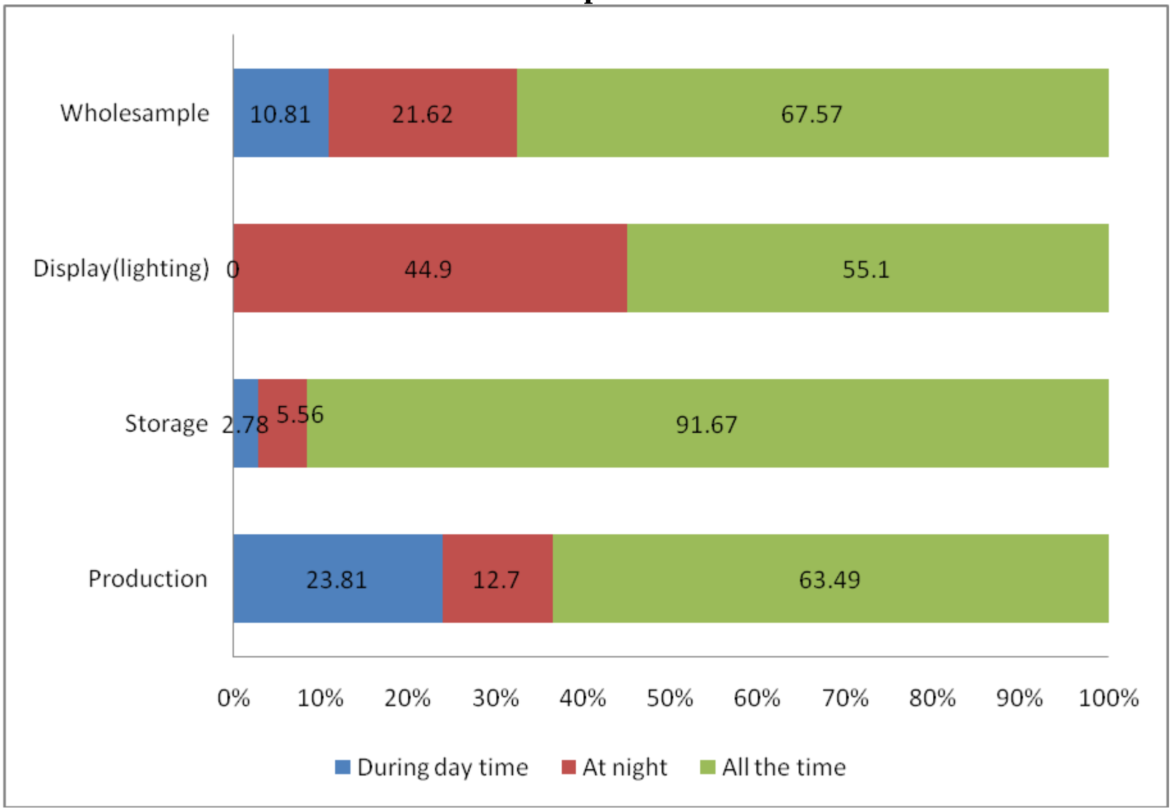
Figure 6: Distribution of hydro electric power supply in the studied districts



	Mazabuka	Monze	Choma	Kalomo	Namwala	whole sample
Consistent supply	10	0	2.17	0	0	2
Scheduled(planned) power cut	70	68	80.43	88.89	64.52	75.17
Unscheduled(unplanned) power cut	20	32	17.39	11.11	35.48	22.83

It is shown in Figure 7 that 67.57% of the sample enterprises (whole sample) need power all the time. Further, about 92%, 63% and 55% of enterprises that use power in storage, production and display (lighting) respectively need power all the time.

Figure 7: Distribution of hydro electric power usage by time of operation



4.2.4. Agricultural enterprise sourcing alternative power supply during load shedding

Figure 8 shows the type of proprietorship that sourced alternative power supply whenever there was a power cut. Of the sampled enterprises ran as Sole proprietorship, about 15% sourced alternative power supply all the time, 25.53% sourced alternative power supply at night, 14% sourced alternative power supply sometimes while 43% never sourced alternative power at all. On the other hand, among the sample enterprises run as Non-Sole proprietorship, sixty-six percent sourced alternative power supply all the time while 22% never sourced alternative power at all.

Figure 8: The relationship between sourcing alternative power supply and the type of proprietorship during load shedding

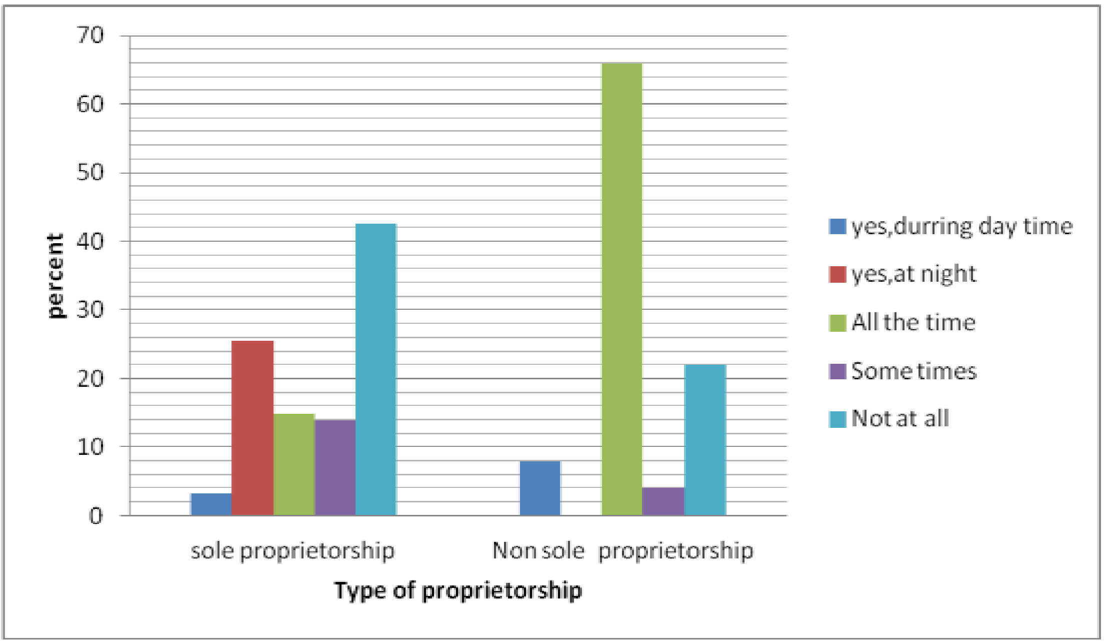
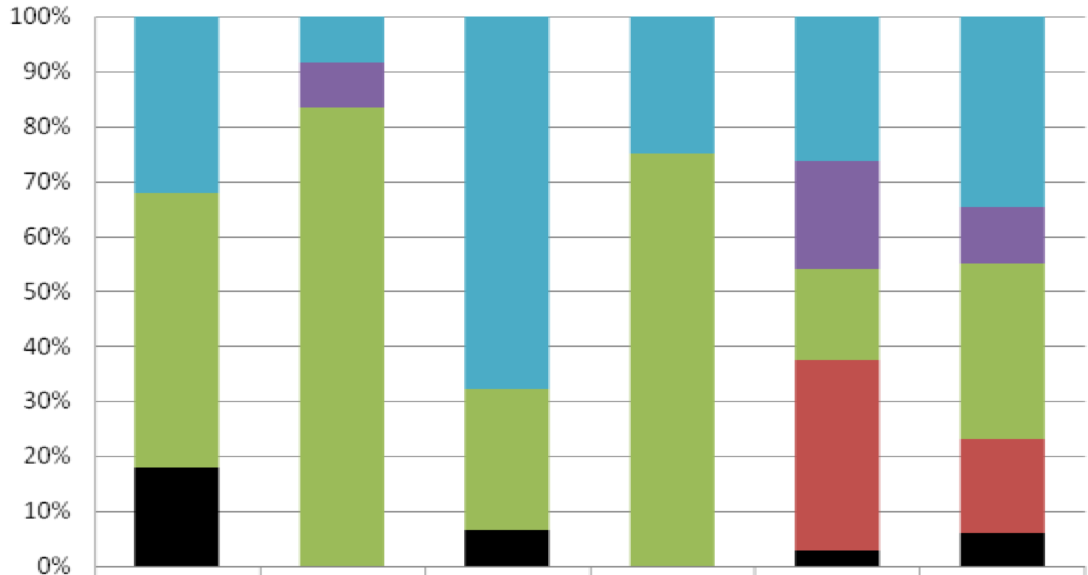


Figure 9 below presents the type of enterprise that sourced alternative power supply whenever there was a power cut. Of the sample dairy enterprise, 50% sourced alternative power supply all the time, 17.9% sourced alternative power supply during the day and 32.14% never sourced alternative power at all. About 83 % of beef abattoirs enterprise sourced alternative power supply all the time and 8.3% sourced alternative power some time and 8.33% did not source alternative power at all. Further, about sixty-eight percent of crop irrigation enterprise never sourced alternative power at all, only 25.8% and 6.45% sourced alternative power all the times and during the day respectively. Of the sample feedlot enterprise, 75% sourced alternative power supply all the time and 25% could not source alternative power at all. Poultry enterprises sourced alternative power supply at night (34.7%), all the time (16.8%), sometimes (19.4%) while 26.4% never sourced alternative power at all whenever there was a power cut.

Figure 9: The relationship between sourcing alternative power supply and the type of enterprise during load shedding



	Dairy(milk collection	Beef(Abbattiores)	crop (irrigation)	Feedlots	poultry	whole sample
Not at all	32.14	8.33	67.74	25	26.39	34.69
Some times	0	8.33	0	0	19.44	10.2
All the time	50	83.33	25.81	75	16.67	31.97
yes,at night	0	0	0	0	34.72	17.01
yes,durring day time	17.86	0	6.45	0	2.78	6.12

4.2.5. Acquisition (ownership) of assets among the sampled enterprises

Table 7 lists assets that were commonly owned and also considered as alternative source of power in the studied enterprise. In the whole sample, 43% of enterprise reported owning a breezier while 57% do not own. Majority of the enterprises that owned brazier were poultry amounting to 80.56%. Further, 39% of the sample enterprise indicated having generator while 61% did not have. Of those that have generators, 30.2% own through buying, 5.37% have rented in, 2.68% own them as gift from well-wishers and only 0.67% borrowed in. The majority of enterprises owning a generator through purchasing were abattoir (91.67%), Feedlot (75%), dairy (27.59%) and poultry (22.2%). Most of the poultry enterprise own rechargeable lamps (72.33%), battery (19.44%) and solar panel (22%).

Table 7: The selected assets owned by sample enterprise

Type of Asset	Whole sample	Type of enterprise				
		Dairy	Abattoirs	Crop irrigation	Feedlot	Poultry
Generator (%)						
-Do not own	61	27.59	8.33	78.13	25	77.8
-Bought	30.2	27.59	91.67	21.9	75	22.2
-Rented in	5.37	27.59	0	0	0	0
-Borrowed in	0.67	3.54	0	0	0	0
-Gift in kind	2.68	13.79	0	0	0	0
Solar panel (%)						
-Do not own	87	93	100	100	100	77.9
-Bought	12	3.45	0	0	0	22
-Gift in kind	0.67	3.45	0	0	0	0
Battery (%)						
-Do not own	82.6	65.5	83.3	100	100	80.56
-Bought	10.7	0	16.7	0	0	19.44
-Rented in	5.4	27.6	0	0	0	0
-Borrowed in	0.67	3.45	0	0	0	0
-Gift in kind	0.67	3.45	0	0	0	0
Breezier (%)						
-Do not own	57	86	91.7	96.9	100	19.4
-Bought	42	10	8.3	3.13	0	80.56
-Gift in kind	0.67	3.45	0	0	0	0
Rechargeable lamps (%)						
-Do not own	63	96.55	100	93.75	100	27.78
-Bought	35.6	3.45	0	0	0	72.33
-Rented in	1.34	0	0	6.25	0	0
Electric Pump (%)						
-Do not own	85.25	93	66.67	56.25	100	97.22
-Bought	13.42	0	33.3	43.73	0	2.78
-Gift in kind	1.34	6.9	0	0	0	0
Number of observation	**149**	**29**	**12**	**32**	**4**	**72**

4.2.4. The experience of enterprise in the Pre load shedding and during load shedding periods

Table 8 lists factors observed on enterprises ran by either Sole proprietors or Non-Sole proprietors ‘before load shedding period[3]’ and ‘during load shedding period’[4]. With regards to “before load shedding period” (from 1st February, 2015 to 30th June, 2015), overall, 99.3% of enterprise were operating while 1.39% of enterprise did not operate. The duration of business was (mean) 130 months i.e. 10.8 years. The main source of capital for enterprises run as Sole proprietorship was 95.7% of their own capital, 3.23% from family and friends, and 1.08% from financial institutions. Of the sample enterprise owned by Non sole proprietors, 50% were cooperatives/association, 39.9% were company owned, public/parastatal (5.66%) and partnership (5.66%). The mean number of casual workers was: 1.5 employees for dairy enterprise, 3.75 employees for beef abattoir, 26.5 employee for crop irrigation and 1.2 employees for poultry enterprise. Further, the mean number of full time employees was: 4.17 employees for Dairy enterprise, 24.7 employees for beef abattoir, 22 employee for crop irrigation and 3.2 employees for poultry enterprise

[3] The “Before load shedding period” is the period from 1st February, 2015 to 30th June, 2015

[4] The “During load shedding period “ is the period from 1st July, 2015 to 1st February, 2016

Table 8: The Pre and during load shedding outcomes on selected social-economic factors

Variable	Whole sample	Type of enterprise				
		Dairy	Abattoirs	Crop irrigation	Feedlot	Poultry
Before load shedding						
-Enterprise operating (%)	99.3	100	100	100	100	98.6
-Enterprise not operating (%)	1.39	0	0	0	0	1.4
-Business experience (Mean months)	103.5	82.07	130	124.9	57	100.5
Source of capital(Sole proprietorship)						
-Own capital (%)	95.7	100	75	95.7	100	96.43
-Family and Friend	3.23	0	25	0	0	3.57
-Financial institutions (loan) %	1.08	0	0	4.35	0	0
Ownership of enterprise(Non-Sole proprietorship)						
-Company(privately owned) %	39.9	13	50	44.4	-	71.4
-Cooperative/ Association (%)	50	86.96	25	33.3	-	14.29
-Public(parastatal) %	5.56	0	0	11.1	-	14.29
-Partnership (%)	5.56	0	25	11	-	0
Number of employees(means)						
-Males		4.3	26	20	-	2.06
	-	(0-20)	(3-65)	(1-74)		(0-7)
-Female		1.64	2.75	15	-	2.1
	-	(0-15)	(0-15)	(0-110)		(0-4)
-Casual workers	-	1.5	3.75	26.5	-	1.2
		(0-13)	(0-25)	(0-120)		(0-9)
-Full time	-	4.17	24.7	22	-	3.2
	-	(0-22)	(4-84)	(0-84)		(0-5)
During load shedding						
-Enterprise operating	95.3	96.6	100	96.6	100	94.4
-Enterprise not operating	4.7	3.4	0	3.1	0	5.6
Business experience(Mean months)	7.4	7.7	8	7.5	8	7.1
	(0-8)	(0-8)	(0-8)	(0-8)	(8-8)	(0-8)
Source of capital(Sole proprietorship)						
-Own capital (%)	97.8	100	75	100	100	98
-Family and Friend	2.25	0	25	0	0	2
Ownership of enterprise(Non-Sole proprietorship)						
-Company(privately owned) %	41.5	18	50	37.5	-	73.3
-Cooperative/ Association (%)	47.2	81.8	25	37.5	-	13.3
-Public(parastatal) %	5.66	0	0	12.5	-	13.3
-Partnership (%)	5.66	0	25	12.5	-	0
Number of employees(means)						
-Males	-	3.8	26	19	-	2.12
		(0-20)	(3-65)	(1-74)	-	(0-7)
-Female	-	1.47	2.75	15	-	2

		(0-15)	(0-15)	(0-110)	-	(0-4)
-Casual workers	-	1.5	3.75	26.5	-	1
		(0-13)	(0-25)	(0-120)	-	(0-9)
-Full time	-	3.86	24	21.55	-	3.25
		(0-22)	(4-80)	(0-84)	-	(0-5)
Number of observation	N=149	n=23	n=8	n=9	n*=4	n=16
		n*=6	n*=4	n*=23		n*=57

Note; In parenthesis ( ) are ranges, n and n* denote observation of the enterprise when Non-Sole proprietorship and Sole proprietorship respectively

During load shedding period (from 1st July, 2015 to 1st February, 2016), overall, 95.3% of enterprise were operating while 4.7% of enterprise did not operate. The duration of business was (mean) 7 months. The main source of capital for enterprises run as Sole proprietorship was their own capital (97.8%) and from family and friends (2.25%). Of the sample enterprise owned by Non- sole proprietors, 47.2% were cooperatives/association, 41.5% were company owned, public/parastatal (5.66%) and partnership (5.66%). The mean number of casual workers was: 1.5 employees for Dairy enterprise, 3.75 employees for beef abattoir, and 26.5 employees for crop irrigation and 1 employee for poultry enterprise. Further, the mean number of full time worker was: 3.86 employees for Dairy enterprise, 24 employees for beef abattoir, 21.55 employee for crop irrigation and 3.25 employees for poultry enterprise.

Tables 9a[5] compares costs of the major inputs incurred, the level of production, and the income/ profits generated by sample enterprises 'before load shedding period' (from 1st February, 2015 to 30th June, 2015) and 'during load shedding period'(from 1st july,2015 to 1st February, 2016). Before load shedding period, the total average cost of the key inputs was; K30,731.81in Dairy enterprise, K1,646,792 in beef abattoir enterprise, K5,734.67 in crop irrigation K43,200 in feedlot enterprise and K6,835.99 in poultry enterprise. Further, the level of production (mean) was; 52,133.84 litres for Dairy enterprise, 440 animals slaughtered/processed in beef abattoir enterprise, 2,525.97 Kg crop harvested for crop irrigation enterprise, 88 animals raised for market in feedlot enterprise and 342 chickens raised for market in poultry enterprise.

During load shedding period (July, 2015 to December, 2015), the average total cost of the key inputs was; K26,126.18 in Dairy enterprise, K 1,670,075 in beef abattoir enterprise, K9,083.36 in crop irrigation K51,825 in feedlot enterprise and K 7230.31 in poultry enterprise. Further, the level of production (mean) was; 34,027.23 litres for dairy enterprise, 323 animals slaughtered/processed in beef abattoir enterprise, 2,996.42 Kg crop harvested for crop irrigation enterprise, 71 animals raised for market in feedlot enterprise and 296 chickens raised for market in poultry enterprise.

[5] The input costs, production level and income/profits was measured every after two months in pre load shedding(end of March ,2015 and end of June, 2015) and in the load shedding period (end of September,2015 and end of December,2015)

Table 9a: The Pre and during load shedding outcomes on enterprise costs, production and income/ profits

	Type of enterprise				
	Dairy	Abattoir	Crop irrigation	Feedlot	Poultry
Variable	n=29	n=12	n=33	n=4	n=72
	………………………		**Means**	…………………………	
Before load shedding					
- Input cost	30731.81	1646792	5734.67	43200	6835.99
-Range	(1200-469697)	(6000-103000)	(60-50000)	(3100-94000)	(0-30000)
- Production level	52133.84	439.5	2525.97	87.75	341.5
-Range	(200-240000)	(34-2200)	(14-20000)	(22-135)	(0-1714)
-Income/profits	34072.79	1303956	24640.73	179102.5	5878.35
-Range	(1400-192257)	(6933-790400)	(140-404000)	(6500-494910)	(0-28000)
During load shedding					
- Input cost	26126.18	1670075	9083.36	51825	7230.31
-Range	(400-243218)	(6000-103000)	(60-104430)	(3600-25000)	(0-38000)
- Production level	34027.23	322.67	2996.42	70.5	295.59
-Range	(200-134000)	(34-1028)	(14-20000)	(18-94)	(0-1714)
-Income/profits	20121.55	1302848	20362.82	161390	5235.81
-Range	(0-115276)	(6327-790400)	(140-249000)	(5800-488900)	(0-35820)

***Note** : costs and incomes/profit is quoted in Zambian Kwacha(ZMW), units for production level include; litres for dairy, kg for crop irrigation, number of animals/birds for abattoir/feedlot and poultry; n is the number of observation*

Furthermore, table 10 shows the summary of the mean comparisons of the input costs, production and income using t test. The results indicate that in dairy (milk collection) enterprise, the average level of production was higher before load shedding (52,133.84liters of milk produced) than during load shedding period (34,027.23liters), and the decline is statistically significant at 0.05 significance level (t=3.0658, p-value =0.0048). In addition, the estimated average profits/ income reduced statistically significantly from K34,072.79 generated before load shedding to K20,121.55 during load shedding period (t=2.7263, p-value=0.0109).

The average total costs of key inputs incurred in abattoir (beef) enterprise was lower before load shedding (K1, 646,792) than during load shedding period (K1, 670,075), and the increase is statistically significant (t=-2.6812, p-value=0.0214).

In poultry enterprise, the average level of production dropped from 341.5 birds raised before load shedding to 295.59 birds during the load shedding period, and the change is statistically significant at the 0.05 significance level (t=3.2108, p-value =0.0020).

Table 10: Mean comparison test of costs, production and income outcomes on sample enterprise

Variable	Reference period: Before load shedding	Reference period: During load shedding	Significance level (mean difference)
Dairy enterprise	..... **Means**	....	
- Input costs incurred	30731.81	26126.18	(t=0.5606, p=0.5795)
- Level of production	52133.84	34027.23	(t=3.0658, p=0.0048) *
- Profits/Income generated	34072.79	20121.55	(t=2.7263, p=0.0109) *
Abattoir enterprise			
- Input costs incurred	1646792	1670075	(t= -2.6812, p=0.0214) *
- Level of production	439.5	322.67	(t= 0.6652, p=0.5197)
- Profits/Income generated	1303956	1302848	(t= 0.0380, p=0.9704)
Crop irrigation enterprise			
- Input costs incurred	5734.67	9083.36	(t= -1.1870, p=0.2442)
- Level of production	2525.97	2996.42	(t= -1.5691, p=0.1268)
- Profits/Income generated	24640.73	20362.82	(t= 0.8832, p=0.3839)
Feedlot enterprise			
- Input costs incurred	43200	51825	(t= -1.1520, p=0.3328)
- Level of production	87.75	70.5	(t= 1.3529, p=0.2690)
- Profits/Income generated	179102.5	161390	(t= 1.8253,p=0.1654)
Poultry enterprise			
- Input costs incurred	6835.99	7230.31	(t= -0.9804, p=0.3302)
- Level of production	341.5	295.59	(t= 3.2108, p=0.0020) *
- Profits/Income generated	5878.35	5235.81	(t= 1.6385, p=0.1057)

Note: *Paired t test (**Ha: mean(difference) ≠ 0**); t=t- value, p=p-value;* ***=significant at 5%*

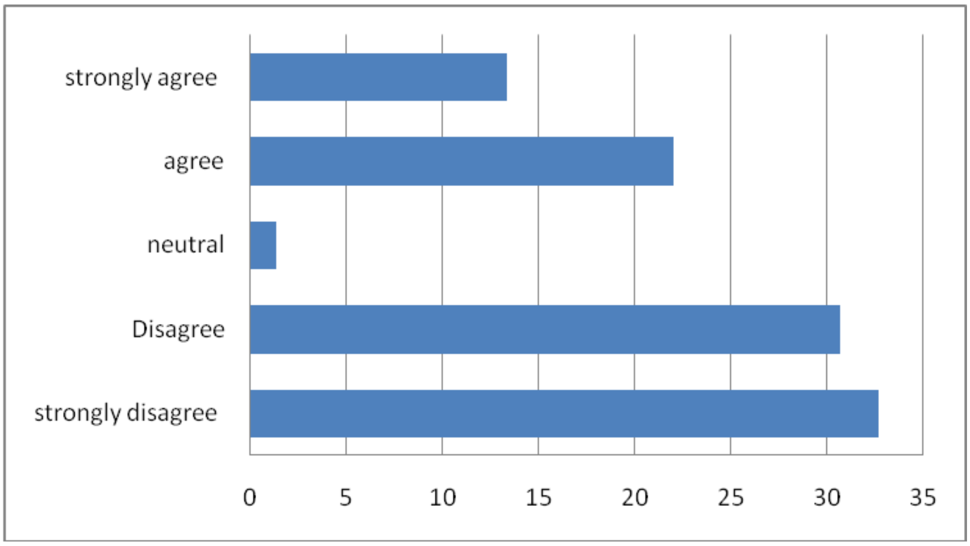
4.3. Chi square test of the effects and extent of load shedding

Table 11 presents the significance levels of a chi square test to determine the relationships between the type of proprietorship (either sole or Non-Sole proprietorship) and various statements about load shedding experienced by the enterprise. Respondents were given statements on how load shedding has affected the performance of the enterprise from July, 2015 to February 2016(during load shedding period). The table reports the observed counts and respective percentages within type of proprietorship given in parenthesis ().

4.3.1. Statement; *Production stops when there is a power cut*

Overall, the majority of enterprise strongly disagree (32.6%) and disagree (29.9%) with the statement that 'production stops when there is a power cut'. With the p-value of 0.000 (less than 0.05) the highest proportion of Sole proprietorship 33.68% disagree and while 55.72% of Non-Sole proprietorship strongly disagree that 'Production stops when there is a power cut'.

Figure 10: Production stops when there is power cut (whole sample)



4.3.2.Statement: *Delivery delays from suppliers due to load shedding*

In the whole sample the majority agrees (46.28%) to delivery delays from suppliers. At 0.05 significance level (p value=0.001), it's statistically significant that a highest proportion of Sole proprietorship (38.95%) and Non-Sole proprietorship (59.62%) experience delivery delay from suppliers.

4.3.3. Statement; *Delivery delays to customers due to load shedding*

Overall, 46.27% of enterprises agree to delivery delays to customers due to load shedding. Of these, majority of Sole proprietorship (40%) farmers and Non-Sole proprietorship (61.54%) farmers were more likely to have had delivery delays to customers due to load shedding. The differences in the percentages are significant at 95% confidence level (p-value =0.025 <0.05) that enterprise experience delays to customer due to load shedding.

Table 11: Chi square test of the effects and extent of load shedding

		Type of proprietorship		
Statement	whole sample	Sole proprietorship	Non Sole proprietorship	Significance level
Production stops when there is a power cut				
-Strongly disagree	48 (32.65%)	19(20%)	29(55.72%)	Pearson Chi-square(4)=20.453
-Disagree	44(29.93%)	32(33.68%)	12(23.08%)	P-value= 0.000
-Neutral	2(1.36%)	2(2.11%)	0	
-Agree	33(22.45%)	27(28.42%0	6(9.62%)	
-Strongly agree	20(13.61)	15(15.79%)	5(9.62%)	
Product quality is affected by load shedding				
-Strongly disagree	11(7.48%)	4(4.21%)	7(13.46%)	
-Disagree	24(16.33%)	7(13.46%)	5(9.62%)	Pearson Chi-square(4)=6.6694
-Neutral	6(4.08%)	3(3.16%)	3(5.77%)	P-value= 0.154
-Agree	70(47.62%)	46(48.42%)	24(46.15%)	
-Strongly agree	36(24.49%)	23(24.21%)	13(25%)	
Load shedding affects hiring decisions				
-Strongly disagree	25(17.01%)	18(18.95%)	7(13.46%)	
-Disagree	15(10.20%)	10(10.53%)	5(9.62%)	Pearson Chi-square(4)=4.1202
-Neutral	8(5.44%)	7(7.37%)	1(1.92%)	P-value= 0.390
-Agree	79(53.74%)	46(48.42%)	33(63.46%)	
-Strongly agree	20(13.61%)	14(14.74%)	6(11.54%)	
Extra costs incurred because of load shedding				
-Strongly disagree	23(15.75%)	18(18.95%)	5(9.8%)	
-Disagree	7(4.79%)	3(3.16%)	4(7.84%)	Pearson Chi-square(3)=8.4100
-Agree	40(27.40%)	31(32.63%)	9(17.65%)	P-value= 0.038
-Strongly agree	76(52.05%)	43(45.26%)	33(64.71%)	
Wages for employees exclude hours of load shedding				
-Strongly disagree	87(59.18%)	54(56.84%)	33(63.46%)	
-Disagree	38(25.85%)	26(27.37%)	12(23.08%)	Pearson Chi-square(4)=6.5417
-Neutral	6(4.08%)	6(6.32%)	0	P-value= 0.162
-Agree	12(8.16%)	8(8.42%)	4(7.69%)	
-Strongly agree	4(2.72%)	1(1.055%)	3(5.77%)	
Delivery delays from suppliers due to load shedding				
-Strongly disagree	13(8.84%)	5(5.26%)	8(15.38%)	
-Disagree	24(16.33%)	16(16.84%)	8(15.38%)	Pearson Chi-square(4)=17.973
-Neutral	10(6.80%)	10(10.53%)	0	P-value= 0.001
-Agree	68(46.26%)	37(38.95%)	31(59.62%)	
-Strongly agree	32(21.77%)	27(28.42%)	5(9.62%)	

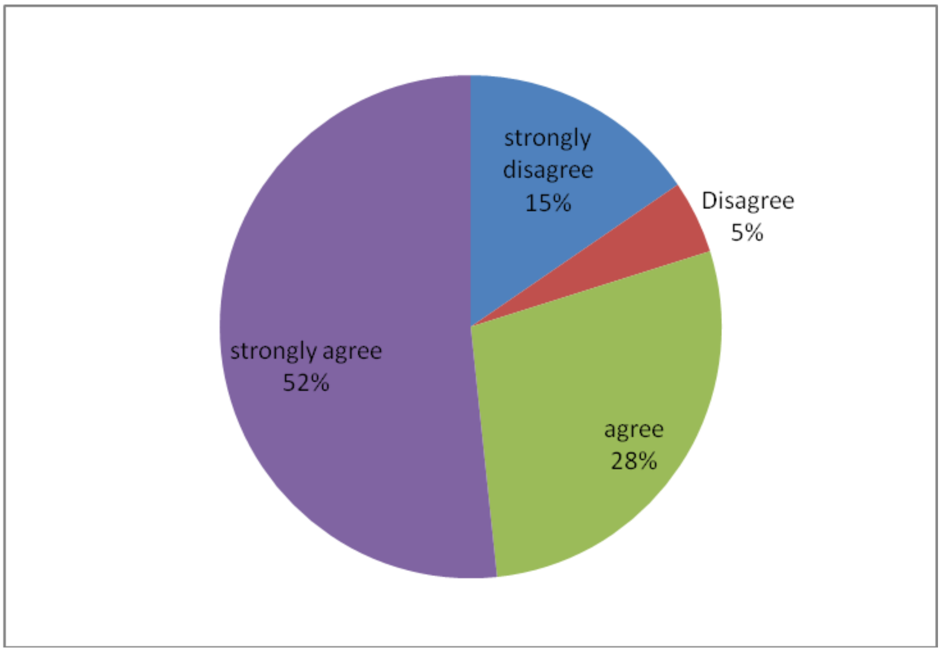
Delivery delays to customers due load shedding				
-Strongly disagree	12(8.16%)	6(6.32%)	6(11.54%)	
-Disagree	27(18.37%)	19(20%)	8(15.38%)	Pearson Chi-square (4)=11.1706
-Neutral	7(4.76%)	6(6.32%)	1(1.92%)	P-value= 0.025
-Agree	70(47.62%)	38(40%)	32(61.54%)	
-Strongly agree	31(21.09%)	26(27.37%)	5(9.62%)	

Note: *The table shows the observed counts and respective percentages within type of proprietorship given in parenthesis ().*

4.3.4. Statement; *Extra costs incurred because of load shedding*

About half (52.05%) of the whole sample strongly agree to incur extra costs due to load shedding. Of these, majority of Non-Sole proprietorship (64.71%) and Sole proprietorship (45.26%) tend to incur more costs due to power cut. At 95% confidence it was statistically significant (p-value=0.038<0.05) that load shedding cause some extra costs on the enterprises.

Figure 11: Extra costs incurred because of load shedding (whole sample)



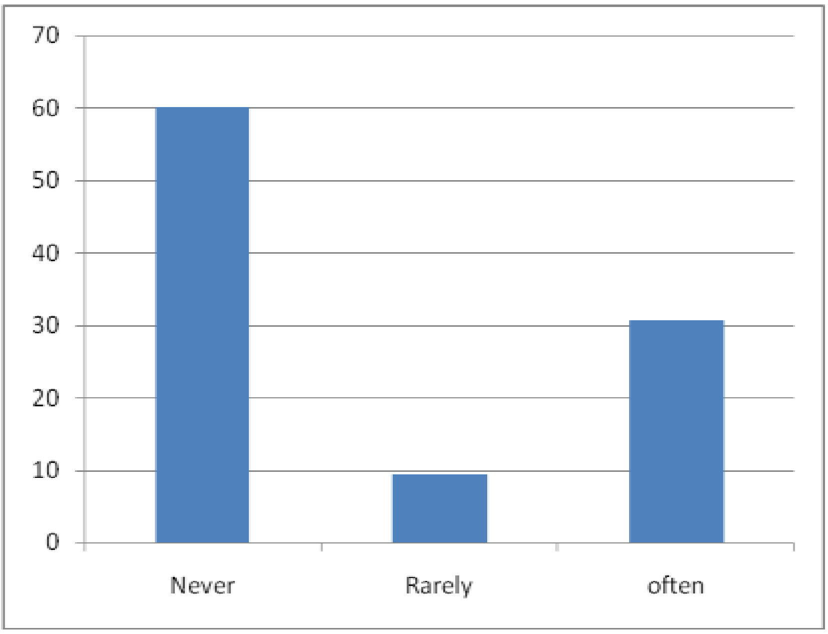
4.4. Chi square analysis of relationship between mitigation measures and type of proprietorship

Table 12 presents the significance levels of a chi square analysis to determine the relationships between the type of proprietorship (either sole or Non-Sole proprietorship) and various strategies on how the enterprise had resorted to mitigate load shedding since July 2015 to February 2016. The table reports the observed counts and respective percentages within type of proprietorship given in parenthesis ().

4.4.1. Mitigation and Adaptation measure; *Waiting and resuming operations when hydroelectric power is restored*

Most of the sample enterprises (59.2%) never wait to resume operations when hydro electric power is restored. It's statistically significant (p-value=0.012) that the majority of Sole proprietorship (50.53%) and Non-Sole proprietorship (75%) would never wait to resume operations until when hydroelectric power was restored.

Figure 12 : Waiting and resuming operations when hydroelectric power is restored (whole sample)



4.4.2. Mitigation and Adaptation measure; *Reducing expansion of the enterprise*

Of the sampled enterprises, 48.30% of them have resorted to reduce the expansion of the enterprises often times. With the p-value of 0.002 (less than 0.05) the highest proportion of Sole proprietorship (49.47%) and 46.15% of Non-Sole proprietorship have often times used this strategy during the load shedding period.

Table 12: Chi square test of relationship between mitigation measures and type of proprietorship

Mitigation measure	Whole Sample	Type of proprietorship: Sole proprietorship	Non Sole proprietorship	Significance level
Reducing of employees				
-Never	136(92.52%)	88(92.63%)	48(92.31%)	Pearson Chi-square(2)=3.6409
-Rarely	4(2.72%)	4(4.21%)	0	P-value= 0.162
-Often	7(4.76%)	3(3.16%)	4(7.69%)	
Reducing expansion of the enterprise				
-Never	40(27.40%)	18(18.95%)	22(42.31%)	
-Rarely	35(24.49)	30(31.58%)	6(11.54%)	Pearson Chi-square(2)=12.3273
-Often	71(48.30)	47(49.47%)	24(46.15%)	P-value= 0.002
Buying alternative tools/equipment to back up power supply				
-Never	53(36.05%)	40(42.11%)	13(25%)	Pearson Chi-square(2)=7.1606
-Rarely	14(9.52%)	11(11.58%)	3(5.77%)	P-value= 0.028
-Often	80(54.42)	44(46.32%)	36(69.23%)	
Renting alternative tools/equipment to back up power supply				
-Never	120(81.63%)	81(85.26%)	39(75%)	Pearson Chi-square(2)=6.33
-Rarely	9(6.12%)	7(7.37%)	2(3.35%)	P-value= 0.042
-Often	18(12.24%)	7(7.37%)	11(21.15%)	
Stocking and use of charcoal/firewood				
-Never	72(49.32%)	35(37.23%)	37(71.15%)	
-Rarely	2(1.37%)	1(1.055%)	1(1.92%)	Pearson Chi-square(2)=16.203
-Often	72(49.32%)	58(61.7%)	14(26.92%)	P-value= 0.000
Waiting and resuming operations when hydro electric power is restored				
-Never	87(59.18%)	48(50.53%)	39(75%)	Pearson Chi-square(2)=8.7616
-Rarely	14(9.52%)	12(12.63%)	2(3.35%)	P-value= 0.012
-Often	46(31.29%)	35(37.23%)	11(21.15%)	

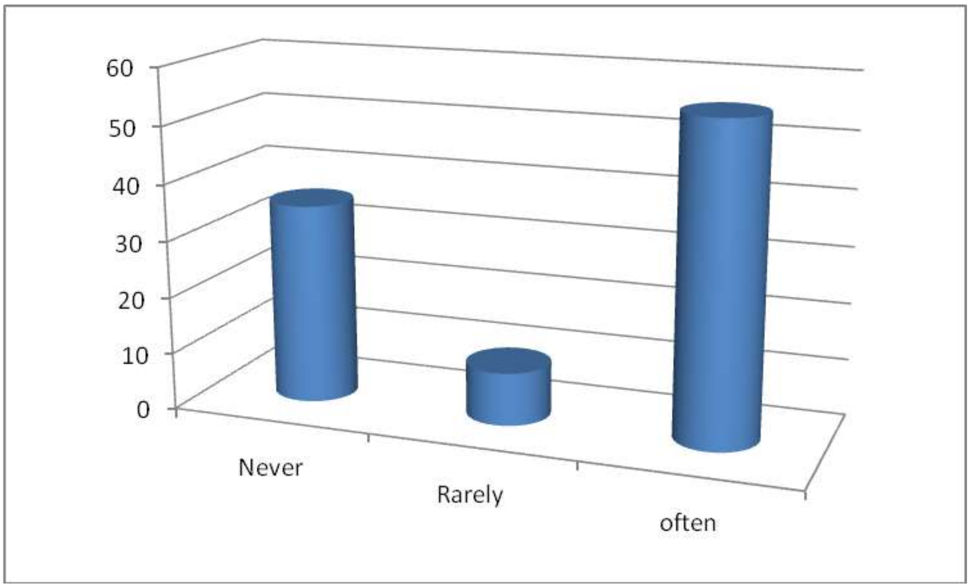
***Note**: The table shows the observed counts and respective percentages within type of proprietorship given in parenthesis ().*

4.4.3. Mitigation and Adaptation measure; *buying alternative tools/equipment to back up power supply*

In the whole sample, slightly more than half (54.42%) often buy alternative tools to back up power supply during load shedding period. Majority of the Sole proprietorship would either buy often (46.32%) or never (42.11%) buy alternative tools, while the highest proportion of

Non-Sole proprietorship (69.23%) often resort to buying alternative tools/equipment to back up power supply. The results suggest the buying of alternative tools is related to the nature of the enterprise (p- value=0.028 <0.05).

Figure 13: Buying alternative tools/equipment to back up power supply (whole sample).



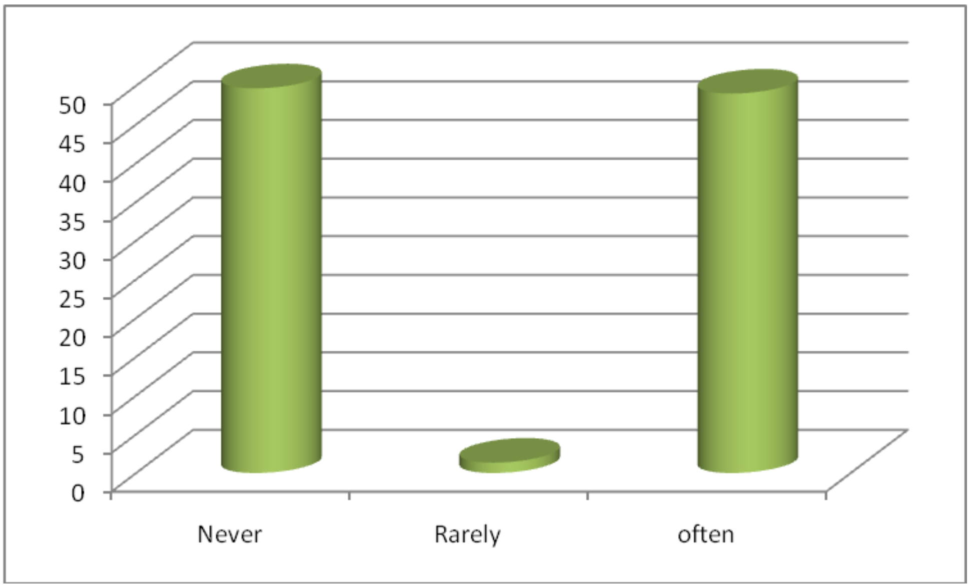
4.4.4. Mitigation and Adaptation measure; *renting alternative tools/equipment to back up power*

The majority in the whole sample (81.63%) never rented alternative tools/equipment to back up power during a load shedding (P-value=0.042). This was common especially among the Sole proprietorship (85.26%) and Non-Sole proprietorship (75%).

4.4.5. **Mitigation and Adaptation measure;** *Stocking and use of charcoal/firewood*

Overall, the sample enterprises could either often (49.32%) stock and use charcoal/firewood or never had (49.32%) at any time stocked and used charcoal/firewood. At 0.05 significance level, it was statistically significant that stocking and use of charcoal/firewood during load shedding was mostly common among the Sole proprietorship (61.7%) compared to 71.15% of Non-Sole proprietorship who never stocked and used charcoal/firewood (p-value =0.000<0.05).

Figure 14: Stocking and use of charcoal/firewood (whole sample)



5.0 FOCUS GROUP INTERVIEWS' RESULTS AND DISCUSSIONS

5.1. Introduction

This section presents the evidence from focus group discussions and data from enterprise survey on the agricultural enterprises relating to how load shedding had affected the performance of their enterprise and the spillover effects.

The vast majority of the sample agricultural enterprise was Poultry (48%), followed by Crop irrigation, Dairy (milk collection centres), Beef (abattoir) and least being feedlots (see figure 1). All feedlots and more than three quarters of poultry enterprise were run as Sole proprietorship. Similarly many crop irrigation enterprises (72%) were run as Sole proprietorship. Compared to enterprise run as Sole proprietorship, the Non-Sole proprietorship mainly consisted of the enterprises specializing in dairy-milk collection centers (about three quarters) and beef abattoirs (66.7%). The main use of electricity varied from one enterprise to another. Overall, 68% of enterprises needed hydro electric power all the time. Of these, the highest proportion of enterprises needed power all the time for storage (92%), production (63%) and display (55%). Dairy enterprises use electricity in cooling, lighting and mixing milk. Milk cooling accounted for the largest block of electrical usage at 25% with lighting surprisingly being the second largest user of electricity (Wisconsin Energy Efficiency and Renewable Energy Resource, 2016). A recent study indicated that 46% of the electrical use was for milk harvesting (vacuum pump, milk cooling and water heating), another 46% was used for lighting and ventilation and the remaining 6% was for feeding, manure handling and other miscellaneous uses. Abattoirs use electricity in slaughtering of animals (usually cattle), pumping running water for sanitation and drinking and refrigeration of beef products. This finding somehow agrees with Australia Industry group (2016) which also presents that meat processing facilities consume energy in: livestock holding; slaughtering and processing; monitoring and testing; cleaning; and packing. It also provides that refrigeration is generally the most energy intensive activity in meat processing facilities (Australia Industry group, 2016) because of the air conditioning systems; hot water / boiler systems; compressors that consumes a lot of power. Feed lots enterprise find electricity very useful in spraying of animals using an electrical spray race, pumping drinking water for animals and in the feed formulation. In the case of crop irrigation enterprise, electricity was seen vital in pumping of water into gardens, more especially the communities using electric bore holes (submersible pumps) and water from Southern Water &Sewerage Company. Electric turbine pumps (either vertical shaft or submersible) are used to pump from deep wells (Evans et al, 1996). As for those who use SWASCO water and ZESCO electricity they pay their bills monthly to these utility companies. For pumping water using electricity farmers are billed every month, even during the months when irrigation pumps are not operating because they mostly are on fixed rates (Evans et al, 1996). In poultry electricity is used for refrigeration, lighting, air conditioning and other mechanical drives (Akram et al, 2013, Jekayinfa, 2016). (Jekayinfa, 2016) also added that poultry processing operations consuming energy in the following order are scalding of defeathering accounted for 44%, eviscerating (17.5%), slaughtering (17%), washing & chilling (16%) and packing (6%).

5.2. **Extent of loadshedding in the affected study areas**

The beginning and severity of load shedding imposed mixed opinions among the agricultural enterprises in the studied areas. However, the four focus group discussions done in Namwala reveal that the district started experiencing load shedding from March, 2015 which became severe between August and September, 2015. They however began to see a reduction in hours of power cuts in April, 2016 although even at the time of the survey load shedding had not completed finished. Eight focus group discussions conducted in Mazabuka, report experiencing power cuts since July, 2015, which became severe in January, 2016 and February, 2016, but eventually started stabilizing in May, 2016. Kalomo started experiencing power cuts in July 2015, and later became severe in September, 2015. However, the hydro power supply was seen stabilizing in Kalomo starting February, 2016. For Choma district, power rationing began in May, 2015, and has been severe since August, 2015 and without any sign of stabilizing. The results of the focus group discussion from Monze, suggests load shedding started in February, 2015, became severe in May, 2015. The power supply was seen stabilizing in Monze since April, 2016.

Although ZESCO had released load shedding time tables, some enterprise in sample area were apparently either not aware of the scheduled power cuts or it was ZESCO failing to follow their programmed load shedding time table. The finding(see figure 6) shows that the highest proportion of Kalomo enterprises experienced load shedding that was scheduled(88.89%), followed by Choma enterprise (80.43%) and the least was Namwala enterprises (64.5%). For abrupt power cuts, Namwala recorded the highest proportion of enterprise experiencing unplanned load shedding (35.45%) followed by Monze enterprise (32%) ,Mazabuka (20%) and the least being Kalomo (11.11%).

Generally, the findings show that Monze and Namwala respectively started experiencing power cuts as early as February 2015 and March, 2015, and were the top two districts having abrupt power cuts. The studied enterprises in Kalomo experienced eight hours of a typical power cut both during day time and at night. The Zambia Sugar PLC in Mazabuka was providing alternative geothermal power supply to the surrounding communities, thus about 10% of the sample enterprises indicated consistent power supply compared to other districts. Overall, power rationing was more severe during day time (as compared to night time power rationing), with a typical duration of 5 to 8 hours representing a mean of 7.6hrs of load shedding. The average duration of load shedding from this research tallies with the report gotten from Engineering Institution of Zambia (2015) whose averages are 6- 10 hours per day . The reports also indicates that load shedding in Zambia affected not only agricultural enterprises but also industries, commercial undertakings, offices and domestic customers alike. This has led to a public outcry and anger against the national utility.

5.3. Differential outcomes on sample enterprises due to load shedding

5.3.1. Cost of the key inputs and production level

Electricity is a valuable input to produce most goods and services, therefore load shedding and a higher electricity price can affect the costing's and prices in other agricultural subsectors and that of the economy both directly and indirectly (www.pmrcZambia.org, 2014). During the focus group discussions, majority of enterprises reported experiencing increased cost of the inputs especially during the 'load shedding period' (from 1st July, 2015 to December, 2015). The extra cost of fuel and alternative power sources became more profound in the load shedding period when compared to the 'before load shedding period'.

According to the All Africa (2016) load shedding had not only affected critical sectors of the economy such as the mining, agriculture and livestock but also the environment. In their research it was discovered that those families with at least five members who are not connected to electricity grid, use 75 Kilogrammes of charcoal per month with a supplement of fire wood for warming water for bathing.

Those families, who are connected to the electricity grid used on average 50-kilogramme bags of charcoal per month with a normal supply of electricity. Deforestation and forest degradation are the second leading causes of global warming, responsible for about 15 per cent of global greenhouse gas emissions, which makes the loss and depletion of forests a major issue for climate change. It is well known that trees help to protect the ground water in the water catchment areas and as such load shedding should be stopped to reduce deforestation and as opposed to employing more forest rangers, researchers, wildlife officers, Zambia Environmental Management Agency inspectors, legal officers and improve their human and material capacity to undertake their duties (AllAfrica, 2016).

Before load shedding (from 1st February, 2015 to 30th June, 2015), abattoir enterprises incurred average total cost of K 1,646,792 for key inputs compared to K 1,670,075 incurred during load shedding(from 1st July, 2015 to December, 2015). Over the five months of load shedding the average total cost of key inputs rose by 1.41%. Abattoirs identify wages, refrigeration, fuel for running generator and cattle as main inputs. Furthermore, abattoirs used to slaughter and or process an average of 440 animals (usually cattle) in the "before load shedding period" compared to 323 cattle slaughtered in the 'during load shedding period''. The average number of animals slaughtered dropped by 26.6% measured in five months during load shedding period.

The key inputs for Feedlots were labour, feed and transport. In the pre load shedding era, the estimated average total cost of key inputs in feedlot enterprise was K43, 200, while during load shedding the input cost increased slightly to K51, 825 representing an increase of 19.97% in the load shedding era. On average the feedlots raised 88 animals (usually cattle) for market (before load shedding) which however declined to 71 animals during load shedding period, representing 19.3% decline. Thus, the average number of animals (steers) raised in feedlots was directly proportional to the average total cost of the inputs.

Majority of crop irrigation enterprises grew cabbage, tomato and green maize respectively, with the key inputs being fertilizer, seed and chemicals. In the 5 months of pre load shedding era, the estimated average total cost of the key input used in crop production was K5,734.67, this however increased noticeably to K9,083.36 during load shedding (from 1st July, 2015 to December, 2015). There was 58.4% rise in the average total costs incurred of key inputs. The harvest (yield) of irrigated crop increased from an average of 2,525.97 kg (before load shedding) to 2,996.42kg during load shedding representing 18.6% increase in the level of production over the five months.

The most common type of birds raised under poultry was broiler and a few layer chickens. Poultry enterprises considered day old chicks, feed, antibiotics / vaccines and charcoal as key inputs. Before load shedding (from 1st February, 2015 to 30th June, 2015), poultry enterprise incurred average total cost of K 6,835.99 for key inputs compared to K 7,230.31 incurred during load shedding(from 1st July, 2015 to December, 2015). The increase in the average total cost of key inputs incurred accounts for 5.8% during load shedding. The average number of poultry raised for market dropped from 342(chickens/birds) before load shedding to 296 chickens during load shedding period representing a 13.5% decline in the level of production. The Poultry Association of Zambia, in its Poultry News bulletin, said the industry, which had already suffered increased input costs over the last six months, was expected to suffer more if the current conditions persist (AllAfrica, 2016).Indeed up to now load shedding has just reduced but has not yet ended in Zambia. This means that the poultry continues incurring increased production costs.

Dairy (milk collection centres) enterprises identify key inputs being wages paid to workers, fuel (diesel), milk, and disinfectants. Before load shedding, the estimated average total cost for key inputs was K 30,731.81 measured over five months compared to K 26,126.18 from July 2015 to December, 2015 in the during load shedding period. The decrease in the average total cost accounts for 15%.However, according to Garcia (2011) milk harvesting, which includes activities such as cooling and operating pumps, accounted for 42% of electricity use and cost in energy audits in the state of New York. Water heating adds 4 percent. Figures also suggest that lighting (24 percent) and ventilation (22 percent) account for nearly the other half of electricity use and costs in a dairy, while manure handling and feeding equipment use only 4 percent and 3 percent of electricity, respectively. Nonetheless the reduction in the production cost in the dairy milk centres is attributed to many hours of load shedding when cooling tanks were not in operational and as such the cost of power went down too. Focus group discussion indicated that most milk tanks stored milk at cooling temperature for over 5 hours before power comes. So cooling being the major use of electricity input meaning that the longer the load shedding the lesser the costs resulting from electricity. This is further supported by the results before load shedding. Dairy enterprise recorded an average of 52,133.84 liters of milk produced compared to 34,027.23 liters produced during load shedding. This represents a reduction of 34.7% in the level of milk produced for five months during load shedding. Therefore, reduction in electricity use is proportional to reduced milk yields. .

Generally, in the first five months of load shedding (July 2015, to December, 2015), average total input costs increased for crop irrigation, feedlot and poultry enterprises while their output per unit also decreased. Furthermore, except for crop irrigation(where the level of production increased), the level of production reduced more in dairy enterprise, abattoirs, feed lots respectively and least being poultry enterprise. Of the 4.7% overall enterprise not operating during load shedding (July 2015, to December, 2015(see table 8), there were drop outs of enterprise in poultry (5.6%), dairy (3.4%) and crop irrigation (3.1%).

5.3.2. Employment status

Firstly, there was no significant differential in the main source of capital for enterprises run as Sole proprietorship before load shedding and during shedding period. When farmers were asked during focus group discussions, most of them indicated that they feared to lay off workers because the government at that time had threaten any employer who wanted to lay off workers. Above all, majority of Sole proprietorship used own capital to run the enterprise, and had attained tertiary education. The active age of participation in Sole proprietorship was above 54 years old. At least 15% of sole proprietors above 54 yrs were pensioners.

One of the issues of concern was a possibility of lying off workers due to load shedding in enterprise running as Non-Sole proprietorship. Among all the studied enterprises, Crop irrigation and abattoir engaged the highest (mean) number of employees, while poultry enterprises engage the least (mean) numbers of employees**.** From findings there were more male employees than female employees, and more full time workers than casual workers engaged across the enterprises. Overall, there were virtually negligible changes in the number of male employees, female employee, casual and full time workers laid off during load shedding. Similarly, IAPRI (2016) suggest temporary labor been laid off, however the number of laid off workers was most likely negligible, while Sing'andu (2009) found power rationing negatively impacting on the firm productivity and production through freezing of employment of new staff to some firms. On contrary, Winde (2015) found that the working households in South Africa experienced a reduction in labor income by 2.70% and more than 129 000 jobs were lost during load shedding. Furthermore according to Pasha et al (2009) and Hafiz & Saleem (2013) in their two research findings on impact of load shedding on domestic consumptions concluded that in Pakistan the loss of output due to outages was estimated to have resulted in a loss of employment of almost 1.8 million. 39 percent of this loss was in agriculture, 25 percent in the industrial and 36 percent in services sectors respectively. Therefore employment is affected by load shedding though varies from one enterprise to other.

5.4. Effects and extent of the effects of load shedding on agricultural enterprise, and adopted mitigation measures

Thus, the absence or discontinuities of hydroelectric power supply imposed effects on the operation of the enterprises differently between the Sole proprietorship and Non-Sole proprietorship. Assuming responsiveness of the type of proprietorship relate to the possible effects of load shedding, respondents were asked statements on how load shedding had affected the performance of their enterprise from July 2015 to February 2016. The study revealed several factors that are statistically significant and positively related to load shedding.

5.4.1. Cost of alternative power supply

The effects and extent of the effects of load shedding were profound in the extra costs incurred to sustain operations of the enterprise. Our study show that more than half (64.71%) of Non sole proprietors (compared to Sole proprietorship (45.26%) agreed having incurred more costs due to power cuts. Similarly Winde (2015) also agrees that load shedding is responsible for increased prices of agro-processed products of between 0.35% (grain mill products) and 0.97 % (meat products). Winde (2015) presents that when there are increased costs there is also reduction in the volume of agricultural production by 1.54%, also reduction in agricultural and food product exports by 3.12% (Winde, 2015). Since load shedding started, our findings indicates that the highest proportion of Non-Sole proprietorship (69.23%) often resorted to buying alternative tools/equipments to back up power supply, and while a minority Sole proprietorship (7.37%) and Non-Sole proprietorship (21.15%) often times resorted to renting alternative tools/equipment to back up power during a load shedding. About 39% of enterprise owned generators, in which the highest proportion was abattoir followed by feedlots and then dairy enterprise (table 7). For enterprises that had owned the generator before load shedding still had to incur the extra costs on fuel (petrol/ diesel) during load shedding. According to Sing'andu (2009) reports there was an increase in the mitigation cost on alternative power source more especially for firms that used standby generators. According to World Bank Group, (December,2015) many enterprises reported increased costs of production, as load shedding forced them to buy and run costly generators or switch shifts to when they have electricity (extra pay is often needed for night shifts) and many declared that they are only meeting between 30 and 40% of scheduled production output. However not all bought the generators. The example was the 13.8% of dairy enterprise that owned generators were as gifts in kind and 27.6% that were renting in.

It is also significant that stocking and use of charcoal/firewood during load shedding was often used by Sole proprietorship (61.7%) compared to 26.92% of Non-Sole proprietorship. Majority (80.56%) of poultry enterprise owned breeziers, as addition to rechargeable lamps and battery/solar panel. During focus group discussions in poultry, majority of the respondents were using charcoal as alternative for heating in poultry, which however was managed at a high cost because charcoal increasingly gained demand during load shedding. Many households resorted to using charcoal for domestic use (cooking) when there was a power cut. According to World Bank Group (December,2015) increase in land degradation has become worse due to load-shedding. In 2015, 32.9% of households in Zambia reported using charcoal for cooking and 50.7% reported using firewood. Only 16.0% reported typically cooking with electricity, but a good proportion of those cooking on electricity would have switched to using charcoal, when load-shedding denied them power (World Bank

Group, December,2015). As such one of the respondents had this to share during the focus group discussions:

> "*As a farmer and traditional leader, I can attest to the fact that we have found it very difficult to control the cutting of trees for fire wood and charcoal whose demand come more from farmers and household users in town who have resorted to use them as alternative source of power for their enterprises and daily lives respectively. The price for a bag of charcoal has increased by about 60% during this load shedding period. This has negative impact on forest on which man and livestock depend on*".

Therefore, in accordance with Boiling point (2008) asserts that added to the economic costs, social and environmental impacts of the power crisis are reality. It appears that it becomes much harder to provide quality health care and education if hospitals, schools, clinics and universities are experiencing electricity power outages.

5.4.2. Delivery delays to customers and suppliers.

The effect of load shedding attributed to delivery delays. A high proportion of sample enterprises agreed to have had delivery delays from suppliers (46.3%) and to customers (46.3%) due to load shedding. A highest proportion of Sole proprietorship (38.95%) and Non-Sole proprietorship (59.62%) experienced delivery delay from suppliers while majority of Sole proprietorship (40%) and Non-Sole proprietorship (61.54%) were more likely to have had delivery delays to customers due to load shedding. As a mitigation measure to load shedding, a highest proportion of Sole proprietorship (49.47%) and 46.15% of Non-Sole proprietorship resorted to reducing expansion of the enterprise. The focus group discussion revealed that, some dairy enterprise were reducing on the amount of milk collected from farmers for fear that milk would go sour when there was no power. Therefore during focus group discussion one of the leaders of the milk centres had this to share:-

> *"Our milk tank was damaged by unscheduled power supply. We lost about 40500 litres of milk worth K1, 37,700 for the period of 3months. On top of that we had to maintain wages for our workers and pay rentals. We had to spend over K20, 000 to repay and pay the technician to work on our tank and buy new generator to avoid future damages". About 30 farmers lost their daily dairy incomes as such some resorted to selling whole animals for animals drugs".*

Without power, abattoirs slowed down the rate of slaughtering animals and increased number of hours and days farmers spent at the abattoirs awaiting their animals to be slaughtered. Eventually, both farmers (suppliers/customers) and animals got stressed. Meanwhile the poultry focus group participants reported losing customers due to their inconsistent supply of chickens. Jekayinfa (2016) agreed that there are delays in delivery to customers and suppliers when there is load shedding. Jakeyinfa (2016) indicates that the growth of the company is slowed down due the burden of high cost of production which is later passed on to the consumers, who are already overstressed with increased prices. Therefore results of such study(delay delivery to customer and suppliers) do provide useful information for carrying out budgeting, forecasting energy requirements and planning plant expansion as mitigation and adaptation measures for future business (Jekayinfa, 2016).

5.4.5. Interruption of production during a power cut

On contrary, it was significant that majority disagreed with statement that 'production stops when there is a power cut', and they never waited to resume operation when hydro electric power was restored, more especially among the enterprises run by Non sole proprietors (compared to Sole proprietorship). This implied that majority of the non sole proprietors were more likely to source an alternative power to continue the operation of the enterprises. Generally, about 65% sourced alternative power supply while 35% did not source at all (see figure 9). A higher proportion of abattoirs (83%), feedlots (75%) and dairy enterprises (50%)

respectively always sourced as alternative power supply to continue with the operations. Solar lumps in some cases were seen being bought and used by poultry enterprises as alternative source of lighting. It is a clean source of energy and is now cost competitive with traditional sources of power like generators, coal and hydro. It can be deployed much faster (1-2 years for utility scale power plants) and few hours for household use compared to 2-5 years for coal and hydro power plants (Engineering Institution of Zambia, 2015).

A minority of those sole proprietors and Non-Sole proprietorship who could not manage to source alternative power supply were forced to shut down the enterprise, especially in poultry and dairy enterprises. This made contribution of the agriculture sector to economic growth to be negative in 2015. Food prices started increasing steadily leading to increased prices for mealie-meal (the main staple in Zambia), vegetables, milk and milk products and meat repeatedly hitting the headlines (Zambia Economist, 2015). Closed down of these enterprises caused slower growth rate and reduced agricultural incomes which led to halted poverty reduction, given the fact that sector is the primary source of income for close to 80% of poor households in the province (World Bank Group, December,2015).

6.0. CONCLUSION

Overall, the study aimed to evaluate the effects of climate induced power load shedding on the productivity and production of smallholder farmers in poultry, dairy, beef, feedlot and crop farmers of selected study areas of Southern province of Zambia. The following summarizes our reseach findings:

6.1. Differential outcomes on various enterprises due to load shedding

The results show that a few enterprise were not operating ‘befeore load shedding period’ (from 1st February, 2015 to 30th June, 2015). However, “during load shedding period’’ (from 1st July, 2015 to 1st February, 2016) the number of enterprise not operating increased considerably. With exception of abattoirs and feedlot, there were drop outs of some enterprise in poultry, dairy and crop irrigation during load shedding. Similarly, the estimated average total cost of the key input increased significantly in abattoir enterprise during load shedding. The study reveals a significant reduction in the estimated average level of production during load shedding period especially in dairy and poultry enterprises. The profits/income generated before load shedding declined more significantly in dairy enterprise during load shedding period. Further, the use of alternative power sources mainly charcoal/breezier became very common among the poultry enterprise while generators were common among dairy, abattoir and feedlot during load shedding.

6.2. The effects and the extent of the effects of load shedding on the smallholder agricultural enterprise

The study reveals several factors that are statistically significant and positively related to load shedding. The effects and extent of the effects of load shedding (from 1st July, 2015 to 1st February, 2016) were profound in the extra costs incurred to sustain operations of the enterprise. Majority of Non-Sole proprietors (compared to Sole proprietorship) agree to incur more costs due to power cuts. Similarly, a high proportion of sample enterprise agreed to have had delivery delays from suppliers and to customers due to load shedding. However, more were Non-Sole proprietorship compared to Sole proprietorship. On contrary, it was significant that majority of sampled enterprise disagreed that ‘production does not stop’, and they never waited to resume operation when hydro electric power was restored, more especially among the enterprise run by Non sole proprietors (compared to Sole proprietorship).

6.3. Adaptation and mitigation measures that smallholder agricultural enterprises have developed to cope with the effects of loadsheding .

As they also try to mitigate the effects of load shedding on the operation of the enterprise, about half of Sole proprietorship and Non-Sole proprietorship often times reduce the expansion of the enterprise. It is also significant that stocking and use of charcoal/firewood during load shedding was oftentimes used more by Sole proprietorship than Non-Sole proprietorship. Similarly the majority Sole proprietorship and Non-Sole proprietorship resorted to renting alternative tools/equipment to back up power during a load shedding, while the highest proportion of Non-Sole proprietorship often resort to buying alternative tools/equipments to back up power supply.

7.0. RECOMMENDATIONS

The supply of electricity in Zambia remains 99% hydro based, however, with the increasing climate variability and marked effects of load shedding in the study area, calls for strategic generation of electricity using other sources such as geothermal, coal, solar and wind. The solar potential is estimated at 5.5 kWh/m2/day, while average wind speeds of 2.5 m/s make them highly suitable to support the affected enterprises (Dairy, irrigation, Poultry, Feedlot and abattoirs). Zambia is not just blessed with enough rivers and waters falls to help in the generations of hydro electric power but also endowed with about 18hrs of abundant sunlight suitable for solar power generation and also well endowed with 24/7 speedy wind in the plains of Kafue flats to generator power using wind dynamos enough to sustain the demand of the growing population and industrialization. Therefore an investment into such technology would go a long way in addressing the power deficit the country is facing which is projected to go up to 2025 if not well addressed.

Further, we suggest that future studies should have an increased coverage/scope (a larger sample size and scope) of a nationwide in nature. In addition, we recommend studies be done on enterprise based one. It’s also important that key government sectors (MAL, Energy, CSO, especially at the provincial and district level) update their database to include farmers or enterprises that are using electricity input.

Understanding how much load shedding impact on forestry would be helpful to bring out mitigation measures on how to address the speedy deforestation in the country and southern province.

Understanding the type of inputs that would do well during the load shedding without reducing productivity of the studied enterprises would go a long way in mitigating and adapting to load shedding too.

8.0. Limitations of the Study

The listing of poultry enterprises and crop irrigation enterprise that use electricity was not officially available to provide a total population from which an optimal sample could be drawn. Therefore, there is possibility of having missed out some enterprise during our listing. Further, the fewness of some enterprise available for instance, Feedlots and Abattoirs lead to compromised optimal sampling. We also experienced cases of non contact among the selected respondents, which further reduced the number of the sample enterprise

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10. Appendix –Questionnaire

THE ZAMBIAN OPEN UNIVERSITY

<u>FARMERS' PROFILE QUESTIONNAIRE ON ZESCO LOADSHEDDING</u>

Dear Respondent

I am undertaking a research project whose central aim is to evaluate the effects of load shedding by Zambia Electricity Supply Corporation (ZESCO) on the productivity of smallholder farmers in five districts of Southern Province namely Mazabuka, Monze, Choma, Namwala and Kalomo. The information being solicited will be treated with utmost confidentiality as it is only meant for academic purposes and therefore no individual views or comments will be singularly published in the final report. These will be aggregated without mentioning farmers' names.

FARMERS' GENERAL PERSONAL INFORMATION

Date	**Phone number;**

Name of Enterprise representative	
TYPE OF PROPRIETORSHIP 1=Sole proprietorship 2= Non proprietorship	

Country	

Province	

District	

(If an enterprise is owned by a company or partnership/ cooperative etc skip to section B)

SECTION A ; THE Sole proprietorship PROFILE-(SPP)(**for enterprise run by one person or uses family labour or has less than 5 employees, (**reference period for loadshedding is -before and after 1st July 2015)

Reference period for pre and post loadshedding	What is your farm business specialisation (type of enterprise) **1=Dairy(milk collection center) 2=beef (Abbattoires) 3= crop(irrigation) 4=Feedlot 5=Poultry 6=Dipping/spraying services**	Sex of the the respondent **1=male 2=female**	Age of the respondent	marital status **1= single 2= Married 3=widow 4=divorced**	Highest level of education by the respondent **1=No formal education 2=primary 3=secondary 4= Tertiary**	Number of house hold members **(ask for all members that they live with and eat together nshima/ meals for the past or next 6 months**)	Employment status of the respondent **1=full time farmer 2=Part time farmer 3= formally employed 4=Pensioner**	How long has this business been in operation (duration of business experience) (refer to **ENTERPRISENAME)**	What is your main source of capital for this enterprise **1=own capital 2=Friends and family 3=Financial institution(loan) 4= other sources** **(after SPP08 - → proceed to section C)**
loadshedding	**ENTERPRISE NAME**	**SPP01**	**SPP02**	**SPP03**	**SPP04**	**SPP05**	**SPP06**	**SPP07**	**SPP08**
1=Before loadshedding started(from 1st February to 30 th June 2015)									

		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
2=During loadshedding(from 1[s] July,2015 to 1[st] February, 2016)		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		

SECTION B; THE NON-SOLE PROPRIETORSHIP PROFILE-(NSPP)(**for enterprise with more than 5 employees)** reference period for loadshedding is **-**before and after 1st July 2015)

Reference period for pre and post loadshedding	What is your farm business specialisation (type of enterprise) **1=Dairy** **2= Beef-Abbortores** **3= Crop(irrigation)** **4=Feedlot** **5=Poutly** **6=Dipping/spraying services**	How long has this business been in operation (duration of business experience)	What is the nature of ownership for this enterprise **1= privately owned(Company)** **2= a cooperative/ association** **3=public(parastatal)** **4= Partnership**	What is the total number of **employees** engaged in this enterprise?		What is the total number of employees with the following educational qualification			How many of these employees are ……. **(after NSPP11 --→ proceed to section C)**	
				Male	**Female**	**primary**	**secondary**	**tertiary**	**Casual workers**	**Full time workers**
loadshiddng	**ENTERPRISENAME**	**NSPP01**	**NSPP02**	**NSPP03**	**NSPP04**	**NSPP06**	**NSPP07**	**NSPP08**	**NSPP9**	**NSPP10**
1=Before loadshedding started(from 1st February to 30 th June2015)										
2=During loadshedding(fr										

om 1st July,2015 to 1st February, 2016)										

SECTION C; POWER(ELECTRICITY) SOURCES AND USAGE-(PS)Reference period is from 1st July 2015 to 1st Feb 2016

type of enterprise (only ask the enterprise given in **section A** or **section B** under the **ENTERPRISENAME** that the respondent has/have specialized in)	Does your enterprise use hydro power (Electricity)? **1=yes** **2=No-→go to PS08**	What is the main use of electricity in your enterprise **1= Production** **2=storage** **3=Display(lighting)** **4= others specify**	When doesyour enterprise's operation mostly need power? **1=during day time** **2= At night** **3= All the time**	In the past 8 months(July 2015 to Feb 2016), how has been your experience with power supply? **1= consistent supply** **2=scheduled(planned) load sheddings/power cuts** **3=unscheduled(unplanned) load sheddings/ power cuts**	What is the duration(hours) of a typical electrical outage/ load shedding in a day (**Note; consider day time from 6 hrs to 18 hrs**)		Do you source an alternative power supply, whenever there is a load shedding/ power cuts? **1= yes ,during day time** **2= yes, at night** **3= all the time** **4= some times** **5= Not at all**	What form of energy(alternative power supply)have you been using in your enterprise **1= Hydro-electric** **2= Wind power** **3= Geothermal** **4= Generator/ solar energy**
					Day time	**Night time**		
ENTERPRISENAME	**PS01**	**PS02**	**PS03**	**PS04**	**PS05**	**PS06**	**PS07**	**PS08**
1=Dairy(milk collection)								
2= beef-Abattoirs								
3=crop(irrigation)								
4=Feedlot								
5=Poulty								
6=Dipping/spraying services								

SECTION D: INPUT COST, PRODUCTION AND PROFIT OF THE ENTERPRISE (ICPP) **(reference period is end of March/ June/ September and December-2015** (Enumerator note that three columns (**ENTERPRISENAME, load shedding** and **month interval)** have been pre entered for you, ask for**ICPP02, ICPP03 and ICPP04, at each month interval point indicated in the month interval** column**)**

type of enterprise **(**only ask the enterprise given in **section A** or **section B** under the **ENTERPRISENAME** that the respondent has/have specialized in)	Reference period for pre and post loadshedding **1=Before load shedding started**(before 30th June,2015) **2=During loadshedding**(from 1st July,2015 to 1st February, 2016)	**(enumerator confirm from section A/ B whether the enterprise was operating before or load during load shedding , and or in both periods)** Was the enterprise operating,,,,,, **1=operating** **2=Not operating**	Reference period for two interval points (There must be two measurements for **ICPP02, ICPP03 and ICPP04**: such as two in the pre load shedding era and two in the load shedding era e.g. every after two months as indicated below)	**Ask if ICPP01 is 1= operating)** on average, what is the total cost incurred for all major inputs used in this enterprise at the end of this month**(refer to monthinterval)**…..? **(input costs eg feed, fertilizer etc -kwacha)**	How much did this enterprise produce at the end this month **(refer to mothinterval)**…..? **(enumerator ask for amount/ quantity of the irrigated crop produced in terms of tons (if crop-irrigation) or ask for number of chicken/animals owned in a dairy/Feedlot/poultry, and or number of services offered(if beef-Abattoirs / Dipping/spraying services at the end of each interval) enter NA if not applicable**	What is your everage profits/ Income generated from this enterprise at the end of this month **(refer to mothinterval)**…..? **(kwacha)**
ENTERPRISENAME	**loadshiddng**	**ICPP01**	**monthinterval**	**ICPP02**	**ICPP03**	**ICPP04**
1=Dairy(milk collection)	1=Before load shedding		1= 30 march,2015	**K**		**K**
			2=30 June,2015	**K**		**K**
	2=During load shedding		3=30 sept,2015	**K**		**K**
			4=30 dec,2015	**K**		**K**
2= beef-Abattoirs	1=Before load shedding		1= 30 march,2015	**K**		**K**
			2=30 June,2015	**K**		**K**

			3=30 sept,2015	**K**		**K**
	2=During load shedding		4=30 dec,2015	**K**		**K**
3=crop(irrigation)	1=Before load shedding		1= 30 march,2015	**K**	**tons**	**K**
			2=30 June,2015	**K**		**K**
	2=During load shedding		3=30 sept,2015	**K**		**K**
			4=30 dec,2015	**K**		**K**
4=Feedlot	1=Before load shedding		1= 30 march,2015	**K**		**K**
			2=30 June,2015	**K**		**K**
	2=During load shedding		3=30 sept,2015	**K**		**K**
			4=30 dec,2015	**K**		**K**
5=Poulty	1=Before load shedding		1= 30 march,2015	**K**		**K**
			2=30 June,2015	**K**		**K**
	2=During load shedding		3=30 sept,2015	**K**		**K**
			4=30 dec,2015	**K**		**K**
6= Dipping/spraying services	1=Before load shedding		1= 30 march,2015	**K**		**K**
			2=30 June,2015	**K**		**K**
	2=During load shedding		3=30 sept,2015	**K**		**K**
			4=30 dec,2015	**K**		**K**

SECTION E: CONSEQUENCES OF LOAD SHEDDINGS ON AN ENTERPRISE–(CPC)(Reference period is from 1st July 2015 to 1st Feb 2016)

Since the past 8 months((July 2015 to Feb 2016), which of the following applies to how load shedding has affected the performance of your enterprise	Effect on an enterprise **1=strongly disagree (SDA)** **2= Disagree** **3= partially disagree** **4= neutral** **5= partially agree** **6= agree** **7= strongly agree (SA)** (using the 7 scale rating, Circle the given response below)
CPC01	
1= production stops when there is a power cut	**1 2 3 4 5 6 7** **SDA SA**
2= product quality is affected by load shedding	**1 2 3 4 5 6 7** **SDA SA**
3= wages paid to employee exclude the hours of power outages	**1 2 3 4 5 6 7** **SDA SA**
4= load sheddings affect hiring decisions (expansion of your workforce)	**1 2 3 4 5 6 7** **SDA SA**
5= load shedding affect investment decisions of your enterprise	**1 2 3 4 5 6 7** **SDA SA**
6= there some delivery delays from suppliers due load sheddings/ power cut	**1 2 3 4 5 6 7** **SDA SA**
7= there some delivery delays to your customers due load shedding/ power cut	**1 2 3 4 5 6 7** **SDA SA**
8= you lose some customers during a load shedding/ power cut	**1 2 3 4 5 6 7** **SDA SA**
9= you incur extra costs on alternative power sources (eg solar panel/ generators / charcoal)	**1 2 3 4 5 6 7**

	SDA	**SA**

Since the past 8 months(July 2015 to Feb 2016), which of the following strategies describe how you have resorted to mitigate load shedding in your enterprise	Action taken **1= Never** **2=Rarely** **3=often** **4= very often**
CPC02	
1=Reducing the number of employees	
2= waiting and resuming operations later when hydro-electric power is restored	
3=Using alternative power sources	
4=Reducing the expansion of the enterprise	
5= Buying alternative tools/ equipment to back up power supply	
6= Renting alternative tools/ equipment to back up power supply	
7= Stocking and use of charcoal / fire wood	

SECTION F; ASSET OWNERSHIP-(AST) **(**reference period is before and after 1st July 2015)

Type of asset (alternative power source)	Do you have …. **1=yes** **2= No--→ to next asset**	How did you acquire the.. **1= Bought** **2=Rented in** **3=Borrowed in** **4= Gift in Kind** **(if the answer is 3 or 4 go to AST05)**	**Ask only if the assset was bought or rented in (from AST02)** How much did you pay for purchasing the…. **(ask for unit price in Kwacha)**	What is your monthly (total monthly)fee/charge for renting this…. **(in kwacha)**	Since 1st July 2015 (July 2015 to Feb 2016), how many.. do you have in working condition now ?**(enter 0 if none)**	Before 1st July 2015(Feb 2015 to 30 June 2015), how many…did you have in working condition? **(enter 0 if none)**	How has been the change in the number of …after and before 1st July 2015? **1=increase** **2= decrease** **3= no change**	State the main reason that has led to the change in the number of … **1=Expansion of business operation** **2= high cost of owning/ renting it** **3= load sheddings/power cuts** **4=no change**
ASSET	**AST01**	**AST02**	**AST03**	**AST04**	**AST05**	**AST06**	**AST07**	**AST08**
1= Generator								
2= Solar panel								
3= Battery								
4= Breezier(charcoal heater)								
5= Heater(electric)								
6=Treadle pump								
7= Petrol/ diesel pump								
8= Electric pump								
9=Milking equipment (cooler/mixer)								
10=Borehole/ well								
11= Rechargeable lamps (lighting)								
12= Pivot centre								

THANK YOU FOR YOUR COOPORATION

FOCUS GROUP DISCUSSION-QUESTIONAIRE

Dear Respondent

I am undertaking ar esearch project whose central aim is to evaluate the effects of loadshedding by Zambia Electricity Supply Corporation (ZESCO) on the productivity of smallholder farmers in five districts of Southern Province namely Mazabuka, Monze, Choma, Namwala and Kalomo.The information being solicited will be treated with utmost confidentiality as it is only meant for academic purposes and therefore no individual views or comments will be singularly published in the final report.These will be aggregated without mentioning farmers' names.

Date	

Name of Enterprise	
Number of interviewees	

Name of Enumerator	

District	

Province	

1. Have you ever used power in your enterprise/Business e.g. poultry, feedlot, irrigation ,abattoirs etc
2. How do you use power in your enterprise?

a. In Production,
b. Storage,
c. Lighting
d. Heating
e. Any other specify

3. (a) When did load shedding start and become severe?

(b) Do you think loadsheding has reduced? If yes, which month did power cut started reducing?

4. How has load shedding affected you in:-

a. Operation of your enterprise
b. Environment i.e. Deforestation

c. Any other specify

5. (a) List the Key inputs and cost that you were using/incurred in your enterprise from 1st February, 2015 to June,2015

(b)List the Key inputs and cost that you were using/incurred in your enterprise from July, 2015 to February, 2016

6. What kind of Assets/form of alternative source of energy (Generators, Solar panels, Battery, etc) did you acquire or use to mitigate power load shedding?(include the cost associated with the assets if any)

7. If it is Crop irrigation,

(a) what type of crops are you growing

(b) What is the source of water you are using

(c) who is the absolute supplier of your water source

8. If it is Poultry,

(a) What type of poultry are you keeping(i.e Broiler, layers, etc)