Sentinel

Social and Environmental Trade-Offs in African Agriculture

Country Report
May 2022

Contextual analysis of agriculture in Zambia

A review of the agricultural sector in Zambia conducted in 2018–19 as a contextual analysis for the Sentinel project

www.sentinel-gcrf.org

Partners:

Copperbelt University
Policy Studies Institute (PSI)
University of Ghana
University of Greenwich
NRI | Natural Resources Institute
Imperial College London
iied
eci University of Oxford
University of Reading
RUFORUM
UCL

Funded by:

GCRF Global Challenges Research Fund
UK Research and Innovation

Authors

This report was written and compiled by Mukanga Mweshi from the Zambia Agricultural Research Institute; Jacob Mwitwa, Phillimon Ng'andwe, Darius Phiri and Chindi Kapembwa from the Copperbelt University, Zambia; Adam Devenish from Imperial College London, UK; and Xiaoting Hou-Jones, Phil Franks and Barbara Adolph from the International Institute for Environment & Development, UK.

Corresponding author: Jacob.Mwitwa@gmail.com

Acknowledgements

The authors would like to thank all their colleagues on the Sentinel project team who provided support and input into the contextual analysis and the compilation and editing of this report.

Sentinel

Social and Environmental Trade-Offs
in African Agriculture

Contextual analysis of agriculture in Zambia

This report provides a contextual analysis of the agriculture sector in Zambia conducted for the Sentinel project in 2018–19. It serves as a useful reference document reviewing the country's various land uses, past and current drivers and environmental impacts of agricultural development, the habitats most affected by agriculture expansion, and the socio-economic benefits and costs of agricultural development. The report analyses assumptions surrounding Zambia's agricultural and conservation policy agenda.

Mukanga Mweshi, Jacob Mwitwa, Phillimon Ng'andwe, Chindi Kapembwa, Darius Phiri, Adam Devenish, Xiaoting Hou-Jones, Phil Franks and Barbara Adolph

CONTENTS

List of tables

List of figures

Abbreviations and acronyms

AfDB	African Development Bank
AU	African Union
CA	Conservation agriculture
CASU	Conservation agriculture scaling-up
CBD	Convention on Biological Diversity
CFU	Conservation farming unit
CIAT	International Centre for Tropical Agriculture
CIFOR	Centre for International Forestry Research
CIMMYT	International Centre for Maize and Wheat Improvement
CITES	Convention on International Trade in Endangered Species
Cop	Conference of the Parties
CPFP	Country Partnership Framework Paper
CSO	Central Statistics Office
DoF	Department of Fisheries
FAO	Food and Agriculture Organization of the United Nations
FD	Forestry Department
FDI	Foreign direct investment
FEWSNET	Famine Early Warning Systems Network
FISP	Farmer input support programme
GDP	Gross domestic product
GMA	Game management area
GRZ	Government of the Republic of Zambia
HRW	Human Rights Watch
IAEA	International Atomic Energy Agency
IBA	Important bird area
ICT	Information and communication technology
IDLO	International Development Law Organisation
IDSP	Irrigation Development Support Project
IITA	International Institute for Tropical Agriculture
ILUA	Integrated land use assessment
IPCC	Intergovernmental Panel on Climate Change
IUCN	World Conservation Union (formerly International Union for the Conservation of Nature)
JAICAF	Japanese Association for International Collaboration in Agriculture and Forestry
JICA	Japan International Cooperation Agency
MAL	Ministry of Agriculture and Livestock
MCTI	Ministry of Commerce, Trade and Industry
MENR	Ministry of Environment and Natural Resources
MEWD	Ministry of Energy and Water Development
MFL	Ministry of Fisheries and Livestock
MGE	Ministry of General Education

MoHE	Ministry of Higher Education
MLGH	Ministry of Local Government and Housing
MLNR	Ministry of Lands and Natural Resources
MLNREP	Ministry of Lands Natural Resources and Environmental Protection
MMD	Movement for Multi-Party Democracy
MNDP	Ministry of Development Planning
MoA	Ministry of Agriculture
MOF	Ministry of Finance
MoH	Ministry of Health
MoTA	Ministry of Tourism and Arts
MTENR	Ministry of Tourism, Environment and Natural Resources
MWSEP	Ministry of Water Sanitation and Environmental Protection
NAIP	National Agricultural Investment Plan
NAMBOARD	National Agricultural Marketing Board
NAP	National Action Programme
NAPA	National Adaptation Programme of Action
NBSAP	National Biodiversity Strategy and Action Plan
NCCRS	National Climate Change Response Strategy
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental organization
NISIR	National Institute for Scientific and Industrial Research
NP	National park
NVAC	National Vulnerability Assessment Committee
OPPAZ	Organic Producers and Processors Association of Zambia
PA	Protected area
PF	Patriotic Front
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SABONET	Southern African Botanical Biodiversity Network
SAHIMN	Southern Africa Humanitarian Information Management Network
SDGs	Sustainable Development Goals
SNAP	Second National Agricultural Policy
SNDP	Seventh National Development Plan
UNCBD	United Nations Convention on Biological Diversity
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WTO	World Trade Organization
ZARI	Zambia Agriculture Research Institute
ZAWA	Zambia Wildlife Authority
ZDA	Zambia Development Agency
ZEMA	Zambia Environmental Management Agency
ZFAP	Zambia Forestry Action Programme

Summary

This report provides a contextual analysis of the agriculture sector in Zambia up to 2019. It looks at the country's various land uses including agricultural use, main agricultural production systems, the environmental impacts of agricultural development, the habitats most affected by agriculture expansion, as well as the socio-economic benefits and social costs of agriculture development. The report identifies the past and current drivers of agricultural development, and evaluates their influence on the ecosystems. In addition, it summarises different socio-political drivers, including key government policies driving agricultural production and the decision-making processes. It also identifies the current agricultural research and extension landscape, and analyses assumptions surrounding Zambia's agricultural and conservation policy agenda.

Topography

Zambia's total land area is 752,614km^2 of which 11,890km^2 is water. The general topography of the country is a primarily high plateau, with some hills and mountains. The lowest point is the Zambezi River, at 329m above sea level, with the highest being Mafinga Central in the Mafinga Hills, at 2,339m above sea level. Zambia has abundant arable land and a tropical climate suitable for the production of various crops. Annual rainfall ranges from 700mm in the southern part of Zambia to 1,100mm in the north, with wet and dry seasons. The dry season runs from April to October, while the wet season runs from November to March. Average annual temperature ranges from 6ºC in the coldest months to 22ºC for the hottest months.

Zambia is divided into three agro-ecological regions (AER) classified according to geo-physical qualities, soil types, climate, land use, and socio-economic parameters regarding its agriculture potential. AER I – approximately 12% of Zambia – covers the semi-arid, rift trough areas of Gwembe, Lunsemfwa, Luangwa and Zambezi valleys with low elevations between 300–900m. In this region, rainfall is erratic with frequent dry spells (droughts), and mean annual rainfall does not exceed 800mm. The crop growing season is short (fewer than 120 days). Due to the predominance of subsistence farming in this region, landholdings are small. The AER II region comprises the central part of Zambia, extending from the east through to the west, that is, including most parts of Western, Central, Southern and Eastern Zambia, and Lusaka provinces. This region receives about 800-1000mm of annual rainfall and has a growing season of 120–150 days, supporting the growth of medium-maturity crop varieties. AER II has the most fertile soils; hence most of the country's commercial farms are found here. AER III constitutes about 42% of Zambia's total land area and covers the northern regions. Hills and mountains ranging from 1,000 to 1,700m above sea level punctuate the plateau areas in this region, except Luapula valley, which has average elevations of 900m. The area is suitable for plantation crops such as pineapple, banana, oil palm, coffee, tea, and sugar cane, and annual crops such as rice, beans, cowpeas, groundnuts, and root and tuber crops.

Land use

Zambia has two main categories of land: customary land (71%), administered by traditional authority, and state land (29%), administered by the Commissioner of Lands on behalf of the state. Within state land, the major sub-divisions are protected areas (Forest Reserves, National Parks, and Wildlife Sanctuaries), Resettlement Schemes and Settlement Schemes, Townships, and Private leases, including new and old farm blocks. More than 43.1 million ha (58%) is categorised as having medium to high potential for agriculture production, with only 15% under current cultivation. The government has created more than ten farming blocks through the Ministry of Agriculture (MoA), one in each of the ten provinces. Since 2007, more than a million hectares of customary land has been converted into state land. Reclaimed land has been designated for crop and livestock production as well as for irrigation. Though Zambia harbours 40% of the freshwater resources in the Southern African Development Community (SADC), less than 15.6% (156 000 ha) of the total agricultural land is under irrigation. At the same time, the country has an irrigation potential of about 3 million ha. To accelerate this programme, the Zambian government has sourced a loan from the World Bank to develop its irrigation infrastructure, targeting smallholder and commercial farmers, particularly in the drought-prone areas. In addition, several small irrigation schemes exist across the country. NGOs and other development partners have constructed a further 2,000–3,000 low-cost earth dams and water impoundments to conserve water for livestock, agriculture and domestic use.

More than 2.4 million ha in Zambia are planted with annual crops, most of which are rain-fed. Over the past 20 years, there has been a marked increase in the number and hectare of crops, though maize has continued to be the principal food security and cash crop, accounting for most of the land under cultivation (42%). Wheat follows this at 12.8%, cassava at 11.8%, groundnuts at 7.9%, beans at 5%, millet at 3.7%, cotton at 3.6%, sweet potatoes at 3%, and sorghum at 2.5%. Other crops include horticultural crops such as vegetables and tree crops. High-value, commercial cash crops include cotton, tobacco, coffee, tea and sugarcane, forming the main agricultural exports. Small-scale farmers produce about 60% of total maize production, while wheat is mainly produced on a large scale.

Compared to other countries in the region, Zambia has abundant grazing land with more than 44 million ha deemed suitable for livestock production. In fact, the area of natural grazing land in Zambia is two to five times larger than that of arable land. The three AER of Zambia are all suitable areas for livestock production. Under small-scale agriculture, most of the livestock in Zambia depends on natural grasslands for feed. This system negatively affects their production and productivity compared to the commercial herd, which receives supplementary feed grown and made into hay. While the potential is enormous, more than 20.3 million ha of grazing land is currently used for grazing by a small cattle population of fewer than five million cattle. Though all AERs are suitable for livestock production, most of the cattle and small ruminants rearing is carried out in AERs I and II. The increase in the production of arable crops such as millet, sorghum, maize, wheat, rice, groundnuts, soybeans, sunflower, cotton and sugarcane has exacerbated the shortage of grass crops because they are grown at the expense of grazing land. Additionally, much of the grazing land is being converted to cropland due to the increase in the human population. The presence of Tsetse flies in some parts of the country also limits cattle production.

There are six major farming systems and three broad categories of farmers in Zambia.
They include:

1. shifting axe and hoe cultivation systems of Muchinga, Northern and parts of Central Provinces
2. semi-permanent hoe system
3. fishing and semi-permanent hoe system of Luapula
4. semi-permanent hoe and ox-plow
5. semi-commercial ox and tractor plough cultivation, and
6. commercial farming.

The first four farming systems are associated with smallholder households, while medium (or emergent) farmers practise the fifth system and commercial farmers use the sixth. All these systems differ in their tillage and labour requirements. The axe/hoe systems use large amounts of labour and are yet low in local costs compared to the ox-drawn plough, and with the latter, the labour costs are spread over larger areas. Ox-and tractor plough forms a major part of farming systems. While in the traditional ox-plough methods, farmers use communal grazing land.

There are three main farmers in Zambia; small-scale, medium and large-scale farmers. Small-scale farmers number about 1.6 million, cultivating less than five hectares using hand hoes. They have little input from external sources, consume most of their products and occasionally sell the surplus. Medium-scale farmers apply a combination of hoes, tractor and animal power, and use improved seeds and fertilisers. The products are sold in domestic markets. Large-scale commercial farmers use machinery for farm operations and plant more than 20 ha annually. They use high levels of purchased inputs and produce almost exclusively for the market or to produce feed for their livestock. Large-scale farmers make up only 4% of agricultural households in Zambia, cultivating 22% of all cropped land.

Threats to biodiversity

As the demand for more food to feed the ever-increasing population grows, the conversion of protected areas into agricultural land has continued over the years, affecting the provision of goods and services provided by the natural ecosystems. Zambia has 16 ecosystems, of which 14 are terrestrial ecosystems grouped according to vegetation life form. The other two are the freshwater aquatic ecosystems and the anthropic land cover types, the latter being different land uses, ranging from cropland to fallow tree plantations. The 14 terrestrial ecosystems are classified based on vegetation type, with the Miombo Woodlands being the dominant ecosystem. The biodiversity found in Zambia keeps these different ecosystems in equilibrium. However, the ecosystems in Zambia are threatened by various factors; some include climate change, pollution, overexploitation of natural resources and habitat loss. There is an estimated total diversity of 6,135 invertebrate species in Zambia, of which 69 species are endemic, and 14 species (mainly freshwater molluscs) are under threat. There are also 59 Botanical Reserves which are located either within or outside forest reserves. These were established to preserve relic vegetation types and encourage in-situ conservation of important genetic resources of plants. Zambia's network of statutory forest reserves includes 175 National Forests and 305 Local Forests. A total of 3,774 flora species exist in Zambia, consisting of 147 algae, 129 mosses, 142 ferns, 530 types of grass, 1,130 non-grass herbs, 1,610 woody plants and 86 crops. The highest diversity of flowering plants occurs in the northern and north-western regions of the country. The water bodies in Zambia are home to about 409 species of fish; of these, only 17 species are considered commercial, that is, fished for human consumption. Lake Tanganyika has the highest diversity of fish with 62%, while Mweru-Wantipa has the lowest fish biodiversity, with less than 1%.

The total bird fauna in Zambia is estimated at 757 species. Of these, 76 are rare, and 100 are endemic. There are 22 species of protected birds in Zambia's National Parks, Game Management Areas (GMA) and bird sanctuaries. Some 15 bird species are either endangered or vulnerable or near threatened based on the most current assessments. Although the country's vegetation is dominated by a single biome – Miombo Woodland – it is home to numerous bird species found in both East and Southern Africa, with a large number of migratory birds coming from the northern hemisphere during the rainy season. Of the 757 species, more than 600 are residents or Afrotropical migrants breeding here. About 100 species are non-breeding migrants, and the remainder are non-breeding Afrotropical migrants and vagrants. Zambia has only one true endemic species. Globally, birds are important agents of pollination and seed dispersal, thereby helping to maintain and restore plant communities. The mammalian diversity in Zambia is estimated at 224. The diversity of amphibians (frogs and toads) is estimated at 74 species, and there is no discernible geographical gradient in species richness. Zambia's diversity of reptiles (lizards, snakes and tortoises) is estimated at 156 species. Much of the wildlife in Zambia is found in 20 National Parks and 36 GMAs.

Agricultural biodiversity (or Agrobiodiversity) is a basic form of biodiversity on which more than a million Zambian households depend directly for their livelihood. This diversity has been affected by historical factors and differences in farming systems, agro-ecological and socio-economic conditions. The Seventh National Development Plan (SNDP) of the Government of Zambia recognises the role of agrobiodiversity in national food security and agricultural development. It fits well with Sustainable Development Goal (SDG) 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture; SDG 12: Ensure sustainable consumption and production patterns; and SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt the loss of biological diversity relevant to food and agriculture. SDG 15 urges us to manage and preserve the Zambian agrobiodiversity sustainably. The conservation and sustainable use of agrobiodiversity is essential for the survival of Zambian farmers, especially the small-scale. It is also critical for the future adaptation of agriculture to a changing environment, especially in the wake of climate change and new pests and diseases. Greater genetic diversity contributes to reducing climatic and disease-related risks and increases community resilience. The main challenge for the agricultural sector is to simultaneously secure high-quality agricultural production for both local and international markets, and at the same time ensure food and nutrition security while conserving biodiversity and sustainably manage natural resources. This strategy is the surest way to improve the wellbeing of the people and human health, especially for rural areas.

The forest ecosystem is the most extensive habitat for most of Zambia's biodiversity. It is complex and supports different interacting units such as trees, wildlife, soil, insects and humans. The forest cover is about 45.94 million ha (61%), comprising indigenous forests and forest plantations. In Zambia, forest cover loss is mainly driven by agricultural expansion, charcoal production, fires, fuelwood collection, industrialisation, livestock grazing, mining activity and infrastructure (roads, power transmission and dams), settlements, urbanisation, urban expansion and wood harvesting. Together, they cause forest losses of more than 276,021 ha every year, translating into about 0.6% per annum, of which 5.7% are the protected forests. The threats to forest resources are exacerbated by policy and regulatory factors such as the degazetting of forest reserves predominantly for infrastructural development purposes. Changes in ecosystems and species richness are directly related to changes in land area under protection, encroachment, and direct exploitation of biological resources. Deforestation and selective cutting of host trees have also destroyed the habitat for epiphytic plants. Increasing encroachment levels resulting from settlements and cultivation have compromised the Protected Forest Areas (PFAs). Despite Zambia having allocated an impressive proportion of its land surface to wildlife conservation, wildlife resources in many GMAs are in steep decline and are not sufficiently productive in ecological, economic or social terms. More than 1.5 million people are estimated to live in these GMAs. Thus encroachment into GMAs and National Parks through human settlements and the search for agricultural land has culminated in habitat degradation and wildlife depletion in Zambia.

The wetlands are an important habitat for most of the country's wildlife. Wetlands account for about 14–19% of Zambia's total area, comprising natural lakes, artificial lakes, open river channels, wooded flooded areas, floodplains, swamps and dambos. The total wetland hectarage is nearly 752,600 of the country. Less than half (310,040 ha) comprise swamps, marshes and floodplains, including Bangweulu swamps, Zambezi floodplain, Kafue flats, Lukanga swamps, Mweru-Wantipa and Busanga swamps. As such, Zambian wetlands support various economic activities, including game viewing, game hunting, ecotourism, fishing, irrigation, dams, small and large-scale agricultural activities, salt mining, and hydro-electric power generation. They also support livelihoods and provide ecosystem services such as reducing the impacts of storm damage and flooding, maintaining good water quality in rivers, recharging groundwater, storing carbon and nutrient cycling, and stabilising climatic conditions. Wetlands are important sites for biodiversity, but the spread of invasive species in these ecosystems poses a serious threat. For example, on the Kafue flats, the invasive plant *Mimosa pigra* has spread and occupies significant proportions of the floodplains, resulting in the displacement of animal species, blocking waterways and reducing food availability for wildlife and domestic animals. The invasive plants have also negatively affected breeding grounds of water bird species of global conservation concern such as wattled cranes and the grazing areas of large herbivores such as the endemic Kafue lechwe (*Kobus leche kafuensis*), thereby contributing to the rapid population decline of this endemic antelope species.

Zambia's natural vegetation is the savanna woodland, dominated by the Miombo and covering about 50% of the country, mainly by tree species of Brachystegia, Julbernardia, and Isoberlinia. This terrestrial ecosystem consists of woodland and grassland vegetation. Grasslands make up about 27.2% of land cover, which provides natural grazing land for cattle. In Protected Areas, human settlements and cultivation have modified and fragmented the grassland vegetation. As such, burning for pasture improvement is very common; however, while the vegetation may have adapted to this act, the increasing frequency of burning tends to create ecological problems. Early burning disturbs birds nesting in the grass. In contrast, uncontrolled late burning meant to provide green forage after grasses start to go dormant often results in reduced rangeland quality as most valuable species are destroyed. The extent of the damage has not been assessed, nor has vegetation recovery on abandoned fields.

Arguably, agriculture expansion constitutes the highest environmental cost. For example, the demand for land has resulted in converting natural habitats into new croplands and reducing the size of the terrestrial carbon sink. Researchers have observed the most remarkable effects of increased agricultural activities in areas previously sparsely populated and where shifting cultivation is practised, that is, Northern and Luapula provinces. When finalised, the farm block development programme will have converted a million hectares of natural forest into agricultural land. Although a less important driver than wood extraction and agriculture, the growing urban population has expanded urban settlements and infrastructure at a rate of 3.2% per annum. Industrial development such as mining, especially in the northwest, has resulted in vast tracts of forest land being cleared to pave the way for new mines, the need for large quantities of wood for tunnel supports, and increasing demand for charcoal to support the energy needs of miners. For example, at the Kalumbila mining concession, infrastructure development is estimated to have destroyed more than 7,000 ha of forest cover.

Economic costs

The loss in natural habitat and deforestation in particular – compared to other ecosystems – directly and indirectly affects the different sectors' economies, such as agriculture and other industrial activities such as mining, human settlement, tourism and wildlife. For this reason, the forests and grasslands are probably the ecosystems with the most policies and other legal instruments. More than 30 legal instruments have been developed and enacted. Agricultural development's social and economic benefits include improved social and recreation amenities for targeted communities, increased taxation due to more investment, improved input supply, and commodity markets. Social ills of agricultural development include forced removals of people from their cropping fields and grazing lands. For example, the establishment and later expansion of the 10,000-hectare Zambeef estate in Chisamba led to the displacement of local communities, disrupting their livelihoods. This displacement has negative consequences on people's health, housing, food and water security, and children's education. Smallholder farmers account for almost 60% of the population. With their dependence on the land for their livelihoods, and their role in feeding around 90% of the Zambian people, pushing them off the land has had negative consequences for the overall Zambian economy.

From an economic perspective, the contribution of agriculture to the overall Zambian economy has not been fully realised. It has hovered around 8–10% for more than 40 years. According to the World Bank, in 2017, forestry, fishing and agriculture as a sector on average contributed 7.2% to the country's GDP (Gross Domestic Product). However, more than 70% of its population is dependent to some degree on agriculture. A snapshot of all the major economic sectors shows that Zambia's main drivers of growth have remained the same as those at independence in 1964. The economy is still heavily dependent on the copper industry. Copper and cobalt still account for more than 75% of total exports, compared with sugar, which contributes just 1.7% of exports, and tobacco, 1.1%. Because copper dominates the country's economy, particularly its exports, global markets have a significant influence on the economy. Yet the dominance of copper exports has harmed the agriculture sector. The collapse of copper prices in the early 2000s presented an opportunity for the agriculture industry. Since 2003, the government has taken a broad step to revitalise Zambia's farming prospects. The introduction of the Farmer Input Support Programme

(FISP) has seen more farmers accessing agricultural inputs and increasing the production of major staple crops.

Furthermore, the improvement in the production levels of staple crops has led the government to embark on crop diversification to attain food security and boost incomes. The Second National Agricultural Policy (SNAP) outlines the government's agenda in crops, fisheries, livestock and forestry subsectors to produce commodities based on comparative and competitive advantage. Thus, the judicious use of biological resources is crucial for sustainable agriculture development. Hence, the various policies and legal instruments developed to preserve biological resources. These legal instruments address the adverse effects of low productivity in agriculture, declining populations of wildlife resulting from poaching or degradation of natural habitats, decreasing fisheries due to over-fishing, and so on.

Food insecurity

A noticeable feature of Zambia's economy is the occurrence of food insecurity and undernutrition in some communities. This problem is exacerbated by the unpredictable weather patterns affecting the farming communities over the past decade in some districts, especially in Lusaka, Southern and Western Provinces. Most agricultural households rely heavily on seasonal rains and subsistence-style farming. As a sector, Agriculture, Forestry and Fisheries employs 58.7% of the population. However, the low productivity of the agricultural sector indicates that more people have meagre incomes. At a national level, the incidence of poverty is estimated at 54.4%. According to the 2015 Living Condition Monitoring Survey (LCMS), in rural areas, poverty is highest among small-scale subsistence farmers cultivating less than two hectares at 78.9%, followed by farmers who own or cultivate two to five hectares at 64.5% and non-agricultural households at 48.6%. Though Zambia's food security situation has improved over the past five years with increased cereal surpluses, the country has remained food insecure, as evidenced by its 114th ranking on the global hunger index and 104th ranking on the food security index for developing countries. The seasonality of alarming levels of hunger and malnutrition, particularly during lean times of the year around September to February, has also been reported.

The main drivers of the Zambia food system are the:

- demographic factors-highly urbanised and moderate population (3.6% per annum); income disparities between urban and rural areas
- government policies
- other factors such as increased market opportunities, improved agricultural practices and political stability, which ensure the delivery of affordable, nutritionally adequate, safe and healthy (and even culturally or religiously acceptable) food to its citizenry.

The main actors in the food supply chain include seed companies, agro-dealers and research institutions. The roles of these actors include making suitable varieties available and encouraging improved agricultural practices along the value chain that include 1.6 million small-scale farmers, aggregators (grain traders), marketeers, Food Reserve Agency (FRA), processors, wholesalers, retailers (including chain stores) and the consumers. Along the various supply chain, steps are taken to reduce food losses and food wastage.

The country's total population is projected to increase from 13.7 million in 2011 to 17.9 million in 2020 and 26.9 million by 2035. The number of people in rural areas is expected to grow from 8.2 million in 2011 to 10.1 million in 2020 and 14.5 million by 2035. The number of people in urban areas is expected to grow from 5.6 million in 2011 to 7.8 million in 2020 and 12.4 million by 2035. During the 2011–2035 period, an average annual population growth rate of around 2.8% is expected, with an average population growth rate of 2.4% per year in rural and 3.5% per year in urban areas. The rural Zambian diet relies on a limited number of crops with very little or no diversity. They are therefore more vulnerable to the effects of droughts and other climate-related factors. Throughout the country regional consumption patterns differ hugely. Maize dominates consumption baskets in southern and eastern Zambia, while cassava predominates in parts of the north. Northern and north-western Zambia form a transition zone between the maize and cassava belts in which households consume large quantities of cassava and maize. For the majority of the rural community in Zambia, their livelihood depends on their own produced food to meet their household consumption needs.

Environmental impact

With the emergence of agriculture as the mainstay of the Zambian economy, more Foreign Direct Investment and large direct investments are being made into the agriculture sector, resulting in more land opening. This has led to growing concerns about the state of degradation of the Zambian environment over the past three decades. Global warming, deforestation, air, water and land pollution are major environmental problems with short and long-term impacts on the Zambian population. Since 1980, the Zambian government has employed various steps and measures to preserve the environment and conserve biological resources. It has domesticated several environmental and agriculture-related conventions, treaties and agreements, and taken some milestone steps, such as the adoption of a National Conservation Strategy in 1985. Several public institutions have been tasked with promoting public awareness of the environment, including the Ministry of Tourism and Arts (MoTA), Ministry of Lands and Natural Resources (MLNR), Ministry of Water Sanitation and Environmental Protection (MWSEP), Zambia Environmental Management Agency (ZEMA), and several government departments. Other awareness activities include formal environmental education in schools, public gatherings, workshops, and communication through a public announcement by ZANIS (Zambia National News and Information Services), electronic and print media. There is a need to promote and encourage understanding of the importance of environmental protection.

In addition, climate variability has already started to affect Zambia, and the projected climate change impacts include rises in temperature, shifts in precipitation, and possible increases in the frequency and intensity of weather events. However, most rainfall projections do not indicate substantial changes in national average annual rainfall. Still, they show decreases in the rain from September to November and increases from December to January. The decreases from September to November could relate to amounts, onset and cessation; the increase from December to January could relate to intensity and length of the rainy season and would inevitably affect the seasonality of crops. These will also significantly impact a wide range of sectors, including the water sector, where increased evaporation is likely to reduce runoff and infiltration, increase losses from dams and wetlands, and increase water demand for irrigation and domestic uses. Analysis of crop sensitivity to climate shocks shows that maize will be among the most negatively affected crops, with significant yield reductions due to anticipated future climate patterns. This situation has policy implications and requires the country to implement policies and programmes that support smallholder farmers to diversify into other more drought-tolerant crops such as cassava, cotton, millets and sorghum.

Agriculture policy

Several vital policies are anchored on the SNDP and vision 2030. SNAP is the key agricultural policy for Agriculture and Livestock and Fisheries ministries for 2016–2021. However, more than 30 legislative instruments in Zambia address the conservation of biodiversity and the protection of the environment. Most of these instruments were enacted more than 30 years ago, and some have been reviewed several times. The most important legislation, policies and institutions in conserving components of biodiversity are in forestry, wildlife, agriculture and fisheries. An overall environmental and natural resources management framework exists through the National Conservation Strategy of 1985, the National Environmental Action Plan of 1994, and the National Policy on the Environment of 2007. In terms of legislation, the Environmental Protection and Pollution Control Act of 1990 is considered the principal legislation covering several sectors. In keeping with the democratic and liberal philosophy of the country under the multi-party political system, since 1995 the government began decentralising the management of public service delivery based on corporate governance principles. This system has enabled local communities to fully participate in managing their government affairs through decentralised organisational structures or arrangements. As the decentralisation gets entrenched in the governance of national resources, even issues of environmental protection are included. In some areas, local citizens participate in the biodiversity management of the country. For example, the community-based natural resources management forum aims to secure community livelihoods through sustainably managing natural resources, reducing the rate of deforestation, ensuring minimal encroachment of protected areas and with the preservation of the forest reserves. As such, solutions for limiting agriculture's environmental costs are increasingly well understood. Several powerful lobby groups exist to ensure favourable policies and laws are enacted in the agricultural sector. These include the Zambia National Farmers Unit (ZNFU), Millers Association of Zambia (MAZ), Seed Traders Association, and some large fertiliser companies that supply the government with fertilisers under the FISP. Other organisations include Conservation Farming Unit (CFU), Farmer Organization Support Program (FOSUP), National Peasants and Small-Scale Farmers Association, Zambia Cooperative Federation, and OPAZ (Organic Producer Association Zambia).

However, to accelerate agriculture, there is a need for a well-coordinated agricultural research and extension system. These are anchored on the Ministries of Agriculture and Livestock and Fisheries. Several government institutions deliver appropriate agricultural extension services, for example, National Agricultural Information Services (NAIS), ZANIS, Department of Agriculture, University of Zambia School of Agricultural Sciences, and other education and research institutions around the country. Under the revised National Decentralized Policy, the local council coordinated the agriculture extension services. This arrangement envisaged accelerating agricultural development at district and community levels.

The government developed policies enabling public and private research institutions to generate appropriate technologies to encourage agricultural development. Such policies include recommendations for innovations that:

- increase productivity and minimise production risks
- investigate market systems
- facilitate agricultural diversification
- ensure sustainable natural resource management and governance
- improve livelihoods, human nutrition, and health-foods for consumers
- promote farmer and farm workers protection
- minimise food waste and develop appropriate food supply systems – encompassing the production, processing, marketing, and purchase of food and related consumer behaviours, resources and institutions, and food safety nets.

In addition, both donors and cooperating partners have been encouraged to provide financial, technical and other support in implementing agricultural policies and programmes and capacity building for stakeholders. The Zambia Agriculture Research Institute (ZARI) is the hub of agriculture research. The other players include National Institute for Science and Industrial Research (NISIR), academia, Non-governmental Organisations (NGOs), and Consultative Group on International Agricultural Research (CGIAR) centres like Center for International Forest Research (CIFOR), International Maize and Wheat Improvement Center (CIMMYT), International Institute for Tropical Agriculture (IITA), and World Agroforestry (ICRAF).

1. Introduction

Among the biggest challenges in sub-Saharan Africa is attaining the Sustainable Development Goals of zero hunger (SDG2), conserving ecosystems (SDG15) and reducing inequalities (SDG10). As the demand for food increases to more than 150% by 2050, it will be vital to increase agriculture production while promoting social equality and minimising the negative impacts of agriculture on the ecosystem as a core of sustainable development (www.iied.org). Previous research by IIED in sub-Saharan Africa indicates that rapid economic development and population increase create a conflict between food security and ecosystem conservation (www.iied.org).

Although Zambia has the largest proportion of poor people in rural areas (www.un.org) depending on agriculture for their survival (http://diva-portal.org), the country's agricultural productivity is among the lowest in the world (AfDB, 2016). Agriculture is thus an important sector to consider when fighting food insecurity and poverty (http://diva-portal.org). However, policymakers in both government and the private sector hardly consider the socio-economic and environmental impacts of agricultural development (http://diva-portal.org). As a result, negative impacts on agriculture have contributed to poorly informed agricultural development strategies – particularly considering projected changes in climate – including forest conservation and restoration policies (http://diva-portal.org). Consequently, those who depend on agriculture for a living are marginalised (http://diva-portal.org). The need for more coherent policies results in long-term sustainable and resilient farming systems (http://diva-portal.org) and ecosystem services (http://diva-portal.org). In such interventions, the primary beneficiaries are the rural and urban poor households. According to http://diva-portal.org, this includes (a) the marginalised poor people in rural areas dependent on subsistence agriculture, and (b) rural/urban populations who produce little or no food themselves and are highly dependent on purchased food. Despite the vital role of agriculture in poverty reduction, the sector lacks attention from both the national and local governments. This document presents a contextual analysis of Zambia's agriculture and forestry sectors. It reviews the present status of land use, forest ecosystems and crop production systems in the country, and how various legal frameworks influence agricultural development. It attempts to identify the other drivers of land-use change and how these are likely to affect the environment and land use. It also documents Zambia's policy, and its institutional and technological landscape that catalyses agriculture development, by considering several intersectoral linkages.

Background

Zambia is rich in forest resources that can contribute to the country's gross domestic product (GDP) and improve livelihoods. However, in the past 50 years since Zambia's independence, deforestation has contributed to the depletion of forest resources. The deforestation rate per annum in the country is estimated at 276,000 ha per annum (Shakacite et al., 2016) and has negatively impacted on goods and services in Zambia. These goods and services occur through direct and indirect use to meet present and future livelihoods, industrial and environmental requirements.

Forests cover more than 65% of Zambia's total land, and 20% is under agriculture. According to Shakacite et al. (2016), the agricultural sector contributes to forest loss in Zambia. For example, the expansion of cultivated land rather than the increased yield per hectare of land (www.encampafrica.org) was responsible for the 65% increase in maize production in 1991 and 2015. Estimates indicate that agricultural land use increased by an average of 1.5% annually from 2000 to 2010. Production and wood fuel demand in urban areas and along main roads have contributed to deforestation (Forest Department, 2016a). The deforestation rate will likely keep increasing as the population continues to rise.

Zambia's forestry sector has the potential to make a significant contribution to economic growth once adequately developed. For this to happen, biodiversity conservation is critical for realising the economic benefits through consumptive and non-consumptive use. Besides timber products, forests are essential for sustaining wildlife, which in turn attracts tourism, protects catchments of the major rivers and wetlands. Trees are a habitat for animals and birds as a source of food and – most importantly – stabilise and maintain the forest's soil, biodiversity and climate (www.risingfountains.org).

Like many other developing countries, Zambia depends highly on the use of natural resources for the livelihood of its people. Unfortunately, since the early 1980s, Zambia's biological resources have been overexploited due to the country's general socio-economic decline (GRZ, 1997). Forests, wildlife and fish are among the most adversely affected biological resources. However, Zambia has ratified many conventions to preserve its biodiversity through the MLNR. In addition, it has developed the National Biodiversity Strategy and Action Plan (NBSAP). Deforestation in Zambia has continued to increase, driven by socio-economic factors such as agricultural land expansion, charcoal burning and land for industrial development. Forests are a significant carbon sink that modulate climate and thus combat environmental degradation and deforestation. Evidence suggests that working with poor rural communities to uplift their living standards while restoring the environment and forests through reforestation is a critical mitigation measure (www.risingfountains.org).

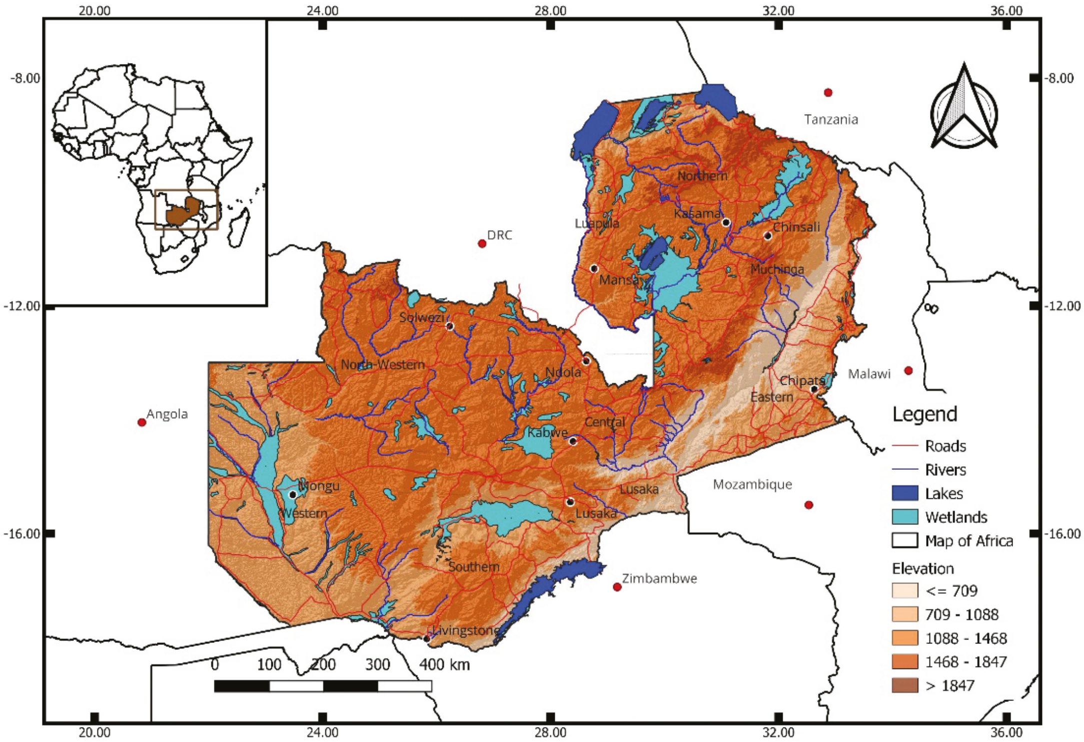
1.1 The scope of agriculture production systems

1.1.1 Proportion of land use and agricultural use

The land mass of Zambia extends 752,614km^2, of which 1.6% constitutes water bodies (Jain, 2007). Plateaus, hills and mountains characterise Zambia's terrain. The uplifted plantation surfaces represent the general topography of Zambia, with elevation increasing from west to east, that is, from the Kalahari Basin to the Mafinga Hills. According to Simson (1985), the lowest point of the terrain is the Zambezi River, located at 329m above sea level, and the highest is found in the Central Mafinga Hills at 2,339m above sea level (Figure 1).

The country has the Zambezi depression in the south falling from the Democractic Republic of Congo (Ntalasha et al., 2014). As a landlocked country, Zambia borders eight countries. To the east, there is Malawi, and to the south, Botswana and Zimbabwe. Mozambique is to the southeast of Zambia, while Angola and Namibia are to the west. The Democratic Republic of Congo (DRC) is north, while the Republic of Tanzania is northeast.

Figure 1. The physical map of Zambia



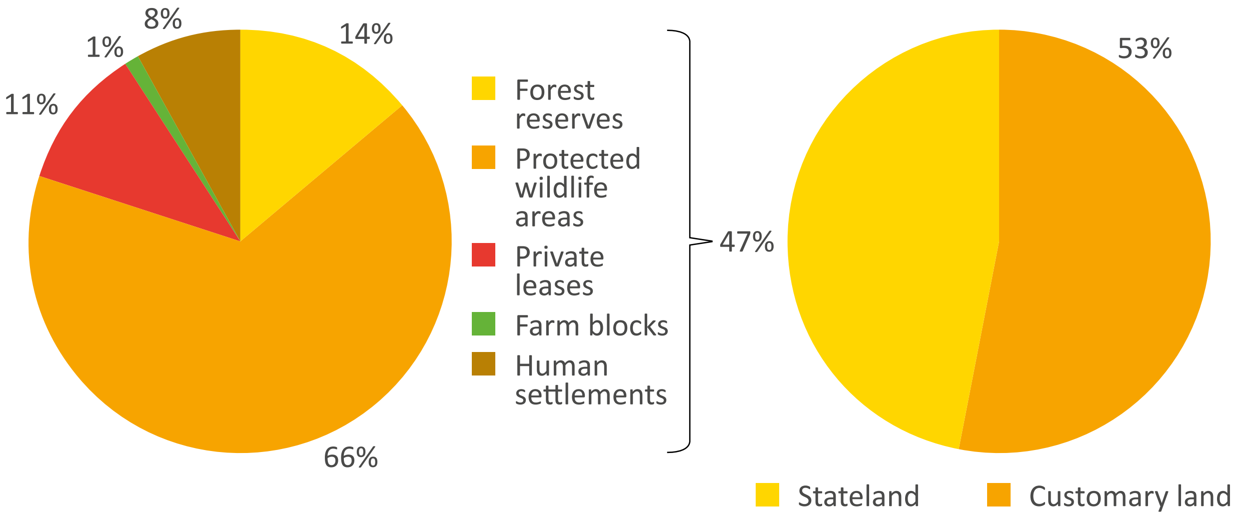
Intricate watershed systems connect Zambia. Two major river basins drain it: (i) the Zambezi/ Kafue basin in the centre, west and south, and (ii) in the north the Congo basin. The Zambezi River tributaries are the Kafue and the Luangwa, which flow mainly within Zambia. The cool, dry season runs from May to August, September to November is the hot and dry season, and December to April is the warm, wet season. The hottest months are October and November, while the driest are June, July and August. Annual rainfall varies significantly across regions, from 700mm in the south to 1,100mm in the north (Hamududu & Ngoma, 2018; JAICAF, 2008; MLNREP, 2014; Simson, 1985).

1.1.2 Land use

The land categories in Zambia comprise customary (53%), which is the land administered by traditional leaders, and state land (47%) administered by the Commissioner of Lands on behalf of the state (Adams, 2003; Chitonge et al., 2017; www.heiguides.org). Customary land is over 40 million ha, accounting for the largest proportion (53%) of Zambia's landmass. This land tenure system is under communal arrangements by indigenous people subdivided into family, individual or group under each traditional leader. Customary land is held in trust by the president through the traditional authorities.

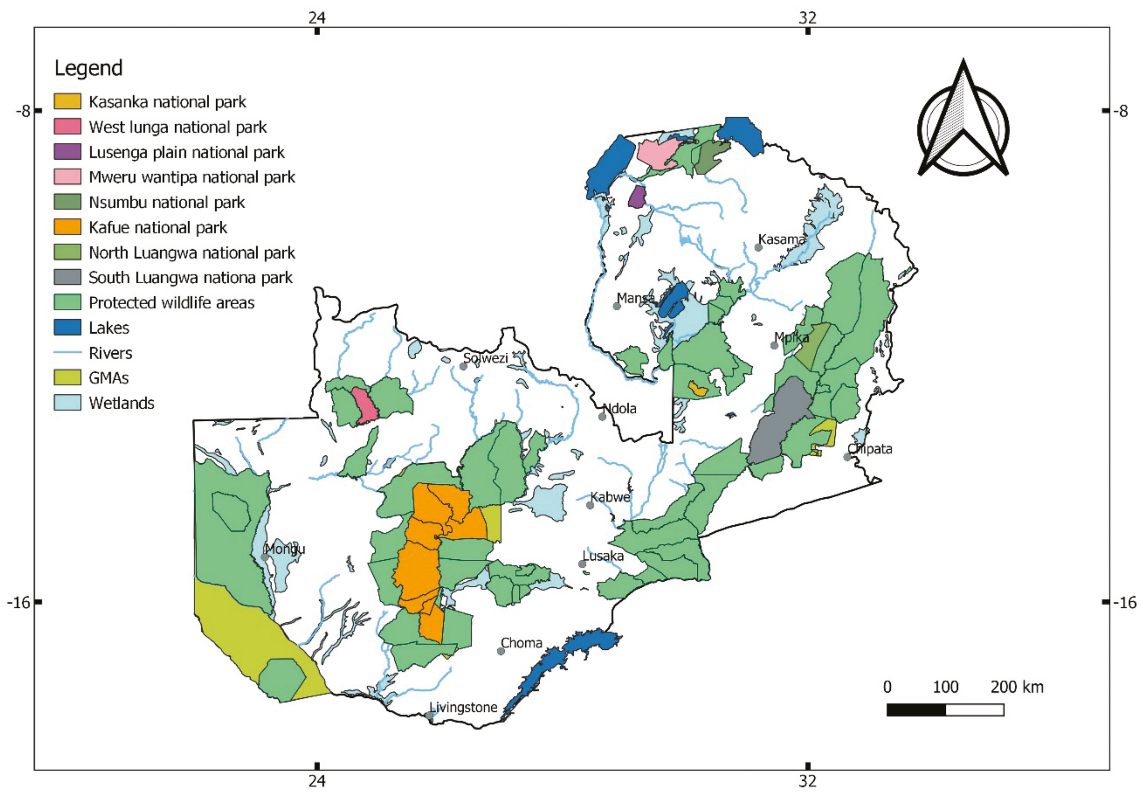
State land is estimated to be 35.2 million ha (47%) and is subdivided into protected wildlife areas (66%) (i.e., National Parks, Game Management Areas); forest reserves (14%); private leases (11%); human settlements and the urban regions (8%); and farm blocks (1%) (Honig & Mulenga, 2015; Shakacite et al., 2016). The proportions of these land categories are shown in Figure 2.

Figure 2. Proportions of land use in Zambia showing (a) subdivisions of land in state land and (b) main land categories



The largest proportion of state land is designated as wildlife conservation areas (i.e. national parks and GMAs) found across Zambia (Figure 3). However, wildlife resources in many GMAs are in steep decline and are not sufficiently productive in ecological, economic or social terms. Over 1.5 million people are estimated to live in these GMAs. Thus, encroachment into GMAs and NPs through human settlements and search for agricultural land has culminated in habitat degradation and depletion of wildlife in Zambia.

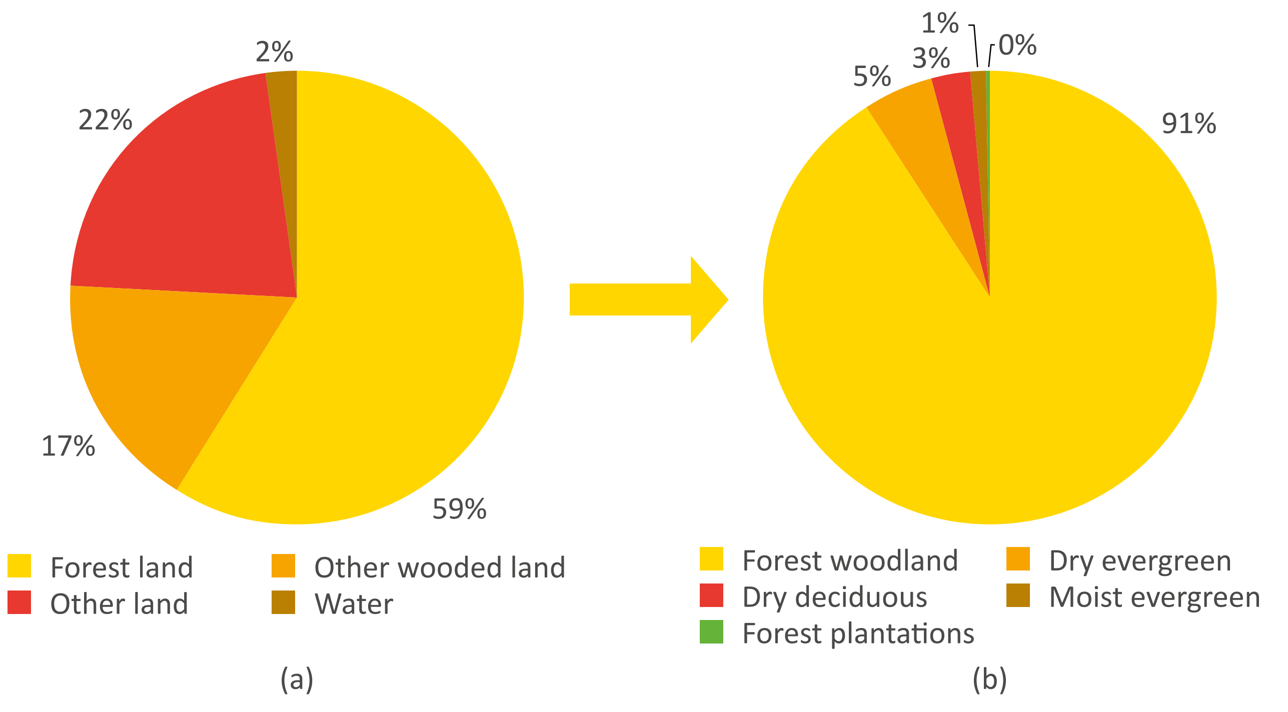
Figure 3. Map of protected wildlife areas showing locations of Game Management Areas and National parks in different parts of Zambia



Studies conducted in the 1980s based on remote sensed data classified vegetation based on total biomass for fuelwood (Chidumayo, 1987a). Nine biomass classes, arranged in order of magnitude, were (i) Wet *Miombo* Woodland, which covered 30.8% of the country's total surface area, (ii) Seasonal *Miombo* Woodland, (iii) Degraded *Miombo* Woodland, (iv) Kalahari Woodland, (v) *Mopane* Woodland, (vi) Dry *Miombo* and *Munga* Woodland, (vii) Swamp and Lake Vegetation, (viii) Scrub Woodland, and (ix) Dry Evergreen Forest, which covered only 1.3% of Zambia's surface area (Forestry Department, 2016b).

The integrated land use assessment report classifies the 75.26 million ha land mass of Zambia into forest land (44.17 million ha (60%)), other wooded land (13.22 million ha), other land (16.53 million ha) and water bodies (1.34 million ha) (Shakacite, 2016) (Table 1). In line with the FAO global forest assessment system (FAO, 2010) forest land was further subdivided in vegetation types that include forest woodland (91%), dry evergreen (5%), dry deciduous (3%), moist evergreen (1%) and forest plantations (0.12%) (Figure 4).

Figure 4. The proportions of forest land use in Zambia according to the FAO classification showing (a) subdivisions of forests and (b) proportions of the main vegetation types of which forest woodland (40.18 million ha) accounts for the largest proportion and forest plantation is the least estimated at 55,000 ha



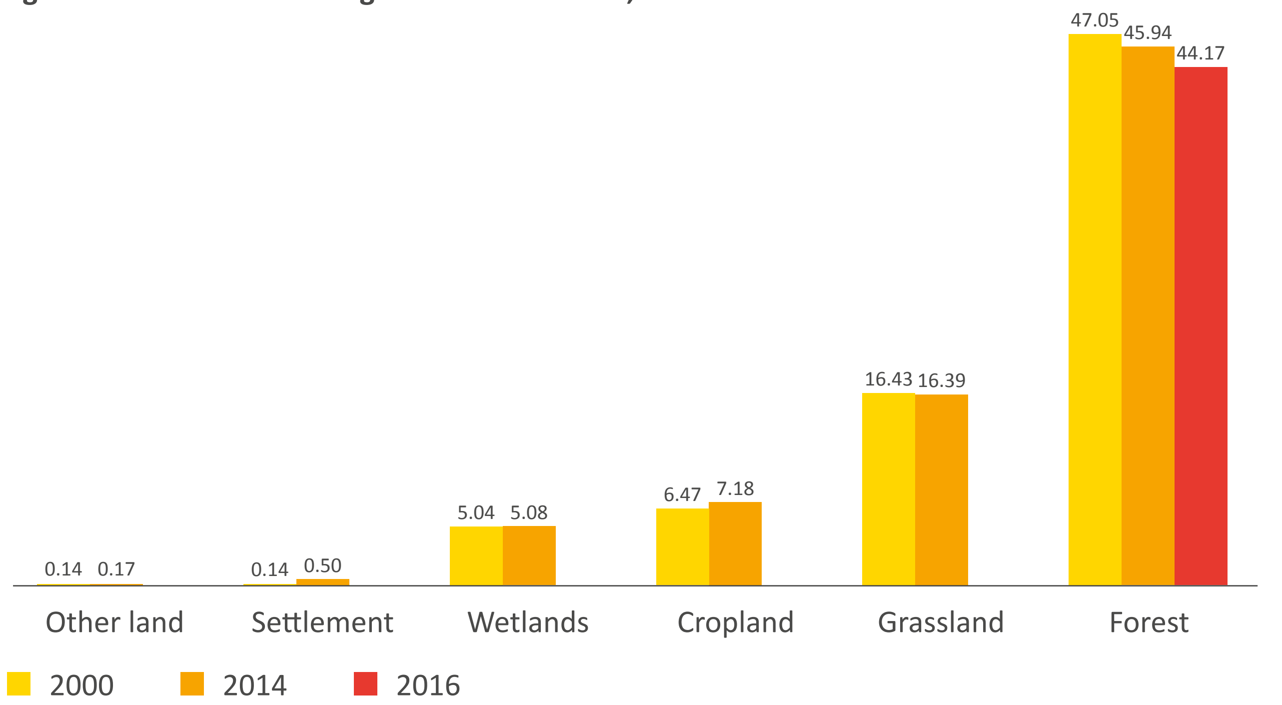
The other wooded land include shrubs, grasslands, marshland, managed lands under annual and perennial crops, pasture and fallow land, and built-up areas; and inland water bodies (lakes, rivers, dams) (Kalinda et al., 2008). The 40.18 million ha forest woodlands commonly referred to as miombo in the literature comprise the wet (39.1%) and dry miombo (17.1%) woodlands (Chidumayo, 1997). Other land use classes are shown in Table 1.

Table 1. Land use categories and vegetation classification

FRA (land) class	Area (ha)	Major vegetation and other lands
Forests	44,170	• Dry evergreen forest
		• Dry deciduous forest
		• Forest plantations
Other wooded land	13,219	Wooded grasslands (plants, shrubs, trees)
Other land	16.533	• Grasslands
		• Bare land
		• Cultivated and managed land
		• Built-up areas
Water bodies	1,339	Inland water
Total land mass	75,216	All

There has been striking land use change over the years in Zambia, based on the land use categories that include forests, grasslands, cropland, settlements and other land (Shakacite, 2016). Striking changes have been observed in forests where a decrease from 47.05 million ha in 2000 to 44.17 million in 2016 and increase in land use has been observed for cropland and settlements, respectively (Figure 5). Settlement area changed from 0.21 million ha in 2000 to 0.50 million ha in 2014 representing an increase of more than 130%, while cropland changed from 6.5 million ha in 2000 to 7.2 million ha in 2014 representing 7.5% increase (Shakacite, 2016).

Figure 5. The land use change trends from 2000, 2014 to 2016 in Zambia



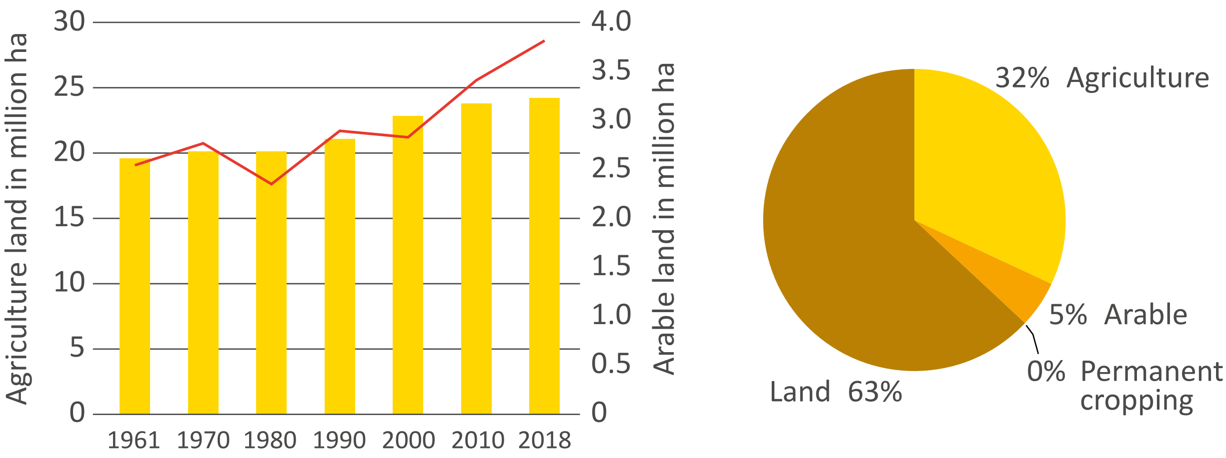
The creation of farming blocks and degazetting of forest reserves are meant to increase access to land for the rural poor, local residents and squatters settlements (Honig and Mulenga, 2015). The Zambia Forestry and Forestry Industry Corporation Limited (ZAFFICO), a listed parastatal company, has over 50,000 ha of forest plantations in forest reserves and less than 7,000 ha is currently under other local supply plantations belonging to the government and farmers (CIAT/World Bank, 2017). However, some of these reserves have been degazetted in recent years for human settlement. According to Shakacite et al. (2016), degazetted areas are characterised by various anthropogenic activities, including agriculture, charcoal production and other livelihoods activities (CIAT/World Bank, 2017). Some studies attributed the forest cover loss in Zambia to economic, industrial, land tenure, institutional and governance issues (Vinya et al., 2012). In contrast Shakacite et al. (2016) identified land use change from forest to cropland and settlements as main drivers of deforestation in Zambia.

1.1.3 Agricultural land

According to Abdulai (2016) and FAO (2019), only 32.06% (23.836 million ha) of the total landmass is agricultural land, though 43.1 million ha (58%) is classified as medium to high potential for agricultural production. Only 15% is currently under cultivation (MoA, 2016a; MLNREP, 2014).

There has been an increasing trend of land under agriculture from 22.8 million ha in 2004 to 23.8 million ha in 2016. This is an average increase of over 80,000 ha per annum, attributed to degazetting and opening up of new areas (Figure 6a). The proportion of arable land is estimated at 5% of the land mass of Zambia (Figure 6b). Permanent land under crops is estimated at 0.36 million ha.

Figure 6. Arable and agriculture land in Zambia showing (a) trend between 1961 to 2018(b) average proportion of arable and agriculture land. Permanent crop is less than 0.5%



	1961	1970	1980	1990	2000	2010	2018
Agriculture	19.5	20.1	20.1	21.1	22.8	23.7	24.1
Arable	2.5	2.8	2.5	2.9	2.8	3.4	3.8

1.1.4 Farming blocks

The MoA has created more than ten farming blocks in Zambia, one in each of the ten provinces (Table 2). According to MAL (2015), the ten agriculture blocks include basic infrastructure development such as bulk water supply, irrigation dams, electrification and roads.

The farm block programme has converted about 100,000 ha of customary land to state land in ten provinces (Honig and Mulenga, 2015) (Figure 7). Farmers within the farming blocks will be on a 99-year leasehold certificate of renewable title. The farm blocks are modeled around the main venture investor who offers market and processing facilities to small and medium-scale farmers. Farmers (small scale and medium scale) are put in an out-grower scheme similar to the one practised by the Illovo scheme-owned Nakambala sugar company. Each farm block is designed to have at least one core (www.theiguides.org) venture arrangement, which is termed a large-scale farm of 10,000 ha, one to three commercial farms of 1,000–5,000 ha (www.zambiahc.org.uk), several medium-scale farms (50–100 ha) and small-scale farmers farming less than 20 ha. The relationships among the different farm categories in each farm block are such that the farms will be organised in an out-grower cluster arrangement. The core venture coordinates production and offers the market focus, with farms growing the same crop (Matenga, 2016). In 2015, the MoA indicated that 531,500 ha of land has already been authorised by customary authorities (Chiefs) for conversion to state land for the farm blocks project (Honig and Mulenga, 2015). The status of the farming blocks is presented in Table 2.

Figure 7. Map showing location of irrigation schemes in Zambia

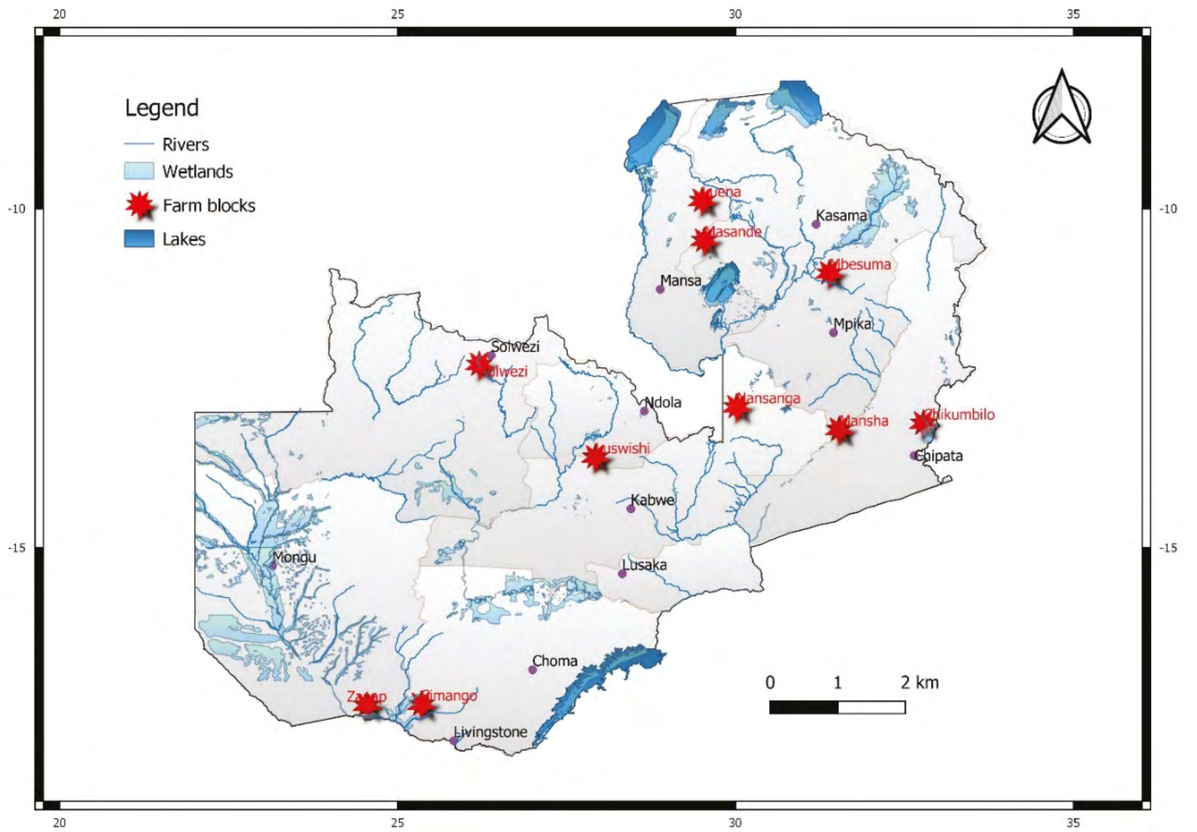


Table 2. Summary of the activities in the farm blocks

Farming block	District	Status
Nansanga	Serenje	Infrastructure is under development by the Zambia Correction Service
Luena	Kawambwa	Open to investors but some access is yet to be completed. Two investors (i.e., Sunbird Bioenergy Africa and Nava Bharat ventures of India) are making progress towards settling to establish an integrated sugarcane estate and a biofuels plant. Each investor has been allocated about 10,000 ha, but other farms are yet to be allocated land
Luwishi	Lufwanyama	100,000 ha identified, feasibility studies have been conducted, and an environmental impact assessment is done. Investors have been identified. The farm block was allocated funds in the 2018 national budget, and phase 1 of its development is expected to be completed in 2020
Simango	Livingstone	36,000 ha identified. 75,000 ha under soil fertility and social investigations (Shawa, 2014)
Mupanshya	Mpika	147,000 ha identified. Feasibility studies were undertaken. About 350 small, emergent and medium-scale farms were demarcated and cadastral surveyed (Shawa, 2014)
Kalungwish	Mporokoso	Feasibility study completed; construction works slated for commencement in April 2018
Chikumbilo		About 38,000 ha of land was secured, and soil feasibility studies were done. Negotiations for a further 62,000 ha are under way. In addition, an environmental impact assessment was conducted (Shawa, 2014)
Kalumwange	Kaoma	100,000 ha identified
Mwase Mphangwe	Lundazi	100,000 ha identified
Sananga Citric Plant	Senanga	1250 ha for the establishment of Citric Processing plant; the land also suitable for mangoes, pineapples and cashew nut
Musakashi	Mufulira	100,000 ha identified

Source: MAL (2015); MFNP (2005)

1.1.5 Agricultural irrigated land

After independence in 1964, the Zambian government started smallholder schemes – parastatal or semi-parastatal – and private commercial schemes, and organised irrigation farming (Coche, 1998). As a result, farmers began producing various crops, including cash crops such as vegetables and fruit. In addition, they started using gravity and motorised irrigation systems (Coche, 1998). However, less than 15.6% of the total irrigated land, 155,912 ha, has carried on large-scale public and private irrigation projects (Table 3). These are located across the country (MoA, 2016a). The rest are at individual farms across the country.

Table 3. Location of the public and private irrigation schemes/projects in Zambia

Irrigation scheme	Crop	Area (ha)	Percent
Copperbelt		4,345	17.8%
Chapula irrigation scheme	Citrus and vegetables	60	0.2%
Ipafu irrigation scheme	Vegetables	85	0.3%
Mpongwe wheat scheme	Wheat	4,200	17.2%
Eastern		52	0.2%
Lukuzye	Vegetables	7	0.0%
Lusowe	Vegetables	10	0.0%
Makugwa	Vegetables	22	0.1%
Vuu	Vegetables	13	0.1%
Luapula		560	2.3%
Kawambwa Tea Scheme	Tea	500	2.0%
Mununshi Banana Scheme	Bananas	60	0.2%
Lusaka		1,656	6.8%
Chanyanya scheme	Rice	50	0.2%
Chiawa Banana	Banana	6	0.0%
Chipapa	Vegetables	10	0.0%
Kaunga	Vegetables	20	0.1%
Masstock Africa Ltd.	Marigold, cotton, paprika	1,570	6.4%

Irrigation scheme	Crop	Area (ha)	Percent
Northern		4,529	18.6%
Chamfula settlement	Maize and groundnuts	187	0.8%
Chintu farm block	Maize	90	0.4%
Kabuta settlement	Coffee	375	1.5%
Kateshi coffee	Maize	490	2.0%
Lubu settlement	Maize & groundnuts	187	0.8%
Lukulu North	Vegetables	2,760	11.3%
Lukupa Nalole	Vegetables	10	0.0%
Mbala seed potatoes	Potatoes	230	0.9%
Ngoli coffee	Maize & groundnuts	200	0.8%
Northwestern		350	1.4%
Mwinilunga Pineapple	Pineapple	350	1.4%
Southern		12,699	52.1%
Buleya Malima	Banana & citrus	57	0.2%
Chiyabi	Banana & citrus	10	0.0%
Kaleya Outgrower	Rice & vegetables	2,600	10.7%
Nakambala Estates	Sugar	10,000	41.0%
Nkandabwe	Sugar	10	0.0%
Siatwiinda	Banana & citrus	22	0.1%
Western	Banana & citrus	200	0.8%
Sefula scheme	Rice	200	0.8%
Grand Total		24,391	100.0%

Sources: Akayombokwa et al. (2015); Coche (1998)

Renewable water resources are estimated at 165km^3 per annum (Akayombokwa et al., 2015) of which 115km^3 comprises runoff, 50km^3 groundwater, and 1,700 dams; Lake Kariba, on the Zambezi River, contributes 50% of the total capacity of about 106km^3 and accounts for 94km^3 of this capacity. The lake is shared between Zambia and Zimbabwe. Many boreholes have been sunk in urban and peri-urban areas, especially along the rail line, with sustainable yields in the range of

20–30 l/s that can irrigate up to 20–30 ha (Akayombokwa et al., 2015). Farmers, civil society and government have built an estimated 2,000–3,000 low-cost earth dams and water impoundments in drought-prone areas of Eastern, Lusaka, Central, and Southern provinces, to conserve water for livestock and domestic agriculture use (FAO, 2005). Most of these earth dams and water impoundments are in a state of disrepair either because of breaching, lack of or insufficient maintenance, or poor designs (FAO, 2005).

Overall, the renewable water resource per capita in Zambia is estimated at 8,700m^3 per annum. Agriculture alone is currently responsible for water withdrawals of about 1.7km^3 pa. The country's irrigation potential lies around 3 million ha (8% of arable land), with an area of 423,000 ha perceived to have high economic potential (Shawa, 2014). Despite this vast potential, only about 7% or 156,000 hectares are currently under irrigation (Evans et al., 2012; Ndiyoi et al., 2009). The total area under a small-scale irrigation scheme is 111,525 ha, while that under medium and large scale is 7,372 and 37,015 ha, respectively (Akayombokwa et al., 2015). Since 2004, the irrigated land has increased significantly by more than 200%, though this is from a very low base. The development of irrigation is guided by the National Irrigation Policy and Strategy (MACO, 2004). However, the lack of available infrastructure for extracting and distributing water, appropriate water extraction technologies, and inadequate access to financial resources by farmers, particularly small-scale producers, has limited the development of the irrigation sector, similar to what has been observed for Comoros (UNEP, 2010).

With support from the World Bank, the Zambian government developed an irrigation programme that targeted smallholder and commercial farmers, focusing primarily on drought-smallholder-prone areas (Zambia Daily Mail, 2014; www.un.org). The Irrigation Development Support Project (2011–2018) established 10,000 ha of irrigation agriculture on land held by smallholders, including emergent or medium-scale farmers. It also made water available for 1,600 ha large-scale farmers. These irrigation sites were in Mwomboshi, Chisamba district (Central Province), Lusitu in Chirundu, Lusaka Province and Musakashi in Mufulira, Northwestern Province. In addition to 11,600 ha, an additional 7,230 ha of smallholder irrigated agriculture is expected to be developed (www.un.org) by expanding sites where feasible. The plan involved constructing irrigation dams and irrigation canals.

Rural small-scale farmers in wetland areas (dambos and seasonally inundated floodplains) (Coche, 1998) have traditionally practised informal irrigation (Coche, 1998; Chidumayo, 1992), with wetlands reported to be a source of livelihood for most small-scale farmers. These wetlands are estimated to cover about 4.8% of the total land area, which translates to about 3.6 million ha (FAO, 2005). In the dry season, local food crops and some cash crops (vegetables, sugar cane, rice and bananas) are produced to complement rain-fed crops production and income (MACO, 2004). Even though irrigation has traditionally been manual using buckets, various civil society organisations have gradually introduced low-cost irrigation technology. Dambos are used for grazing in the dry season when the upland vegetation is dry and with little nutritive value (http://siteresources.worldbank.org). Other uses of these dambos include a collection of thatching grass, providing water for livestock, hunting for small animals, fishing, and most importantly, for dry season vegetable growing.

1.1.6 Cropped land

The data presented in Table 4 show that between 2014 and 2018, more than two million ha annually were planted with annual crops (CSO, 2014a, b; 2016b, c; 2018; 2019). Zambia has seen a remarkable increase in land for crop production over the years (MoA, 2016a). Maize, both local and hybrid, is the principal staple and cash crop that accounts for more than 65% of land under cultivation. An estimated 105kg/person/annum of maize is consumed in Zambia. Most of it is ground into meals and consumed as stiff porridge or fermented for beer, with by-products used as livestock feed (www.yieldgap.org/zambia). Wheat follows this at 12.8%, cassava at 11.8%, groundnuts at 7.9%, beans at 5%, millets at 3.7%, cotton at 3.6%, sweet potatoes at 3% and sorghum at 2.5% (Kalinda et al., 2008). Pearl millet, soybean, sugarcane, sunflower, tobacco and various vegetables and fruit are other important crops (www.yieldgap.org/zambia). Dry season production is used to complement rain-fed crop production and income. Crops produced in the dry season include some local food crops and cash crops such as vegetables, sugar cane, rice and bananas (Coche, 1998). Maize cultivation is dominant among crops produced in Zambia. This has policy implications, particularly encouraging appropriate land use, crop diversification, research, and extension services delivery. While most smallholder farmers practise multiple cropping and intercropping, the actual numbers are not known and the combined yields of these farmers is reported to be relatively low. Yet, the benefits of this practice are to diversify production and increase total yields. Because most small-scale farmers cultivate small parcels of land simultaneously, intercropping is common (Chipeta et al., 2014). This system is well adapted

Table 4. The proportion of cropped land for the different annual crops 2011–2018

Year	Arable land	Total cultivated to annual crops*	Maize	Other cereals	Food Legumes	Root & Tuber crop	Industrial annual crops§
	1000ha						
2011	3,600	2,905.4	1,570.2	185.0	389.9	372.3	387.8
2012	3,800	2,940.9	1,519.1	171.8	426.7	421.2	402.1
2013	3,700	2,712.5	1,419.3	176.4	433.1	423.2	260.3
2014	3,800	2,795.2	1,499.3	165.3	486.1	420.4	224.1
2015	3,800	2,818.1	1,494.5	183.3	471.3	420.2	248.7
2016	3,800	2,679.8	1,395.6	166.3	461.6	424.2	232.1
2017	3,800	3,063.2	1,645.7	172.5	583.6	429.5	231.7
2018	3,800	2,447.2	1,403.3	115.6	596.18	256.2	79.8

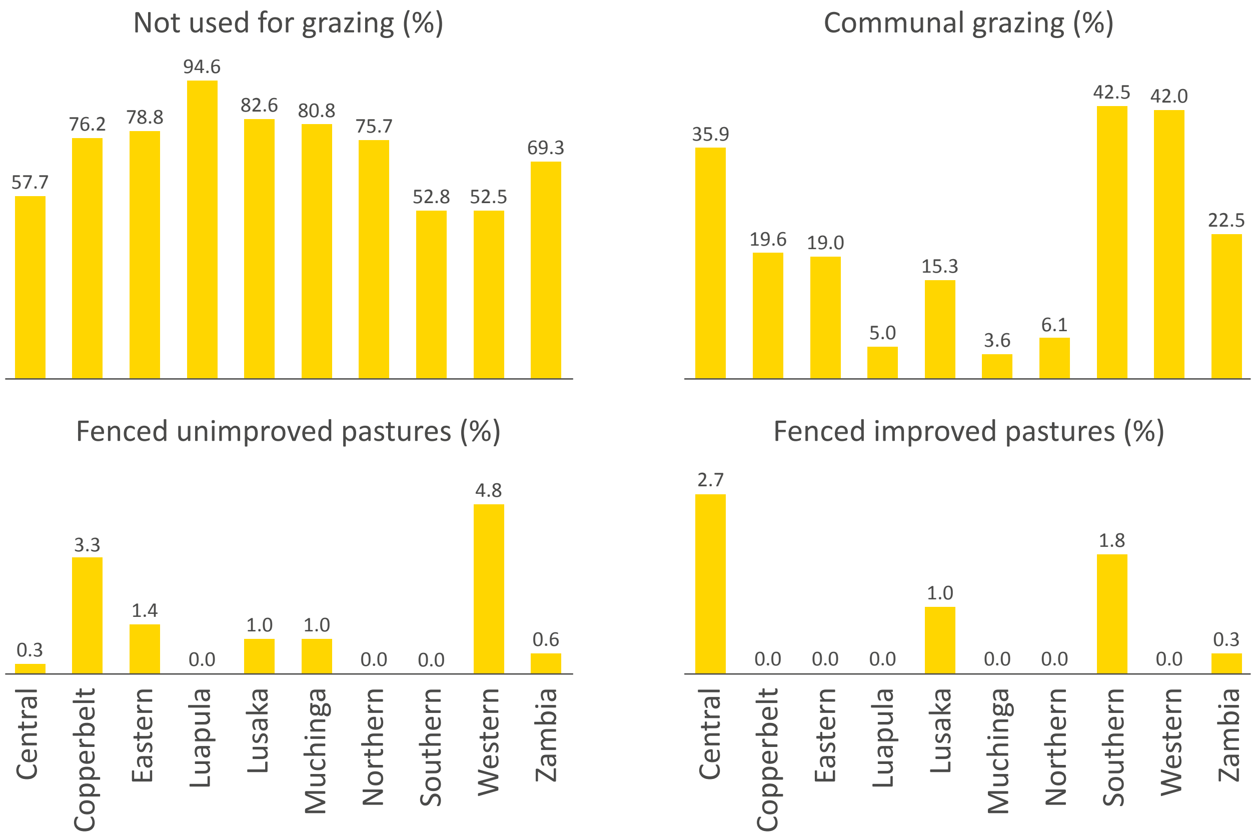
* Excludes estimates for Horticulture crops; § Annual Industrial crops = Tobacco, Cotton and Sunflower.
Source: CSO (2014a, b; 2016b, c; 2018b, 2019), FAO (2017a)

to the low level of technology used by these farmers. The widespread application of intercropping technologies results from their relative simplicity, sustainability, environmental friendliness and limited demand for external inputs (Mukungu, 2002). Though no information exists about the extent of intercropping Conservation Agriculture (CA) (Thierfelder et al., 2017), evidence from the literature shows that the proportion of land for different annual crops has changed significantly over the years (CSO, 2014a, b; 2016b, c; 2018b, 2019, FAO, 2017a).

1.1.7 Land for grazing

Land used for natural grazing in Zambia is two to three times that of arable land (see Table 4) and all three agro-ecological zones are suitable for livestock production. Zambia has an estimated 0.14 head of cattle per hectare of land suitable for grazing, despite having about 4.3 million cattle heads (MoA, 2016a). Luapula Province has the highest size of forest land not used for cattle management (Figure 8).

Figure 8. The proportion of forest area in each province in Zambia used for livestock management: 2014 data



Livestock productivity in Zambia is low, constrained by poor animal husbandry practices, seasonally poor nutrition, accessibility to water in the dry season, inadequate livestock infrastructure, and high disease incidence. In terms of livestock feed, only the commercial herd that receives supplementary feed is cropped and made into hay. Non-commercial livestock depends on natural grasslands and browses for feed (www.gafspfund.org). The country is well-endowed with grazing land compared to other countries in the region. The abundance of grazing land, estimated at more than 13.6 million ha, far outstrips the number of livestock, estimated to be under three million cattle (Shakacite et al., 2016; www.gafspfund.org). Only six million tons (33%) is required for cattle, goats and sheep production out of the total annual dry matter, consumable fodder and grass production of 18.4 million tons. Despite the abundant dry matter production, smallholder farmers have poorly managed pasture, leading to overgrazing and subsequent decline in animal weight in the dry season (www.gafspfund.org). The shortage of grass and grazing land in Zambia is primarily due to the ever-increasing importance attached to the growing of cash crops (millet, sorghum, maize, sugarcane, soya beans, sunflower, groundnuts, cotton, wheat and rice) at the expense of grazing land (Daka, 1998; Topps & Oliver, 1993). In addition, grazing land is being continuously transformed into cropland as the human population increases (Lungu, 1998).

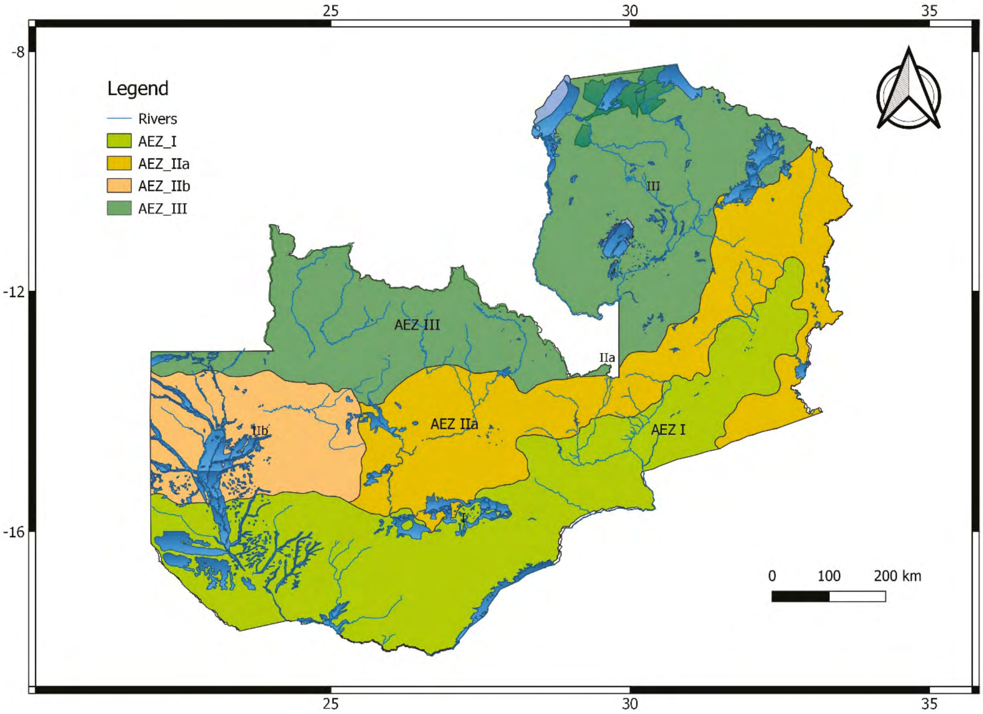
Tsetse fly in some parts of the country has also had a negative impact on cattle livestock production (Laohasinnarong et al., 2015). It is estimated that about two-thirds of Zambia's natural grazing resources are being used for livestock while the other third (120 000km²) is unusable due to Tsetse fly infestation (GRZ, 1994). Animal diseases that affect the livestock sector in Zambia include African Swine Fever, Contagious Bovine Pleuro-pneumonia, East Coast Fever, Foot and Mouth Disease, Newcastle disease, tick-borne diseases, Tsetse fly and internal parasites, particularly *Fasciola* in cattle and *Haemonchus* in goats (CUTS, 2011; Sinkala et al., 2014). However, these have little or no effect on land suitability for grazing, as there has been an improvement in controlling these diseases and their vectors which have increased livestock numbers (Meyer et al., 2016).

1.2 Main agricultural production systems and farm types in Zambia

1.2.1 Agricultural production systems

Zambia is subdivided into 36 ecological zones, grouped into three agro-ecological regions (AER) (Figure 9) distinguished by socio-economic status, farming systems, land-use, soil types and geophysical parameters (Akayombokwa et al., 2015; Ndiyoi et al., 2009; Phiri et al., 2013). There are distinctive features in each agro-ecological region, such as soil types and farming systems, including livestock and biodiversity, cropping systems, thermal regimes, rainfall patterns and quantities, and length of growing periods.

Figure 9. Map of Zambia showing agro-ecological regions



Agro-ecological Region (Zone) I

Agro-ecological region I, covering about 12% of Zambia's land area (JAICAF, 2008), is made up of the semi-arid, rift trough areas of Gwembe (in Southern Provinces), Lunsemfwa and Luangwa (in Eastern and Central), and Zambezi valleys (in Kazungula and Sesheke districts), with low elevations between 300 and 900m. Rainfall is erratic with frequent dry spells (droughts), and mean annual rainfall not exceeding 800mm. The growing season is short, varying from 80 to 120 days. AER I is generally characterised by relatively high temperatures. During the crop growing season, the mean daily temperatures may range from 20°C to 25°C. During the cold season, mild to severe frost may occur. The soils are poor, mostly sandy, characterised by low water holding capacity (JAICAF, 2008). AER I has limited production potential for agriculture due to poor and sandy soils. Forty-eight per cent (48%) of the rural population lives in Region I. Small-scale farming dominates in this region, with most farmers cultivating less than one ha of land (JAICAF, 2008; Chikowo, 2016). AER I is drier and predominantly planted with drought-tolerant crops such as pearl millet, sorghum, sesame and cotton, with extensive cattle grazing. Even though some households grow maize as the preferred staple food, its production potential is low. The region has good potential for horticultural and irrigated crops. Landholdings are low due to the predominance of subsistence farming in this region, despite favourable conditions encouraging the keeping of small ruminants, such as goats. Other livestock reared include chickens, sheep and pigs. Tsetse flies limit cattle husbandry, particularly in valleys and in national parks (Laohasinnarong et al., 2015). Cereal production, fishing and tourism in parks and lakes are the region's main livelihood activities (FEWSNET, 2014). Significant variations in agricultural production occur because the area is prone to droughts and flooding. The site has a less well-developed quantity and quality of market infrastructure and general physical access than other parts. Extensive cattle ranching is another potential livestock production option in this AER, except in some parts of the region where Tsetse fly infestation exists. The potential for goat rearing, fishing and cashew nut production is high in the Sesheke district (Western Province), Sinazongwe, and Kazungula districts in Southern Province.

Agro-ecological Region (Zone) II (AER II)

AER II extends from the east to the west and is subdivided into IIa and IIb based on soil characteristics (Bunyolo et al., 1995; Ndiyoi et al., 2009). Plains, plateaus and mountain ranges characterise region II. It includes much of central Zambia, with most Western, Central, Southern, Eastern and Lusaka provinces (Akayombokwa et al., 2015; Saasa, 2003). It accounts for about 40–46% of Zambia's land area. Altitudes range from 1,000–1,400m above sea level. The region receives about 800–1,000mm of rainfall and has a 120–160-day growing season, supporting the growth of medium and late maturing crop varieties. Region II receives significantly more rainfall than region I and contains the most fertile soils. That is why most of the country's commercial farms are found here. However, there are dry spells with temperatures reaching 23–26°C during the hottest month in October and dropping to 16–20°C in the coldest months of June and July.

AER IIa. The region extends across the sand veld plateau areas of Central, Eastern, Lusaka and Southern Provinces (Saasa, 2003; FEWSNET, 2014). These plateaus have the best agricultural potential in the country, and are considered suitable for the production of a diversified range of rain-fed food and cash crops and livestock. The soil types have slight to severe chemical and physical limitations for crop production; they are slightly acidic under moderate rainfall conditions, have low organic matter, low nutrient reserve, low water holding capacity, and shallow rooting depth (Akayombokwa et al., 2015). There are three soil types identified:

- slight to medium acidity and slightly leached clayey soils, red to reddish,
- medium to strong acidity, clayey to loamy soils that are moderately leached; and
- medium to strong acidity, coarse sandy loams in large valley dambos.

However, these soils are generally fertile and support permanent cultivation. Crops include cotton, cowpeas, groundnut, maize, sorghum, tobacco, wheat and a range of cash crops such as sunflowers, irrigated wheat and soybeans, as well as several horticultural crops, which are usually produced in surplus. Rural livelihoods in this region are mainly dependent on cereal, cash crops and livestock production. Commercial farming is widespread in this area, although most households have adopted the more traditional, subsistence and rain-fed crop production techniques. The increased production potential of the region is aided by the presence of abundant, perennial water sources for irrigation, particularly in commercial farming areas. This region accounts for the bulk of commercial crop production and livestock products, with more than 70% of the large commercial farmers located here. The region is suitable for beef, dairy, fisheries, poultry, and other livestock such as cattle, chickens, goats, pigs and sheep (JAICAF, 2008). The major constraints in this region include the lack of low-cost agrochemicals and technologies to manage pests and diseases, soil degradation and depletion of soil fertility.

AER IIb. This region constitutes the western plateau made mainly of the Kalahari sands and the Zambezi flood plains. Region IIb is characterised as a semi-arid plain due to differences in soils. Rainfall patterns in Regions IIa and IIb are similar. Region IIb has mostly sandy soils with low water-holding capacity and nutrient reserves (Bunyolo et al., 1995). Soils are less fertile, which in combination with high temperatures, reduces the potential for maize production. Fishing opportunities and wetlands suitable for rice production are provided by the Zambezi River and surrounding plains. The quality and level of soils and temperatures, respectively, are also suitable for producing bambara nuts, cassava, cashew nuts, sorghum, and millets, with cattle (beef and dairy) and poultry production dominating upland (JAICAF, 2008). Flooding and livestock diseases are characteristics of AER IIb. It has an underdeveloped road network and poor water transport system across the Zambezi River, which hinders the connectivity of most areas to main markets. The market infrastructure is also poorly developed.

Agro-ecological Region (Zone) III

AER III covers about 42% of the total land area (JAICAF, 2008) and covers North-Western, Copperbelt, Muchinga, Northern and Luapula Provinces, and the northern Central Province. The plateau areas in this region are punctuated by hills and mountains ranging between 1,000–1,700m above sea level, except the Luapula valley, which has average elevations of 900m (Akayombokwa et al., 2015; Saasa, 2003). AER III is a high rainfall area (>1,000mm per year). The growing season lasts more than 160 days and is characterised by relatively moderate mean monthly temperatures ranging from 16^{o}C to 25^{o}C (Phiri et al., 2013). On average, this region is moderately suitable for producing cereals, legumes, root, and tuber crops like cassava and sweet potatoes. Most of its soils are highly weathered and leached. In addition, there is an intermittent occurrence of strongly acidic soils across AER III. Soils in region III are generally poor, characterised by high exchangeable aluminium and manganese, toxic to most crops, and lime is applied to soil to overcome the high pH levels. However, these agro-climatic conditions, particularly the high rainfall, make cultivating crops like coffee, sugar cane, rice and pineapple possible.

AER III is also one of the most sparsely populated areas in Zambia, with less than 20% of the rural population. Small-scale farming is a common feature in this region. Cash crops in AER III include bananas, coffee, irrigated wheat, maize, pineapples, rice, soybeans, sunflower, tea and tobacco. Besides root tuber crops, the other crops grown include sunflower, soybeans, millet, sorghum, pineapples, several food legumes and maize. The occurrence of Chambeshi-Bangweulu floodplains and dambos also makes it possible to grow lowland rice.

Apart from crops, large-scale mining in AER III drives a strong labour and trade economy, especially around the mining areas of North-Western and Copperbelt Provinces. The vast forest resources and plantations in this region also contribute to an active timber industry. The population is most concentrated around the mining areas. At the same time, the border districts provide opportunities for cross-border trade. Several lakes are found in the eastern part of the region, and the Luapula-Chambeshi river basin offers opportunities for fishing and irrigation. Rural livelihoods in this region vary but depend primarily on cereal and cassava production and fishing. With crop diversification and value-addition in the agricultural sector encouraged by the SNDP (MNDP, 2017), many plantation crops have now been established in this region, including pineapple, sugarcane, palm oil, forest and forest products.

1.2.2 Farming systems in Zambia

Using the FAO classification, Zambia's farming systems are classified under three broad groupings: maize mixed, cereal root-crop mixed, and agro-pastoral millet/sorghum (Dixon et al., 2001). In the maize mixed farming systems, livelihood comes principally from growing maize, tobacco, cotton, legumes and cassava, and rearing cattle, goats, poultry, as well as off-farm work (Garrity et al., 2012). Under the agro-pastoral farming systems, rural livelihoods come from growing sorghum, maize, sesame, pulses, pearl millet, rearing poultry, sheep, cattle, goats and off-farm work. While in the cereal-root crop mixed farming systems, farmers' livelihoods are derived from mainly growing sorghum, maize, millet, cassava, food legumes and keeping cattle.

For comparison within the Zambian agriculture set-up, six major farming systems have been recognised (Chomba 2004; Saasa, 2003). These are:

1. shifting axe and hoe cultivation systems of Muchinga, Northern and partly Central Provinces
2. semi-permanent hoe system
3. fishing and semi-permanent hoe system of Luapula
4. semi-permanent hoe and ox-plow
5. semi-commercial ox and tractor plough cultivation, and
6. commercial farming.

The first four farming systems are associated with smallholder households, while medium (or emergent) farmers practise the fifth and the sixth, including commercial farmers (Chomba, 2004). The number of farmers involved in the first five systems is unknown. All these systems differ in their tillage and labour requirements. The axe/hoe systems use vast amounts of labour and are yet low in local costs. In farming practices where the ox-drawn plough is used, there are associated labour costs, but these are spread over larger areas. Keeping oxen requires extra land for grazing. Apart from farming systems 5 and 6, where ox-plough is involved, farmers use communal grazing land.

1. Shifting axe and hoe cultivation

As a type of intensive farming, shifting cultivation is locally known as the "*Chitemene*" system (Kapekele, 2006). It involves slashing and burning types of agriculture, and is predominantly practised in the northern part of Zambia (Araki, 2007; Grogan et al., 2013). Trees are cut or pollarded, stacked and burned to create a thicker layer of ash that helps improve soil fertility.

Spatial distribution: It is practised in AER III; widely used in the North-western, Copperbelt, Central, Northern and Luapula provinces.

Resource use (farm size and type of land): Though there are numerous variations of the Chitemene systems, three main types of Chitemene are practised, depending mainly on the tribal traditions and soil characteristics (Matthew et al., 1992; Schultz, 1972; 1976). The distinction between Chitemene systems is based on the ratio of the cleared area to the cultivated size, shape, period cultivated, and the rotation on the site. The three types are:

- Large circle Chitemene – this is practised in plateau areas in Luapula, Northern and Muchinga province. It has the following distinguishing features: pollarding trees and stacking branches in circular or oval patterns occupying 1/6 to 1/10 of the cleared area. The land use is from four to six years. The size of cropped land (that is, land cleared) is about 2 ha.
- Small Chitemene is practised in an area extending from Lavushi Manda district, westward to the north of Kapiri Mposhi along the Muchinga Escarpment in Central Province. Predominant tribes

practising the Chitemene system in these regions include the Laala and Swaka. The system's main features include cutting trees and stacking cuttings into a series of long, rectangular-shaped mounds. Unlike large circle Chitemene, the cleared area may contain more than one mound to be burned or cultivated. The immediate cultivated land use is for two to three years.

- Block Chitemene is a predominant system extending from Kapiri Mposhi to Mufumbwe districts and is a common practise of the Lamba and Kaonde people of Central, Copperbelt Northwestern provinces. The main features of this system include cutting large trees at the base, leaving them to dry, and then burning them before the rains. All cleared and burned areas are planted. The size of cleared land is less than 1 ha. Continuous cultivation seldom exceeds three years in the small Chitemene. The fallow period depends on the time for vegetation regrowth, which is shorter in the clearings of large Chitemene, where only branches are lopped.

Type of crops grown/livestock kept: In the large Chitemene, common crops include finger millet, cassava, groundnuts, beans, maize, sweet potatoes and sorghum. Cassava is usually the dominant crop. In small Chitemene, the predominant crops are millet, maize, sweet potatoes and sorghum. In the block Chitemene, the main crops are maize and sorghum.

Farming practices: The slash and burn system generates a surplus of ash in concentrated spaces, raising the soil pH from 4.0 to 4.5. The heat from biomass burning induces fumigation, killing weeds and making the soil into a fine tilth. The ash patches of the field are then cultivated to improve soil fertility and weed control. The systems are known to be ecologically sound at preserving the soil fertility and feasible where the population is sparse and wood lot plenty (Kapekele, 2006; Matthew et al., 1992). However, they tend to have very high land requirements. In this regard, labour requirements for soil cultivation are avoided. Although the Chitemene system has been condemned, this cultivation practice persists today.

Productivity/crop yields and cropping intensity: Cropping under shifting cultivation is highly variable. The productivity of a Chitemene system is limited to a few years until the soil pH declines. The first crops are typically fast-growing and nutrient-demanding, such as maize, sorghum or millet. Subsequent crops tend to be slower-growing and less nutrient-demanding such as cassava or legumes. Characteristics of the cropping result in a rapid decline in soil organic matter and soil fertility. An increase in weed pressure often accompanies this decline. Labour requirements for weeding often exceed crop productivity return, so moving and clearing new plots is more favourable than continued cropping. At this point, the vegetation is left to regrow into the fallow phase. The length of fallow required to restore the original productivity of the land depends on many factors, including the duration of the preceding cropping phase. Evidence suggests that it takes 20 to 25 years of fallow before regrowth occurs, and Chitemene is repeated (Giller & Palm, 2004). However, due to population growth, land pressures, maize's nutrient requirement, and the desire to sell more maize, farmers have switched from traditional crop rotations to a monoculture of maize and have resorted to clearing more Chitemene fields (Kapekele, 2006). According to Chidumayo (1987), the Chitemene system has contributed to the loss of 37% of biomass over 40 years in the northern part of Zambia. Other adverse effects of this practice include increased water run-off and soil erosion, loss of biological diversity, and increased soil degradation.

Labour force (family or wage labour): The system involves about 40% of the country and about 20% of the rural population, and work is entirely family sourced (Kapekele, 2006; Saasa, 2003).

The extent of market integration and commercialisation: While access to markets is an essential requirement for the rural poor to enjoy the benefits of agricultural growth, farmers in this farming system produce primarily for home consumption and have limited participation in markets. Production is inherently low due to their remoteness from markets, seasonal labour constraints, and inadequate input supply and output markets (World Bank, 2004).

2. Semi-permanent hoe cultivation

Two systems are included here. One is the subsidiary garden system of urban employees (or some form of urban agriculture), and the other is the Luangwa system (Prior, 1982; Schultz, 1972).[1]

Spatial distribution: The system comprises gardens located on the outskirts of urban centres, hence found countrywide (Hampwaye et al., 2007). The Luangwa system covers the whole Luangwa valley and those of Lunsemfwa and Lukusashi valleys in AER I. (Schultz, 1976). In the Luangwa system, the more fertile soils are restricted to the alluvial fringes of the water courses where most crop fields are located, making up 10% of Zambia's land mass.

Resource Use (Farm size and type of land): The subsidiary garden system of urban employees involves men and women cultivating small pieces of fields after having finished their paid work (Hampwaye et al., 2007). The areas are relatively small at less than 1 ha. These fields frequently occupy open spaces or are developed on the outskirts of larger towns during the rainy season or where it is possible to be watered. They are often interspersed with residential areas and, in some cases, along the trunk roads. These fields serve as a supplementary source of food and occasionally produce for sale. The fields are abandoned once the urban employee (owner) relocates to another area or they are passed on to another person. This system makes small land requirements per family possible and facilitates a more stable land settlement and land tenure system (customary). Under the Luangwa system that covers the Luangwa, Lunsemfwa and Lukusashi valleys, there is minimal crop production due to the harsh climatic conditions, although some significant livestock rearing, for example, goats, poultry and some limited cattle production. Little land for agricultural expansion is another constraint, hence continuous cultivation on the same land. Droughts or spurts of rainfall causing floods and crop destruction characterise these areas due to their particular agro-climatic conditions, rendering the site unsuitable for crop production.

Types of crops grown/livestock kept: In the Luangwa system, the dominant crops grown include sorghum, millet, cowpeas and legumes, with very little purchased inputs; traditional breeds of cattle and goats are also kept (Kunda, 2012). While in subsidiary agriculture, the primary staples are cassava, maize, sweet potatoes and beans (Schultz, 1976).[2] Plots in the valley bottom include fields of banana and sugarcane. Trees, such as fruit trees (for example, mangoes), are often found scattered throughout the area.

Productivity/crop yields and cropping intensity: Crop production and productivity are deficient, mainly for subsistence purposes. The fields are generally small, and their yield in relation to the labour input is meagre. Soil nutrients are mined with little regard for future returns. In the Luangwa system, fallowing is practised more to suppress weed growth than to encourage soil regeneration. The intensity of cropping decreases from the domestic gardens in the vicinity of the dwellings (huts) to the more wide-scattered peripheral fields.

---

[1] Only available literature.

[2] Only available literature.

Labour force (family or wage labour): Since it's subsistence, it is essentially farmed with family labour, with the majority being women and youths. However, household labour capacity is not shared equally because of traditional concepts of how work is divided between men and women. For example, men do not carry out weeding. More than 10% of the urban population in high-density townships is involved in subsidiary gardening, and 3% of the rural population in the Luangwa system (Schultz, 1976).[3]

Extent of market integration and commercialisation: There is a general absence of farmers within this farming system (Luangwa). Any involvement is usually through middlemen and relies on a government support programme for any farm inputs.

Changes over time: Unlike the rigid traditional division of labour between sexes associated with many shifting systems, there's a move towards a more flexible use of the available farm family labour, driven by the demands of cash cropping. An essential feature of semi-permanent hoe cultivation is the increasing involvement of men in fieldwork such as weeding and harvesting. This often results in improved crop tendering and management. Traditionally, several people in a household cultivate the food they need for themselves and depend on a plot that might be considered a sub-farm within the family holding. With increasing permanency and commercialisation, land and labour use within a holding are becoming more centrally organised (Schultz, 1972). Main activities include the shifting axe system, tree felling and clearing more land. At the same time, hoe cultivation and weeding are the most time-consuming tasks in the semi-permanent hoe cultivation farming system. In 2002, FISP introduced subsidised hybrid maize seeds and fertiliser packs to smallholder farmers. This has resulted in farmers investing more energy in permanent cropland and maize, as opposed to the more customary shifting agricultural system (Chitemene) and crops grown (German et al., 2013).

3. Fishing and semi-permanent hoe cultivation

The main sources of livelihood in this system are fishing and subsistence farming. This farming system integrates fishing with relatively uniform crop cultivation (Schultz, 1976).

Spatial distribution: Fishing and semi-permanent hoe cultivation are practised chiefly along rivers, lakes and swamps such as Lake Mweru, Lake Mweru Wantipa and Lake Tanganyika in AER III, as well as flood plains in Western Province in AER II. The systems covered 12% of the rural population in 1976 (Schultz, 1976) and reduced to about 7% of the rural population by 2003 (Saasa, 2003).

Resource use (farm size and type of land): The majority of the farming households within this system cultivate on average less than 1.5 ha, and slightly more than 54% of the land in these areas is administered under traditional authority (Sitko et al., 2015).

Type of crops grown/livestock kept: The dominant activity is fishing, which is carried out mainly for income generation. The predominant staple food crop is cassava, followed by maize. Groundnut cultivation is co-dominant in Bangweulu swamps and the lower Luapula valley. Sweet potato production has increased in recent years, particularly in Luapula valley and lowland rice production in the Bangweulu swamp around the Lunga districts (MoA, 2014). In Luapula, about 35,000

[3] This is the only documentation available. The areas where the Luangwa system operates is highly sparsely populated 2–3 persons/km^2

households depend on fishing for their food security, with fish trading dominated by women and fishing activity by men. An additional 400 to 500 households practise fish farming, often combined with agriculture (PLARD, 2010).

Farming practices and technology used: Cropland follows the edges of swamps and lakes as closely as possible to reduce the distances to fishing compounds. The farmers within this system use a hoe to cultivate and combine with fishing, another income-generating activity. Cassava is planted on ridges or mounds by using the grass manure (fundikila) technique. Maize, beans, pumpkins and/or groundnuts may be planted between the cassava in the first year. Improved crops mean cassava harvesting is now continuous. Occasionally, the cassava harvest is followed by a planting of groundnuts.

Productivity/crop yields and cropping intensity: Crop yields are generally low. Traditional livelihoods are based on the substantial supply of fish from the major lakes and other water bodies. Therefore, agricultural activities were considered secondary. The cultivation frequency of cassava stands at 86%, followed by maize at 72% and groundnuts at 48% (Schultz, 1976). Thanks to government support under the FISP, there has been a significant increase in maize production (MoA, 2014). Bean and groundnut yields have also been consistent.

Labour force (family or wage labour): The farming system is based on manual labour input, mainly family labour (Schultz, 1976). The men are engaged in fishing while women and the youth carry out the bulk of crop cultivation. Women contribute significantly to agricultural production by providing labour (PLARD, 2010). Planting cassava, groundnuts and beans are shared responsibilities among men and women. However, weeding, traditional cassava processing, shelling and winnowing of groundnuts and beans are tasks for women and children.

The extent of market integration and commercialisation: The marketed product is exclusively fish, with minimal sales of the surplus crop. While the large proportion of crops grown in these systems are for home consumption, the market opportunities for selling surplus crops are generally small-scale, diverse and location-specific. The absence of market infrastructure such as bulking centres for larger-scale buyers makes access to markets by smallholder farmers a challenge. This problem is further compounded by high transport costs associated with long distances to urban markets in the Copperbelt, Lusaka and Katanga Province of the DRC. Consequently, this puts cassava, beans, groundnuts and fish produced in the areas where this farming system is practised at a disadvantage when trying to supply these markets. In an effort to overcome this, some form of trade in these commodities occurs along main trunk roads (PLARD, 2010). Cassava, in particular, suffers from having a low value compared to its weight. A combination of low productivity and high variable costs results in generally low gross margins to farmers.

Changes over time: According to Nelson (2000), the human population in the north has increased due to its proximity to the markets in the DRC trading areas. Therefore, some of the sites have become vulnerable to food insecurity. Fertile land is becoming scarce. With the introduction of the early maturing crop varieties in Bangweulu and market opportunities on the Copperbelt and the DRC, cassava production is steadily increasing. Similarly, groundnut and sweet potato production are rising due to local and external demands (Mansa, Copperbelt and DRC).

While maize's dominance was causing the decline of finger millet, this trend is now reversing despite its poor performance when grown on permanent fields. Forest resources are declining, and fisheries are reported to be almost depleted. Apart from being localised in the National Parks and GMAs, wildlife is practically non-existent. With changes in the farming system and the introduction of more crops in these areas, only a small rural population carry out this type of farming. Government interventions with donor support have been promoting agricultural use of wetlands, which stimulated the cultivation of new sites.

4. Semi-permanent hoe and ox plough

This semi-permanent hoe and ox plough farming system is widespread in AER II, in which annual rainfall ranges from 800mm to 1,000mm. The dominant crops grown are cassava, beans, finger millet, groundnuts and maize (Chomba, 2004; Saasa, 2003). Twenty-five per cent of the rural population (or 17% of the total population) are covered by this farming system, where farmers practising both hand-hoe cultivation and cattle rearing have adopted the ox-plough to till the land (Saasa, 2003).

Spatial distribution: There are three subdivisions identified within this system: farming systems of Mambwe, Ikumbi and Nyika close to the border with Tanzania; Barotse Sand (Luvale, Kaoma, Barotse and Sesheke systems); and (iii) Gwembe and Zambezi escarpment systems (Schultz, 1976). The farming system that has developed in Mambwe, Ikumbi and Nyika has a distinct method of soil improvement, incorporating grass and herbs into mounds. These plants then decompose to form compost. The mounds are used either directly for planting or are spread out before planting.

On the Barotse Sands, cultivation is characterised by the complex variety of agricultural techniques, which have been developed in adaptation to the region's various natural conditions, especially on the central Barotse plain where the Zambezi is the predominant feature (Rajaratnam et al., 2015; Schultz, 1976;). The river's yearly flood dictates the human and ecological activities of the area. The floods usually occur between November and June at depths of 1.5 to 3m, depositing essential nutrients to the nutrient-depleted Kalahari sand soils (Rajaratnam et al., 2015). Cattle grazing and agricultural production take place in the lowland grasslands of the floodplains during the dry season. The forested woodlands of upland zones are mainly used for cattle grazing during the yearly flooding of the lowlands. The nutrient-depleted upland soils have a negative impact on agricultural production.

In the Gwembe/Zambezi valley, the arable land is confined to the valley floor. The climate is much drier than on the neighbouring plateau, and has poor soil conditions that hamper cultivation. This restricts the choice of crops grown, resulting in relatively low crop diversity. Setting up the fields along the river allows for semi-permanent cultivation. Manure is often applied to the more deficient soils on the plateau.

Resource Use (Farm size and type of land): The fields are usually less than 2 ha and belong to the customary land tenure system controlled by traditional authorities (Adams, 2003). Ploughing of land with oxen is widespread and dominates, especially in areas where larger alluvial plains are available for cultivation in Gwembe and Zambezi Escarpment. However, in most places, hoes are also used for cultivation. Ox-ploughs are often hired from their owners in return for a payment in cash, kind or services.

Types of crops grown/livestock kept: Maize, finger millet, sorghum, groundnuts and beans are the dominant crops; traditional cattle and goats are also kept. Livestock has been the primary source of draught power in these systems (Schultz, 1976), though this has recently declined due to disease and droughts. Among the Lozi and Mambwe, cattle raising offers ox-drawn ploughing, which facilitates the expansion of cultivated areas. More than 80% of all households claim to possess cattle, goats, chickens or sheep, depending on where they are. On Barotse Sands, the cropping and cattle raising closely follow the spatial variation of rainfall, the extent of flooding and the depth of the sand layer. In the wetter northwestern areas (Luvale system), cassava is dominant, with fewer cattle. Maize is more critical in the southeast (Kaoma system), where sands are not as deep. In the southwest, which is drier with a lesser sand depth, maize and sorghum are the main crops, and cattle rearing is the major activity.

In the Zambezi Escarpment system, the most important crop is maize and is grown on almost all holdings. In the lower areas of the Escarpment, sorghum is very important, and groundnuts are the most important subsidiary crop closer to the plateau.

Productivity/crop yields and cropping intensity: The application of cattle manure maintains soil fertility. The prolonged use of the same land has resulted in nutrient depletion, even though the soil structure is generally reasonable. Farmers under the Mambwe and Nyika system are unable to use lime to counteract soil acidification because of its unavailability, their lack of knowledge in using it, as well as the finances to purchase it (Chomba, 2004). Because plots on the flood plains are small, farmers have intensified cultivation on fertile alluvial soils by using oxen to plough and applying cattle manure. The choice of crops varies and is severely restricted due to agro-climatic conditions, especially in the Gwembe/Zambezi valley. In the western systems on Barotse Sand, the regional averages are 2.8–3.2 crops per holding, 2.3–2.5 in Gwembe valley/Zambezi Escarpment, and around Kaoma on average four crops.

In the Mambwe system in Mbala, finger millet is usually rotated with other crops such as groundnuts, beans and maize for three to five years, followed by a three to five year fallow period. It is common practise to plant millet in the third year and a legume after that. In such cases, mounds are used. This system tends to minimise soil nutrient exhaustion. It can support 20–40 persons per square km. Overall, productivity is low though the percentage of land cropped is among the highest in the country, and crop density per agricultural household is also extremely high. On average, four types of crops are cultivated. In the Nyika system, maize is the most important crop. The cultivation frequency is 100%. However, the maize fields are subject to a reasonably regular rotation scheme of four or more years of continuous cultivation followed by a shorter fallow period. Cultivation is proceeded by burning small heaps of cleared vegetation. The grass between the burnt debris is dug out, and it is decomposed to form compost.

Labour force (family or wage labour): About 25% of the rural population uses these farming systems (Saasa, 2003). Most of the labour is provided by members of the household (Schultz, 1976). These systems require a lot of labour, and lack of labour becomes a prime constraint.

Extent market integration and commercialisation: Market access is improved and complements the government Input Support Program to participate in the markets. Value of marketed crop production per hectare is slightly higher than in the shifting system due to cattle (Schultz, 1976).

Changes over time: In Gwembe valley/Zambezi Escarpment, the damming of the river led to the loss of winter gardens on the riverbanks beside the loss of former settlements. These changes have increased the dependence on irregular rainfall. Planting on rain-fed land is thus staggered to protect against drought. This change has resulted in more land being opened which often can be a stable land settlement.

In the Mambwe system, in areas where the population is higher and there are fewer trees, the *fundikila* or grass mound system of cultivation has evolved. This system came about following the breakdown of the Chitemene system as the population increased and the area became deforested (Stromgaard, 1989). It has subsequently altered over the past four decades due to increased animal draught power (Grogan et al., 2013). Furthermore, households that can adopt animal traction mostly have greater capital assets regarding access to implements, land and livestock. For these households, ox ploughing used to bury grass turf under long ridges to aid decomposition has replaced the tedious labour-intensive process of making mounds. During planting, the ox ploughs are used to spread the ridges before finger millet is broadcast the first season, followed by cassava and maize. Smallholders in the Ikumbi farming system have grown Arabica coffee since the 1950s while the acreage has been increasing. Yet a lack of investment has led to declining yields. Northern coffee is making some efforts to promote out-grower schemes. Most smallholder-produced coffee is currently not irrigated, and farmers get fewer than 20% clean coffee beans. People in the region have increasingly adopted more intensive systems of agriculture during the past decades. The plots in these systems are cultivated intensively over long growing periods and given little or no fallow periods. The crops and the size of the fields within these systems range from mono-cropped maize on larger areas to staple crops intercropped with vegetables on smaller plots.

5. Semi-commercial ox and tractor plough systems

This intermediate category falls between a traditional system producing mainly for home consumption and commercial farms. These systems rely on the widespread use of both oxen and tractors for cultivation (Schultz, 1972).

Spatial distribution: They are primarily found in AER II, though some occur in AER III. The land-use system belongs to an intermediate category between the traditional systems, which produce mainly for home consumption and the commercial farms.

Resource Use (Farm size and type of land): This group consists mainly of emergent farmers (by government definition: transitional phase from semi-subsistence to commercial). The land areas cultivated are usually above five ha, employing draft and tractor ploughing (Saasa, 2003). The farms are few and are on agricultural title, especially those in degazetted forest reserves.

Farming practices and technologies used: There is widespread tractor ploughing, as comparatively large tracts of land are planted. Farmers prepare land faster and on time. In addition, ploughing helps remove weeds, which choke plants. The downside is it hardens the ground when used extensively, making the soil unfit for growing crops. Permanent cultivation is made possible by the application of industrial fertilisers and cattle manure.

Types of crops grown/livestock kept: These systems specialise in one or few crops (Schultz, 1976). These cash crops, particularly beans, cotton, groundnuts and maize, are dominant. Livestock is the major asset for farming activities, though the farmers are equally affected by pestilence attacking animals.

Productivity/crop yields and cropping intensity: In general, farm outputs are higher than in other farming systems except for the commercial farming system (Saasa, 2003). The land requirement per unit of agricultural household is high due to the cash-oriented expansion of cropland and pastures for cattle.

Labour force (family or wage labour): About 25% of the rural population uses these farming systems (Chiwele et al., 1996). Labour is at times hired. Most medium-scale farmers transitioning from small-scale to medium-scale (emergent) are involved in this farming system.

The extent of market integration and commercialisation: The priority is income generation. The production of these crops for the market depends on reducing production costs and increasing yields. Production costs vary significantly according to crop husbandry and management.

Changes over time: More land is being opened and it is often a more stable land settlement.

6. Commercial farming

Well-developed crop and livestock management practices characterise commercial farming, which includes highly specialised farming systems with considerable variations. Their characteristics are extensive mechanisation, high-level technology and management, and the rearing of exotic livestock breeds.

Spatial distribution: They are in both AER II and III, with a much higher concentration in the former (Saasa, 2003). They are mainly located on state land, which incorporates the land with the best potential. They are primarily concentrated along the line of rail/urban areas, that is, a narrow strip 30 to 50km wide from Zimba in Southern province to Kapiri Mposhi in Central Province and northwards to Copperbelt, Mkushi and Serenje, from Lusaka westward towards Shibuyunji and Mumbwa. And on other segments of state land including a small area around Chipata (for cotton and soybean) and in the north around Kasama and Mbala (coffee) (Adams, 2003). With the farm block development plan (MAL, 2015), several such farms are earmarked in a block or more-or-less contiguous area.

Farm size and type of land: Farms are above five ha (Jayne et al., 2016), on the agricultural title, with a leasehold period of 99 years renewable (Adams, 2003; Chitonge et al., 2017).

Types of crops grown/livestock kept: Typically, farming is mixed either at an individual farm level or in a block (Smalley, 2013). Crops and livestock grown and produced include industrial and plantation crops such as coffee, tobacco, bananas, sugarcane, staples (for example cassava, barley, sorghum, maize and irrigated wheat); agro-fuel (sunflower, soybeans); high-value horticulture; and livestock (dairy, poultry, cattle ranching) (Eliste et al., 2007; Saasa, 2003). They are mainly rearing exotic livestock breeds. Livestock is the major asset for farming activities, and the farmers have equally been affected by the pestilence that attacked animals.

Farming practices and technologies used: There is intensive mechanised farm equipment, high-level technology and management (Chomba, 2004). The farmers in the farming system use improved irrigation such as sprinklers or center-pivot. They depend on fertiliser at the expense of other practices that enhance soil quality (Jayne et al., 2014a). According to Haggblade & Tembo (2003), for commercial farmers, mechanised minimum tillage methods with leguminous crop rotations such as soybeans, green gram and sun hemp are the conservation farming practices frequently used. A significant share of commercial farmers in Zambia have now adopted minimum tillage techniques. Farmers in this system use lime application to mitigate the effects of soil acidification.

Productivity/crop yields and cropping intensity: Crop yields have improved following economic liberalisation, which allowed commercial farmers to profit. They can enhance yields of cash crops such as soybeans at high rates, and benefit from agro policies that are well focused on specific commodities such as maize (Gerseen-Gondelach et al., 2015).

Labour force (family or wage labour): Of the 3.042 million people directly employed in the agricultural sector (ZambiaInvest.com, 2017), fewer than 0.036% are formally employed on large-scale farms (CSO, 2016d). However, most of these farms rely primarily on hired labour, both permanent and seasonal (Smalley, 2013). Except for plantation crops such as sugarcane, the majority of hired labour are women and youths. Henceforth, the rural population in the surrounding communities are mainly employed as seasonal labour on these farms.

Extent of market integration and commercialisation: Commercial farming is symptomised by an increased dependency on capital markets as a source of farm inputs, a significant availability of hired labour, and an aspiration for profit in preference to minimising risks (Smalley, 2013). These farmers aim at accessing both local and foreign markets and finance, cultivating high-value and export-oriented crops, such as soybeans, sunflower, cotton and horticultural products (Saasa, 2003). There is some incorporation into value chains (maybe less vertically integrated than various plantations).

Changes over time: This farming system has witnessed rapid increase mainly due to large direct investment, such as farm blocks, acquisition of land by urbanites, and increased mechanisation (Jayne et al., 2016; Sitko & Jayne, 2014).

1.2.3 Type of farmers and farm size

There are three broad categories of farmers in the Zambian agriculture sector: smallholders, medium and large (Chapoto & Chisanga, 2016).

Small-scale farms

There are about 1.6 million small-scale farmers in Zambia (CIAT-World Bank, 2017). This includes all categories of small-scale farmers, ranging from those cultivating less than one ha (traditionally classified as asset-poor or resource-poor farmers) to those that farm between 5–20 ha. However, in some other literature (Eastwood et al., 2010; Eliste et al., 2007; Saasa, 2003), this definition is restricted to those who cultivate fewer than five ha for their own consumption.

Spatial distribution: They are found throughout the country in all three agro-ecological regions.

Farm size and land type: Smallholder farms constitute about 75% of the agricultural households in Zambia (CSO, 2016d) and could be broadly classified into two groups, based on their farm size:

- Category A: farmers with farms smaller than two ha and comprising 74.9% of smallholders
- Category B: farmers with farms from 2–5 ha.

However, the report on Climate-Smart Agriculture in Zambia (CIAT-World Bank, 2017) includes a third category, "C"; small-scale farmers with farm sizes of 5–20 ha.[4] However, farmers in this latter group are referred to as "emergent" (Sitko & Jayne, 2014).

[4] These are "emergent farmers". By Zambian government definition emergent farmers are small-scale farmers who cultivate more than 5ha and up to 20ha of land. They occupy the transition phase between small-scale semi-subsistence production and large-scale more commercial farming.

Types of crop grown/livestock kept: Their main activity is to produce major staple crops for home consumption, cash crops such as oil, fibre crops and livestock. According to Chapoto & Chisanga (2016), the rising demand for animal proteins is driving a significant change in livestock markets for smallholder farmers. Fisheries and livestock account for between 8.6% of smallholder incomes, up to 20%, depending on the livestock type and production area. On average, livestock accounts for 21.6% of the smallholder productive assets, though the relative importance of animals varies from province to province (Chapoto & Chisanga, 2016).

Farming practices, technologies used and extent of market integration/commercialisation: There are two main types of farmer in this category:

- Small subsistence-oriented family farms cultivating less than one ha with one or two types of crops or livestock (cassava, groundnuts, maize or goats). Semi-permanent hoe and shifting cultivation are examples.
- Small semi-subsistence or part-commercial family farms (small-scale) with 1–5 ha. The main objective is family sustenance, with the production of crops for home consumption and materials for use on the farm, followed by income generation for procurement of:
  - non-farm produced food essentials such as salt, tea, cooking oil
  - clothing, medicines, transistor radio, batteries, etc
  - limited inputs, including pesticides and fertiliser.

In the second type, production is primarily driven by cash crops that may be rain-fed or irrigated. Usually, the land is farmed to its maximum intensity even though its variety is determined by the length of the growing season. The growing season depends on the temperature, adequate rainfall and irrigation water supply in irrigated crops. Crop production is closely integrated with livestock production (fish, poultry or larger animals). These are kept for several uses: livestock and crop production, draught power (except on the smallest farms), transportation, manure production for use on crops and pond fertility levels, and a store of wealth. Farms generally generate a high proportion of farm and household resources. However, farmers depend less on purchased inputs. Where farmers do use them, this is restricted to the production of cash crops including cotton, sugarcane and tobacco. In such circumstances, crops used for subsistence receive little or no purchased inputs. Residual fertiliser, usually soil tilth and soil moisture, is used to produce non-cash crops from some previous commercial crop. Dual levels of technology classified as advanced and traditional methods are used on farms that use purchased inputs to make some main cash crops and non-cash crops, respectively. Some of these farmers are participants in an out-grower scheme run by large commercial entities, for example, Kaleya smallholders producing sugarcane for Nakambala Sugar Estates (Matenga, 2016). Most communal/smallholder farmers employ unsustainable soil and crop management practices. They plough the soil at shallow depths, remove all crop residues, graze or burn them, coupled with late planting and bad crop management. Many small-scale farmers are engaged in conservation farming (Haggblade & Tembo, 2003) and organic farming (OPPAZ, 2006).

Productivity/crop yields and cropping intensity: Smallholder agriculture (small-scale farmers) in Zambia is characterised by low productivity (Eliste et al., 2007; Kabamba & Muimba-Kankolongo, 2009; MAL, 2013). Most smallholders produce primarily for home consumption, depending entirely or mainly on their cereal production for food security (Moyo, 2016). However, due to low productivity levels, this causes considerable threats to farmers' livelihoods as very few farmers can sell their surplus to generate income. This makes them highly vulnerable, and, in case of drought, farmers need outside assistance in the form of seed, fertiliser or food aid (Kodamaya, 2011; 2015). Since 2002/3, subsidies for fertiliser and hybrid maize seed have re-emerged as a cornerstone of the Zambian government's agricultural development and poverty reduction strategies (CSPR, 2005; Mason et al., 2013). They were designed to enable small-scale farmers to develop the capacity to engage effectively in maize production and use an engine for agricultural diversification (ZIPAR, 2016). However, due to low maize–fertiliser response rates, poor timing and high plant populations, and diversion of fertiliser intended for the programme, there has been limited success (Mason et al., 2013). Hence the government has downsized the programme and weeded out non-intended beneficiaries. During 2017/18, 600,000 small-scale farmers were weaned off or did not receive the subsidy (Mulenga, 2017).

Labour force/gender: The majority of small-scale farms use family labour and simple hand tools (Kasanda, 2017). They are heavily dependent on unpaid labour, frequently that of women and children. At the national level, 78% of women are engaged in agriculture, while in the rural areas, more than 60% are women (CSO, 2016d). Therefore, they constitute an essential component of the labour force for agriculture. However, their role in most cases is often to assist men in family farming or production for home consumption. This is due to their restricted access to production equipment and land compared to men and their prominent role in household work and child-rearing (JICA, 2016). According to Namonje-Kapembwa & Chapoto (2016), men generally are more likely to access credit, extension services, own and cultivate more land, and have higher productive asset value than women. However, differences occur, depending on whether these female farmers are wives or are household heads. For example, women in male-headed households are more likely to access agricultural extension services, credit, labour and land than women in female-headed households. This is more prominent on plots owned (controlled) by men than women when adopting improved technologies such as fertiliser, hybrid seed, herbicides and animal traction. Female farmers are less likely to adopt hybrid seed, fertiliser and animal traction than their male counterparts due to limited access to resources (credit). Consequently, if facilitated with appropriate support services, women have the potential to significantly contribute to food and nutrition security, given their dual roles related to both agricultural production and nutrition (food preparation) (MAL, 2013).

Changes over time: Due to high poverty levels in rural areas, most of the population are small-scale subsistence farmers cultivating less than two ha and cannot produce enough surplus for sale to benefit from government spending on agriculture (MAL, 2013). On the other hand, a minority of smallholder farmers constitute 3–4% of the total small-scale farm households and cultivate five ha annually. Above that, they are drifting towards commercialisation – growing more cash crops and being part of out-grower schemes. These constitute the emergent farmers (Sitko & Jayne, 2014). The total area and percentage change in this type of farm are presented in Figure 10.

Medium-scale farms

There are about 400,000 medium-scale farmers in Zambia (CIAT: World Bank, 2017). The 2015 LCMS (CSO, 2016d) indicates that about 17% of the farm households in Zambia are medium-scale farmers. Based on farm management, these farmers are classified into (1): medium-scale specialised family farms; and (2) medium-scale emerging commercial farmers often on leasehold terms dictated by the landlord. Type 1 is more dominant for the two kinds due to more land acquisition by urban dwellers or salaried workers.

Spatial distribution: These farms are geographically dispersed across the country, but tend to cluster around major urban centres. For example, along rail lines and major road infrastructure from the capital Lusaka, northwest to the urban centres of the Copperbelt, northeast towards the Tanzanian border, and the main trunk road to high-density rural areas of Southern and Eastern Provinces (Sitko & Chamberlin, 2015).

Farm Size: 20–100 ha. Medium-scale farms cover more than 50% of total farmland in Zambia (Jayne et al., 2014b).[5]

Types of crop grown/livestock kept: The major crops grown include maize, cassava, beans, groundnuts, paddy rice, and cash crops like tobacco, soybeans, sunflower and cotton. Type 1 farmers usually specialise in poultry, piggery, dairy, or vegetable production around metropolitan areas, orchids and horticulture.

Farming practices, technologies used and extent of market integration/commercialisation: Several factors account for the existence of medium-scale farms, including opportunities to make a profit and proximity to urban markets, particularly for farms that produce dairy, pigs, poultry and vegetables. These farms rely on high technology inputs – high-yielding variety seed, inorganic fertiliser, herbicides or pesticides that constitute purchased inputs. Dependence on commercial inputs (feed and veterinary supplies) is even greater for livestock farms to produce beef, poultry and pigs (Lubungu et al., 2015). A number of medium-scale farmers practise organic farming (OPPAZ, 2006).

Productivity/crop yields and cropping intensity: Several physical and geographical factors including water, good soils, favourable temperature and rainfall regimes influence farming. However, productivity is higher than for small-scale farmers, especially for recent land acquisitions (Sitko et al., 2015).

Labour force/gender: Use both families and hired labour, oxen or hired tractors. Like on large-scale farms, men and youth make up a large proportion of hired labour (CSO, 2016a). This is contrary to the promises investors make when approaching communities to gain access to agricultural land (Rocca, 2016). One of the main potential benefits of increased agricultural commercialisation is supposed to be the creation of employment for women. However, very few women benefit from such employment, mainly because of the casualisation of labour associated with commercialisation, which does not suit women. Therefore, women have a relatively minor income compared to men (Daley, 2011).

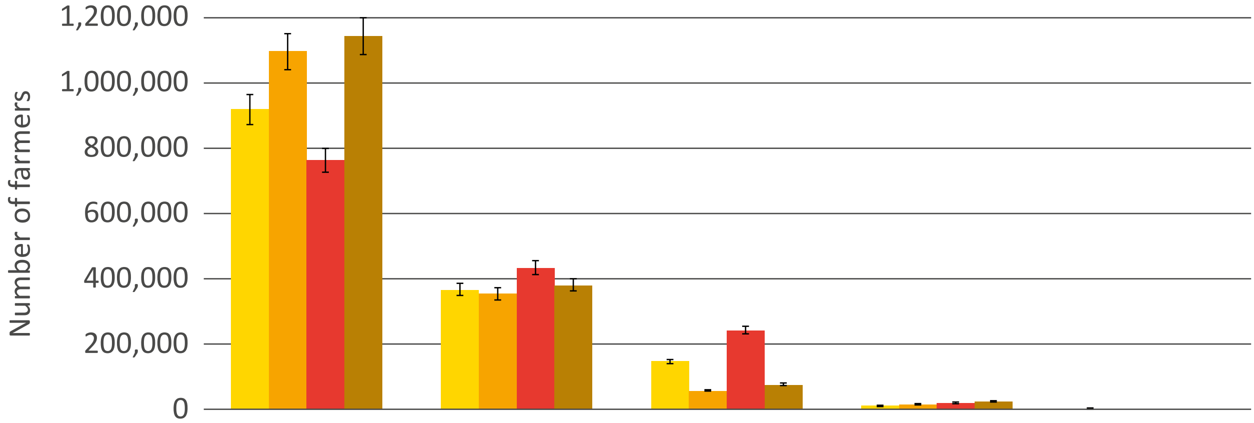
Changes over time: There has been a significant increase in this category of farmers (Sitko & Chamberlin, 2015). They tend to dominate farm lobby groups, allowing them to influence agricultural policies and public expenditures to agriculture in their favour, and have led to an increase in the number of urban households owning land. The growth in medium-scale farms has been attributed to land acquisitions by wage earners from the urban areas. According to Jayne

[5] In some other literature, medium-scale farmers are defined as farmers that cultivate between 5 and 100 hectares (see Jayne et al., 2016). For reasons mentioned above those cultivating 5–20 ha are classified as “emergent” medium scale therefore the number of medium-scale farmers is higher than in other studies.

et al. (2016), urban households own between 5–35% of total agricultural land. In addition, the government has negotiated with the traditional authority to transfer roughly one million ha of customary land to the state for the development of ten farm blocks, 100,000 ha each (MoA, 2014). Each of the farm blocks has a large nucleus farm surrounded by roughly 350 private farm holdings on 86,000 ha, the majority of holdings being medium-scale (Jayne et al., 2016). According to Sitko et al. (2015), this new set of medium-scale farmers, from urban areas, are better educated and more likely to be employed in the public sector with positions ranging from teachers, health workers and agricultural extension workers on the one hand, to higher-level positions in government ministries, on the other. Secondly, a considerably larger number of these farmers have acquired larger pieces of land relative to small-scale farmers. They used non-farm wage income to acquire their land, and most of these acquisitions have been recent. It appears wage income growth, particularly from public sector employment, is driving a significant share of the expansion of medium-scale land ownership in Zambia (Nicholas et al., 2015).

Moreover, these wage earners appear to be using their knowledge of bureaucratic systems gained from public sector employment to navigate opaque systems for acquiring land titles. However, use of acquired land by this group of new-scale farmers has been relatively poor, thus affecting their productivity compared to smallholder farmers. The total area and percentage change in this type of farm are presented in Figure 10.

Figure 10. Number of small, medium and large-scale farmers in Zambia



	Small-scale "A""	Small-scale "B"	Small-scale "C"	Medium-scale	Large-scale
2009	916,787	366,628	146,334	9,030	1,500
2011	1,095,360	354,116	56,409	13,839	0
2014	762,685	434,035	242,270	19,632	0
2016	1,144,000	380,800	75,200	24,280	740

Large-scale farms

There are two types of large-scale commercial farms: *(*1) Large commercial farms, usually owner-operated farms that combine ownership of the primary means of production with management and operated on modified estate lines <1,000 ha, and (2) Commercial estates, that are mono-crop, managed by professionals and privately owned, for example, Nakambala Sugar, Northern Coffee, Zambeef farms with farm sizes more than 1,000 ha. Type 1 is more prevalent than type 2. There are more than 740 large-scale commercial farmers (CIAT: World Bank, 2017). Large-scale farmers make up only 4% of farm households but cultivate 22% of all cropped land.

Spatial distribution: Large-scale farms are located mainly along railway lines or near major urban centres, more dominant in AER II (Southern, Lusaka, Eastern and Central provinces) and part of AER III (Copperbelt Province, Mkushi and Serenje districts, around Kasama and Mpika).

Farm size: This category of farmers is characterised by farms bigger than 100 ha (Chapoto & Chisanga, 2016; CIAT: World Bank, 2017).

Types of crop grown/livestock kept: Highly diverse, cultivating cash crops such as maize, irrigated wheat, sugarcane, cotton, tobacco, soybeans, cut flowers, several horticultural crops and raising livestock (Chikowo, 2016). Livestock kept include cattle, dairy, sheep and poultry. Some large-scale farms are also engaged in game ranching and fisheries.

Farming practices, technologies used and extent of market integration/commercialisation: Because of their favourable position, they are the principal beneficiaries of the commercial value chains, market information delivery systems, support services by the private sector and public investments in infrastructures, especially in the farm blocks (MAL, 2015). Due to location within the proximity of rail and main urban centres, they have increased access to markets. Due to the economies of scale, large-scale farms can bargain in the input and output markets. They also take advantage of advanced technologies – HYV, fertilisers, pesticides and so on, and are market-oriented. Their operating objective is to maximise sales or profits. Where out-grower schemes are established, these farms provide access to markets and services for small and medium producers (Matenga, 2016; Stringfellow, 1996).

Productivity/crop yields and cropping intensity: These farms are characterised by extensive mechanisation and high-level technology and management (Saasa, 2003). Crop production and their farming systems are mechanised. Output per unit area is optimised, mono-cropping is widespread, and there is increased specialisation. Their principal characteristic is growing commercial high-value industrial crops such as sugar, tea, coffee and coarse fibres.

Changes over time: Commercial estates were first established to produce raw materials for export to Europe and North America. A transition was later made to produce some food and beverage products. This role has continued except that they now also serve national industrialisation. Livestock-based estates have also emerged in recent years close to metropolitan areas for production, particularly beef, broiler and pork production. They have favourable access to land and subsidised credit for machinery, driven by favourable government policies. The Land Act of 1995 also allowed foreign investors to acquire land in Zambia via leasehold (Nolte, 2014). The total area and percentage change in this type of farm is presented in Table 6.

2. The scope of environmental impacts

2.1 Ecosystems and biodiversity in Zambia

According to NBSAP-2 (MLNREP, 2015a), Zambia has abundant natural resources and is mildly enriched with biological diversity. People, especially in the rural areas, mainly rely on exploiting the biological resources for their livelihood. Biodiversity contributes to ecosystem goods and services needed for the economy to function properly.

Ecosystems

Zambia has 16 ecosystems, of which 14 are terrestrial ecosystems classified as closed forests, open forests with grass, termitaria and grasslands ((MLNREP, 2015a; MLNREP, 2015b). The closed forests (dry deciduous and evergreen) include montane, swamp and riparian, while the open forests include grasslands and woodlands (Table 5 and 6). The other two ecosystems are the freshwater aquatic and the anthropic land cover. The land cover types include tree plantations, cropland and built-up environments. The perennial rivers, natural and artificial lakes characterise the aquatic ecosystems. Anthropogenic factors have significantly altered the terrestrial and aquatic ecosystems in Zambia, particularly converting forest land for food production to sustain the ever-increasing human population and urbanisation (Shakacite et al., 2016). Ecosystems have also been changed by industrial and infrastructure development, pollution and invasive species (Table 5) (Forestry Department, 2016b).

Table 5. Type and proportion of ecosystem in Zambia

Biome	Ecosystem	Land area	
		(ha)	percentage
Forest	Dry evergreen	1,583.5	2.1
	Deciduous	673.5	0.9
	Thicket	190.0	0.3
	Montane	4.0	0.0
	Swamp	153.0	0.2
	Riparian	81.0	0.1
Woodland	Chipya	1,556.0	2.1
	Miombo	29,448.0	39.1
	Kalahari sand	8,426.0	11.2
	Mopane	3,701.0	4.92
	Munga	3,059.5	4.1
	Termitaria	2,426.0	3.2
Grassland	Dambo	7,576.0	10.1
	Floodplain/Swamp	12,907.5	17.2
Aquatic	Lakes and rivers	1,050.0	1.4
Anthropic	Cropland, forest plantations and built-up areas	2,421.0	3.2
	Total	75,261.4	100.00

Source: Shakacite et al. (2016)

Before anthropogenic clearance and disturbance, these forest types covered more than 65% of Zambia's total land area (Tables 6). The only available information on diversity in the country is based at species-level, while ecosystem information seems to be limited vegetation types, according to ILUA I in 2008 (Forestry Department, 2016).

Table 6. Land use class and forest types in thousand hectares[6]

Forests (=/> 10% canopy cover) Calculated from ILUA survey data	**Area Cover ('000 ha)**	**Proportion %**
Evergreen forest	819	1.1%
Semi-evergreen forest	34,145	45.4%
Deciduous forest	14,865	19.8%
Other natural forests	139	0.2%
Broadleaved forest plantations	0	0%
Coniferous forest plantations	0	0%
Total	**49,968**	**66.4%**
Other wooded land (5–10% canopy cover or shrubs/ bushes canopy cover >10%)	**Area Cover ('000 ha)**	**Proportion %**
Wooded grasslands	4,897	6.5%
Shrubs/thickets	1,158	1.5%
Total	**6,055**	**8.0%**
Other land (<5% canopy cover or shrubs/bushes canopy cover <10%)	**Area Cover ('000 ha)**	**Proportion %**
Barren land	9	0%
Grassland	6,085	8.1%
Marshland	1,332	1.8%
Annual crop	4,700	6.3%
Perennial crop	236	0.3%
Pastures	464	0.6%
Fallow	2,387	3.2%
Urban	7	0%
Rural	551	0.7%
Extraction site/mining area	0	0%
Total	**15,771**	**21.0%**
Inland water (area occupied by major rivers, lakes and reservoirs)	**Area Cover ('000 ha)**	**Proportion %**
Lake	2,693	3.6%
River	774	1.0%
Dam	0	0%
Total	**3,467**	**4.6%**
Total Country Area of Zambia	**75,261**	**100%**

Source: ILUA 1 Report (Forestry Department, 2008).

[6] Though done before 2008, there has been more recent documentation (see Shakacite et al., 2016)

Ecosystems dynamics

The influence of environmental factors such as geomorphological processes and climate allows ecosystems to be dynamic (Mayer & Reitkerk, 2004). There have been some changes in the extent of the ecosystem over the past million years due to climate. For example, there is an increase in the water flow of the Luangwa river along the middle section of the valley as it flows in the Zambezi River, causing a lot of soil erosion and producing lots of sand and silt river bed and banks. In addition to this problem, the ecosystem structure and function have been altered by biotic factors such as fires and land cultivation (MLNREP, 2015a).

Wetlands

Wetlands including natural and artificial lakes, river channels, flooded wooded areas, flood plains and swamps account for about 14–19% (75,260km^2) of Zambia's total area (MLNR, 2018a). Dambos are small shallow wetlands found in flat plateau areas. Dambos cover 12% of Zambia, characterised by grasses, rushes and sedges (https://www.wwfzm.panda.org). Swamps, marshes and floodplains cover about 30,104km^2 (MLNR, 2018a). There are three basins in Zambia: Luapula, Zambezi and Lake Tanganyika. The Luapula basin comprises Chambeshi River; Luapula River; Kalungwishi River; Bangweulu Lake and Swamps Complex; and Lake Mweru (fifth national report to the UN Convention on Biological Diversity, MLNREP, 2015b). The largest catchment area is the Zambezi comprising: Kafue River; Luangwa River; Upper Zambezi; Lukanga Swamps; the Middle Zambezi, now dominated by Lower Zambezi and Lake Kariba, Mweru-Wantipa, and the Busanga Swamps. The smallest is the Lake Tanganyika basin, characterised by the most diverse biodiversity, including fish with Nilotic affinities. These wetlands are located within the central African plateau with elevations ranging from 1,000–1,600m above sea level.

These wetlands contribute to economic development by supporting various economic sectors such as tourism, agriculture, fisheries, and forestry. Wetlands provide ecosystem services such as reducing the impacts of storm damage and flooding, maintaining good water quality in rivers, recharging groundwater, storing carbon and nutrient cycling, thereby helping to control pests and stabilise climatic conditions. Wetlands are also important sites for biodiversity and the prevention of soil erosion.

Details of the diversity of various species (MLNREP, 2015b; Forestry Department, 2016a):

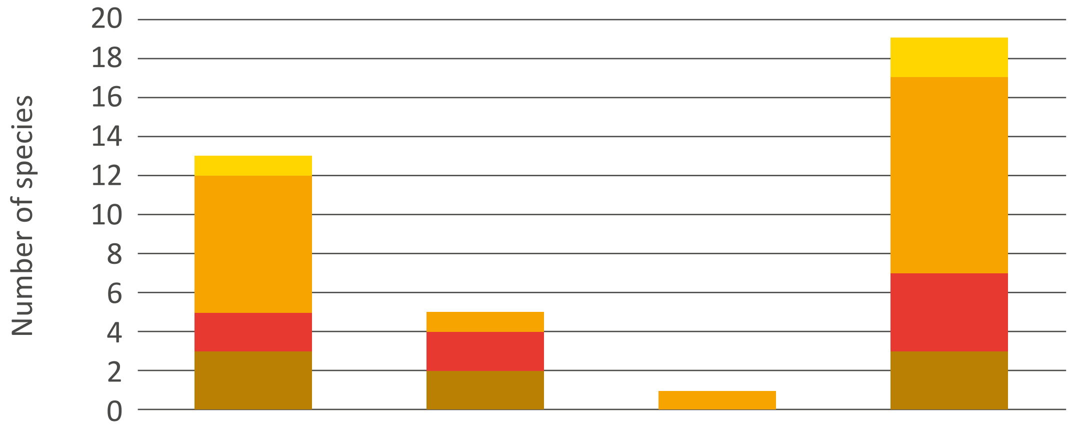
(i) Micro-organisms

In Zambia, an estimated 598 species of micro-organisms have been identified. The spatial distribution of these micro-organisms tends to be influenced by rainfall distribution, with higher rainfall areas having abundant micro-organisms. The groups of micro-organisms include fungi (446 species), viruses (35 species), bacteria (12 species) and protozoa (4 species). Similarly, although the totals are 33% plants, 63% animals and 4% bacteria and micro-organisms (MLNREP, 2015b), this again merely reflects the poor state of current knowledge about micro-organisms and plants.

(ii) Invertebrates

Zambia has an estimated 6,135 species of invertebrates. It is estimated that 69 species are endemic. According to MLNREP (2015b), 14 species among the freshwater molluscs are threatened (Figure 11). The insect group (grasshoppers, locusts, biting flies and ticks) are among the most diverse, followed by snails and roundworms. The grasshoppers comprise 127 species, and 27 are endemic to Zambia. However, these estimates may be understated due to knowledge gaps in the literature specific to Zambia.

Figure 11. Invertebrates and their conservation status in Zambia



	Molluscs	Insecta	Crustacia	Total
Near threatened	1	0	0	2
Vulnerable	7	1	1	10
Endangered	2	2	0	4
Critically endangered	3	2	0	3

Among the critically endangered snail species are the *Bellamya pagodiformis*, *Bellamya crawshayi and Bellamya mweruensis*. At the same time, *Tanganyicia rufofilosa, Bridouxia ponsonbyi* and *Bulinus nyassanus* are vulnerable. The *Melanoides admirabilis* is near threatened while the butterfly, *Acrea acrita ambigua*, is also endangered.

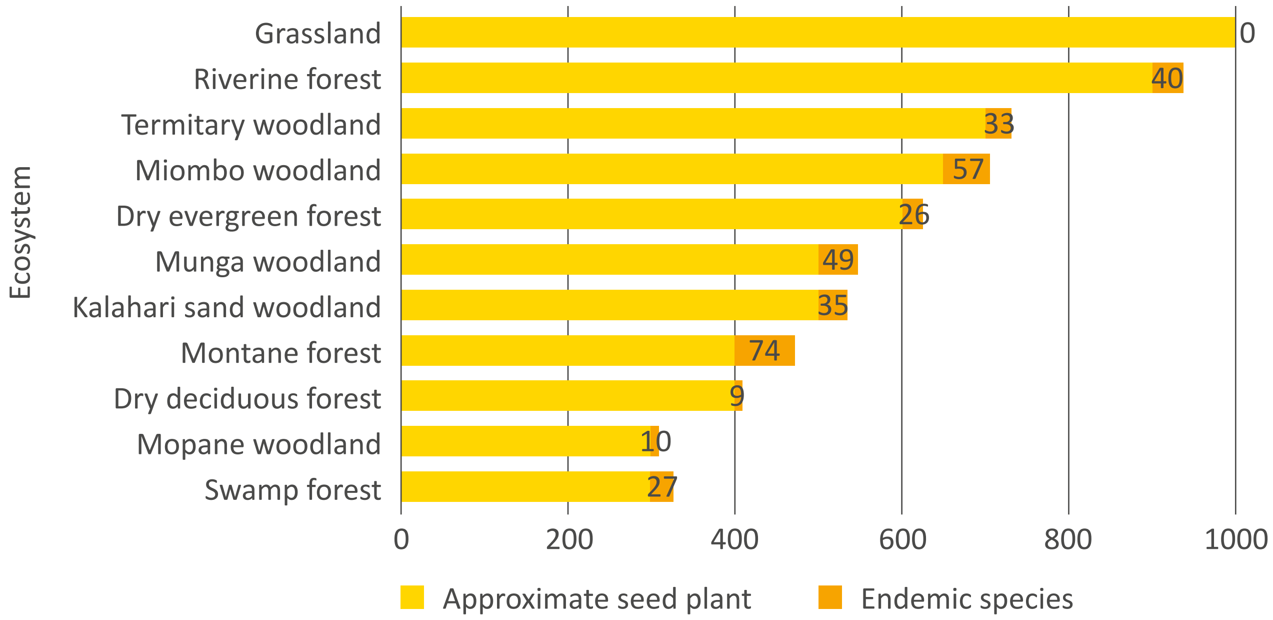
Zambia's network of statutory forest reserves is made up of 175 National Forests and 305 Local Forests, administered by the Forest Department (MLNREP (2015a). The management objective of LFs is to protect and conserve major water catchments and their biodiversity while sustainably using the resources. There are 59 Botanical Reserves located either within or outside forest reserves, preserving the vegetation types and promoting in-situ conservation of genetic resources in the country.

A total of 3,774 flora species exist in Zambia, consisting of 147 algae, 129 mosses, 142 ferns, 530 kinds of grass, 1,130 non-grass herbs, 1,610 woody plants and 86 crops (Forestry Department, 2016b). According to Kokwe & Matakala (2015), the Northern and the North-Western parts of Zambia have the highest diversity of flowering plants, with species richness estimated at 36–48 per ha (MLNREP, 2015b). The Miombo woodland is the centre of the Brachystegia and the Monotes genera, generally found in the Mpulungu block in Northern Province, Solwezi block in North-western Province, and Mpika-Serenje block in central Zambia. The Kafue Headwaters hosts the largest continuous area under forest reserves, particularly in Solwezi, Kasempa and Mwinilunga. Some smaller blocks are located in Mansa, Mkushi and Siavonga. The seed plant and termitary ecosystems are located in the grasslands (MENR, 2000).

There are several varieties of orchids endemic to Zambia. An estimated 397 species of orchids in Zambia are found in the Miombo woodlands, mopane and munga woodlands.

The approximate diversity of seed plants in the different ecosystems in Zambia is summarised in Figure 12.

Figure 12. Diversity of seed plants in the different ecosystems in Zambia



Source: Forestry Department (2016b)

According to the Forestry Department (2016a), 143 plant species in Zambia are considered threatened, and of these, 33% are woody plants and 67% are herbs. The distribution of these threatened plants by ecosystem based on Southern African Botanical Diversity Network (SABONET) data is given in Table 7 according to the Forestry Department (2016b).

Table 7. Distribution of threatened plants by ecosystem and habitat (SABONET Red Data list for Zambia)

Broad habitat	Habitat	Species/subspecies	Proportion (%)
Forest	Evergreen	4	2.80
	Montane	7	4.90
	Swamp/Riverine	10	6.99
	Thicket	9	6.29
	Sub-total	**30**	**20.98**
Woodland	Miombo	18	12.59
	Kalahari sand	3	2.10
	Unspecified	9	6.29
	Sub-total	**30**	**20.98**

Broad habitat	Habitat	Species/subspecies	Proportion (%)
Termitary		1	0.70
Grassland	Dambo	16	11.19
	Montane	9	6.29
	Swamp/Floodplain	11	7.69
	Unspecified	2	1.40
	Sub-total	**39**	**27.27**
Unspecified	Special	17	11.89
	Other	27	18.88
	Sub-total	**44**	**30.77**

Source: Forestry Department (2016b)

Woodland ecosystems affected by anthropogenic activities, such as land cultivation and wild fires, have negatively impacted ecosystem structures. Infrastructure development in new districts has increased the demand for wood fuel (firewood and charcoal) beause of a lack of connection to national electricity grids and pressure from the rising population. Some scholars have also suggested overgrazing as a contributing factor to Miombo wood degradation (Mwale et al., 1996; Forestry Department, 2016a).

(iii) Fish

The abundant water resources such as lakes, swamps and flood plains support more than 409 species of fish (MLNREP, 2015a), 17 species of which are commercially used for human consumption. Musuka et al. (2017) reported 106,798 MT as fish production and 155,000 MT as domestic consumption, suggesting importation of 45,000 MT. The highest number of fish species are found in Lake Tanganyika. According to MLNREP (2015a), out of 289 fish species, 76% belong to Lake Tanganyika. In this regard, this lake is a unique fishery exhibiting the highest diversity of fish fauna, while lake Mweru-Wantipa has the lowest fish diversity. Other endemic species include 24 species in Mweru-Luapula, 20 species in Upper Zambezi, 13 species in Kariba/Middle Zambezi, nine species in Lake Bangweulu, and none in Mweru-Wantipa.

Though some fisheries belong to the same water basins, there are some noticeable differences or similarities in species composition. The highest similarity is between Bangweulu and Mweru-Lazuli at 72%, probably due to sharing the same drainage basin. This is followed by the upper Zambezi and Kafue with 67% similarity, despite belonging to different basins. At the same time, Kariba and Middle Zambezi have a low similarity at 37%, probably because the Upper Zambezi is separated from these two by the Victoria Falls, which is a significant barrier to fish migration. Lake Tanganyika fisheries are very distinct from these water basins due to their isolation.

(iv) Birds

There are an estimated 757 species of bird fauna, 76 of these species being rare, and 100 being endemic (MLNREP, 2015a; Birdlife International, 2018) (Table 8). Zambia's National Parks, bird sanctuaries and Game Management Areas are home to 22 species of protected birds. Based on current assessments, 15 bird species are either vulnerable, endangered or near threatened. The relationship between bird species diversity and ecosystem diversity is non-existent. Important bird species have benefited from the existence of a large expanse of wildlife reserves found in protected habitats. Such areas include National Parks, GMAs, two bird sanctuaries and private aviaries. There is an overall lack of data and information in the country, particularly concerning migratory species, even though bird habitats seem to be well protected.

There are more than 44 species of birds found in different types of woodlands. These birds are the diurnal raptor family – Accipitridae, which include vultures, hawks, eagles and so on, associated with either mopane or Miombo forests (Birdwatch, 2019). A mixed species of birds can be found in the Miombo woodland, comprising bird parties of ten to 20 species, of which several are territorial insectivorous birds. The mopane forest has several species that are confined to this habitat, in open places and edges of plains and wetlands. More than ten species could be found in light areas created by human activities, including the Black Shouldered Kite, Black-bellied Bustard, and Namaqua Dove. Several bird species are associated with the Acacia trees, which grow in much of Zambia, particularly the southwest. These include the African Mourning Dove, Acacia Pied Barbet, the migrant Tit Babbler, Burnt-necked Eremomela, Crimson-breasted Shrike and so on. The Red-billed Buffalo Weaver tends to build nests in baobab trees, while hollows in the same tree are breeding places for the Mottled Spinetail. In addition, there are also several birds associated with palm trees, for example the Palm-nut Vulture occurs typically in the vicinity of Raphia or Elaeis palms.

The Miombo woodland vegetation is home to numerous bird species found in East and Southern Africa, with many migratory birds coming from the Northern hemisphere during the rainy season. According to Birdwatch (2019), there are 753 bird species. More than 600 species are residents or Afrotropical migrants that breed in the Miombo woodlands, and about 100 species are non-breeding migrants and vagrants. The Barbet ((*Lybius chaplini*) is Zambia's only endemic species. According to Birdwatch (2019), the Black-cheeked Lovebird (*Agapornis nigrigenis*) is a near-endemic species as it can sometimes be found in neighbouring countries.

According to Birdwatch (2019), there are 15 flagship bird species, including:

1. Zambian Barbet (*Lybius chaplini*). The fruiting *Ficus sycomorus* in open savanna/Miombo areas, edges of cultivated fields, gardens and pastures is a habitat for the Zambian barbets
2. Wattled Crane (*Bugeranus carunculatus*). Wattled Cranes are present as breeding residents in shallow wetlands adjoining grasslands, dambos and floodplains throughout much of the Zambian plateau
3. Grey-crowned Crane (*Balearica regulorum*). Generally found in dry and wet open areas. This bird species can also be found in shallow flood plains (for example, Kafue flats, Busanga plains, Bangweulu swamps and Barotse flood plain), grasslands and open riverine woodlands
4. The white-headed Vulture (*Trigonoceps occipitalis)* occurs in most habitats in Zambia

5. The white-backed Vulture (*Gyps africanus*) comprises about 85% of the vulture population found in the open
6. Hooded Vulture (*Necrosyrtes monachus*) is found alongside Zambia's major rivers and around open woodlands. The bird feeds on a variety of food, including dead fish and large carcasses
7. Black-cheeked Lovebird (*Agapornis nigrigenis*) is found in mopane (*Colophospermum mopane*) woodlands and is considered endemic to Zambia
8. Slaty Egret (*Egretta vinaceigula*): The upper Zambezi, Kafue Flats, and the Bangweulu wetlands constitute a habitat for Slaty Egret, making it vulnerable to changing floodplains just like the Wattled Crane
9. Shoebill (*Balaeniceps* rex). Found and breeds in the Bangweulu wetlands
10. Taita Falcon (*Falco fasciinucha*). Inhabits and nests rocky gorges, eg, the Batoka, which used to be its preferred habitat. However, it is no longer found there due to possible disturbances from tourists. This bird is a very weak competitor, dominated by larger falcons found in the same habitat
11. Margaret's Bats (*Batis margaritae*): This mammal is the most common in the *Cryptosepalum* forests in North-western Zambia
12. African Pitta (*Pitta angolensis*). A secretive species whose habitat includes forests and thickets around the riverine, particularly eastern half of Zambia. It inhabits the southern part around Pemba and Mutulanganga IBA – the only confirmed breeding site in the country. The species is an intra-African migrant present in Zambia from October to April
13. Blue Swallow (*Hirundo atrocaerulea*) is a bird that inhabis and breeds in montane grasslands, mainly under overhangs or holes in the ground. It is the only known bird that breeds in the grasslands of the Nyika Plateau towards Malawi
14. Kori Bustard (*Ardeotis kori*) is the flagship species of Zambia's southernmost grassland IBAs such as Simungoma, about 10km from the Zambia-Namibia border
15. Southern Ground Hornbill (*Bucorvus leadbeateri*); found everywhere though numbers are in decline because it is hunted for use in traditional medicine

Although data on birds in Zambia is limited, studies in the Southern African Development Community (SADC) block suggest that various anthropogenic activities threaten the ecosystems on which the faunal depend (Cooper et al., 2017). Cooper et al. (2017) reported that half of the bird species seemed to be declining due to ecosystem disturbance linked to land cover changes in natural and forest plantations. They also observed that the impacts in fauna varied depending on species-specific characteristics. The 25-year modelling indicated a loss of more than ten species, with birds of prey particularly affected. According to Newbold et al. (2013), land-use change negatively impacts the habitats of birds, consequently reducing the bird species' resilience to climate change leading to extinctions.

Globally, birds are essential agents of pollination and seed dispersal, thereby helping to maintain and restore plant communities and agriculture (Pecha et al., 2008). In this regard, the relationship between land-use changes and their impacts on bird species populations and seed dispersal need to be incorporated into conservation interventions. For example, Pecha et al. (2008) assert that in studies conducted in Central America birds' abundance is more important in seed dispersal than

Table 8. Species richness and IUCN threatened species in birds

Category	Type	Species total
Birds	Land birds	600
	Migratory	203
	Seabirds	7
	Waterbirds	133
	Breeding endemic	3
	Total number of birds	733
	Important Bird & Biodiversity Areas	
	Number of IBAs	42
	Total IBA area	10,568,150 ha
	Endemic Bird Areas	
	Number EBAs	4
IUCN Red List	Extinct	0
	Extinct in the wild	0
	Globally threatened	20
	% threatened	3
	Critically endangered	3
	Endangered	4
	Vulnerable	13
	Near threatened	16
	Least concern	695
	Data deficient	2

Source: Birdlife International (2018)

the species richness or proximity to the forest patch. Their study reported a correlation between the richness of the seed dispersed with "wetness", a remotely sensed metric of vegetation, at various scales. However, there is a limitation in determining the numbers of forest-dependent species and enumeration of those involved with seed dispersal, pollination and insect predation. There is a considerable knowledge gap in Zambia regarding birds as agents of pollination and seed dispersal. The species on the IUCN (International Union for the Conservation of Nature) Red List are presented in Table 8 according to Birdlife International (2018).

(v) Mammals

MLNREP (2015) estimated 224 mammalian diversity in Zambia, exhibiting a slight correlation (r = 0.58) with ecosystem diversity. The highest diversity is found in munga woodland and grassland and lower diversity in dry deciduous forests. In Zambia, much of the wildlife is found in 20 National Parks and 34 GMAs. Twenty-eight animal species and subspecies in Zambia are considered either endangered or vulnerable.

(vi) Vertebrates

Amphibians

Kokwe and Matakala (2015) estimate there to be 74 species of amphibians (frogs and toads), and 13 of these are found in one locality, for example, the Nyika dwarf toad (*Bufo nyikae*) recorded in Nyika plateau. In this regard, the geographical gradient in the species richness of amphibians in Zambia is not discernible (MLNREP, 2015a). However, some species are considered vulnerable due to a restricted range (Table 18).

Reptiles

Zambia is known to have an estimated 156 species of reptiles (snakes, lizards and tortoises) (MLNREP, 2015a). There is a total of 45 species found in one locality and are thus considered rare.

2.2 Agrobiodiversity

Agriculture biodiversity has also been identified as an important form of biodiversity for livelihood influenced by differences in farming systems, agro-ecological and socio-economic conditions based on historical patterns. Agriculture biodiversity has been incorporated in Zambia's SNDP to ensure food security and agricultural development (MNDP, 2017). This plan fits well with the SDG2: *End hunger, achieve food security and improved nutrition and promote sustainable agriculture*; SDG12: *Ensure sustainable consumption and production patterns*; and SDG15: *Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*.

Agrobiodiversity includes *"all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem"* (COP decision V/5, appendix; https://www.cbd.int/agro/whatis.shtml). Glenn (2006) populated a list of the species on the IUCN database showing the group species, common and scientific names (Table 9).

Table 9. List of species on IUCN Red List as being endangered/threatened

Group of species	Species common name	Scientific name
Amphibians	Nyika dwarf toad	*Bufo nyikae*
Reptiles	African slender-snouted crocodile	*Crocodylus cataphractus*
Birds	African white-backed vulture	*Gyps africanus*
	African skimmer	*Rynchops flavirostris*
	Black cheeked lovebird	*Agapornis nigrigenis*
	Black-tailed Godwit	*Limosa*
	Black-winged Pratincole	*Glareola nordmanni*
	Blue swalloa	*Hirundo atrocarulea*
	Cape vulture	*Gyps coprotheres*
	Chestnut banded Plover	*Charadrius pallidus*
	Corncrake	*Crex*
	Denham's Bustard	*Neotis denhami*
	Eurasian Curlew	*Numenius arquata*
	Eurasian Peregrine Falcon	*Falco peregrinus*
	Great Snipe	*Gallinago media*
	Greater Spotted Eagle	*Aquila clanga*
	Lappet-faced vulture	*Torgos tracheliotos*
	Lesser Flamingo	*Phoeniconaias minor*
	Lesser Kestrel	*Falco naumanni*
	Lilian's Lovebird	*Agapornis lilianae*
	Madagascar Pond-heron	*Ardeola idea*
	Olive-headed Weaver	*Ploceus Olivceiceps*
	Pallid Harrier	*Circus macrourus*
	Papyrus Yellow Warbier	*Chloropeta gracilirostris*
Snails	Bellamya mweruensis	*Bellamya mweruensis*
	Belamya crawshayi	*Belamya crawshayi*
	Bellamya pagodiformis	*Bellamya pagodiformis*
	Bridouxia praeclara	*Bridouxia praeclara*
	Bridouxia ponsonbyi	*Bridouxia ponsonbyi*
	Melanoides admirabilis	*Melanoides admirabilis*
	Tanganyica rufofilosa	*Tanganyica rufofilosa*

Group of species	Species common name	Scientific name
Insects	Cataract hooktail	*Paragomphus cataractae*
	Eriksson's Copper	*Erikssonia acraeina*
	Onychogomphus styx	*Onychogomphus styx*
	Red jungle-Skimmer	*Hadrothemis scabrifrons*
	Thermochoria jeanneli	*Thermochoria jeanneli*
Mammals	African Elephant	*Loxodanta africanus*
	African Lion	*Panthera leo*
	African White Bellied Pangolin	*Phataginus tricupsis*
	African Wild dog	*Lycaon pictus*
	Ansel's Shrew	*Crocidura ansellorum*
	Black Rhinoceros	*Diceros bicornis*
	Checkered Sengi	*Rhynchocyon cirnei*
	Cheetah	*Acinonyx jubatus*
	Common Hippotamus	*Hippotamus amphilus*
	Delectable soft-furred mouse	*Praonyus delectorum*
	Kafue Mole Soft	*Cryptonys kafuensis*
	Large ear Free-Tailed Bat	*Otomops martiensseni*
	Leopard	*Panthera pardus*
	Puku	*Kobus vardonii*
	Straw-coloured Fruit Bat	*Eidolon helvum*
	Striped leaf-nosed bat	*Hipposideros vittatus*
	Tanzanian Vlei Rat	*Otomys lacustris*
	Temnick's Ground Pangolin	*Smutsia temminckii*
	White Rhinoceros	*Ceratothererium simum*
	Zambian Mole Rat	*Fukomys anselli*
Plants	African Mahogany	*Khaya anthotheca*
	Baphia speciose	*Baphia speciose*
	Brachystegia bakeriana	*Brachystegia bakeriana*
	Bread Palm	*Encephalartos schmitzii*
	Cassipourea fanshawei	*Cassipourea fanshawei*
	Embelia upembensis	*Embelia upembensis*
	Fringe Tree	*Chionanthus richardsiae*
	Hallea stipulosa	*Hallea stipulosa*

Source: Glenn (2006)

Agrobiodiversity results from the interactions between farmland management systems and practice, genetic resources, and the environment. In this regard, agrobiodiversity's sustainable use and conservation are vital for several smallholder farmers to assure their survival, livelihood and risk management, especially facing climate change and diseases. Agrobiodiversity increases their resilience, but due to increased agricultural development, there has been a marked decrease in Zambia's rich agrobiodiversity (Forest Department, 2016b). Although several government policies and legislation have been put in place to stem this decline, they are not well documented (Shakacite et al., 2016). For example, the extinction of traditionally cultivated crop species and varieties and local animal breeds have been observed (Shakacite et al., 2016; Forest Department, 2016b). Some approaches to curb the loss of agrobiodiversity include active involvement of the communities in conservation, such as considering women, smallholders, indigenous knowledge and pastoralists in the conservation process. Some interventions may develop appropriate policies and legislation, capacity-building in governmental and non-governmental institutions, public awareness-creation, and supporting farmers in conserving and using their genetic resources economically and sustainably (MLNREP, 2015b). In this regard, agrobiodiversity is cross-cutting, tackling all aspects of the economy. Therefore an integrated multi-sectoral approach is needed as a timely intervention mainstreamed at local, national and international levels.

Zambia is extraordinarily rich in biodiversity and ecosystem services, and the wealth of indigenous knowledge is a valuable asset for its sustainable development (MLNREP. 2015a). The vast diversity is reflected in climatic and physical differences across the country (Forestry Department, 2016a). More than 64% of Zambia's population depend directly on these ecosystem resources and services in rural areas, while the urban and peri-urban population supplement their incomes, energy, medicine and other essentials, from them (MLNREP, 2015b). Thus, Zambia's biodiversity plays a critical role in the functioning of ecosystems (Shakacite et al., 2016). A healthy ecosystem provides goods and services needed by humans, such as reducing soil erosion, climate stabilisation, carbon sequestration, water, and soil nutrient cycling, and crop production through pollination (Forestry Department, 2016a).

Although the information on annual forest loss in Zambia is limited, the country has one of the highest pools of carbon in its forests and woodlands (Shakacite et al., 2016). As well as being a habitat for animals, forests are also involved in seed dispersal and germination. Forests are a valuable economic resource for supporting natural systems and improving peoples' livelihoods through the provision of timber and non-timber forest products (Turpie et al., 2015). To conserve biological diversity in forests, Zambia has established Botanical Reserves which serve three objectives, namely: (i) to preserve some relic vegetation types and plant species; (ii) to act as sources of germplasm for multiplication and breeding programmes; and (iii) to act as reference sites in determining human impacts on forest ecosystems outside the reserve. There are 59 Botanical Reserves in Zambia that cover 148,000 ha (Forestry Department, 2016a).

The establishment of herbaria, gene banks and botanical gardens are part of Ex-situ biodiversity conservation in Zambia. For example, a collection of indigenous and exotic plants can be found at Munda Wanga botanical garden in Chilanga. Among the larger herbaria in the country include Mt. Makulu, the Forest Department in Kitwe, and the University of Zambia in Lusaka. According to MLNREP (2015), there are at least 107 cultivated plant species in Zambia, and of these, 15% are indigenous, 33% are naturalised and 52% are exotic. Five species of wild rice are related to the cultivated rice. In addition, there are 567 wild crop relatives in Zambia based on 107 cultivated crop species. It is estimated that 7% of the plant species are naturalised due to long periods of cultivation and have thus evolved some functional adaptation (Mwila et al., 2008). According to Mwila et al. (2008), the National Plant Genetic Resources Centre (NPGRC) at Mt. Makulu has 5,996 seed samples collected from different parts of Zambia. The *ex-situ* collection at the NPGRC also includes 207 cassava germplasm, 152 sweet potato germplasm, and 55 germplasm maintained in a field gene bank as living plants. An estimated 50% of the country's total diversity constitutes cassava and sweet potato collections, with the rest available in farmers' fields as *in-situ* conditions. The development of varieties takes place including cassava, common beans, finger millet, groundnuts, maize, pearl millet, sorghum, soybeans, sunflower oil, sweet potato and wheat. The research focused on various crops, including bambara groundnuts, cowpea, kenaf, pigeon pea, rice, vegetables, and tree and plantation crops.

The primary food and cash crops such as maize, sorghum, groundnuts, wheat, cotton, sunflower and beans have benefitted from the introduced germplasm in their crop development and improvement programmes. Some of these crops' breeding programmes have incorporated local germplasm collected from within the country. More local germplasm has been used in minor crops such as finger millet, pearl millet, bambara groundnut and sweet potato than introduced crops. Agro-biodiversity is defined following the Convention on Biodiversity and refers to the "variability among living organisms associated with cultivated crops and domesticated animals and the ecological complexes of which they are part". In the integrated land use assessment, agrobiodiversity has been assessed from agro-ecological zones and farming systems. Some wild edible plant species such as cowpea, sorghum, sesame and various cucurbit species have been found. The crop with significant genetic diversity included cowpea (*Vigna unguiculata*), sorghum (*Sorghum bicolor*), bambara groundnuts (*Vigna subterranea*), beans (*Phaseolus vulgaris*) and maize (*Zea mays*). When comparing the genetic diversity between traditional and commercial farming, the traditional system was found to have more diversity. The food crops included maize, sorghum, cassava, sweet potatoes and groundnuts. According to Mingochi & Luchen (1997), traditionally, customary laws helped people invent and implement management and conservation systems that reduced and prevented the misuse and exploitation of natural resources; traditional farming systems have greatly influenced the preservation of genetic diversity. Passive conservation of semi-cultivated or wild relish species constitutes most of the traditional cultivation practices. An example is the retention of vegetation around graveyards to respect the dead, making these sites rich in vegetation and biological resources. Similarly, the seasonal bans on the harvesting of fish and hunting of animals and birds by most cultures allowed animals to breed, which helped sustain the productivity of these resources. Traditional leaders such as chiefs and headsmen play a pivotal role in ensuring beneficial traditional conservation practices at community and village levels. This is passed down to a household level where the household head teaches young family members to uphold the traditions.

Based on intra-species agro-biodiversity assessment, Zambia has a total of 7,278 germplasm accessions conserved ex-situ (MLNREP, 2015a). The study found ten species of domestic animals (primarily cattle) and six species of birds, mostly chickens. By 2016, the estimated population of cattle countrywide was five million, and that of chickens was about 714 million, representing a significant increase of 7.7% and 22% over the previous year figures in 2015, respectively (Chapoto & Chisanga, 2016). There are three main indigenous cattle breeds in Zambia: Barotse, Angoni and Tonga. The estimated annual increase of the goat and sheep populations is about 5% and 7%, respectively. However, the cross-breeding of indigenous and exotic livestock species in Zambia is expected to increase (FAO & IAEA, 2014).

According to Corlett (2017) seed dispersal is key to the massive diversity of the woodlots over vast tracts of land. Numerous seed dispersal agents consume small fruits, while the dispersal of large fruits is carried out by fewer dispersers, such as a handful of species of mammals and birds, which are highly vulnerable to hunting, fragmentation and habitat loss. Controlling hunting in both forest and agricultural areas is vital in conserving biodiversity, reinforcing the important role of elephants, hornbills, civets, bulbuls, fruit bats and gibbons in seed dispersal. Seed dispersal mediated by animals that eat fruit is central in the dynamics and regeneration of many vegetation types.

The long-term survival of plants is affected by the ongoing fragmentation of forest ecosystems and the depletion of dispersers. Abedi-Lartey et al. (2016) state that such practices threaten biodiversity and the ecosystem's functions and services. For example, the straw-coloured fruit bat, *E. helvum*, travel long distances across fragmented landscapes and are essential for maintaining genetic connectivity and colonising new sites for plant species. Knowledge regarding the seed dispersal of alien species is crucial to managing invasion risk in fragmented natural habitats (Egawa, 2017). For example, in Zambia, birds disperse up to 90% of plant species such as trees like African mahoganies (*Meliaceae*), which depend on avian dispersers. Medicinal plants, and other economically important species rely on various dispersal agents found in forests. Some seeds are enormous and depend on large fruit-eating birds such as hornbills and curassows to disperse them. For example, the *Entandrophragma utile* and *Khaya anthotheca* rely almost entirely on birds for seed dispersal.

Reproduction in flowering plants depends on pollination. In this process, pollen is transferred from the male anthers to female stigma. In this way, fruit and seed production and pollination are the primary processes for sexual reproduction (FAO, 2007). Pollination is carried out by animals, wind, and water. Though bird pollination is less common than seed dispersal, it is vital for certain plant groups, such as tropical understory herbs. Birds pollinate between 3 and 5% of more than 1,500 species of crop or medicinal plants, three-quarters of which cannot self-pollinate. The role played by animal pollination is particularly unique and robust, allowing the exchange of genetic material between plants over long distances and enhancing genetic diversity.

2.2.1 Crop pollination by wild pollinators

Although information on the contribution of animal pollinators to biological diversity across the landscapes and ecosystems of Zambia is inadequate, indicators can be inferred from existing reports on forest biodiversity in the country. It is well known that forest biodiversity provides habitat and food for birds, insects, animals, fungi, micro-organisms; insects, bats, and birds, which also serve as pollinators (Forestry Department, 2016a). Tree canopy and grass cover intercept raindrops, thereby reducing soil erosion. Surface litter maintains soil organic matter (carbon) and nutrient content through decomposition, which have profound implications for the agricultural sector for crop and livestock fodder production. Following the ratification of the Convention on Biodiversity (MLNREP, 2015a) and Conference of the Parties to the Convention in International Trade in Endangered Species (National Assembly, 2010), Zambia has started to implement biodiversity-based approaches in agricultural programmes in a bid to reduce GHG emissions. Agricultural biodiversity encourages a wide range of species and varieties that tolerate different climate extremes, from drought to flooding and extreme temperatures.

Farms are also being encouraged to increase yields through climate-friendly farming practices that reduce emissions, improve genetic varieties, species, soil and landscapes. Zambian farmers can be empowered to increase yields, while reducing waste and dependencies on external inputs through climate-smart agriculture. Ajayi et al. (2006) suggests applying various agroforestry interventions such as hedgerows, cover crops and intercropping to minimise soil erosion. For example, a yield of 3 t/ha of maize could be achieved by applying 15 t/ha fresh weight of *Gliricidia sepium* green manure. According to Asseffa (2016), agrobiodiversity is under a lot of threat from monoculture systems and climate change. Communities are not only recipients of technologies but contribute their knowledge in plant breeding and creating new varieties that are more resilient to climate change. Therefore, conducting seed fairs would increase biodiversity and raise awareness among farmers, researchers, policymakers, extension staff and the media. Farmers must start growing more crops, which is essential for livelihoods and food security. However, there are many policies in place for plant breeders and researchers, but very little for farmers who are even restricted from marketing certain seeds. The balance of the scale is tilted so much towards mono-cropping, with much financial support for research but not for farmers. There is a need for a legislative framework that includes a national biodiversity authority, acknowledging community rights and traditional knowledge, and establishing a biodiversity fund. Community seed banks, where people share and learn about seeds, are common in some areas, but these are usually invisible from a scientific perspective. Scientists say that farmers produce grains, not seeds: seeds are to plant, grains are to eat.

Value of pollination/pollinators in the ecosystems

The primary purpose for animals visiting flowers is to collect and consume rewards rather than to aid pollination. In this regard, flowers produce nectar, a source of sugar consumed mainly by birds, bats, insects and non-flying mammals. The pollen from flowers is used as a source of protein, fatty acids, minerals and vitamins; and is mainly used by bees (to supply larval cells), flies, beetles, birds, bats and non-flying mammals. Other beneficial products from plants include the oils (collected by certain bees for supplying their larval cells), and resins collected by various bees for use in nest construction, and a range of other materials are also used. To enable the continuation of reproduction and multiplication of flowering plants, the process of plant pollination is fundamental. Pollination is critical to enhancing the evolution of flowering plants and fruit/seed production (FAO, 2007). The importance of animal pollinators in food crops is vital to sustaining productivity. Though the contribution of the animal pollinator population to biological diversity is inestimable, central to biological diversity conservation is humankind's survival (FAO, 2007).

According to Ollerton et al. (2011), insects, other animals and other vectors such as wind and water are responsible for pollinating an estimated 87.5% (about 308,000 species) of the world's flowering plants. Sub-Saharan Africa, South America and Asia are thought to have a higher degree of dependency, with an estimated 98% of plants depending on animal pollination (Johnson, 2010).

The protection of woodlands, forests, grasslands and wetlands and mechanisms such as pollination are essential for conserving plant diversity. Conserving pollinators is instrumental to enhancing plant diversity and avoiding threats of food insecurity, bad cash crop economies, and extinction of plant species in the natural ecosystems. As much as flowering plants largely depend on pollination for their reproduction and survival, the dependency of wild flowering plants on pollinators (birds, small mammals and insects) has not been estimated and documented. It is nevertheless thought to be higher than that by water and wind. Crops such as fruit trees, cut flowers, sunflowers, cotton and so on, are among the cultivated crops highly dependent on such pollinators. The demand for pollinators grows as agricultural productivity increases, as insect pollinators are essential for many fruit and vegetable crops. Unfortunately, the habitat that pollinators need is also removed by developing large farms and landscapes for agriculture (FAO, 2007).

Diversity of pollinators in Zambia and unique attributes of pollination systems

There is a wide diversity of pollinators in wild pollination systems. According to Eardley et al. (2009), more than 2,600 bee species are described in Africa. In Zambia, however, the accurate number of bee species is not known. Most of the bee species in Africa are effective pollinators except the parasitic bee taxa. Additionally, other essential pollinating species include flies, beetles, wasps, butterflies and moths (known to be necessary for orchids and many other night-blooming flowering plants).

Status and trends of pollinators and pollination

Until recently, concern about the decline of pollinators has been low globally (Gemmill-Herren et al., 2014). Almost half the studies on pollinator decline come from only five countries: Australia, Brazil, Germany, Spain and the USA, with only 4% from Africa (Archer et al., 2014). This situation highlights the bias in information and the lack of data for some countries. Evidence suggests that there is no complete assessment of the level and course of pollinators and pollination services in Africa (Gemmill-Herren et al., 2014; Melin et al., 2014). Thus, researchers are inclined to use data on global trends to pull out the relevant, if scarce, data and trends in the African region. Crop reproduction is enhanced by visits from wild insects to crop flowers. Vertebrate pollinators in Africa include bats, non-flying mammals such as rodents and lemurs, and birds, particularly sunbirds and white-eyes. Africa is rich with unique pollinators in natural ecosystems. For example, sunbirds visit aloes, bats are seen on parkia flowers, and there exists an ancient system of beetle pollination of cycads, as well as *Ceropegia* flowers and their imprisoned pollinator flies.

Due to a lack of data, the existing levels of wild pollinator populations are vague and not easy to assess. At a global level, Aslan et al. (2013) estimated the threat posed by vertebrate extinctions to the worldwide biodiversity of vertebrate-pollinated plants. They further identified Africa, Asia, the Caribbean and global oceanic islands as geographic regions at particular risk of disruption of pollination (and dispersal). Globally, there is evidence suggesting that when food resources and nesting site habitats are conserved, pollinators can be sustained over long periods (Aizen et al., 2009). Significant shifts in the population of pollinators arise from disease infestation and loss of habitats or alteration. Added to these problems is the proliferation of invasive plant species and alien competitors, and increasing pesticide use. Comparative surveys between disturbed and undisturbed sites have shown that massive disturbance of habitats could lead to a spatial homogenisation of bee communities (decline in beta diversity) in addition to impoverished pollinator faunas (Carvalheiro et al., 2013). The status of pollinators such as birds and moths of Africa can also be affected by nectar plants and sources. Moth species are important pollinators, but information is lacking on the population dynamics in Zambia.

With regards to honey bees, it is not easy to determine the population of the colonies in a geographic locality due to:

1. movement, when the whole honey bee colony moves as a swarm
2. division of a honey bee colony by a beekeeper into two or more parts during the active season to multiply colony numbers
3. uniting colonies into one in periods of flower dearth or during cold temperatures
4. lack of registration of colonies and the labour intensity of this business
5. differences between nations, and disparity over time in how information on colony numbers is collected.

These factors, when put together, hinder reports on the yearly rates of colony mortality (the percentages of colonies that die yearly) and the overall number of colonies at any point and time. Indeed, colony mortality rates have recently been reported to be much higher than the usual rate of ca.10.

During the past 50 years, global agriculture has become more dependent on pollinators, with the proportion volume increase of more than 300% of agricultural production dependent on pollinators (Aizen & Harder, 2009). Developing countries in Asia, Africa and Latin America have experienced a much steeper increase in pollinator-dependency than developed countries in Europe and North America, with some exceptions (eg, Canada). According to Aizen et al. (2008), in the year 2006, pollinator-dependent crops comprised 33% of developing countries, and 35% of developed countries' cropped land area. (There has been a faster expansion in developing countries where pollination-dependent crops are cultivated more than nondependent crops (Aizen et al., 2008).

2.3 Habitats affected by agriculture

(Unfortunately, few summary maps exist due to a lack of documentation)

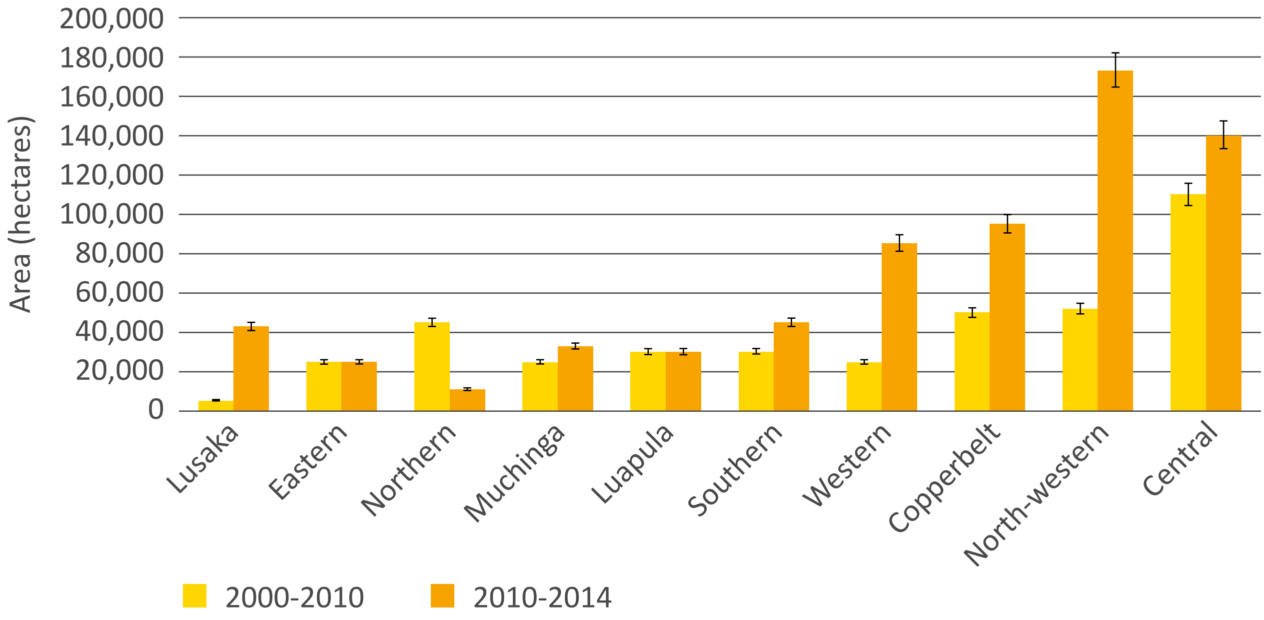
Historical trend

Forests, grasslands and wetlands have all suffered significant habitat loss due to agricultural activities over recent decades, with reasonable estimates of declines available between 2005 and 2015 (MLNREP, 2015a).

Forest habitat loss

The main activities contributing to the loss of forest habitat in Zambia are agricultural expansion, deforestation, energy supply, increased urbanisation, mining activity and infrastructure (roads, power transmission and dams) (MLNREP, 2015a). A recent assessment by Birdwatch Zambia (Likando et al., 2010) provides an excellent example of how these activities impact protected areas and their biodiversity. The annual deforestation rate in Zambia is estimated to be 276,000 ha of the total forest cover (Shakacite et al., 2016; Mabeta et al., 2018). Mabeta et al. (2018) attribute deforestation to an increase in the urbanisation rate of 3.2% per annum, infrastructure development such as housing, energy, transport, and irrigation increases. Earlier, Shakacite et al. (2016) attributed deforestation to land-use change from forestry to agriculture, for example, degazetting six forest reserves in Copperbelt, Southern and Eastern Provinces between 2000 and 2011, predominantly for infrastructural development, farming and settlement purposes. This resulted in a loss of more than 280,000 ha of natural forest reserve (MLNREP, 2015a) (Figure 13).

Figure 13. Loss of forest habitat in each province in Zambia



Source: Kasaro & Siampale, 2015

In Northern Zambia, most of the primary forest has mainly been lost due to shifting cultivation (Sprague & Oyama, 1999). Forests are also areas with the highest diversity of flowering plants. More than 350,000 ha of national forest in North-Western Province has been cleared for mining and agriculture (MLNREP, 2015a).

Changes in protected land areas, encroachment and the depletion of biological resources have a direct correlation to ecosystems and species richness. In some parts of Western Province, orchid habitats and the orchids were depleted permanently by the transformation of peat bogs (swamp) to cultivation. Additionally, converting dryland ecosystems to cultivation and livestock grazing land has triggered the disappearance of saprophytic organisms in the ecosystem. Deforestation and selective cutting of host trees have also destroyed the habitat for epiphytic plants. Table 10 shows that between 2000 and 2014, significant losses occurred in forest reserves. According to Shakacite et al. (2016), the total forest cover and the area under grasslands decreased by -1.48% (from 47,054 million ha in 2000 to 45,943 million ha in 2014). It decreased by -0.05% (from 16,426 million ha in 2000 to 16,390 million ha in 2014), respectively (Shakacite et al., 2016). The decrease in these land cover classes is attributed mainly to human encroachments related to different livelihood (anthropogenic) activities. For instance, agriculture (cropland) land, which is the mainstay, increased by 0.95%, from 6,467 million ha in 2000 to 7,183 million ha. In 2014, land under settlements increased by 0.48%, from 0.137 million ha in 2000 to 0.502 million ha in 2014.

Table 10. Rate of deforestation by province from 2000 to 2014

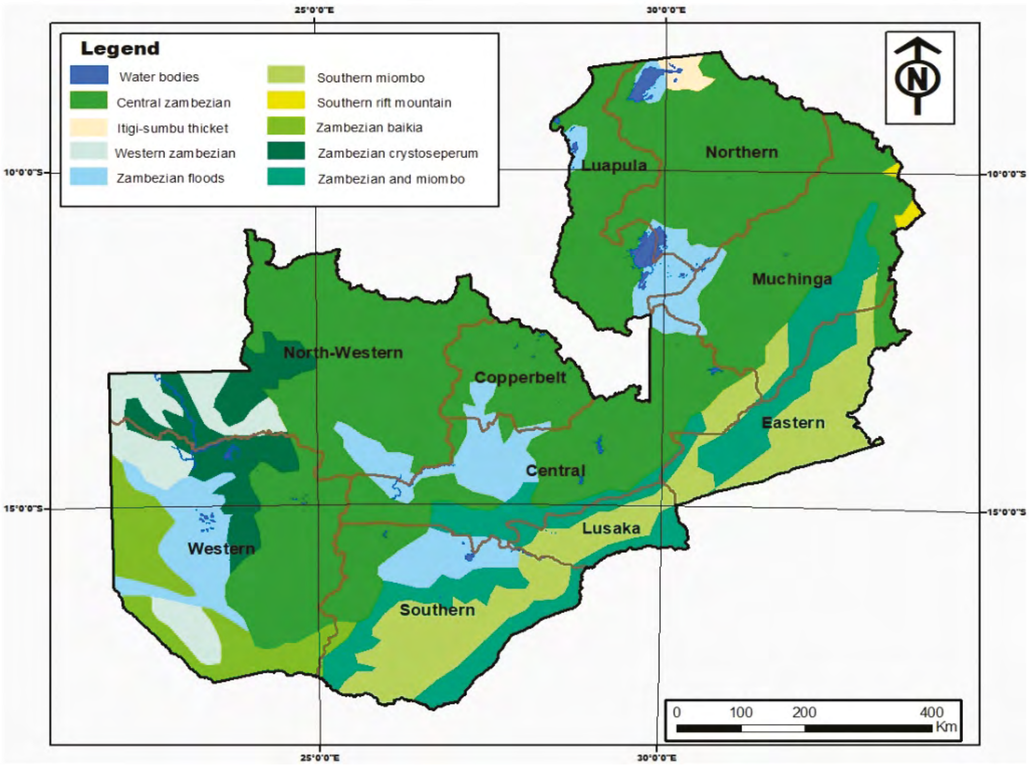
	Total Loss	Arithmetic Mean	Annual rate
Name of province	Over 14 (A-C)	Mean	%
1. Central	421,985	30,142	6.89
2. Copperbelt	122,614	8,758	6.07
3. Eastern	13,809	986	0.38
4. Luapula	36,154	2,582	1.09
5. Lusaka	6,723	480	0.47
6. Muchinga	30,448	2,175	0.48
7. Northern	20,222	1,444	0.47
8. North-western	282,122	20,152	3.09
9. Southern	25,004	1,786	0.66
10. Western	151,751	10,839	2.17
Total	1,110,832	79,345	2.36

Source: Shakacite et al. (2016)

Increasing levels of encroachment resulting from settlement and cultivation have also compromised the Protected Forest Areas (MLNREP, 2015a). Encroachment into forest reserves is widespread in Zambia and threatens the integrity of these protected areas, thereby compromising the protected National and Local Forests (Nyrienda et al., 2018). Available data on National Forests indicate that 47% of these forest reserves have been encroached by human settlements and agricultural activities. The proportion of encroached reserves ranges from 21% in the Kafue basin to 100% in the Middle Zambezi. These threats to forest-protected areas extend to the 59 Botanical Reserves in which 15% and 24% have been significantly disturbed by man (and in some cases by large wild animals) and encroachment, respectively. In addition to encroachment, increased commercial timber harvesting and illegal coppicing have contributed to deforestation and forest degradation, especially in forest reserves.

Population growth and internal migration, for example, from Southern Province to Central Province due to the droughts of the 1990s and people’s basic needs, have also increased the demand for fuelwood and the pressure to transform forests in open areas into land for agriculture. The World Bank estimates that the conversion of forest to cultivation increases by 1.5% per year (Chidumayo, 2013). Under customary tenure, land for cultivation is given by traditional chiefs. If there is not enough land available in open areas, forest reserves are occasionally used because these are often considered communal land or abandoned sites, henceforth easy targets for unlawful exploitation and encroachment (Figures 14, 15 and 16). In Zambia, the terrestrial ecosystems based on vegetation type fall into four main divisions, namely: forest, thicket, woodland and grassland. These are further subdivided into the Central zambeziana, Itingi-nsumbu thicket, Western zambiezian, Zambezian floods, Southern miombo, Southern rift mountain, Zambezian baikaea, Zambezian crystoseperum and Zambezian miombo. Forests and woodlands are predominant and cover 60% of the country's total land area. In addition, the country has fresh water aquatic ecosystems (water bodies) (Figure 14). The transformation of forest reserves to other land uses is exemplified by projected deforestation up to 2030 (Figure 15). The forest reserves, especially in the vicinity of big cities such as Lusaka, are converted to urban land use. Others have been either severely degraded or converted to agriculture, resettlements or illegally encroached. Because charcoal requires more wood for its production, charcoal in the country's urban areas has serious implications on forest biodiversity due to wastage during conversion.

Figure 14. The terrestrial ecoregions of Zambia



Information on the loss in different habitats has been gathered from the three biodiversity observatories established in Zambia since 2014 (Jurgens et al., 2018). These observatories are located in Luampa, Dongwe and Kafue National Park. All of them are located within Miombo terrestrial ecosystem and provide benchmark data on vascular plant diversity and deforestation hot spots mainly in the southern miombo vegetation (Figure 15).

The projected rate of deforestation is presented in Figure 16. The amount of forest cover loss in 2000 and 2010 was estimated at 890,400 ha and is expected to increase to 1,358,200 ha in 2020. However, this loss is expected to decline further from 1,358,200 ha in 2020 to 1,238,800 ha in 2030. Although Zambia still enjoys the existence of primary forests, such forests are rapidly changing to other land uses (Figure 16). The primary forests are projected to be found mainly in Northwesten province by 2030 and hots spots are expected to increase along the line of rail from Copperbelt, Central, via Lusaka to Southern province.

Figure 15. The deforestation hotspots in Zambia

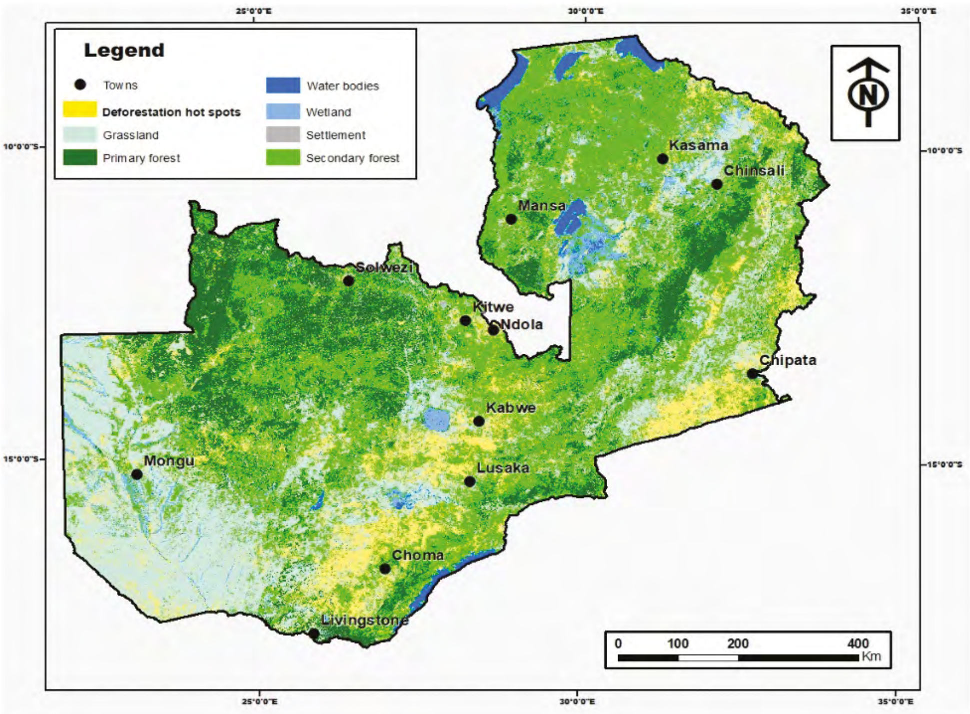
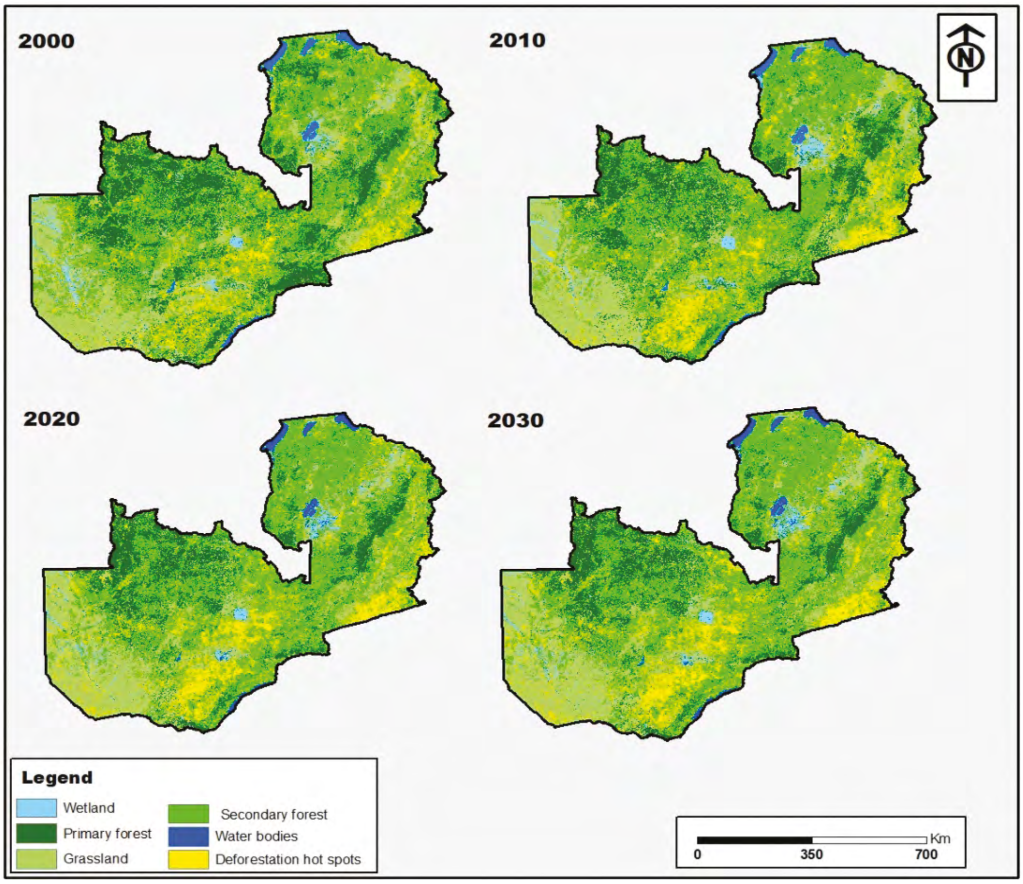


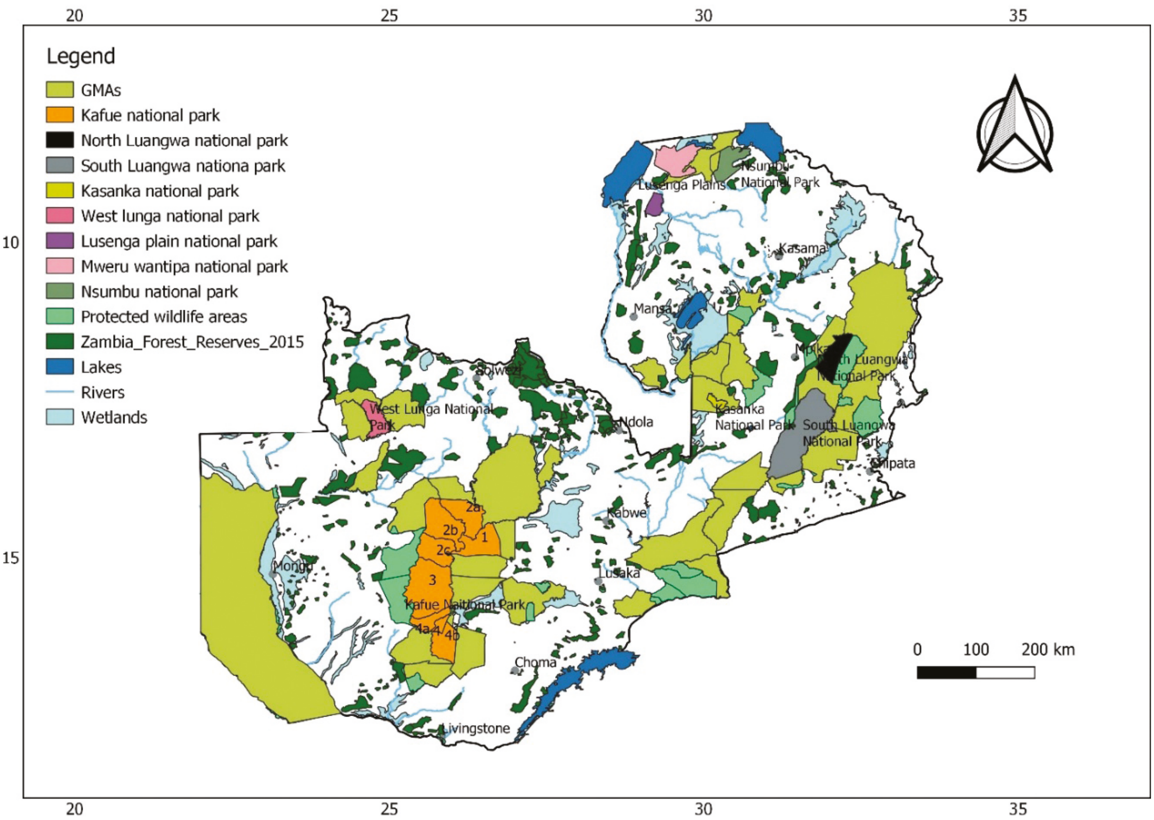
Figure 16. The projected deforestation as a result of land-use change in Zambia



Game Management Areas (GMAs) habitat loss

Lindsey et al. (2013) reported that 40% of the land in Zambia is protected, out of which 20 National Parks cover 65,000km² and 36 game management areas cover 167, 000 km². Protected areas also include several categories (Figure 17). There are no human settlements in National Parks, and wildlife is solely for photo-tourism purposes, but human settlements are permitted in the GMAs (Lindsey et al., 2013). In the GMAs, wildlife use is primarily for trophy hunting and meat for local consumption (Lindsey et al., 2013). The literature suggests that wildlife in GMAs is not productive in ecological, economic or social terms. As a buffer to National Parks, the decline in GMAs will negatively impact the economy and livelihood.

Figure 17. Map of Game Management Areas, National Parks and Forest Reserves in Zambia



Humans and wildlife coexist in GMAs. In this regard, more than 1.5 million humans in GMAs conduct their economic activities sustainably (MLNR, 2009). According to Lindsey et al. (2014), the human population growth rates in GMAs have grown more than the rates outside GMAs (average in GMAs was 2.49 ± 0.18% vs. 2.31 ± 0.24%, outside). Lindsey et al. (2014) report that humans have modified 40% of the GMAs compared to 2.9% in National Parks and 71.2% outside the protected area network. The habitat loss in GMAs is estimated at 0.69% per annum, compared to 0.03% in National Parks and 0.51% outside of the parks network. Consequently, evidence suggests a decline of wildlife population in GMAs evidenced by the declining GMA biomass (mean 247 ± 69 kg/km²), contrasting National Parks (996 ± 309kg/km²), which in turn are lower than in extensive (unfenced) private game ranches (2,424 ± 305kg/km²) (Lindsey et al., 2014). The diversity of wild ungulates is also lower in GMAs (5.5 ± 0.71 species) than in National Parks (7.6 ± 1.2 species) or extensive game ranches (11.1 ± 0.86 species).

The GMA and National Parks have been encroached by human settlement, which has resulted in habitat loss and depletion of wildlife in Zambia (Table 11). For example, encroachment has been reported in Bilili Springs and Mukungule (Lindsey et al., 2013). The Mumbwa GMA has also witnessed an increase in encroachment due to agricultural activities, resulting in the degradation of GMAs by 25% area according to Lindsey et al. (2013) and Mabeta et al. (2018) summarised in Table 11.

Table 11. Estimate of the extent of habitat conversion in some selected GMAs

GMA	Average Size (km^2)	Human Settled Area (km^2)	Human Settled percentage (%)
Luangwa Ecosystem GMAs			
Mukungule	1,661	1,355	81.6
Munyamadzi	2,675	523	19.5
Lumimba	4,149	959	23.1
Lupande	4,393	1,994	45.4
Musalangu	7,810	2,769	35.5
Sandwe	1,299	426	32.8
West Petauke	1,498	203	13.6
Chisomo	3,016	552	18.3
Kafue Ecosystem GMAs			
Mumbwa	2,089	978	46.8
Bilili Springs	3,678	3,660	99.0
Kafue Flats	1,372	445	32.5
Mufunta	6,411	1,150	18.0
Sichifulo	3,600	645	18.0
Namwala	3,162	2,643	83.6
Nkala	202	68	33.6
Kasonso Busanga	7,780	213	5.0
Mulobezi	3,591	591	16.4
Mufunta	3,795	416	11.0

Source: Lindsey et al. (2013)

Wetlands habitat loss

Zambia's abundant resources include more than 750,000km^2 (13%) of wetlands, a habitat that supports GMAs and National Parks (MLNR, 2018a). Evidence suggests that wetlands that support different economic activities have declined, affecting wildlife and fishing. Consequently, some economic activities, including game viewing, game hunting, eco-tourism, fishing, irrigation, dams, small-scale and large-scale agricultural activities, salt mining, and Hydro-Electric Power (HEP) generation, have been affected (Lindsey et al., 2013). The Environmental Management Act No. 12 2011 (National Assembly, 2011), provided for the protection of several wetlands. In line with the Ramsar convention, eight sites have been designated as Wetlands of International Importance (Ramsar sites), covering a surface area of 4,030,500 ha and listed in Table 12.

Table 12. Ramsar sites in Zambia

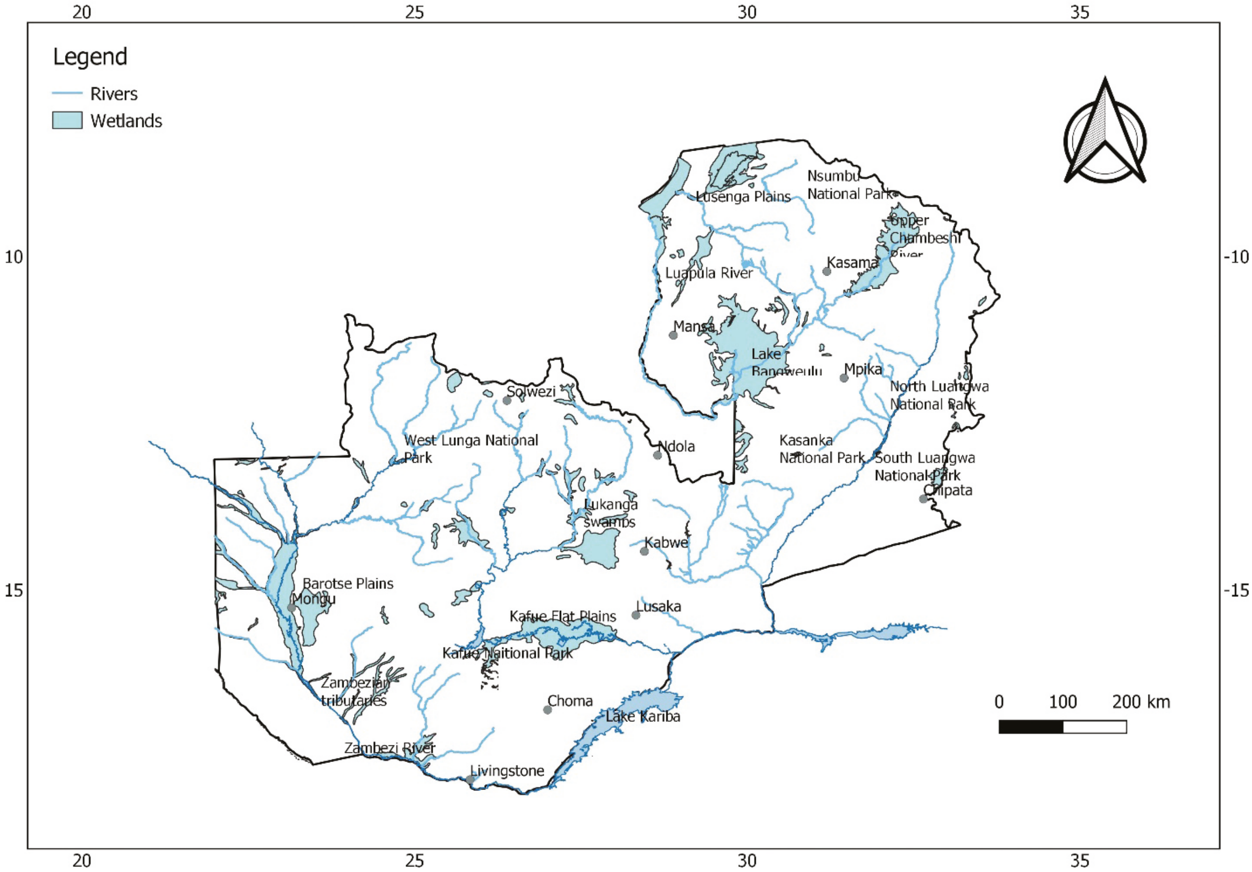
Name of Ramsar Site	Area (km^2)
Bangweulu Swamps	11,000
Busanga Swamp	2,000
Kafue Flats (includes Lochinvar & Blue Lagoon NPs)	6,005
Lake Tanganyika (portion in Zambia)	2,300
Luangwa Floodplains	2,500
Lukanga Swamp	2,600
Mweru-Wa-Ntipa Swamps	4,900
Barotse Floodplain	9,000
Total	**40,305**

Source: https://www. rsis.ramsar.org

Zambia has several wetlands (Figure 18). These wetlands are currently threatened due to poor management, indiscriminate drain digging and overgrazing (MLNR, 2018a).

In addition, the spread of invasive species in wetlands ecosystems poses a severe threat to biodiversity. For example, Shanungu (2009) reported the invasive plant, *Mimosa pigra* in the Kafue Flats, occupying a significant proportion of the floodplains. This invasion displaced animal species such as Kafue Lechwe (*Kobus leche kafuensis)*, contributing to the rapid population decline of this endemic antelope species (Shanungu, 2009). It also blocked waterways, and reduced food availability for wildlife and domestic animals, as well as access to fishing grounds (Shanungu, 2009). The breeding grounds of waterbird species of global conservation concern, such as Wattled Cranes, have also been affected (Shanungu, 2009). The study also reported the water hyacinth (*Eicchornia crassipes*), commonly referred to as Kafue weed, Kariba weed (*Salvinia molesta*) and Azzola (*Azzola pinata*). Water hyacinth, in particular, has affected power generation because of the costs associated with weed management to prevent them from damaging turbines.

Figure 18. Map of wetlands of national importance in Zambia



The red-clawed crayfish (*Cherax quadricarinatus*) has spread in many wetlands' ecosystems, including the Kafue flats and Zambezi Floodplains, resulting in increased fish post-harvest loss and destruction of fishing gear. This invasive species compromises the biodiversity of the native fish stock. The obscure snakehead (*Parachanna obscura*) is a freshwater fish native to western central Africa, and it is invasive in the Mweru-Luapula system. This predatory species may compete with native species for food and habitat, and if left uncontrolled, it is likely to expand its range and permanently alter aquatic ecosystems' balance throughout Mweru-Luapula.

In addition, an increase in the human population and the number of unplanned and uncoordinated settlements in these wetlands – caused by the lack of land-use plans in the wetland ecosystems – has resulted in:

1. Habitat destruction (unsustainable agriculture practices and extensification, deforestation, wildlife displacement, mining)
2. Overharvesting of wetland resources (overfishing resources, poaching, damning, etc.)
3. Uncoordinated developments resulting in tremendous pressure on wetlands.

No estimates are available on the amount of Zambian wetland lost to agriculture and human encroachment.

Overfishing, deforestation for the production of charcoal and for 'slash and burn', land conversion for large-scale agriculture, invasive species, pollution (pesticide discharges and industrial waste), and climate change are all potential threats to the Lukanga swamp ecosystem (Chabwela, 2017; McCartney et al., 2011; MLNREP, 2015a). Farming activity in the nearby areas has resulted in land erosion, turbidity of the water and siltation (MLNREP, 2015a; Rebelo et al., 2010).

Grassland habitat loss

The Savanna woodland is Zambia's major terrestrial biome, of which 50% constitutes the Miombo. The Savanna, made up of woodland and grassland vegetation types (Day et al., 2014; Shakacite et al., 2016) has annual mean temperatures of 20–30°C and a yearly rainfall of 500mm–1,500 mm from south to north. Shakacite et al. (2016) reported 27.2% of land cover as grassland, relatively open at ground level, affording easy passage by animals and people.

The Central Zambezian Miombo woodlands are found on the flat central African plateau that makes up much of the country. This region is located in Southern Province – the largest commercial farming area in Zambia south of the plateau and Lusaka Province. It is also found in the Muchinga escarpment in Central and Northern Provinces and most Eastern regions except the bottom of the Luangwa Valley and a patch of the plateau around Petauke. Southern Miombo woodlands cover 15% of the country, are drier than the central Zambezian Miombo woodlands, and are more scattered and generally smaller. Compared to the Zambezian Miombo, this region has a relatively high proportion of woody shrubs and is interspersed with dambos; grassy wetlands forming the headwaters and margins of rivers up to 30% of the ecoregion. The ecoregion has suffered extensive deforestation, especially in the highly urbanised Copperbelt Province due to charcoal production and clearing for farming, the centre of Central Province for ranching and agriculture, and Kasama and Mansa for charcoal production and Chitemene farming.

Zambezian and Mopane woodlands are found at lower elevations in the valleys and cover 15% of the country. This region is located along the Zambezi and Kariba valleys east of the Caprivi Strip, the south part of Lusaka Province, and Lower Zambezi National Park. They are also found along the bottom of the Lunsemfwa and Luangwa valleys – including North and South Luangwa National Parks closer to the river – and in a strip running north of the Kafue Flats in Central Province, south in Southern Province, as well as up to Caprivi Strip. These areas also include dense grasses.

Western Zambezian grasslands are the most extensive non-floodplain grasslands in Zambia, covering about 5% of the country, and supporting large herds of wildebeest that migrate between western Zambia and Angola. This region is found in patches in the extreme west of North Western Province, northwest of the Kabompo and Lungwebungu Rivers; Liuwa Plain National Park in Western Province northwest of the Barotse Floodplain (Zambezi River); and plains within Sioma Ngwezi National Park in Western and North-Western provinces.

Flooded grasslands and savannas biome

This biome is represented by one ecoregion covering around 10% of the country. Plants, animals and people in Zambia have evolved to a reasonably reliable cycle of flooding, which brings some ecological advantages that promote biodiversity. As a country with very distinct rainy and dry seasons, with high rainfall in the former and relatively flat topography, Zambian rivers and low-lying areas are prone to flooding, and there are extensive permanent swamps. The role of termites in building mounds that remain above most of the flood is vital, as this provides habitats for plants less tolerant of getting waterlogged and safe breeding sites for birds and some animals.

The Zambezian flooded grasslands comprise eight sites, forming a broad chain running from southwest to northeast. The chain extends into Namibia and Botswana at one end (Caprivi wetlands and Okavango Swamp) and Tanzania and Kenya. Birds exploit this chain in their migration, and in former times, animals also migrated along the chain. The main sites along the flooded grasslands are:

- Barotse floodplain, Luanginga River floodplain, and Luena Flats in Western Province
- Bangweulu Swamps and floodplain, Northern and Luapula Provinces
- Kafue Flats, Central and Southern Provinces
- Lukanga Swamp and floodplains of the Kafue and its tributaries in Central Province and southwest Copperbelt Province
- Lake Mweru Wantipa/Mweru Marsh floodplain, Northern Province
- Busanga Swamps and plain, Kafue National Park, North Western Province
- Upper Chambeshi River floodplain, Northern Province
- Luapula Swamps south of Lake Mweru, Luapula Province.

The other ecoregions include Itigi-Sumbu thicket. This area is the smallest in size found in northern Zambia and comprises an almost impenetrable bush consisting of about 100 plant species woven together so densely that it is virtually impossible to walk through. It is found between Lake Mweru Wantipa and Lake Tanganyika at Nsumbu National Park. The others are Montane Grasslands found at high elevation along the border with Malawi, characterised by scrublands, major lakes and rivers.

Cattle grazing is the main activity in the grassland plains. Its carrying capacity is not yet exhausted (Simwinji, 1997) because diseases limit cattle multiplication. Burning for pasture improvement (particularly *Loudetia simplex*) is a common practise that makes grass palatable to animals, but it creates ecological problems. For example, early burning disturbs birds nesting in the grass, and several bird species are reported to have decreased when burning regulations have been ignored (Turpie et al., 1999). Uncontrolled late burning to provide green forage after grasses start to go dormant is considered a significant cause of rangeland degradation (Simwinji, 1997).

Grazing can be selective towards rare or local livestock breeds and thus play a role in rejuvenating rural economies and promoting traditional rural skills, as well as providing a fascinating educational resource. Data on the amount of grassland that has been lost due to agriculture is scant or not available. In National Parks and GMAs, which make up a large portion of the natural grasslands, human settlements and cultivation have modified and fragmented the grassland vegetation. The extent of the damage in most of them has not been assessed, nor has vegetation recovery on abandoned fields. The grassland plains are frequently used for cattle grazing, and cattle numbers have been increasing, though they are still considered below the system's carrying capacity (Simwinji, 1997). According to the MLNREP (2015a) report, the extent of grassland ecosystems and their relative representation in Forest Reserves and National Parks in Zambia varies by major habitat, as shown in Table 13.

Table 13. The extent of grassland ecosystems and their relative representation in Forest Reserves and National Parks in Zambia

Ecosystem	Major habitat	Extent in Zambia		Proportion (%)	
				Protected area	
		Area (km^2)	%	Forest reserves	National Parks
Montane grassland	Grassland	65	0.01	29.43	70.77
Dry wetland grassland	Dambo	37,266	4.95	9.54	6.43
Wet wetland grassland	Floodplains and swamps	56,389	7.49	0.01	9.79

Source: MLNREP (2015a).

2.4 Most impacted habitats and their location

Agricultural expansion

Agriculture's demand for land drives the conversion of natural habitats and is arguably its highest environmental cost (Tanentzap et al., 2015). According to Maxwell et al. (2016), no human activity has altered the face of the planet more than agriculture (the production of food, fodder, fibre and fuel crops; livestock farming; aquaculture; and the cultivation of trees). New croplands come mainly at the expense of natural habitats, particularly forest reserves. As long as agricultural expansion continues, it remains the primary driver of biodiversity loss in general. Specifically, the expansion drivers depend on scale, crops, goal or objective (projected output and whether demand is for subsistence use, domestic or international markets, and end uses, for example, human food, animal feed or biofuels). Globally the conversion of land for agriculture is estimated to account for 80% of deforestation (Kissinger et al., 2012), and ca. 53% of terrestrial species assessed as threatened by the IUCN (IUCN, 2014).

Land conversion also reduces the size of the terrestrial carbon sink. Goldewijk et al. (2011) report that one third of the global land area has been converted to croplands and pasture, releasing an estimated 205±70 Pg C to the atmosphere. Some reports suggest that around a third of the cumulative anthropogenic CO_2 has been emitted since 1750 (Le Quéré et al., 2018). Conversions from natural vegetation to agriculture generally decrease soil carbon stocks, while conversions to natural grasslands generally increase (Guo & Gifford, 2002). Intensive cultivation, overgrazing, bush fires, cultivation of marginal and easily eroded land, mechanisation, and the widespread use of chemicals and pesticides have intensified degradation and led to the rapid decline of species richness and abundance.

In Zambia, the most remarkable effects of increased agricultural activities are being observed in areas previously sparsely populated and where shifting cultivation is practised (Northern and Luapula provinces). The development of large sugar estates (Daily Mail, 2017), biofuel, coffee and forestry has resulted in large areas of previous carbon-rich land being cleared. The farm block development programme, which will create more than ten farm blocks, is another substantial agricultural undertaking (MFNP, 2005). According to ZDA (2014), more than one million ha has been set aside for this programme. However, the concentration of likely mono-cropping in the farming block could lead to plant genetic resource erosion over time. Forest reserves and GMAs could potentially be impacted in all these development agendas. The development of intensive agriculture is expected following the construction of dams by the Irrigation Development Support Project (IDSP) at Mwomboshi in Chibombo, and Lusitu in Siavonga Musakashi in Mufulira district. This will lead to an increase in pesticide use that will likely pollute the environment. However, some mitigation measures have been proposed (MAL, 2017).

The planned infrastructure in Zambia, along with human settlements, account for more than 3.2% growth in the area required per annum (Gumbo et al., 2013). Deforestation is an unavoidable consequence of infrastructure development, including housing, transport and energy (Foster & Dominguez, 2010).

Zambia's economy is highly dependent on copper and cobalt production and export. It is also a growing industry, with Zambia experiencing a steady increase in mining output over the past decade. This activity is located in the Copperbelt and Northwestern Provinces. In terms of exports, the mining industry contributes more than 70% of foreign exchange earnings and is the most significant contributor to GDP (IDLO, 2011; World Bank, 2018b). Mining can cause deforestation during initial clearance and because of the need for large quantities of wood for tunnel supports, and increasing demand for charcoal to support the energy needs of miners (Gumbo et al., 2013). For example, at the Kalumbila mining concession, infrastructure development is estimated to have caused the loss of more than 7,000 ha of forest cover (Vinya et al., 2012).

Location of the likely impact

The SNDP envisages a prosperous middle-income economy that offers employment opportunities for all Zambians of different skills and backgrounds, and will be achieved by harnessing economic diversification and growth opportunities. It forms the building block formulated to meet the goals contained in Vision 2030. The Zambian people aspire to live in an industrialised middle-income country that is strong and dynamic and presents opportunities for the better wellbeing of all. When implemented, this vision will make Zambia an economy that is self-sustaining, competitive, dynamic, and resilient to any external pressures, free from donors, and supporting the stability and protection of biological and physical systems. As a result, the Zambian economy is expected to expand, with investment in infrastructure development occurring in rural and peri-urban areas (MNDP, 2017). New districts have been created, power generation plants and new mining licenses issued, opening up rural areas to massive socio-economic activities. This results in more land being cleared to pave the way for roads, schools' health posts, residential houses and so on. Though not documented, losses in biodiversity may have occurred, but to minimise this, Environmental Impact Assessments will be undertaken.

2.5 Ecosystem types with the most traction in policies

Forests are an essential component of Zambia's natural capital and provide benefits critical for rural populations, urban areas and the national economy (Mackenzie, 2014). The forest cover in Zambia is estimated at 66% (Forestry Department, 2016a), with a rate of deforestation ranging from 0.5 to 0.6% ha per year, making it the country with the second-highest per-capita deforestation rate in Africa and the fifth-highest in the world (Turpie et al., 2015).

In addressing the main drivers of deforestation, the government has developed and enacted several legal instruments (Mabeta et al., 2018; Mackenzie, 2014) to conform with international conventions. Most of the policies cover the forest, woodlands and grasslands because they are more linked with agriculture and other industrial activities such as mining, human settlement, tourism, wildlife and so on. In this regard, more than 15 legal instruments have been developed and enacted (Table 14) to address the forest ecosystems either directly or indirectly, with the view of either accessing or preserving the services and goods they provide. It is estimated that forests directly contribute to the national economy, equivalent to about 4.7% of GDP, rising to 6.3% with multiplier effects (Turpie et al., 2015). The most valuable benefits include charcoal, sediment retention, and erosion control; non-wood forest products; and eco-tourism and other services, such as the provision of industrial round wood, pollination services and carbon storage.

Between 1990 and 2010, Zambia lost about 3.332 million ha (6.3%) of forest cover, according to the Climate Change Monitoring update (Matakala et al., 2015). This extreme loss of forests is due to Zambia's increasing population size, shifting subsistence cultivation practices, intensive pressure on agricultural land to meet the nation's food demand, and increased commercial farming. Even though most of the woodlands and forests in Zambia are on customary land, there is no purposeful or systematic management and institutional planning framework for the conservation and sustainable use of forests on customary land.

Table 14. Relevant national policies and legislations supportive of different ecosystems in Zambia

Government policy and legal framework	Year adopted	Biome (ecosystem) addressed
National Policy on Climate Change	2012	Forests, woodlands, grasslands, aquatic, anthropic
National Agricultural Policy	2016	Forest, grasslands, anthropic
National Forest Policy	2015	Forest
Mining Policy	2013	Forests, woodlands
Water Policy	2013	Forest, aquatic, anthropic
Fisheries Policy	2001	Forest, grassland, aquatic
National Irrigation Policy and Strategy	2004	Forest, woodlands, aquatic, anthropic
Land Policy	1995	Forest, woodlands, grasslands
Wildlife Policy	1998	Forest, woodlands, grasslands, aquatic
Wetlands Policy	2014	Forest, woodlands, grasslands
National Policy on Environment	2009	Forests, woodlands, grasslands, aquatic, anthropic

Government policy and legal framework	Year adopted	Biome (ecosystem) addressed
National Energy Policy	2008	Forest, woodlands
Biotechnology and Biosafety Policy	2007	Anthropic, grasslands
National legislation supportive of the biodiversity include:		
Agricultural Lands Act	1994	Forests, woodlands, grasslands, aquatic, anthropic
Forest Act	2015	Forests, woodlands, grasslands, aquatic, anthropic
Mines and Minerals Development Act	2012	Forests, woodlands
Water Resources Management Act	2011	Forests, aquatic
Fisheries Act	2011	Forest, grasslands, aquatic
Lands Act	1995	Forests, woodlands, grasslands, aquatic, anthropic
Wildlife Act	1998	Forest, woodlands and grasslands
Environmental Management Act	2011	Forests, woodlands, grasslands, aquatic, anthropic
Disaster Management and Mitigation Act	2010	Forest, woodlands, grasslands, anthropic
Energy Regulation Act	1995	Forests, woodlands
Biosafety Act	2007	Forest, anthropic
Local Government Act	1991	Forest
Natural Heritage Conservation Commission Act	1989	Forest, woodlands and grasslands
Natural Resources Conservation Act	1970	Forest, woodlands, grasslands, anthropic
Tourism Act	1979	Forest, woodlands, grasslands, aquatic
Noxious Weeds Act	1953	Forest, woodlands and grasslands
Plant Pests and Diseases Act	1959	Forest, anthropic
Plant and Variety Seeds Act	1968	Forest, anthropic

Source: http://www.parliament.gov.zm

3. The scope of social impacts from agricultural development

3.1 Social benefits of agricultural development

In the areas where the farm blocks and irrigation schemes have been created, there has been employment for local populations and business for small-scale farmers (ZDA, 2011). This development has broadened the tax base and contributed much-needed revenue to the government. In the few farm blocks already created, the government has rolled out social amenities such as schools, post offices, rural health posts, electricity supplies, and roads (Zambia Daily Mail, 2017). The private sectors and local communities have complemented the government's efforts by establishing shops. It is anticipated that the produce from the farm blocks will lead to an increase in export earnings from the agriculture sector and contribute to the country's GDP, thereby leading to an improvement in the national economy.

Farm block development will inevitably lead to more investment in the agricultural sector. Further improvement in the farm block will enable rural communities to access farming inputs and will lead to more opportunities for rural communities to sell their produce.

Rural poverty leads to urban migration, which causes undue poverty among rural migrants who cannot find employment in urban areas. Through the MoA, the Government of Zambia believes that the implantation of a farm block development programme shall stem rural-urban migration (Shawa, 2014). New roads and communication towers are being set up in rural areas, especially in the new farm blocks, to improve market access. To increase agricultural production in these blocks, irrigation facilities have been given priority (MoA, 2016a). For example, the Zambian government – with support from the World Bank – has partnered in constructing three irrigation dams at Mwomboshi (Chisamba), Lusitu (Chirundu) and Musakashi (Mufulira) (MAL, 2017). The Mwomboshi Irrigation Scheme will benefit 6,000 commercial and small-scale farmers, the Lusitu dam will benefit 4,000 and Musakashi, 5,600 farmers. The communities in these farming blocks could benefit once these amenities are provided.

In a study of different large-scale commercial farming models, Matenga and Hichaambwa (2017) assert that commercial farms could benefit surrounding areas by providing employment, especially if they have on-site processing and local economic links through the establishment of out-grower schemes. Lay et al. (2018) suggested that large-scale farms would increase smallholder farmers' access to fertilisers and other inputs because they can attract agro-dealers or set up shops closer to them. This boost would mainly be helpful in the absence of the distortionary effect of the FISP which the government of Zambia widely implements. Additionally, some large-scale farms, as part of corporate social responsibility, have established schools, health posts, graded roads, and contributed to socio-cultural events.

3.2 Social costs

Large-scale agricultural investments have often coincided with inadequate governance systems, unclear property rights, and heightened multi-level competition between national players in determining land access. At the local level, negative implications for smallholder livelihoods have been reported (Matenga & Hichaambwa, 2017), while welfare outcomes remain highly contested (Bellemare, 2012). The associated social costs include displacement of untitled subsistence farmers, an increased number of migrant workers, and reduced grazing land (MAL, 2017; Lunstrum & Ybarra, 2018). For example, the establishment and later expansion of the 10,000-hectare Zambeef estate in Chisamba led to forced removals of people from their cropping fields and grazing lands (Hall et al., 2017). Local communities have little representation in national committees and suffer from limited capacity to evaluate the consequences of investments. The HRW (2017) reports that the displaced families have frequently not been compensated. This displacement has negative implications on their health, housing, livelihoods, food and water security, and children's education. Smallholder farmers account for almost 60% of the population and are dependent on the land for their livelihoods. At the same time, they feed around 90% of the Zambian people, so pushing them off the land has had negative consequences for the overall Zambian economy.

Zambia's dual land tenure system has presented multiple pathways for land acquisition: through government imposition as custodians of the national development agenda, local and traditional authorities, or private individual citizens as dealers. In practice, however, land acquisition has often bypassed local communities (Nolte, 2014). Reports of advancing personal gains or lack of broader community consultations have followed. Low education, lack of resources, and power place communities in weaker negotiation positions. Their exclusion can mean negative commitments to rights and local livelihoods. With the agriculture expansion estimated to account for 90% of forest cover loss (Ihemeremadu & Alexander, 2017), losses of rural livelihoods associated with forests such as hunting, honey collection, access to medicinal plants and herbs and so on, have increased. Many people and communities' food and livelihood security depend on the sustained management of various biological resources necessary for food and income generation from agroecosystems, including forest resources.

4. Drivers (current and past) that influence ecosystems and agricultural systems

4.1 Economic drivers

Some of the economic drivers that influence ecosystems and determine the course of agricultural systems are highlighted below.

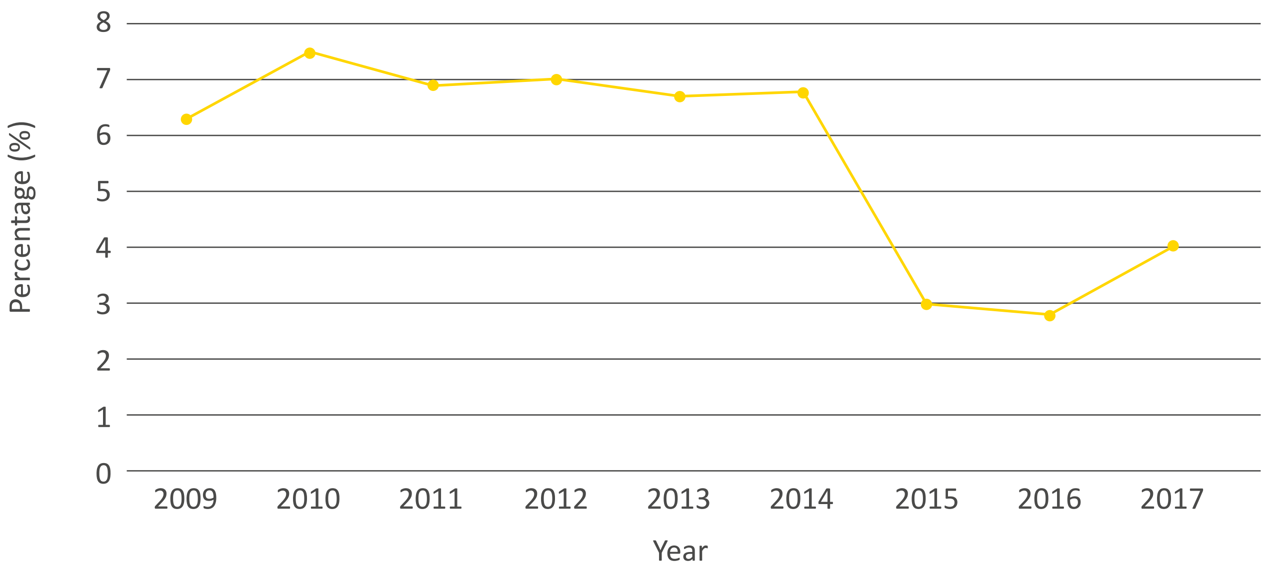
4.1.1 Economic contribution of agriculture

At independence from Britain in 1964, Zambia, which was rich in copper deposits and agricultural potential, was rated as one of the most prosperous countries in sub-Saharan Africa up to the mid-1970s (UNCTAD, 2006; Sardinis, 2014; Sikamo et al., 2016). After that, its economy plummeted with the slump in world copper prices and the civil unrest in all its neighbouring countries except Botswana, Malawi and Tanzania that lasted until the early 1990s. The occurrence of a two-year drought in the early 1990s, coupled with weak copper prices one the international markets, was a challenging period for Zambia. The economy witnessed a negative growth or no growth at all.

In 1992, the government launched an economic reform programme with substantial divestment of state enterprises. By 2004, 259 state enterprises had been sold off, among several agro-based firms such as Lusaka Cold Storage Company, Chibote farms, and ZADL farms (Serlemitsos & Fusco, 2003). This reform programme was meant to liberalise the market and reduce government participation in the economy leading to a more diversified economy and the development of exports such as flowers, fruit, vegetables, gemstones, cotton lint and sugar. But the economy was not robust enough to absolve the adverse effects of the privatisation process. During the same period, poverty levels among the Zambian population increased, attracting support from the donor community and international cooperating agencies. The government shifted its emphasis to poverty reduction and introduced a tight fiscal policy. This brought inflation down from very high levels in the mid-1990s (183% in 1993) to single figures from the mid-2000s. The privatisation of the copper mines by 2000 resulted in new investment and better management, and by 2004 world copper prices were rising. However, in 2002 Anglo-American decided to pull out of mining in Zambia, being the major mine employer on the Copperbelt. For a short time, its decision impacted negatively on the mining sector's contribution to the economy. In 2005, Zambia qualified for the IMF/World Bank Heavily Indebted Poor Countries Initiative debt relief, deriving US$224 million in debt relief, which released it from 80% of its annual debt-service commitments. This development reflected macroeconomic stability and sound fiscal policies, which had resulted in good growth in the 2000s.

From 2005 onwards, Zambia's economy has shown steady growth, and the country's macroeconomic performance indicators improved significantly. For example, between 2005 and 2010, the country witnessed an economic growth of 4–8% per annum, reaching a climax in 2010, then to between 4–7% p.a. during 2011–15, despite an adverse international economic climate (World Bank, 2018a) (Figure 19). The real GDP growth for Zambia has been on average 6.7% per annum from 2000 to 2015, though growth slumped between 2015 and 2017 due to dwindling power supply, depreciation of the currency and falling copper prices (CIA, 2018). The revised macroeconomic indicators suggest that the real GDP growth slowed to 3.4% in 2017 from 3.8% in 2016. This was despite higher copper prices, expansive monetary policy and a bumper crop harvest in 2017. Economic activity has faced a drag from a deteriorated fiscal and debt situation (World Bank, 2018b). Large domestic public expenditure arrears increased non-performing loans (to 13.4% of outstanding loans in May 2018, from 9.7 % in 2016, leading to lower private-sector lending). Private sector lending has been further crowded out by increased government domestic borrowing at high yields. In addition, the non-mining industry and services have been affected by low private investments and consumer demand. The country's lack of economic diversification and reliance on copper as the exclusive leading export makes it vulnerable to changes in the world commodities market. Prices fell in 2015 due to waning demand from China, and the DRC overran Zambia as Africa's biggest copper producer. The GDP growth regained in 2017 as the price of minerals increased (CIA, 2018).

Figure 19. Zambia annual economic growth rate



Source: Trading Economics.com, 2017

The country's lack of economic diversification and significant reliance on copper as its primary export makes it vulnerable to volatility in the world commodity market. This is seen especially in 2015 due to declining demand from China. Other contributing factors include adverse weather conditions caused by El Nino and electricity deficits, which have further slowed down production in many sectors of the Zambian economy. In recent years, Zambia's economy has seen a significant recovery. Inflation declined from 35.2% at the end of 1996 and closed at 8% by the end of 2014 (Rasmussen, 2015). According to CIA (2018), despite recent strong economic growth and its status as a lower-middle-income country, widespread and extreme rural poverty and high unemployment levels remain significant problems, made worse by a high birth rate, a relatively high HIV/AIDS burden, and by market-distorting agricultural and energy policies. A technical brief by the Zambia Institute of Policy Analysis Research (ZIPAR, 2016) indicates that the Zambian government raised US$3 billion from international investors by issuing separate sovereign bonds, that is, US$750 million in 2012, US$1 billion in 2014, and US$1.25 billion in 2015 (Nalishebo & Halwampa, 2015; IMF, 2017). The issuance of Eurobonds led to a rapid increase in debt, which has translated into substantial annual debt service payments, from US$34.14 million in 2011 to US$484 million in 2016. Power generation in Zambia has also been affected by the poor management of water resources. The multiplier effect of this situation is the negative impact on industrial productivity and the GDP. Inflation increased, and the local currency depreciated sharply against the dollar through 2016, leading the central bank to restrict lending (Bank of Zambia, 2016). Rampant spending in recent years has increased the fiscal deficit to more than 8% in 2017 and may encourage the government to seek external financing from the IMF to fund the shortfall.

For the past 40 years, the economic contribution of agriculture to the GDP is insignificant, compared to other sectors of the economy. This situation is different from other African countries. Agriculture contributes on average less than 10% (MoA, 2016a). According to the World Bank (2018b), agriculture, forestry and the fishing sector on average contributed 7.2 % to the country's GDP in 2017, while industry and services contributed 35.8% and 57.3%, respectively (Table 15). In the early 1970s, agriculture accounted for just under 10% of GDP, which increased gradually in the 1980s, and has fallen since 2000 (Table 15). However, 85% of the population depends on agriculture (Chikowo, 2016).

Table 15. Sectoral contribution to real GDP growth

Sector	1965–70	1971–76	1977–93	1994–99	2000–09	2010–15	2017
	Average percentage						
Agriculture, forestry and fishing	13.7	10.7	16.3	24.6	17	9.2	7.2
Mining and quarrying	33.3	32.6	8.9	6.3	8.7	9.2	14.8
Manufacturing	9	11	21.6	9.7	9.4	8.1	7.6
Electricity, gas and water	1.4	2.5	3	3.5	2.6	2	3.1
Construction	5.4	7.2	3.7	7.8	10.4	9.9	10.3
Services	36.9	36.2	44.9	40.7	21.8	55.8	57.3

Source: CSO, National Accounts (2012–2017); World Bank (2018b)

Industry includes mining, manufacturing, energy production and construction. Services cover government activities, communications, transportation, finance and other private economic activities that do not produce material goods.

The contribution of industry to Zambia's GDP has been dominated by mining and quarrying since independence. The sector contributed 6% to GDP at independence, and 90% of foreign exchange earnings were from the copper trade. Between 1964 and 2017, the service industry sector has grown and contributes more than 35% to GDP, mainly from non-traditional exports (Mulenga & Ngombe, 2017). The service sector is Zambia's largest formal employment sector, with a strong performance in the tourism, transport and telecommunications industries (CSO, 2016).

For example, in 2000, the service sector accounted for 21% of people employed in the country, especially in the informal segment of the sector. The growth in the industry is estimated at 3% per annum (CSO, 2016).

However, it does not sufficiently produce tradable goods and is thus dominated by foreign firms. Between 2000 and 2016, the trade deficit on services increased from US$6.7 million in 2000 to US$508 million in 2016 (World Bank, 2018). As a result, the urban labour market remains characterised by very high rates of informality. Though the number of jobs may have increased, the returns from labour and the number of hours worked have declined.

Zambia's significant economic growth is along the rail line from Livingstone town, Lusaka, Central, to the Copperbelt province. Meanwhile, other areas and people have remained, to a very great extent, excluded from recent economic progress. This situation has led to territorial imbalances that persist to the present day. While uneven geography of production can be a good sign of economic performance, what is not desirable is when disparities in living standards and access to services persist over time. The government hopes to see an increase in the performance of agriculture and its contribution to the economy (Shawa, 2014) while emphasising value addition as outlined in the SNDP (MNDP, 2017). Promotion of the Zambian agricultural sector is one of the government's priorities to diversify the economy and move away from the over-dependency on copper and cobalt production as its leading exports. Government efforts will focus on agricultural diversification in livestock, fisheries, crops and forestry products, considering each product's competitive and comparative advantage and agro-ecological zones.

How has the economy shaped agriculture and the ecosystem?

Since independence, the agricultural sector has faced several challenges that have affected its performance. Between 1964 and the 1980s, the political ideology of the 1st Republican President Kenneth Kaunda, humanism philosophy, influenced Zambia's agricultural development. It aimed to ensure food self-sufficiency, equitable distribution of wealth, increase employment levels, as well as secure political patronage among the Zambian people (Nyanga, 2006). This included direct state intervention in the marketing of farm produce and the provision and distribution of inputs such as fertilisers and disease control methods. Much of the development of agriculture was undertaken by state-owned and controlled agencies. The state fixed the prices, heavily subsidising agricultural production, especially maize production, including the supply of inputs and marketing (Saasa, 2003). As a result, government subsidies through its parastatal institutions such as the National Marketing Board and cooperatives, enabled rural communities to easily access agricultural input supply and marketing infrastructure. However, the continued decline in copper prices on which the economy depended, and the increase in oil prices made it increasingly difficult for the government to sustain the subsidies. This development forced the Kaunda-led government to rely on outside funds, resulting in the huge increase in external debt. The impact of the world recession on the Zambian economy intensified in the late 1970s. Internally, the lack of experienced human resources within the public service proved to be a problem, especially at policymaking and policy-implementing levels. Like many other developing countries, the Government of Zambia was pressured by the World Bank and the IMF to take up structural adjustment economic policies in the mid-1980s to address the economic crisis.

Consequently, economic development packages – Structural Adjustment Programs – driven by multilateral financial institutions such as the IMF and World Bank fostered changes in Zambia's agricultural policies. This phase of policy reforms was often marked by abandoned attempts to adopt structural adjustment policies because of the need to secure political support for President Kaunda's United National Independence Party (UNIP) government. Due to wrong policies, including the abandonment of the IMF structural adjustment programme at one time in 1984, the growth of the agricultural sector was negatively affected. Hence, the mid to late 80s were characterised by gradual and incomplete removal of subsidies and state withdrawal from active involvement in the agricultural sector.

According to Saasa (2003), during the 1970s and much of the 1980s, agricultural products' production levels fluctuated considerably. This fluctuation was caused by numerous factors, including uneconomical prices paid to farmers, poor rainfall patterns and inefficient marketing systems. Increased maize production during this period was achieved at the expense of other food crops, given the government's supportive bias favouring the staple crop. The country had also made little progress towards diversifying its economy from mining. Consequently, the whole economy was severely affected when the price of copper halved in seven months in 1974–75 and continued falling in real terms for a further eight years. The drastic decline in the profitability of the copper mines, which had provided almost half of government revenue in the early 1970s, led to severe cutbacks in government expenditure. One of the sectors that suffered was agriculture. The reduced government budget brought about a deterioration in the quality of support services to farmers. Extension staff became less mobile and, thus, less supportive of farmers in the field.

Similarly, farmer training operations were significantly curtailed. Veterinary services also deteriorated, and the tsetse flies control measures in the areas prone to this almost collapsed. The government encountered problems in meeting its obligations, such as failing to pay farmers for their produce. At the same time, controlled producers' prices were not adjusted in line with production costs due to the government's declining capacity to sustain subsidies on urban consumers. Agricultural credit also suffered from the government fiscal squeeze despite rising demand.

A shortage of machinery spare parts in the country significantly affected large-scale commercial farmers' productivity. Furthermore, accessing fertiliser became a major problem, as the foreign exchange needed to import it slowly dried up. The deteriorating conditions resulted in a progressive decline in marketed maize production and a move from a food surplus nation in 1970 to a net food importer by 1983, necessitating more subsidies to maintain the low urban food prices. Consequently, the country found itself spending between 15 and 19 % of government revenue on agricultural subsidies and 10% of its foreign exchange on food imports, an intolerable situation in a country with severe foreign exchange difficulties.

Between 1991 and 2001, the first Movement for Multi-Party Democracy (MMD) government introduced policies to cut public spending, liberalise the national financial market, and privatise state-owned enterprises (Rakner, 2003). The policy reforms initiated in 1992 targeted agriculture as part of the economic Structural Adjustment Program (SAP). The major focus of the policy reforms was to liberalise the agricultural sector and promote private sector development and participation in the production and distribution of agricultural goods and services. During 1991 and 2001, the agricultural industry had to cope with sudden cutbacks in public spending, and there was no firmed-up agricultural policy. All the services that had been available under the UNIP government, such as fertiliser subsidies, dipping and vaccination for livestock development, and free extension services, stopped immediately. Cooperatives, unions and parastatals, previously responsible for marketing agricultural produce and inputs, were abolished. The small-scale farmers no longer had access to micro-credit that the Lima Bank formerly provided.

The ad hoc government agricultural policy endeavoured to create an enabling environment for private sector participation through numerous measures such as the withdrawal of direct government involvement in production, marketing and distribution of inputs and produce, privatisation of parastatal companies, the elimination of price controls and subsidies in the sector. The policy objectives for the industry were, among others, to:

- *ensure nation and household food security through a dependable annual production of adequate supplies of foodstuffs at a competitive cost;*
- *generate income and employment through increased agricultural production and productivity;*
- *contribute to sustainable industrial development by providing locally produced agro-based raw materials and*
- *increase agricultural exports, thereby enhancing the sector's contribution to the national balance of payments.*

Strategies for attaining these policy objectives included – among other things – strengthening and monitoring the liberalised markets, facilitating private sector development, and diversifying agricultural production, particularly among smallholder farmers. The review and realignment of institutions and legislative arrangements was a critical policy objective.

From 1995 to 2001, the primary vehicle for the implementation of these policy objectives in agriculture was the Agriculture Sector Investment Program (ASIP) under the MoA, Food and Fisheries (MAFF) (World Bank, 2003). ASIP used a holistic approach to provide improved and sustainable services, using resources more efficiently. It pooled donor resources into basket funding for various activities. It also liberalised the market, reduced government involvement in commercial activities, and Zambia introduced efficient public spending mechanisms. Sub-programmes included: Extension, Irrigation, Research, Agriculture Training, Animal Production and Health, Agriculture Finance, Marketing and Trade, Seeds, New Product Development, Farm Power and Mechanisation, Policy and Planning, Standards, and the Rural Investment Fund (World Bank, 2003). To effectively execute these sub-programmes, the government, with advice from the donor community and cooperating partners, restructured the ministry.

Following President Levy Patrick Mwanawasa's (second MMD Administration) inauguration, the government policy shifted decisively in favour of agriculture. The aim was to make it competitive and diversified away from maize. The agricultural policy targeted the private sector by giving out-grower schemes a stronger role in the development process of Zambian agriculture. The government's vision was to anchor Zambian agriculture in science and technology and ensure that farmers adopted farming practices that were economically and environmentally sustainable. By 2003, during the second MMD government administration, Zambia attained the Highly Indebted Poor Country completion point and financial support improved by 2006. The World Bank provided a total of US$2.7 billion in debt relief. By 2004, the new "National Agricultural Policy" provided for the implementation of the Comprehensive African Agriculture Development (CAADP) to boost Zambia's agricultural productivity. Not much was achieved between 2008 and 2011, with the third

MMD administration in office. It merely continued with all agricultural policies that had been agreed before 2008. The Sixth National Development Plan (2011–2015) was approved in 2010. Small-scale farmers were serviced by the Farmer Input Support Programme introduced in 2003 to increase their production and productivity. Very little support was given to large-scale farmers. The three MMD-led governments saw massive investment in non-traditional crops such as sugar cane, cotton, tobacco, coffee and tea. Some commercial farmers migrated to Zambia from both South Africa and Zimbabwe due to political instability and favourable farming environments in Zambia.

In 2011–2016, the first Patriotic Front (PF) government administration attempted to reform the FISP and promote crop diversification. Its pro-poor agenda increased the number of beneficiaries of FISP while implementing the Second National Agricultural Policy (SNAP) (MoA, 2016b). SNAP was approved in 2016, and the government has been optimistic about implementing the CAADP compact (AU/NEPAD, 2013). The Seventh National Development Plan (SNDP), with an elaborate chapter on agriculture, was approved in 2017 (MNDP, 2017). The goal of the SNDP is to create a diversified and resilient economy for sustained growth and socio-economic transformation, driven by agriculture, tourism, manufacturing and mining. The SNDP is one of the building blocks intended to help accelerate economic growth and job creation. Zambia intends to diversify its economy to reduce over-dependency on the extractive industries, especially copper mining. At the same time it will ensure agriculture is modernised to improve productivity and prioritise value addition through agro-industries as the bedrock of transitioning to an industrialised economy. Small-scale and large-scale investments in the economy are being encouraged, especially with the creation of ten new farming blocks – at least one in each of the ten provinces – to increase agricultural production and productivity (Shawa, 2014).

The increased investment was expected to be accompanied by an increase in agricultural labour productivity (or growth in the manufacturing sector (Chapato & Chisanga, 2016)). However, it is common in any lopsided economy for commercial farmers/producers to largely account for any agricultural growth. Unlike the smallholder farmers, the commercial farmers have largely not benefited from the national programmes such as the FISP and the FRA, the two main spending programmes in agriculture. It's clear that any recorded increase of production in staples like maize (CSO, 2014–2016; 2018b) has been mainly due to the rise in the hectarage (more land under the crop) rather than productivity. This situation suggests that more land is being cleared as more people enter the sector. The government spending to support the FISP was 30% of total agricultural sector budgetary allocation, and between 2004–2011 47% was spent on poverty reduction programmes related to agriculture (CSPR, 2005). Through FISP, Zambia's government provides beneficiary farmers with subsidised fertiliser and hybrid maize seed (Mason et al., 2013).

By contrast, a vast group of people in Zambia live in a parallel, semi-subsistence world. This is characterised by the lack of access to vital productive assets and market opportunities, leading Zambia to have some of the highest hunger, undernourishment and malnutrition rates in the world (Mofya-Mukuka & Mofu, 2016; Richards & Bellack, 2016). Reducing rural poverty has been a major challenge for the government in Zambia, linked to inadequate support for smallholder farmers. The challenges include limited access to land water, lack of appropriate agriculture equipment and proactive policies for diversification. Consequently, negative impacts on livelihood have been observed, particularly in the rural parts of the country. Some of these constraints have been addressed in the SNDP (MNDP, 2017).

The sustainable use of biological resources is recognised to be critical for sustainable development in Zambia. Natural and biological resources such as forests, fish and wildlife could offer the basis for sustainable use and development. Hence the development of the various policies and legal instruments (MLNREP, 2015a). As the Zambian economy starts to expand, several economic activities have been initiated, with some development activities known to have adverse effects on forest biodiversity. These include (i) agriculture, (ii) deforestation, (iii) construction of energy supply infrastructure, (iv) urbanisation, (v) mining, and (vi) infrastructure (roads, power transmission and dams) (Forestry Department, 2016a). The actual impacts of these activities on forest biodiversity have not been adequately documented in Zambia. The increase in economic activity has led to large tracks of land being cleared for agricultural expansion (farm blocks, large-scale farms, resettlement schemes, irrigation schemes), mining and other economic activities (MFNP, 2005). More than a million hectares have been set under the farm block development plan (Shawa, 2014). On the other hand, intensive agriculture systems have become the norm. They are widely practised, while traditional approaches such as Chitemene and fundikila – that use small farm areas with a 15–20-year fallow period to allow for forest renewal – are on the decline.

Since independence, copper mining has been the driver of Zambia's economy and a primary foreign exchange earner (Sikamo et al., 2016). In recent years, the sector has witnessed huge investments that have seen new mines opening up on the Copperbelt and Northwestern Provinces. Besides directly competing for land, environmental concerns related to mining may affect the crops, forest, fisheries, livestock, wildlife and humans (Office of Auditor-General, 2014). These include air pollution, soil and water, geotechnical issues, and land degradation (Lindahl, 2014). The mining industry (mainly the copper smelters) contribute more than 98% of the country's SO_2 emissions. High SO_2 concentrations directly affect the health of both humans and biota. Metal discharges from mining activities have negatively impacted biodiversity and altered species composition in streams. The government regulatory agencies, notably ZEMA, have been vigilant in ensuring that licences for proposed mines within protected areas are not issued until after exhaustive environmental impact assessments are undertaken (ZIEM, 2012).

According to MNDP (2017), the diversification of the economy has led to an increase in non-traditional economic activities, such as tourism. However, the unplanned tourism sector may have negative consequences on biodiversity. According to Liu and Mwanza (2014), tourism requires a great deal of infrastructure, including hotel parking lots and restaurants, which typically bring many negative consequences, such as increased pollution levels, the destruction of natural habitats, the displacement of natural wildlife, and undesirable influences to once remote cultures. Zambia has not adequately monitored the development of new hotels and airports, some within protected areas.

4.1.2 Main crops and livestock products contributing to economic growth

Within the agriculture sector, the dominant crops are maize, irrigated wheat, mixed beans, and groundnuts (for consumption and as cash crops), cotton, tobacco, soybeans (mainly industrial crops), and sugar cane (primarily as an export product). While dairy, beef, goats, sheep and poultry (especially broiler and layers) dominate the livestock sub-sector.

a. Main crops and livestock products contributing to economic growth

Several crops are grown in Zambia and contribute significantly to economic growth (Chapoto et al., 2018). Zambian farmers grow various crops grouped as grains, oilseeds and high-value crops (Table 16). Maize remains popular among farmers, as it is a dominant staple food in Zambia. Maize, cassava, wheat, rice, sweet potatoes, groundnuts and mixed beans represent the main food staples in the country in terms of area planted and production volume. Zambia's main agricultural export products include cotton, tobacco and sugar (Esterhuizen, 2015; Strategic Shift, 2019).

According to Chapoto & Chisanga (2016), maize is the primary crop grown by households and accounts for 34%, seconded by groundnuts (20%) and cowpeas (13%). The percentage of households growing maize in 2015 (national average) was 89.4%. During the 2013/14 season, groundnut production increased from more than 37,000 MT over the previous output of 106,791MT to 143,591 MT. Soya beans and wheat output reduced from 260,000 MT to 214,000 MT and 273,000 MT to 201,000 MT respectively during the same period. Production of millet and mixed beans slightly increased in 2014 by 6,000 MT and 5,000 MT respectively, while sorghum output reduced from 14,971 MT in 2013 to 11,557 MT in 2014.

Table 16. Crop production and area planted in the farming seasons 2014/15–2017/18

	Area planted (ha)				Production (MT)				2017–2018
Crop	2014/15	2015/16	2016/17	2017/18	2014/15	2015/16	2016/17	2017/18	% change
Maize	1,494,451	1,364,977	1,644,741	1392,546	2,618,221	2,873,053	3,606,549	2,394,907	(33.60)
Groundnuts	243,397	222,952	269,611	284,708	111,429	131,562	168,699	181,722	7.75
Sunflower	89,664	127,096	105,184	97,851	34,726	61073	50,220	47,594	(5.23)
Cotton	158,619	139,196	113,649	118,763	103,889	111,902	89,293	88,219	(1.20)
Soybeans	129,507	145,763	231,630	205,508	226,323	267,490	351,416	302,720	(13.86)
Wheat	33,459	31,017	26,773	21,709	214,229	159,534	193,713	114,463	(40.91)
Burley tobacco	5,304	4,846	5,428	7,787	6,083	6,476	8,416	11,512	36.78
Virginia tobacco	10,662	6,237	5,215	6,273	19,811	12,540	12,079	13,382	10.79
Rice	42,984	25,595	33,303	34,217	25,514	26,675	38,423	43,063	12.08
Sorghum	24,331	33,699	33,728	32,308	8,123	14,107	17,337	13,130	(24.27)
Millet	47,007	53,699	52,280	49,105	31,967	29,973	32,566	32,278	(0.88)
Mixed beans	93,432	90,434	83,635	84,566	50,398	45,351	45,938	52,351	13.96
Cassava	–	–	–	–	–	–	1,031,484	–	

Source: CSO (2014–2016); CSO, 2018a

Performance of the different crop sub-sector

Maize

Maize (mainly white maize) is Zambia's most produced and consumed staple food and is produced primarily in Eastern, Central and Southern Provinces (CSO, 2014a, b; 2016b, c; 2018b; 2019). Maize is exported formally and informally to several countries in the region. It is consumed across the country as fresh or dried (grain, flour) products and is also used to brew local drinks. The maize value chain involves multiple private and public actors, large and small-scale, formal and informal (Collier, 2017). The National FRA is the big market actor and is involved in both purchasing and selling on the market and, to a large extent, influences the trade policy. Zambia both became and sustained its role as an essential source of maize for the Southern African region in the past ten years.

Average maize production over the past eight years has been around 2.8 million MT, produced mainly by small-scale agriculture, with 73% of farmers cultivating fewer than two ha of land (MoA, 2016a; 2016c; CIAT-World Bank, 2017) (Table 16). The crop is heavily subsidised for smallholder farmers through FISP (Rasmussen, 2015). In the 2016/2017 maize production season, Zambia crop forecast posted a record maize production of 3,606,549 MT, with a surplus of 1,178,516 MT (CSO, 2018a). Due to the La Niña weather conditions and an increase in the area of maize planted, maize production in Zambia increased by 26% over the previous season of 2015/2016, according to Crop Forecasting Survey (CFS). The total area under maize was reported to have increased by 21% from 1,364,977 ha in 2015/2016 to 1,644,741 ha in the 2016/2017 agricultural season. In 2017/18, the total quantity of maize produced was 2,394 907 MT. Central Province grew the highest amount at 19.5 %, followed by Eastern Province with 19.2%. The lowest was Western Province with 3.55% of total maize production. Maize yield only changed marginally from 2.10 MT/Ha to 2.19 MT/Ha in 2015/2016 and 2016/17 agricultural seasons, respectively (CSO, 2018a). This production was 33.6% less than the previous season 2016/18. Out of the 2,394,907 MT of maize produced, 46% had been sold by the season's close. A total of 104,735 MT of basal and 109,940 MT of top-dressing fertiliser were used in maize production.

Rice

Rice is mainly produced in five of the ten provinces of Zambia: Western, Northern, Luapula, Eastern and Muchinga Provinces. Although rice production has remained relatively stagnant in the past ten years (2009 to 2018), rice production in Zambia is around 40,750 MT. It has increased by three-fold from 17,000 MT in 2000 to 43,063 MT in 2018 (CSO, 2018a), making it a critical emerging cereal food crop in Zambia. In the 2017/18 farming season, only about 1.4% of land under cultivation was devoted to rice production compared to 57% for maize. Rice production in the country is still in its infancy, with a yield of about 1.26 MT/ha.

Wheat

Over the past five years, there has been a three-fold reduction in wheat production by farmers in Zambia, from yields of 309,100 MT in 2014/15 to 114,463 MT in 2017/18 (CSO 2016c; 2018a). This production is against the national requirement of 395,000 MT as estimated by the MoA's Food Balance Sheet (National Assembly, 2017c, 2017; Chapoto et al., 2018). The bulk of this reduction was observed in the 2017/18 season alone when preliminary estimates indicated that Zambia would produce 114,462 MT of wheat, a decline of 40.9% from the previous year (CSO, 2018a). On the other hand, ZNFU provisional post-harvest data indicates 171,474 MT (Chapoto et al., 2018). The total available wheat stocks amounted to 206,663 MT. Given the estimated national wheat annual requirement of 414,750 MT for the country, Zambia will need to import some wheat to fill the deficit. There is a 48% progressive reduction in the area planted between 2013 (41,810 ha) and 2018 (21,709 ha) (Chapoto et al., 2018). This reduction is attributed to several challenges affecting wheat production, including reduced irrigation water and power, which have limited the subsector's growth in the past five years.

The Mkushi farm block, the largest wheat-producing area in the country, experienced a significant reduction in water availability in the 2017/2018 agricultural season. This reduction came about because the main rivers had 30% less water during the production period, ultimately affecting irrigation. Therefore, yields in Mkushi were reported to have dropped by about 25%. However, opening new farming blocks like the Nansanga farm block in Serenje will likely add more to national wheat production as more land is being put under irrigated wheat. On average, wheat production in the past season is estimated at 219,000 MT (Table 16).

Cassava

Average national cassava production for the past four-year seasons, that is, 2012/13 to 2016/17, is estimated at 1,011,048 MT (FAO, 2017; CSO, 2018a). Cassava output increased by 0.52% from 1,036,908 MT in 2013 to 1,031,484 MT in 2017. This was driven by demand for feedstock in brewing, biofuels and mealie meal, and cassava blends expected to be produced by the millers with a ready market in schools, hospitals, prisons and disaster response, and other vulnerable communities. The production of cassava is expected to double or triple in the years to come (FAO, 2019).

Mixed Beans

Mixed beans are among the six most widely grown crops in Zambia, apart from maize, groundnuts, sweet potatoes, cassava and rice. As a legume, mixed beans help to provide the necessary diet diversity, while supporting incomes for smallholders. About 15.9% of the smallholder farmers in Zambia grew mixed beans in 2017, compared to 13.9% in 2016, representing an increase of 2% (National Assembly, 2017c). Production of mixed beans increased slightly by 13.9%, from 45,938 MT in 2017 to 52,351 MT in 2018 (CSO, 2018a). The area planted increased from 83,635 in 2017 to 84,566 ha in 2018 representing 1.11%, with a marginal yield increase from 0.55 MT/Ha to 0.62 MT/Ha, respectively. The area under mixed beans has been declining since 2014 with yields below one MT per ha – both areas of great concern. Most farmers grow local cultivars favoured for their colour and taste but have low yield potential and are susceptible to pests and diseases. Local cultivars have a low average yield of between 0.3 to 0.5 tonnes per ha.

Groundnuts

Groundnuts is the second most widely grown crop by smallholder farmers in Zambia, with 52.9% of households producing groundnuts in 2017, a drop from 56.6% in the previous year (a decrease of 3.7%). Groundnuts production has been on an upward trend since 2015, continuing into 2017. According to the Crop Forecast Survey (National Assembly, 2017c), groundnuts production increased by 28% from 2016 production levels to reach 168,699 MT in 2017 and by 7.75% to a record 181,172 MT in 2018 (CSO, 2018a). This is due to an increase in the area planted, up 20% in 2015/16. However, it decreased marginally by 1.19% in the 2017/18 season. The average yield per ha increased from 0.63 to 0.64 MT/Ha (representing a 2.04% increase from the previous year). The groundnut's value chain growth offers significant opportunities for smallholder farmers as smallholder farmers dominate it. It is a vital income source, especially for women (Curtis et al., 2015). Groundnuts are also crucial in addressing the malnutrition challenges Zambia faces by offering a diversified complementary diet, especially among children, whose average stunting and wasting rates are among the highest in sub-Saharan Africa. There are significant links to peanut butter processors and export markets, such as South Africa and China. However, occurrences of aflatoxins limit this valuable source of protein (NFNC, 2007; Alamu et al., 2018). One of the primary reasons for the decline in groundnut yields and production is that farmers continuously recycle groundnut seed, resulting in the deterioration of yields (Chirwa et al., 2015; Ross & De Klerk, 2012). Therefore, making Zambian groundnuts competitive on the world market requires investment in the seed supply and ensuring Sanitary and Phyto-Sanitary (SPS) compliance, particularly with groundnuts susceptible to aflatoxin infection. Public investment in testing facilities, which were freely available to companies seeking to export groundnuts, would help offset some of the risks of investing in the sector and stimulate more production and productivity.

Horticulture

Horticultural production holds one of the best prospects as a pathway out of poverty for most land-constrained smallholder farmers (Chapoto et al., 2018). Albeit it is highly constrained with a myriad of challenges, mainly on the marketing side. For example, the sector faces very high price volatility, increasing the risk and reducing profitability for most poorly-resourced smallholder farmers. The high price volatility arises mainly from underdeveloped marketing channels, with more than 80% of the horticultural products being traded on the informal market. In addition, there are limited value addition opportunities and refrigeration facilities required to deal with the inherent short shelf life of most horticultural commodities. Price volatility has been most prominent for tomato and onion compared to cabbage and rape. Between April to July 2017, the prices of tomato and onion spiked upward but have since been trending downwards, with onion prices spiking again in October. The price spike in tomatoes experienced over the period has also been attributed to the outbreak of *Tuta absoluta* in Zambia and the region as a whole.

Soybean

In the 2017/18 season, Zambia produced 302,720 MT of soya beans, a decrease of 13.86% from 351,416 MT produced in the 2016/17 season (CSO, 2018a). In 2017/18, of this output smallholder farmers accounted for 42% of the production. More than 191,930 ha was planted, representing a decrease of 14.83% over the previous hectarage. The yield also declined by 2.91%, from 1.52 to 1.47 MT/ha. This decrease could be attributed to the unfavourable weather conditions in the main soybean growing areas, that is, Central and Lusaka provinces. The average yield among the small-scale farmers was 0.93 MT/Ha, compared to commercial farmers whose average yield was 2.87 MT/Ha. Zambia's soya beans national requirement is about 268,000 MT, which means that Zambia produced a surplus of nearly 200,000 MT in 2016/17.

Due to the high price of soya beans in the 2016/17 season and large carryover stock, the market prices for soya beans in the 2017/18 marketing season crashed, dropping by 44% compared to the previous marketing season. These low market prices caused a public outcry from farmers, which made it difficult for them to continue producing the crop. The government's FRA reacted by including soya beans among the crops it purchased in 2017, offering above-market prices, especially in Eastern province where prices had been the lowest. Nevertheless, at the end of its buying period, FRA had only purchased about 3,215 MT (MoA, 2017). Towards the end of the year, however, soya bean prices had shown significant recovery, and by mid-November the prices were 23.9% higher than the market price of US$297/MT at the start of the marketing season in June.

Cotton

According to the 2017/18 production season CFS results, seed cotton production was 88,219 MT, a 1.20% decrease from the 2016/17 production season of 89,293 MT (CSO, 2018a, b). The area planted was 106,881 ha, representing an increase of 1.45% from the previous season. About 8.3% of households grew cotton in 2017/18, compared to 11.5% in the 2016/17 season, a drop of 3.2%. Total cotton purchases by cotton ginners in 2016/17 were about 52,000 MT, indicating that actual cotton production was possibly lower than forecasted in the CFS (Chapoto et al., 2018). While the rainfall patterns were favourable for cotton production earlier in the production season, the heavy rains experienced at flowering stages of the cotton plant affected the development of the lint and seed. The heavy rains partly explain the decline in both yield and total production. Another reason for the decrease in area planted was the low price of cotton relative to soya beans, a competing cash crop for smallholder farmers.

Tobacco

Tobacco production is an essential contributor to Zambia's economy in terms of labour and revenue generation and increased over 350% in the two decades from 1993 to 2013 (FAO, 2015b; Labonté et al., 2018). About 70% of the tobacco grown in Zambia is the flue-cured Virginia type, and almost all of the rest is Burley (Goma et al., 2015). According to Mulenga (2018), tobacco exports increased from $1.7 million in 1995 to $156.5 million in 2012, although the figures vary depending on the source. Tobacco leaf is an important cash crop for farmers, about 10,000 of whom grow it (Tembo & Sitko, 2013) and a significant source of employment in the country (Namutowe, 2013). Tobacco contributes only 9% to GDP. However, estimates of tobacco-related work are contentious. The conflicting policy environment has affected the growth of the sector (Mulenga, 2018). In 2017/18, combined tobacco production was 24,984 MT. This production was 21% more than the previous season's production of 20,510 MT (CSO, 2018a). The total area planted for tobacco in 2018 was 13,913 ha, 31% more than the previous 10,594 ha. The number of small and medium-scale farmers engaged in growing tobacco in 2017/18 was estimated at 12,895 (CSO, 2018). The favourable pricing boosted by exports to the far-east was an incentive for the sub-sector.

Sugarcane

Sugarcane production in Zambia is under irrigation systems located in the Northern and Southern regions. Miller-owned estates contribute about 60% of the total sugarcane production, and 40% of the sugarcane production is from independent farmers and out-grower schemes (Sikuka & Bonsu, 2017). The sugar industry contributed about 3% to Zambia's GDP in 2016, and 6% to total national exports that year. Zambia sugarcane crop decreased by 3% to 3,250,745 MT in the 2016/17 season, from 3,353,217 MT in the 2015/16 season. This decrease from the 2014/15 season was caused by drought in the sugar-growing areas, lower yields, and power interruptions that restricted irrigation (Sikuka, 2017). Three milling companies dominate the sugar industry in Zambia, namely: Zambia

Sugar Plc, Kafue Sugar (Consolidated Farming Ltd), and Kalungwishi Kasama Sugar (Kalinda & Chisanga, 2014). Zambia Sugar Plc is the most dominant among the three millers, contributing about 92.5% of the total sugar production. Its majority shareholder is Illovo Sugar Pty Ltd (a South African-based Sugar Company). Kafue Sugar and Kasama Sugar are both privately-owned companies that contribute about 7.2% and 0.3% to the total sugar production, respectively (Sikuka & Bonsu, 2017). The sugar industry employs around 11,000 workers, with dependents probably exceeding 75,000 (Palerm et al., 2010). The sugar sector generates more than US$45 million in gross export revenue annually, which had almost doubled from the mid-1990s when export earnings stood around US$25 million (World Bank, 2007).

Livestock

Livestock is an essential subsector of primary agriculture in Zambia and contributes 3.4% to the country's GDP (Lubungu & Mofya-Mukuka, 2012); together with fisheries it accounts for 35% of the agricultural GDP (Chapoto et al., 2018).

On average, it supports 37.4% of rural households in Zambia and accounts for 39.2% of their income (CSO, 2016d). Livestock contributes at least 6% of smallholder household income through sales and consumption and, depending on species, could be as high as 45% (Lubungu & Mofya-Mukuka, 2012). It forms about 20% of the productive areas. Eastern and Southern Provinces have the highest population of livestock, about 58.8%, followed by Central Province with 17.7%. However, in the past few years, there has been a marked increase in livestock in Northern and Muchinga Provinces. The 2015 LCMS (CSO, 2016d) reported that the poultry subsector was on the rise, and production has improved over the years owing to emerging producers in urban areas of Lusaka, the Copperbelt, and others. Slightly more than 31% of households owned cattle while only 16% were reported to own pigs. According to Chapoto et al. (2018), more than 80% of rural smallholder households owned chickens, followed by goats, which accounted for 35%.

There has been remarkable growth in the livestock subsector between 2013 and 2017 in both numbers and products (Table 17 and 18). For example, pig production exhibited the highest growth rate from 2013 to 2017 at 307.8%, followed by goats at 168.6% from 2013 to 2017. The lowest growth was in the cattle population at 33%. Egg production showed an upward trend in production at 96.6 % from 2013 to 2017. Egg production – and ultimately consumption – is projected to grow to 77 eggs per capita by 2019 in Zambia to meet the demand for the use of eggs as a cost-effective protein-rich food source (Krishnan & Peterburs, 2017). The beef and dairy sectors are growing at around 7% and 10% annually respectively. In 2017, the Zambia government continued to implement livestock restocking programmes by multiplying and selling cattle and goats to small-scale farmers, women, youths and differently-abled people. Evidence from the literature suggests there has been a significant change in pig production in Zambia (CSO, 2016d; 2018b) (Tables 17 and 18).

Table 17. Livestock population 2013–2017

Livestock	2013	2014	2015	2016	2017	2013–2017
	('000)					% change
Cattle	4,026.65	4,300.00	4,624.22	4,984,909	5,388.69	33.8
Sheep	115.34	131.30	149.42	170,637	195.89	69.8
Goats	3,376.43	3,500.00	4,095.00	4,823,910	5,692.21	168.6
Pigs	1,098.95	1,533.41	2,146.76	3,048,403	4,481.15	307.8
Poultry	112,605.27	146,055.27	174,470.00	212,853.58	266,066.75	136.3

Source Chapoto et al., 2018; CSO, 2016d; 2018b

Table 18. Livestock products 2013–2017

Livestock	2013	2014	2015	2016	2017	2013–2017
	('000)					%
Milk (MT)	452	463	524	585	645.96	42.9
Eggs	630,113	1,058,000	1,097,376	812,953	1,239,425	96.6
Hides (MT)	246	278	289	303,174	314	27.6
Beef (MT)	3,474	3,800	4,104	4,624	4,985	43.4
Pork (MT)	383,379	408,751	439,408	470,064	500,720	30.6
Poultry (MT)	3,409	3,818	4,353	4,803	5,275	54.7

Source: Chapoto et al., 2017

Fisheries

Fish production is crucial to Zambia's rural economy as a source of animal protein (55%), micronutrients and income (Musuka et al., 2017). It contributes 1% GDP or US$109 million with more than 300,000 fishers, fish farmers and processors (CSO, 2014).

Zambia has nine major fisheries namely Kariba, Tanganyika, Itezhi-tezhi, Bangweulu, Lake Mweru, Mweru-wantipa, Kafue River, Zambezi River and Lukanga. Furthermore, there are community and private dams and ponds found in all the provinces in Zambia, which can also support aquatic life or fish. Aquaculture development or fish culture per se is most common in North-western, Copperbelt and Eastern provinces. However, some of the most significant capture fisheries are in Lusaka, Kafue and Siavonga districts. Other provinces where fish capture dominates have seen a steady increase in aquaculture activities in the past ten years. Overall, growth in the fisheries sub-sector for both capture and aquaculture has been strong. Fish production increased three-fold in the aquaculture subsector from 9,535 MT in 2010 to 30,254 MT in 2017; and by 12.3% in capture fisheries, from 76,396 to 85,762 MT for the same period (Chapoto et al., 2018; Musuka et al., 2017). The estimated national fish demand in 2017 was 120,000 MT per annum, but only about 70,000 tons are supplied, leaving a deficit of 50,000 tons provided through imports.

The fisheries sector in Zambia experienced some key policy gains in 2017 (Chapoto et al., 2018; Genschick et al., 2017). With the major fisheries faced with depleting fish stocks, since 2016 the central focus of the Ministry of Fisheries and Livestock (MFL) has been on training co-management committees, monitoring, control and surveillance, and stock assessments (MFL, 2018). The Department of Fisheries has also implemented a mandatory annual fish ban to reverse declining fish stocks. With support from donors and other cooperating groups, the government has promoted aquaculture by establishing Aqua parks in high potential zones under the Zambia Aquaculture Enterprise Development Project. Commonly used fish species in aquaculture include the longfin tilapia (*Oreochromis macrochi*), three spotted tilapia (*Oreochromis andersonii*) and the redbreast tilapia (*Tilapia rendalli*). The most commonly farmed species, particularly in the commercial sector, is the Kafue river strain of the three spotted tilapia. Other species include the common carp (*Cyprinus carpio*), red swamp crayfish (*Procambarus clarkii*) and the Nile tilapia (*Oreochromis niloticus*).

b. Main agricultural products (crops and livestock): food trade deficit/surplus; imports and exports

Food security – deficit/surplus

Despite a decade of consistent economic growth, Zambia faces numerous challenges, including food insecurity and undernutrition. These challenges have been exacerbated by the unpredictable weather patterns that have affected farming communities over the past decade in some districts, especially in Lusaka, Southern and Western Provinces. Most agricultural households rely heavily on seasonal rains and subsistence-style farming. And while food insecurity is often associated with rural areas, it is increasingly recognised as a serious and growing problem in the cities and towns (Mulenga, 2013). The low level of agricultural productivity and increased dependency on imports to meet its food needs, coupled with rapid urbanisation, are the primary food security challenges. However, Zambia ranks 104th out of 113 countries in the world on the Global Food Security Index by the Economist Intelligence Unit (Corteva Agriscience™). Zambia ranked 115th out of 119 countries in the 2018 Global Hunger Index. With a score of 37.6, Zambia suffers from an alarming level of hunger.

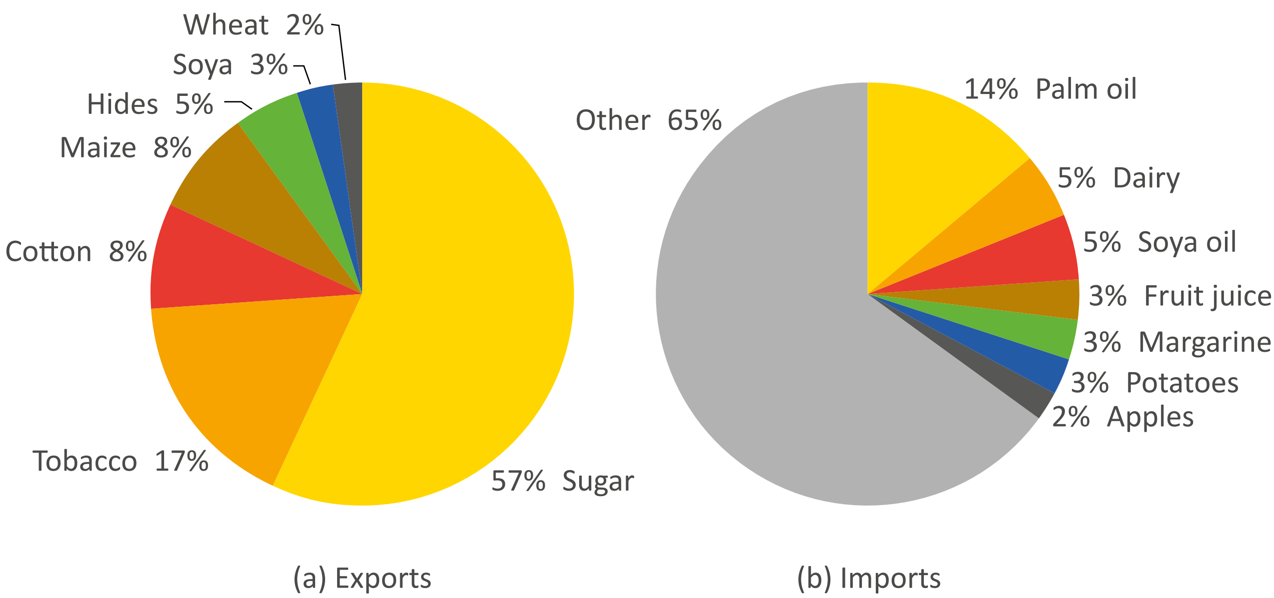
The primary income and food source for most households in Zambia is maize production. As a crop, maize is particularly vulnerable to drought, and increasingly erratic and lower rainfall has severely impacted maize production, especially in southern and western Zambia. However, with subsidised inputs, annual national maize production has surpassed national consumption levels, thereby registering a bumper harvest for the past five seasons (CSO, 2014–2018). Equally, the food legume, root and tuber, and horticultural production have increased three-fold in some cases (Chapoto et al., 2018). In 2016/17, despite the armyworm infestation experienced in most parts of the country and not uncommon to the late distribution of subsidised inputs, Zambia still recorded an above-average harvest of 2.394 million MT, thanks to good rainfall in the Central and Northern parts of Zambia. Given the estimated maize production (2.394 million MT) and moderate carryover stock (an estimated 1.138 milion MT in 2014/15 and 2016/17 seasons), total maize availability is estimated at 3.53 million MT. This was more than adequate to meet national staple food requirements, with an exportable surplus of 1.18 million MT.

Because of this, in 2018, the staple food availability for most areas in the country was normal to above normal levels. In addition, most food legumes and rice posted an increase in production over the 2016/17 season (CSO, 2018). However, more than 20 districts – mainly in the southern part of Zambia – experienced some food deficits due to dry spells experienced in those areas. Nevertheless, with food available at the household and national level, acute food insecurity was minimal. The National Vulnerability Assessment Committee at the Disaster Management and Mitigation Unit assessed 16 districts, most of which were chronically food-insecure areas. These are the same ones receiving food assistance even in average years.

Agro-exports and imports

Data from Trade Map (2016) revealed that the main agricultural and agro-processed product exports from Zambia to the rest of the world were cereals (mainly into SADC and East African Community (EAC) regions), sugar, cotton, raw hides and skins, and tobacco products (Figure 20). Other important exports include coffee (Arabica), fuzzy cotton seed, paprika and soybeans. Occasionally in some years, marigold meal, groundnuts and seeds have brought important export values, but the performance of these products seems to be erratic (WTO, 2002). Between 1995 and 2001, total non-traditional agricultural exports such as flowers increased from US$43 million to US$122.1 million. As a result, the agricultural sector's contribution to non-traditional exports increased from 23% in 1990 to 39% in 2001 (MACO, 2002). Zambia exported agricultural goods worth US$0.8 billion in 2014.

Figure 20. Major agricultural products exported in 2014

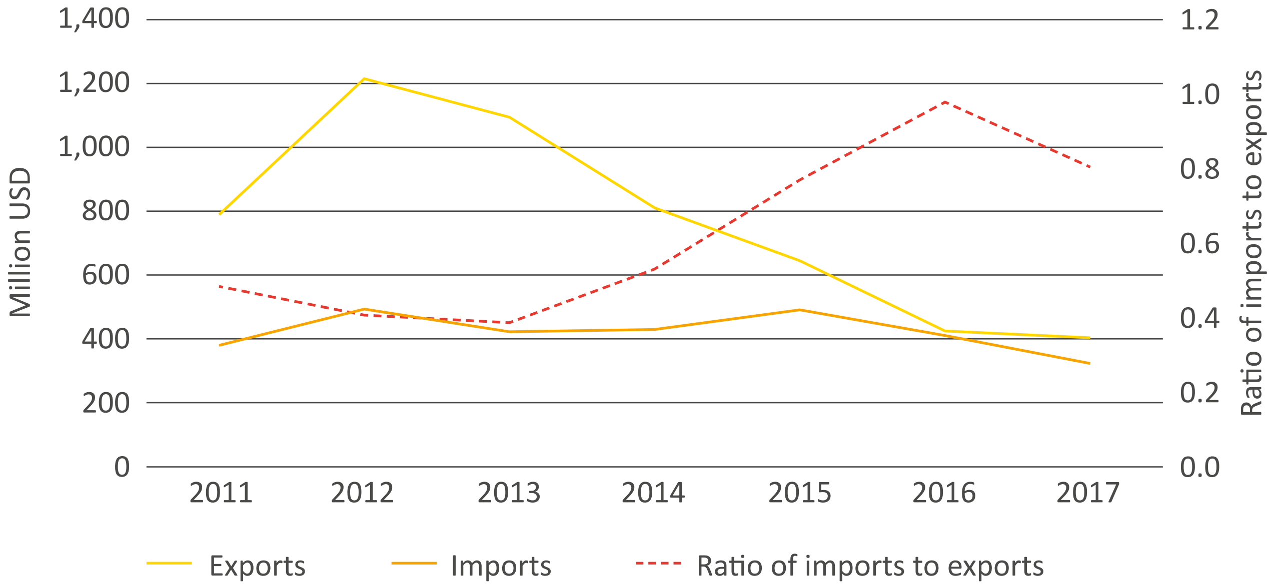


Source: Esterhuizen, 2015; Strategicshift, 2019

The difference, 31%, is probably due to other agricultural commodities. In 2017, the main exports were sugars and sugar confectionary, cereals, tobacco, oilseed and fruits, and cotton. The government has been emphasising the value addition in line with the SNDP (MNDP, 2017).

The major agricultural imports include potatoes, dairy, margarine, fruit juices and palm oil (Figure 20). Between 2011 and 2016, the value of agricultural products imports has stayed almost consistent at around US$420–440 million while agricultural exports have been trending downwards (Chapoto et al., 2017). This trend is shown by the rising ratio of agricultural imports to exports, meaning the country is increasingly importing more agricultural products than exporting (Figure 21). However, the government indicates that export earnings from agricultural products recorded a marginal increase of 0.5% of K549.8 million in November 2018. This is reflected in the overall positive trade balance.

Figure 21. Major agricultural products imported in 2014



Source: Esterhuizen, 2015; Strategicshift, 2019

4.1.3 Sector employment

As of 2015, the total working population in Zambia was 10,128,909, of which 58.5% were in the labour force, and the rest were economically inactive (CSO, 2016). Of those in the labour force, 43% were in paid employment, 6.3% were unpaid family workers, and 9.2% were not working. Of the labour force, 65.9% were male and 51.7% were female. Rural areas (61.3%) had a more significant percentage share of the labour force than the urban population (55.4%). Agriculture, forestry and fisheries had the highest proportion of employed persons at 58.7%, while the lowest was in water supply sewerage, waste management and remediation activities, and real estate activities at 0.1%. The agriculture, forestry and fisheries industry also had the highest proportion of employed persons at 86.9% in rural areas. In contrast, trade, wholesale and retail distribution in urban areas accounted for the highest proportion at 31.1%. More women were mainly employed in agriculture, forestry and fisheries (63.2%), followed by trade, wholesale and retail distribution (19.8%) and education (3.6%). Households as employers made up 2.8%, with other service activities at 1.9% and human health and social work at 1.4%. Compared to other industries, more men were employed in agriculture, forestry, and fisheries (55.1%), followed by construction (6.6%), manufacturing (6%), and transportation (4.3%). Therefore, it is evident that agriculture is the main livelihood of the rural population (UNDP, 2015).

The proportion and distribution of sector employment for the years 2008, 2012, 2014 and 2017 is presented in Table 19. Between 2008 and 2017, there was a marked reduction in the number of people employed (27%), with formal employment increasing by 115%. The highest percentage increase was in the trade, wholesale and retail distribution industry, followed by construction. In contrast, others indicated a negative growth, especially in the mining and quarrying sector, where more than 17% of the jobs were lost in the formal sector. The establishment of chain stores and malls might explain the observed increase in employment in the trade, wholesale and retail distribution industry. During the 2012 and 2017 period, which coincides with the first ruling PF government, agriculture, forestry and fishing posted a 38.4% reduction in the total labour force employed, while mining and quarrying dropped by 37%, construction by 22.7%, and transport by 18.3%. The jobs in trade, wholesale and retail distribution increased by 23.6%. In the formal sector over the same period, employment in agriculture, forestry and fishing, and construction sectors increased 4.8 and 2.5 times respectively. This trend could have been attributed to civil service recruitments in agriculture, forestry and fishing and the massive construction works currently under way in the country (RDA Pave 800 and L400). Zambia's sector employment, by selected sub-sectors industry, suggests that employment in mining and quarrying dominates the economic sectors according to the labour force survey (Table 19) (CSO, 2008, 2012, 2014, 2017).

Table 19. Zambia's sector employment, by selected sub-sectors industry

	Employed population (number, % total employment)				Formal employment (number, % sectoral employment)			
Industry	2008	2012	2014	2017	2008	2012	2014	2017
Zambia	4,095,508 (100)	5,499,673 (100)	5,859,225 (100)	2,971,170 (100)	511,338 (11)	1,154,931 (21)	1,339,802 (23)	1,096,832 (36.9)
Agriculture, Forestry and Fishing	3,212,320 (78)	2,872,331 (52)	2,865,161 (48.9)	1,768,605 (59)	71,888 (2)	132,127 (4.6)	143,258 (5)	415,622 (23.5)
Mining and Quarrying	30,728 (1)	88,251 (2)	82,029 (1.4)	58,007 (2)	62,082 (67)	76,955 (87.2)	70,544 (86)	51,571 (88.9)
Manufacturing	122,271 (3)	216,660 (4)	222651 (3.8)	233,721 (8)	36,923 (23)	93,164 (43)	82,380 (37)	92,294 (39.5)
Construction	66,366 (2)	187,906 (3)	181636 (3.1)	145,211 (5)	13,889 (17)	83,618 (44.5)	52,674 (29)	49,193 (33.9)
Wholesale and Retail trade	396,503 (10)	645,571 (12)	691389 (11.8)	798,012 (27)	28,706 (7)	109,101 (16.9)	208,108 (11)	247,629 (31.1)
Transport and Storage	65,316 (2)	137,301 (2)	164058 (2.8)	112,100 (4)	29,484 (31)	104,623 (76.2)	72,185 (44)	34,164 (30.5)
Communication and Information		42,104 (1)	17578 (0.3)	12,493 (0.4)		18,905 (44.9)	11,777 (67)	10,909 (87.3)

Figures in parenthesis indicate percent
Source: CSO (Labour Force Surveys: 2008, 2012, 2014, 2017)

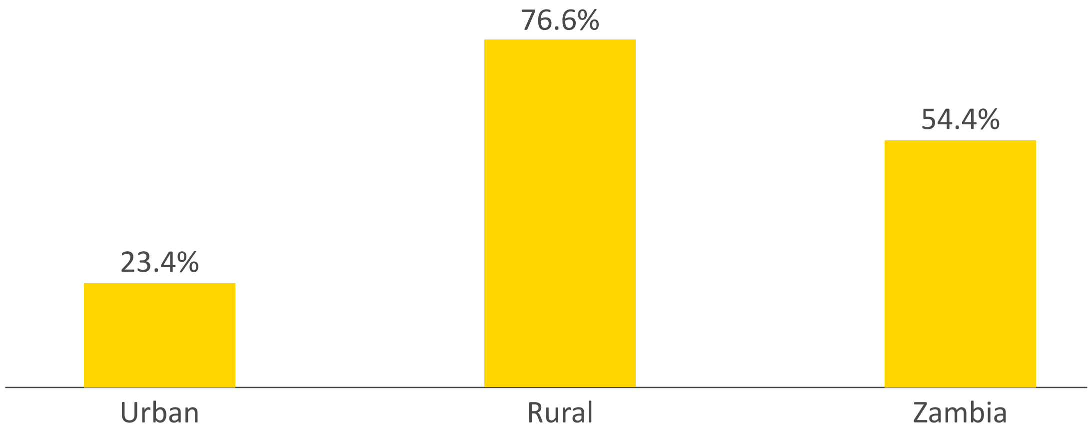
4.1.4 Poverty in urban and rural areas

Over half the population is categorised as living in poverty, that is, living on less than US$1.90 per day, with prevalence higher in rural areas, at 76% compared with 23% in urban areas.

The majority of Zambians continue to live in poverty (Chapoto et al., 2016; MNDP, 2017), estimated at 54.4 % (Figure 22) of the population. That means that 54 out of every 100 Zambians are poor. Analysis of the 2015 Living Conditions Monitoring Survey (LCMS) results by rural-urban reveals that poverty in Zambia has continued to be more of a rural than an urban phenomenon.

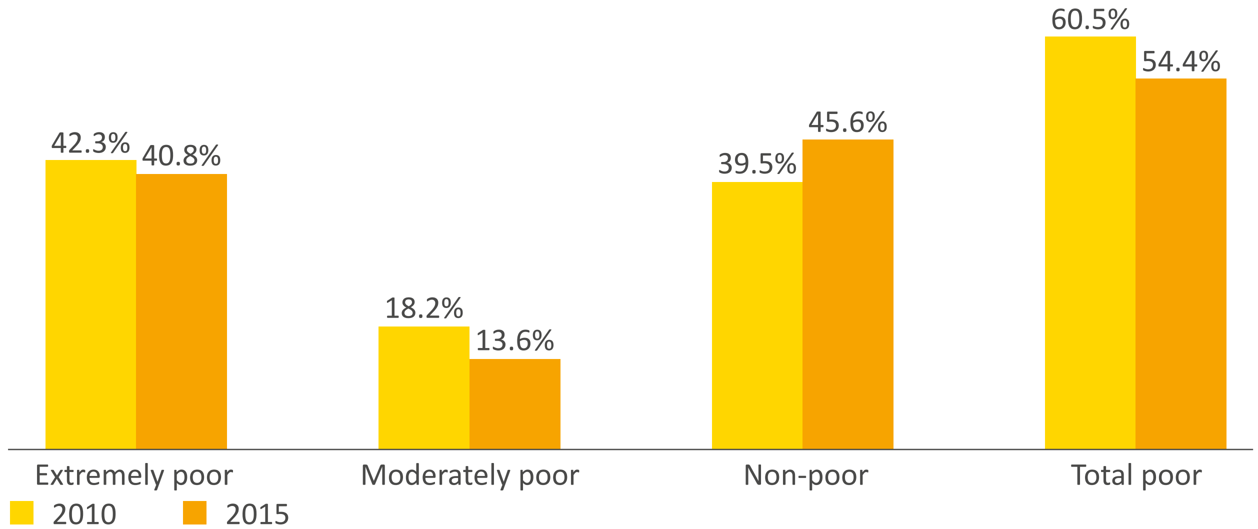
Between 2010 and 2015, there was a 6.1% reduction in poverty (Figure 23). But in rural areas, in 2015 the proportion of poor people remained at the 2010 level, estimated at 76.6% (Figure 22); three times higher than in urban areas (23.4%) (CSO, 2018). According to the 2015 LCMS (CSO, 2016), in rural areas, poverty rates are highest among small-scale subsistence farmers cultivating less than 2 ha (78.9%), followed by those farmers with 2–5ha at 64.5% and non-agricultural households at 48.6%. Rural poverty distribution by gender further indicates that extreme poverty is higher among female (29.6%) than male-headed agricultural households (21.7%).

Figure 22. The incidence of poverty by residence, Zambia, 2015



Source: CSO, 2018

Figure 23. Percentage distribution of the population by poverty status 2010 and 2015



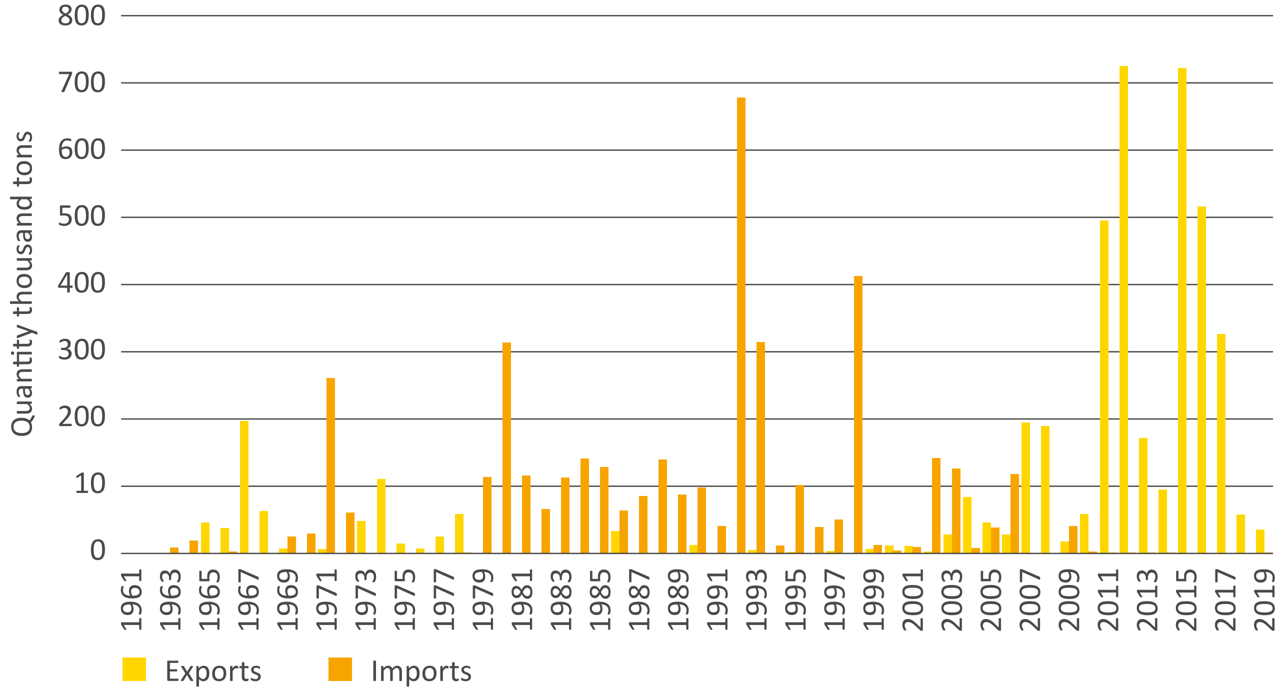
Source: CSO 2018

4.1.5 Food security situation

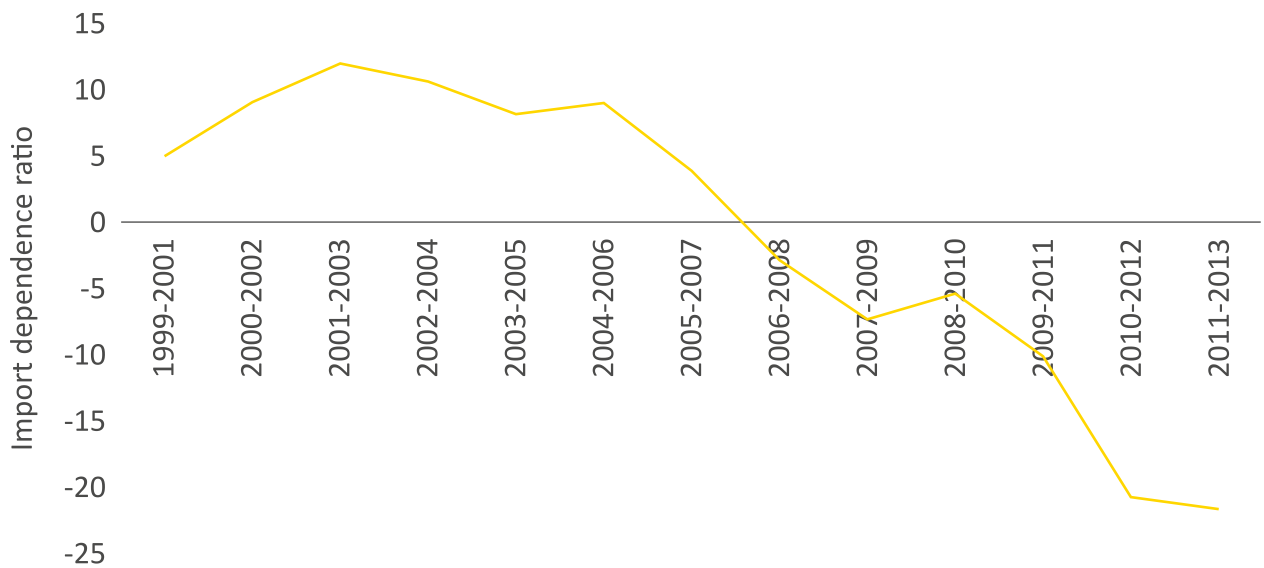
Summary: Zambia's cereal import dependency ratio has increased from 1968 to 2007. This trend suggests that Zambia became more dependent on imported grains and therefore was more vulnerable to changes in world food prices up until 2007. The import dependence ratio (IDR) for cereals is calculated as a ratio of imports x 100 to the apparent consumption (production + imports-exports). In 2007 the IDR began to decline, suggesting that Zambia started to export cereals (FAO, 2015b). Since 2007 Zambia has moved from being a net cereal importer to a net cereal exporter (Figure 24).

Figure 24. Zambia's cereal export and import quantities (a) 1961–2017 (top panel); and cereal import dependency ratio (three-year average) (b) 1999/2011 to 2011/13 (bottom panel)

(a)



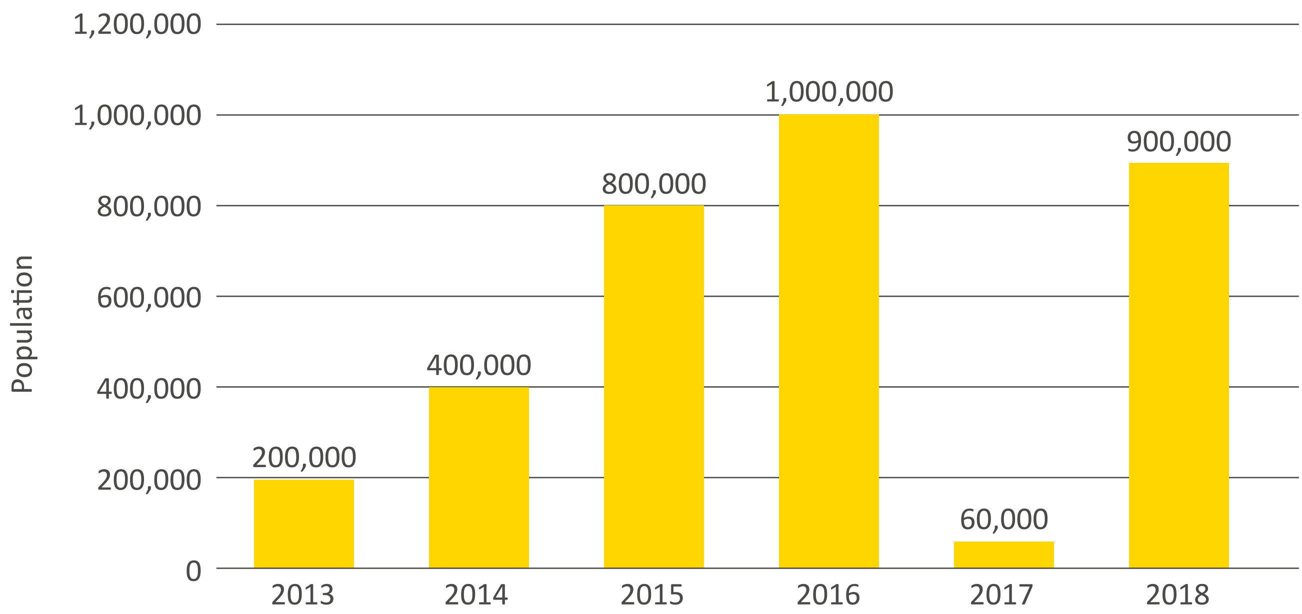
(b)



Source: http://www.fao.org/faostat/en/

While Zambia's food security situation has improved in the past five years with increased cereal surpluses, the country has remained food insecure, as evidenced by being ranked 114th on the global hunger index and 104th on the food security index for developing countries (Grebmer et al., 2018; Smith et al., 2018). Chronic malnutrition (stunting) is estimated to affect about 45–47% of rural households, while malnutrition (wasting) is known to inflict about 6% of all rural households. In addition, only 59% can access safe water, having profound negative implications on the health and nutritional status of the people (World Bank, 1994; 1996). Children affected with chronic malnutrition are likely to remain physically and/or mentally impaired for life, even if they survive. Therefore, these high malnutrition rates have severe implications for Zambia's development prospects (Murray & Mwengwe, 2005). Reasons for Zambia's food insecurity include insufficient food production arising from poor agriculture technical support services; unfavourable climatic conditions, disease, and insect attacks; inadequate incomes and inability to purchase food; limited markets and transport systems to take food from surplus to deficit areas within the country; and the impact of HIV/AIDs on the productive capacity of households (Mulenga, 2013). Some of Zambia's rural communities have experienced the detrimental impact of HIV/AIDS on households' productive capacity and food security (MNDP, 2017). The total population in IPC Phase 3 (Crisis food insecure) and Phase 4 (Emergency food insecure) from July to September 2018 stand at 609,500. This figure increased to 954,100 from October 2017 to March 2018 (SADC/NVAC, 2018). Between 2014 and 2018, the highest number of food-insecure people was 0.98 million in 2016/17, and the lowest was in 2017/18 at about 66,800 people (Figure 25). However, it is expected to increase to almost a million due to the prevailing drought conditions. On average, the country faced minimal acute food insecurity, which is redeemable by the availability of food as the harvest comes through (SADC/NVAC, 2018).

Figure 25. Food insecure population trends



Source: SADC/NVAC, 2018

The seasonality of alarming levels of hunger and malnutrition, particularly during lean times of the year around September to February, has also been reported (Mofya-Mukuka and Mofu, 2016). The National Food Security produced a balance sheet between 2012/13 and 2016/17 which showed a positive trend (Chapoto et al., 2017; CSO, 2018a). The annual average national food balance sheet for maize surplus for the five years was 830,656 MT, compared to 668,721 MT for 2008 to 2011. For the 2015/16 marketing season, the national food balance sheet revealed a surplus of 876,768 MT, indicating that the country was food secure. However, this surplus was 23.9% lower than the 2014/2015 marketing season, which had achieved 1,152,505 MT. This trend was mainly due to a fall in maize production. There was a deficit of 35,000 MT in paddy rice production, while cassava flour recorded a surplus of 111,825 MT. Zambian National Food Balance assumes that staple foods represent 70% of the total diet, which is considered to be 2,030 Kcal per person per day. In the balance sheets, staple foods are represented by five main kinds of cereal (maize, sorghum, millet, wheat and rice), tubers (cassava, sweet potatoes and Irish potatoes), food legumes (mixed beans, groundnuts, cowpeas) and vegetables. Of the five major cereal crops (maize, sorghum, millets, wheat and rice), maize is the most consumed cereal. It accounts for 60–80% of the national calorie consumption. National consumption of maize in 2018 is estimated at 2.9 million MT, more than twice that of cassava (1.18 million MT). Cassava is the second most important food crop in Zambia. Cassava uses human, livestock and industrial inputs. Cassava accounts for roughly 15% of national calorie consumption and is Zambia's second-largest source of calories (Dorosh et al., 2010; Khonje et al., 2015). Bananas and yams are not crucial food crops in Zambia. Although wheat is grown by large-scale commercial farmers, other crops are mainly produced by small-scale farmers.

Maize became the dominant crop with the emergence of urbanisation brought about by the development of mines on the Copperbelt in the 1960s and 1970s. The per capita consumption of maize rose from 145 to 170 kg per annum between the 1970s and the late 1980s (Mungoma & Mwambula, 1996). It has remained very important to the Zambian economy ever since. However, surveys conducted in 2007 and 2008 revealed a declining dependence on maize as an urban staple food, indicating it was no longer the dominant staple food in urban Zambia, except among the poor (Mason & Jayne, 2009). Since the Zambian government has been making pronouncements on food diversification, there has been an increased dependency on cereals. Zambia is a net exporter of maize and maize products into the SADC region. This status is evident by the amount of resource the government has spent on agriculture through the FSIP and the increase of cereals compared to other crops.

4.1.6 Agricultural production, food demand, and population growth

The population in Zambia remained low from independence until the 1980s, and since then, the increasing population has resulted in an increase in agriculture compared to other economic activities (ZDA, 2010). From 1980 to 2000, the country experienced a slump in the agricultural sector. Previously, grain markets operated through rural cooperatives and the disbanded National Marketing Board, and the infrastructure was maintained. With the economy liberalised, a statutory body, the Food Reserve Agency (FRA), was created in 1996 through parliament to buy strategic reserves of the major staple food crops, principally maize, to ensure national food security (CUTS, 2016). In 2005, the FRA act was amended, and in addition to its original mandate, crop marketing and maize price setting were also included. Other crops bought by FRA include cassava, soybeans, and rice. The private sector buys the rest.

From 2006 onwards, there has been a 6% sustained growth in Zambia's agricultural sector, due to ideal rainfall patterns in parts of the country, expanded planted areas, and favourable policies in agriculture implemented by the government. This strong performance is despite poor distribution of rains, load shedding, rising input prices, and the depreciation of the Kwacha, which in some years has resulted in the decline in the agricultural sector's overall contribution to the GDP (Chapoto & Chisanga, 2016). The increased availability of farm inputs to farmers countrywide and a corresponding increase in fertiliser and hybrid seed technology have raised farmer productivity and efficiency. The number of beneficiaries under the FISP increased from 500,000 in 2006 to one million small-scale farmers by 2016 (FAO, 2017). The availability of grain market (FRA and the private sector) and favourable producer price has motivated small-scale farmers to increase output to meet the national demand. Zambia's population, estimated at 17.6m (World Population Review, 2018), has been growing at the rate of 3.5% per annum.

In contrast, the agricultural growth rate has been varying, estimated 2–3% annually. Zambia's maize production increased by 27% in 2017 from the previous year, attributed to good weather patterns (Chapoto et al., 2017). This output was generally sufficient to meet the national requirement of 2.9 million MT required for human consumption, livestock and other industrial use.

4.1.7 Impact of global markets on the economy

Summary: Zambia's economy has been driven by the copper industry for several years, with copper still accounting for more than 75% of total exports, compared with sugar, which contributes just 1.7% of exports, and tobacco 1.1% (2017 data, WTEx). Because copper dominates the country's economy, and mainly its exports, global markets significantly influence the economy. The dominance of copper exports has in the past harmed the agriculture sector – an example of the "Dutch disease" paradox (Lofgren et al., 2003). The collapse of copper prices in the early 2000s created an opportunity for the agricultural sector (Lofgren et al., 2003).

Zambia is a net importer of goods and services (Table 20). In 2017, Zambia exported ZMW77.9 billion and imported ZMW83.7 billion, resulting in a trade deficit of ZMW 5.7 billion (CSO, 2018b). Net imports accounted for 30.1% of GDP in 2017. The main exports are copper and cobalt, tobacco, flowers, food, live animals and cotton, and the main imports are machinery, transport equipment, petroleum products, chemicals and foodstuffs.

Table 20. Trade balance 2014 -2017 (ZMW)

Flow Year	Total Exports (FOB)	Imports (CIF)	Trade Balance
2014	59,613,355,510	61,086,450,451	-1,473,094,941
2015	60,782,547,898	73,318,492,674	-12,535,944,776
2016	67,223,106,880	77,681,194,790	-10,458,087,910
2017	77,910,809,622	83,650,784,137	-5,739,974,515

Source: CSO, 2018b; Exchange rate ZMW10.87 = 1 USD.

Zambia's economy is mainly dependent on one major commodity – copper – for its foreign exchange earnings. Other exports include cane sugar, barley, tobacco, gemstones, cotton lint, fresh flowers, cotton yarn, fresh fruits and vegetables, maize and wheat. Notable trading partners in terms of export shares are South Africa (31.3%), the DRC (18.7%), China (9.3%), Kenya (8.3%), Algeria (5.9%) and India (4.4 %) (CIA, 2015). Copper and copper products account for more than 70% of Zambia's export income and are thus vulnerable to price swings. Due to the favourable copper prices on the international market and the increased influx of foreign investments in the mining sector, the industry has continued to grow since 2004. With this increased investment, the mining industry still plays a significant role in sustaining Zambia's economic growth, averaging close to 6% in the past five years (MNDP, 2017). Annual copper production has been increasing at an average of 8% since the second half of 2014, reversing the sharp slide witnessed in early 2014. In 2017, the economy grew by an estimated 5.5–6%, somewhat above the average for African economies. The average yearly inflation rate fell from 10.1% in 2017 to 7.9 % in 2018 (Bank of Zambia, 2019), helped both by falling world oil prices and by the Bank of Zambia's monetary tightening. Between June 2014 and March 2015, world oil prices fell by more than 45%, while the gradual decline in commodity prices persisted. The plunge in oil prices was driven by increases in unconventional oil production, weakening global demand, a significant shift in OPEC policy, unwinding geopolitical risks, and an appreciation of the US dollar.

The price of copper, Zambia's key export, has also continued falling from its late-2010 peak, although prices remain well above historical levels. From June 2014 to January 2015, copper prices fell by 15%, reflecting weak demand from China, the world's largest metals consumer. Copper prices remained weak in the first quarter of 2015 off the back of continuing US dollar appreciation, ample supply, and lacklustre demand. Following the drop in the international prices of copper in 2013–15, the government's fiscal position weakened. This situation led to the depreciation of the local currency and reduced outputs from the Zambian mines in 2014. In the second quarter of 2015, the prices and output plunged further due to China's economic slowdown. These external shocks posed severe economic problems such as increased inflation, unstable currency, reduced forex and widening budget deficit. The meltdown in the global economy during 2013–2015 also caused an increase in the country's trade deficit from US$179 million in 2014 to US$386 million in 2015 (MoF, 2015). The government adjusted several critical economic policies to respond to serious problems: revising rules on VAT refunds, announcing a new mining fiscal regime, and a rising fuel prices so that the government could recover import costs.

To add to that, the Zambian kwacha came under renewed pressure. It lost between 17–56% of its value against the US dollar from December 2014 to 2017 (ZMW 7.7 to 12.3). This performance remained cyclical due to increased government borrowing and in part steps taken by the Bank of Zambia to tighten credit. Over the medium term, economic growth has continued to hold and then accelerate to around 6–7% per year in 2016–2018. Although inflation was expected to rise in 2019 due to the extended dry spell, it fell in 2018. Low commodity prices, a more stable exchange rate, and adequate local harvests in the past five seasons helped contain inflationary pressures and boost real disposable incomes. The resulting pick-up in private consumption, coupled with increasing copper exports projected for 2019, were expected to strengthen economic growth prospects. The revenues earned from copper sales are used to pay several government services and imports. With copper mining in the hands of the private sector, the government has instituted a stringent taxation system to recoup revenues from the mining sector.

Zambia is a member of the Common Market for Eastern and Southern Africa (COMESA), SADC and Tripartite free trade agreements (FTAs). The regional markets enhance trade in SADC and COMESA identified by the government to transform Zambia into a regional trade hub. Despite belonging to these three FTAs, Zambia's participation in intra-Africa trade is poor with regional integration slow to develop. Zambia, though landlocked, is also land-linked, sharing borders with eight countries. It has continued to remain a transit country for SADC goods (World Bank, 2018b). Raw and refined copper, which accounts for 75% of Zambia's exports, is not in-demand in Africa.

Though Zambia has signed many bilateral, regional and international trade agreements, several tariff and non-tariff barriers to trade have continued to reduce Zambian exports in the region, including small-scale businesses. These include high transportation costs, stiff competition, firm capabilities and restrictive regulations at regional and national levels (Fessehaie et al., 2015). The country's domestic products have struggled to compete effectively with imported products for a combination of reasons, including lack of market access due to limited logistics support and poor road infrastructure. Good trade logistics are also crucial for any supply chain where costs matter – agribusiness commodities can be particularly affected when inefficiencies and delays lead to high costs, especially for perishable and refrigerated goods.

The regional economic blocks, COMESA and SADC, have been promoting regional value chains in agro-processing, mineral beneficiation and pharmaceuticals sub-sectors. However, there are several challenges (Paremoer, 2018) for Zambia. For example, Zambia's largest trading partner in sub-Saharan Africa is South Africa, which imports most goods, including processed food. These imports originate from firms with expertise that are well established and whose products are perceived by customers to be of higher quality than locally processed foods. As a result, firms domiciled in Zambia, especially indigenous ones, find it extremely hard to compete in such a liberalised market. To ensure these regional value chains work at the national level, Fessehaie et al. (2015) suggest the need for targeted interventions to improve local firms' performance, given the stiff competition and other challenges they face in processing goods, especially agricultural products.

The policy framework aims to promote economic diversification away from copper at the national level, which continues to be an essential export commodity since independence. This encourages growth in the agriculture and manufacturing industries, and intends to make Zambian products more competitive in the region and earn more forex. Zambia has abundant agricultural resources. However, despite increasing in recent years, still only 14% of total agricultural land (32.6% of total land area) is used. Hence why the agricultural sector has been identified as one of the critical drivers to diversify the Zambian economy away from copper mining (MoA, 2016a; MNDP, 2017). The enhancement of export competitiveness and the creation of markets for agro products and commodities are key to the success of diversification. Agro-processing activities will add value to products, thereby creating links with other sectors and increasing the profit margins received by producers. This strategy will help relieve the economy from the volatile changes affecting copper prices and production. It is thought that economy diversification will build up foreign reserves in the long run and hence help stabilise the exchange rate. Through the SNDP, the government intends to provide financial and technical support to the agriculture and manufacturing sectors to foster economic growth and development. In addition, the government recently approved an industrialisation and job creation strategy to promote industrial development (Fessehaie et al., 2015).

The Export Board of Zambia and the Zambia Export Growers Association are prominent bodies that promote export business. Chapoto (2014) observed that the global financial crisis of 2007–2008 raised fears about food prices for most poor households in Zambia. The extensive price swings for the primary staple food, maize, reinforced the generally held view that food prices were too strategically and politically important to be left to the market forces of demand and supply. They expose poor farmers and consumers to unacceptable price spikes and collapses (Chapoto & Jayne, 2009). Ineffective response policies, mistrust between the government and private sector, protracted discussions, inaction among key agriculture stakeholders, and rent-seeking behaviour by others, (Chapoto, 2014) caused the delayed implementation of strategies to deal with rising food prices, especially for maize. Some policy responses to the crisis included the export ban and restriction on maize, considering the national and regional trade implications. Other government interventions focused on the agreement with millers on the quantity of maize to be imported if any, and how much each of the different stakeholders should import. Other agreements included the request for import duty waivers from the Ministry of Finance (MoF) and subsidised maize grain from FRA to millers for onward transmission to consumers.

4.1.8 Characteristics of the food system

Drivers of food systems in Zambia

The main drivers of the Zambia food system include demographic factors characterised by a highly-urbanised and moderate population (3.6% per annum); income disparities between the urban and rural areas, government policies, increased market opportunities, improved agricultural practices, and political stability, which ensure the delivery of affordable, nutritionally adequate, safe and healthy (and even culturally or religiously acceptable) food to its citizenry. The main actors in the food supply chain include the seed companies agro-dealers and research institutions, who make available suitable varieties and improved agricultural practices; the farmers, of which 1.6 million are small-scale farmers; aggregators (grain traders), marketeers; the FRA; the processors; wholesalers; retailers (including chain stores) and the consumers. Steps are taken to reduce food losses and food wastage along the supply chain.

The food system is dominated by the staple cereal crop maize, with various food legumes, animal-source foods, fruit, and vegetables eaten in small quantities, particularly among the most impoverished families (Mwanamwenge & Harris, 2017). Maize is the primary food security crop in Zambia. Many Zambian households grow maize each year, including more affluent urban households, who often have a piece of land cultivated in a rural area. The dominance of maize is historical; it was initially promoted to supply mealie meals or maize flour to the migrant mineworkers on the Copperbelt during the colonial period (Issahaka et al., 2018). The suitability of maize to a large swath of Zambia's environment has made it an ideal staple crop and it has retained this stronghold on its agricultural development (Saasa, 2003). As a result, the focus of successive post-independence Zambian governments in the agriculture sector has been to retain national food security through maize production, usually equated in political rhetoric with maize self-sufficiency.

The state of the country's food system has continued to be of concern to the local authorities as it has a strong focus on growing a single crop (maize), in practice called mono-cropping. Maize mono-cropping has eroded ecosystems, crop diversity and regrettably reduced the variety of foods on the dinner tables of many Zambians. The diets of Zambians have been heavily reliant on maize since the colonial period. Maize production has been encouraged by introducing price differential subsidies and uniform prices for inputs (fertiliser, seeds and agricultural chemicals) and crop producer prices, resulting in high maize production and a considerable cost to the economy. These policies and preferences have perpetuated maize-based diets across the country, particularly as diets based on maize became cheaper. Despite favourable government policies and strategic plans to improve food and nutrition security, Zambia's food and agriculture system has failed to ensure neither food security nor adequate nutrition. Very little support, if any, has been provided to other crops such as sorghum, millet, beans and cassava. For instance, since 2007, the Zambian government has spent more than 50% of its agricultural budget on supporting maize and procuring fertiliser through its FISP and output price support through the FRA. Therefore, many Zambians have continued to live with food insecurity and malnutrition due to poor diets: seasonal hunger affects countless families; a significant proportion of children suffer from stunted growth; some are overweight and suffer from non-communicable diseases. National nutrition and agricultural policy in Zambia recognises the need to grow and diversify nutritious foods to tackle hunger and improve diets.

The bulk of the maize (about 60%) is produced by smallholder agriculture under rain-fed traditional agriculture or using input-enhanced agriculture. This uses improved seed and inorganic fertiliser, with more than 50% provided under FISP. This is then bought by either FRA or the private sector. The private sector is made up of middlemen, aggregators (grain traders), and millers/processors who then mill the commodity into flour for home consumption. Given that maize is susceptible to pests, diseases and variability in climate, the government has been promoting food diversification through initiatives such as the Japan International Cooperation Agency (JICA) -funded rice diversification project and Finnish fund PLARD II. The CFU has been promoting conservation agriculture techniques among smallholder farmers countrywide. And the DFID/Irish aid-funded Scaling Up Nutrition (SUN) aims to improve household nutrition. All these initiatives aim to improve crop diversification and cash incomes for the farmers, while introducing food diversification at the household level (MNDP, 2017). For example, one of the principles of conservation agriculture is rotating cereal crops with legumes. Including a food legume promotes food diversification at the household level, while also improving soil fertility (Mayer, 2015).

Further promoting indigenous vegetables or once underutilised, neglected or traditional crop species has led to improved nutritional security and income generation. Zambia food diversification goals are anchored on the SNDP. Besides ensuring food and nutritional security, it also recognises the need to shift attention from maize to more drought-tolerant crops in light of climate change (MNDP, 2017). Seasonal hunger still affects many families; a significant percentage of the population is hunger stricken (CSO, 2016). Although local food prices have fallen for almost all major food groups over the past two decades, high and worsening inequality means many households, especially in the rural areas, cannot access diverse foods. SNAP (MoA, 2016a) recognises the need to increase and diversify the production of nutritious foods and to improve availability.

The SNDP also emphasises the development in the agriculture sector value chains. This chain includes investment in crop production, livestock, fish, marketing and agro-processing, including distribution mechanisms and export markets (MNDP, 2017). Only a few portions of cereal – maize, sorghum, millets, wheat, rice and cassava – are transformed through the value addition process into refined milling products. For example, maize – the major staple crop for most Zambians –

is processed into maize flour, locally known as a mealie meal. The industrial refining of maize is mainly concentrated in urban areas of Lusaka and Copperbelt provinces. Rice is milled and packaged by COMACO at its factories in Chipata and Lundazi under its brand 'It is wild'. The processing of cassava into starch is still in its infancy. The primary source of dried cassava is Luapula province, which supplies 60% of yields to the Copperbelt and Lusaka provinces and the Chembe border market (Haggblade & Nyembe, 2008).

While all the major commercial millers are privately owned and located either along the rail line or in provincial capitals, there are several small-scale millers in most urban and rural areas that mill small amounts of grain for their clients. In addition, through the presidential initiative, the government has constructed more than 650 solar-powered milling plants run by cooperative societies across the country (MNDP, 2017). Besides moderating the mealie price, they help to add value to the locally-produced cereals and cassava. The government has also encouraged the processing of non-cereal crops such as sugar and edible oils. In the sugar industry, the leading player in Zambia Sugar PLC, owned by Illovo Group and located in Mazabuka (92.5%) (Sikuka & Bonsu, 2017). The other two smaller sugar plantations are Kafue Sugar (7.2%) and Kasama (0.3%).[7] In the edible oils industry, the primary producer is Mount Meru Oils.

4.1.9 Status of infrastructure and implications for marketing and processing

SNAP aims to provide an environment that stimulates sustainable agricultural development (MoA, 2016a). It is expected to promote competitiveness, boost efficiency and increase productivity and profitability in the agriculture sector. It will thus contribute effectively to attaining food and nutrition security, employment creation, increased incomes and reduced rural poverty (Chapoto et al., 2011). A vital driver in the crop sub-sector is the investment in appropriate, affordable and cost-effective irrigation technologies, as well as to farm mechanisation. This investment strategy is being undertaken alongside the creation of agricultural farm blocks. The government has recognised that to enhance agricultural production and productivity, basic infrastructure such as roads, electricity and irrigation must be made available to all categories of farmers. Currently, ten agricultural blocks are being developed across the country (ZDA, 2014) with funding from the World Bank. A further three dams are being constructed (World Bank, 2011) to increase yields per hectare. This scheme adds to a further 15 existing smallholder irrigation schemes, though some of these require rehabilitation and revamping of their management to ensure they are efficient (MAL, 2015). SNAP envisages that the good road network will provide cheaper access to input supply and product markets.

The government has also looked to provide water points for livestock, especially in drier parts of the country, such as the Southern Province. This includes constructing communal dip tanks and livestock breeding and re-stocking centres (Bbalo, 2015; MoA, 2016a). Through the African Development Fund-supported Livestock Infrastructure Support Project, the MFL has been improving smallholder livestock production and productivity in Northern and Muchinga Provinces, by creating market links and increasing household income (AfDB, 2013).

[7] A methodology for such a food system mapping was developed by the EU H2020 funded research project SALSA – see http://www.salsa.uevora.pt/en/.

The rivers, lakes and swamps cover an estimated 15 million ha of fresh fisheries. The fisheries sector contributes significantly to employment, income generation and poverty reduction, particularly in rural areas where it can be considered an essential open employment sector (Musumali et al., 2009). Distinct groups that carry out fishing in Zambia are industrial operators and traditional or artisanal large fishing vessels exploiting the pelagics. With more than 25,000 fishers, artisanal fisheries still dominate production output and labour. Private and individual traders, of which many are women, constitute the bulk of fish suppliers.

The Department of Fisheries within the MFL is tasked, through the Fisheries Act, Cap 200 of the Laws of Zambia, to govern and manage Zambia's fisheries resources. Its activities, aimed at the sustainable use of fisheries in the country, are:

- the Annual Fishing Closure, from 1 December to 28 February, to allow for the breeding of the commercially-exploited tilapia bream, and
- a complete ban on using destructive fishing methods such as forcefully driving fish into set nets (kutumpula), using explosives, using weirs targeting migratory fish, and beach seine nets, which, being operated in shallow waters, destroy fish nests and foul the water by stirring up silt.

To increase fish production, enhance nutrition and improve the sustainable management of fisheries, the government has targeted popularising aquaculture and the collaborative management of capture fisheries. Fish and fish products account for more than 20% of animal protein intake and provide essential micronutrients to most of Zambia's population, who are highly vulnerable to malnutrition (Musumali et al., 2009). The government's financial and technical input into the sector has popularised pond culture techniques and established institutional and technological infrastructure to support the growth of the fish industry. As a result of this support and international and civil society assistance, the Department of Fisheries has promoted aquaculture development in Zambia, resulting in more than 6,000 small-scale farmers operating more than 13,000 fishponds throughout the country. In addition to small-scale producers, 16 large commercial fish production businesses have started fish production on the Copperbelt, Lusaka and Southern Provinces, where ideal fish markets are located. An estimated 10,000 t/yr. of fish is produced from aquaculture, with 25% coming from commercial producers and 75% from small-scale aquaculture. Due to the expansion of aquaculture in all ten provinces, Zambia is now one of the largest fish producers in sub-Saharan Africa. With support from the African Development Bank (AfDB), the government has embarked on establishing aquaculture parks (Oladapo et al., 2013). By stimulating a viable aquaculture subsector in Zambia, the project intends to promote economic diversification, food security and sustainable employment generation, all of which are central priorities of the Zambian government. Establishing aquaculture parks creates a viable and inclusive business opportunity. Through enhanced production and productivity, it can improve the livelihoods of men and women beneficiaries along the aquaculture value chain. Overall, it helps improve the performance of the fisheries sub-sector and increases the production of fingerlings (MoA, 2016a).

Fish produced in Zambia is primarily for human consumption after being produced, processed and distributed in various forms. Fish is sold fresh; frozen and filleted; salted and sun-dried; smoke-dried; or just sun-dried. Fish is rarely processed into fishmeal for animal feed, but there is however processing for ornamental purposes. According to FAO (2003), infrastructure and facilities for particular processing operations in Zambia include:

- filleted fish – freezing plants, packaging, processing equipment and spices;
- fresh fish – packaging factories, ice plants, and transportation receptacles such as cooler boxes and refrigerated vehicle containers;
- frozen fish – freezing plants, refrigeration, refrigerated transport;
- live (ornamental) – air and land transport, concrete tank production, drugs, holding tanks, oxygen cylinders and aeration, plastic bags and pipes;
- salted fish – drying racks and salt production and packaging material factories;
- smoke-dried fish – packaging, smoking kilns and drying racks;
- sun-dried fish – plastic sheet manufacturers, drying racks, wire mesh manufacturers.

The orientation of production towards domestic demand in Zambia has led to poorly-developed fish market facilitation operations. The domestic fish market is currently a sellers' market and thus requires little additional improvement effort. Though not restrictive, health and safety requirements for regional and international fish export markets require cold storage, packaging and transportation. Nationally, areas with large and dense populations such as Central, Copperbelt, Eastern and Lusaka Provinces are lucrative fish markets.

While there has been a lot of investment in agricultural infrastructure, including machinery, over the past few years (MoA, 2016a), some existing agricultural infrastructure has remained in a deplorable state or state of neglect. The government intends to overhaul the existing infrastructure and establish a new one outlined in the SNDP and SNAP. Through the enactment of agricultural marketing, livestock development, and diary development acts, the government is meant to reform the agriculture sector further and enhance its performance (MNDP, 2017; MoA, 2016a).

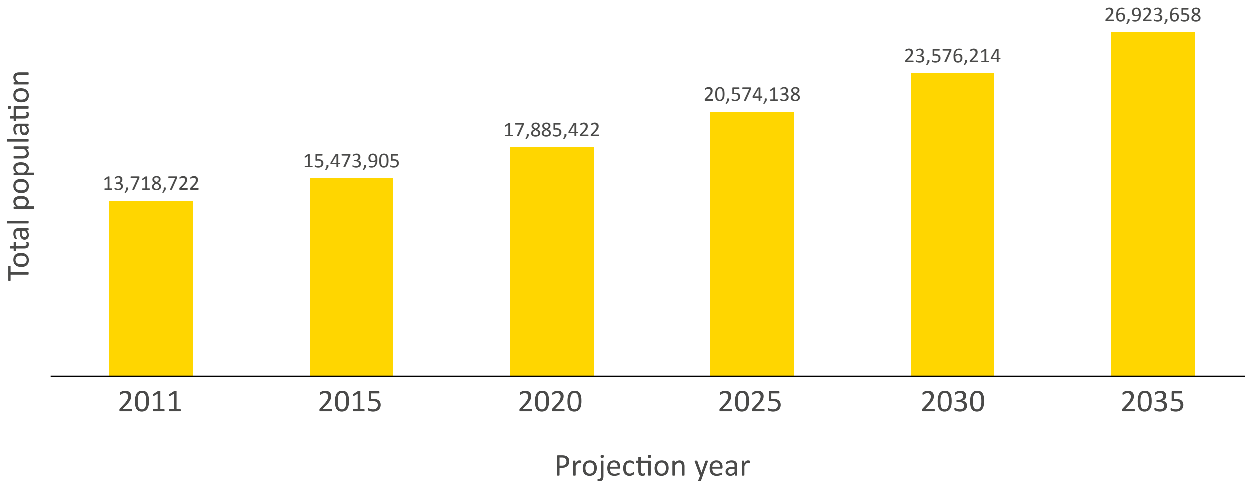
Transport infrastructure plays a vital role in economic development by integrating society and allowing the free movement of people and resources. Despite the increased investments in the transport sector in Zambia, access to rural areas is still poor. According to GIS mapping data, only 16.8% of the rural regions live 2km from an all-season road. More than 50% of smallholder farmers in Zambia live within 3km of a feeder road accessible by vehicular transport (Keyser et al., 2012). Therefore, proximity to feeder roads is fundamental for encouraging traders to enter into otherwise remote areas to provide markets for smallholder farmers' surplus production (Chapoto, 2014). But, even when roads are available in Zambia, these tertiary or feeder roads are in deplorable condition, with many becoming impassable during the wet season. For the agricultural sector, these roads are critical and add to the cost of agricultural inputs (provision of seed, fertiliser) and outputs. Therefore, improving access roads has been prioritised in the SNDP and SNAP.

4.2 Demographic drivers:

4.2.1 Current rate of population growth

In 2017, Zambia's population was estimated at 16.4 million (CSO, 2018b), compared to 13.09 million estimated in 2010, a 25.3% increase (CSO, 2013b, 2018b) (Figure 26). Although revised estimates for 2017 put the population at 17.09 million (www.worldometer.info, 2018). In contrast, CSO (2013b) projected the country's total population to increase from 13.7 million in 2011 to 17.9 million in 2020 and 26.9 million by 2035, representing a 100% increase (Figure 26). In rural areas, the population was estimated to increase from 8.2 million in 2011 to 14.5 million by 2035, and in urban areas from 5.6 million in 2011 to 12.4 million by 2035.

Figure 26. Population projections 2011–2035



Source: CSO, 2013b; 2018b

In 2017, 55.3% of the national population was estimated to live in rural areas, 54.7% in urban areas (CSO, 2018b). According to the CSO (2018) census report, the higest population was in Lusaka Province with 3,002,530 people, followed by Copperbelt Province with 2,480,657. Northwestern Province had the lowest population at 879,229. The population density in Zambia is estimated at 24 persons per km^2. The proportion of young people aged below 15 years was 45.95 %; 15–24 years (20%); 25–54 years (28.79%); 55–64 years (2.95%); and 65 years and above (2.31%) (CIA, 2018). In 2017 56.5 % of people in urban areas were women, rising to 57.4% in rural areas. The population density was 24 persons per km^2, on average, with Lusaka Province accounting for the highest density with 126 persons per km^2. The population comprises 70 different Bantu ethnicities (CIA, 2018; CSO, 2013c).

The population growth rate between 2010 and 2020 was estimated at 2.8% (CSO, 2013b). The CIA (2015) attributed this high growth rate to the high fertility rate of six children per woman, driven by the lack of access to family planning, low education levels and unemployment among women and girls. However, fertility declined by 1.5 children per woman in the previous 30 years. The CIA (2015) reported broad fertility disparities between urban and rural locations and observed early marriages among poor, uneducated women in rural areas with early childbearing. The life expectancy in Zambia is low, and the CIA (2015) report attributes this situation primarily to the prevalence of HIV/AIDS (CSO 2013c; CIA, 2015).

With regards to emigration, Zambia ranks low in comparison to other African countries and is comprised predominantly of the well-educated. The educational infrastructure for the development of skilled labour in essential fields such as nursing, medical doctors, and other health professionals has been limited for many years compared to some sub-Saharan nations. This has led to 'brain drain' significantly affecting the country and reducing the human capital.

The CSO (2013b) projected an annual growth rate of about 2.8% by 2035. Population growth in the urban areas was higher (3.5%) than in the rural areas (2.4%). There were 7,655,669 men and 7,818,236 women in 2015, expected to increase to 8,852,174 men and 9,033,248 women in 2020 and to 13,319,362 men and 13,604,296 women in 2035 (CSO, 2013b). The population in rural areas is estimated to decline from 58.2% in 2015 to 53.9% by 2035 (Table 21). On the other hand, the proportion of women in rural and total populations will be fairly stable, averaging 50.5 % from 2015 to 2035 (CSO, 2013b).

Table 21. Population distribution in Zambia from 2010 to 2035 period

Year	Population	Annual	Median	Density	Rural Pop.	Female	Female
		% Change	Age	(p/km^2)	%	% Total	% Rural
2035	26,923,658	2.84	17.4	24	53.9	50.5	50.4
2030	23,576,214	2.92	17.3	23	54.5	50.5	50.4
2025	20,574,138	3.01	17.2	22	55.4	50.5	50.4
2020	17,885,422	1.57	17.2	23	56.7	50.5	50.5
2018	17,609,178	3.01	17.2	24	57.2	50.5	50.5
2017	17,094,130	2.93	17.2	23	57.5	50.5	50.5
2016	16,591,390	3.02	17.2	22	57.9	50.5	50.5
2015	16,100,587	3.06	17.1	22	58.2	50.5	50.5
2010	13,850,033	2.82	16.5	19	61.4	50.1	51.1

Source: CSO, 2013b, 2018a

Zambia's fast population growth rates suggest that the age structure will remain unchanged for the economically active (15–64) and the reproductive (15–49) age groups. According to the CSO (2013b) report, the economically active age group comprises 46.6% of the population and 51.2% for the reproductive group, respectively. The proportion of youths between 15 and 35 years of age was projected to be 35.2% and 36.3% by 2020 and 2035, respectively. The life expectance at birth was projected to increase from 52.6 years in 2011 to 61.2 years by 2035 (CSO, 2013b), suggesting declines in childhood and adulthood mortality. The reductions in mortality have been attributed to health interventions that addressed malaria, HIV/AIDS, diarrhoea, and malnutrition problems and thus enhanced survival prospects.

The CSO report observed that the life expectancy for males at birth is expected to increase by 10.1 years from 51.1 years in 2015 to 61.2 years in 2035, while females will gain 8.5 years to 64.1 years by 2035. The life expectancy in Southern Province is projected to be the highest in the country, estimated at 67.8 years for females and 61.4 for males, and lowest in Luapula Province with 60.8 for females and 54.7 for males. The median age increased from 17.1 in 2015 to 17.2 in 2020 and rises to 17.3 in 2030 (Table 21) (CSO, 23013b).

The CSO (2013b) reported that females in Central, Luapula and Copperbelt provinces are expected to gain nine years or more in life expectancy at birth during the projection period. The most negligible gain among women is projected to occur in Southern Province (4.7 years) and Muchinga Province (5.5 years). Although Southern and Muchinga Provinces are projected to make marginal gains in life expectancy at birth during the projection period, both provinces had a relatively higher life expectancy at birth at baseline in 2010.

The CSO (2011) reported that the number of people living in urban areas was expected to increase from 40.6% in 2011 to 46.1% by 2035. The CSO (2013c) said that rural areas would continue to have higher fertility rates than urban areas. Urban areas will continue to experience population increase, estimated at 40.6% in 2011 and rising to 46.1% by 2035 (CSO, 2013b). Thus, although migration from rural to urban areas will continue, the population in rural areas is expected to continue rising due to relatively higher birth rates than urban areas. Of course, the actual future pace of urbanisation will depend on differences in mortality and future migration trends (which are very difficult to predict) and the extent to which rural areas become reclassified as urban. Among the provinces, Copperbelt and Lusaka Provinces are projected to continue being the most urbanised provinces, reaching 87.1% urban and 86.4% urban respectively, by 2035 (CSO, 2013b). However, North Western and Muchinga Provinces are projected to experience the most significant percentage point increase in urban population during the projection period.

Table 22 shows the population and household distribution by socio-economic strata and residence. Results show that 90% of the population in rural areas comprised small-scale farming households, and the stratum with the least percentage share was the large scale, at 0.2%.

Table 22. Distribution of the rural population by Stratum in Zambia, 2015

Stratum	Population	Percent share	Households	Percent share
Rural	910,0647	100	1,718,060	100
Small-scale	810,3729	90.0	1,542,587	89.9
Medium-scale	403,872	4.5	56,974	3.3
Large-scale	21,348	0.2	287	0.2
Non-agriculture	472,699	5.3	115,692	6.7

Source: CSO, 2016d

4.2.2 Changes in demand for different types of food

The introduction of maize as a food crop during pre-colonial times resulted in a gradual shift from the consumption of indigenous crops such as millet, sorghum and cassava to maize meals. According to Mwanamwenge and Harris (2017), these indigenous food crops have been marginalised by maize. The Nshima (thick porridge) based on maize meal is the most preferred dish by most Zambians. It provides high starches but is generally low in other macro and micronutrients. To mitigate the micronutrient deficiency, yellow maize, which contains beta carotene, has been introduced to the market (Simpungwe et al., 2017). However, most Zambians still prefer white maize, which provides half of people's calorie intake. Still, Simpungwe et al. (2017) observed that cassava is still preferred as a staple food in some regions, making it second to maize.

There is little diversity of crops in Zambia's agriculture as only a limited number of introduced crops and some indigenous ones are used as food (Mwanamwenge and Harris, 2017). Mwanamwenge and Harris (2017) reported that food dishes in most households in Zambia change throughout the year, according to the season. The use of wild indigenous edible vegetables has declined in favour of a limited selection of introduced varieties of vegetables such as rape, cabbage, spinach, among others. The report observed that the food basket comprises grains, vegetables and meat, which are nutritious for the health and development of infants and young children. However, the high cost of meat products limit their consumption among children in Zambia. Compared to urban households, the food dish for rural dwellers is monotonous and limited.

The third basic staple food includes wheat-based products, which are increasingly important, particularly in urban areas that now account for a higher budget share than maize (Mason & Jayne, 2009). The increased demand for rice, especially in urban areas, has continued to push for more production and imports (JAICAF, 2008; MoA, 2016d). Within Zambia, regional consumption patterns differ pretty sharply. Maize dominates consumption baskets in southern and eastern Zambia, while cassava predominates in parts of the north. Northern and north-western Zambia form a transition zone between the maize and cassava belts, with household consumption of large quantities of cassava and maize. This dual staple zone, where households consume a seasonally and inter-annually variable blend of maize and cassava-based food products, covers a wide swath of northern Zambia. Therefore, national per capita averages camouflage a wide variation in consumption patterns across these different food staples, according to the surveys conducted by the Central Statistical Office (CSO, 2018b; 2019) (Table 23).

Across all AERs, urban areas tend to favour wheat consumption relative to rural areas. But all the consumption patterns have been able to match the food requirements (Table 23). The tables below show a steady increase of between 31–42% in crop production. The population increased by almost 50% between 2000 and 2013. However, there were between zero and marginal changes in the quantities consumed by a person over the same period. The amount of food consumed per person and their contribution to daily calorie intake and protein supply per capita remained the same.

Table 23. Consumption of three major food staples in Zambia and change over time: 2000–2013

Crop	Year	Population	Production	Quantity consumed	Daily calorie intake	Protein
		(X1000)	('000 MT)	(Kg/Capita/ yr.)	Kcal/capita/ day	(g/capita/ day)
Maize	2000	10,200	1,219	120.7	1015	26.75
	2005	11,462	1,283	111.8	941	24.79
	2010	13,089	1,477	111.7	940	24.77
	2013	15,153	1,725	118.6	999	26.31
	2015	15,474	2,618	119.2	970	25.81
	2018	17,609	2,394	119.4	883	26.31
Wheat	2000	10,200	125	12.4	100	3
	2005	11,462	154	13.4	107	3.22
	2010	13,089	106	8	65	1.94
	2013	15,153	176	12.1	97	2.92
	2015	15,474	214	12.2	98	2.89
	2018	17,609	114	12.4	99	2.45
Cassava	2000	10,200	774	76.67	231	1.89
	2005	11,462	1,003	87.46	264	2.16
	2010	13,089	1,094	82.78	249	2.04
	2013	15,153	1,017	69.62	211	2.16
	2015	15,474	952	69.72	214	2.17
	2018	17,609	1,118	72.16	223	2.15

Source: FAO, 2019; CSO, 2018b; 2019

For most rural communities in Zambia, their livelihood depends on agricultural activities as their primary source of food and income. These households largely depend on their own produced food to meet their household consumption needs (CSO, 2016d). Hence easy access to their own produced goods and services enhances the welfare and living standards of these households. It also reduces the burden of large cash requirements where money is not easy to acquire. For easy comparison, these quantities of own-produced food consumed were converted in monetary terms by comparing the amount produced with the market value of the same product and quantity within the locality (Table 24). In terms of household expenditure, there was a slight movement in the amount spent on food items, and on their own produce. The most significant change was in rural compared to urban areas. Northwestern Province had the most significant increase in household expenditure, followed by Central Province. The least was Western Province. In terms of contribution of own produce to household food items, Western had the largest according to the statistics by the National Census of Population and Housing (CSO, 2013c; CSO, 2016a) (Table 24).

Table 24. Per cent share of household expenditure on food items and own agriculture produce in stratum/provinces in Zambia: 2010 and 2015[8]

Stratum/ Province	Households		% Share of household expenditure on food		% Share of total expenditure on own produce	
	2010	2015	2010	2015	2010	2015
Zambia						
Total	2,513,768	3,014,965	40.6	48.5	10.8	13.5
Rural	1,495,861	1,718,060	56.4	64.6	30.2	24.5
Urban	1,017,907	1,296,905	36.74	39.1	3.5	3.1
Provinces						
Central	235,560	292,049	46.7	57	16	15.8
Copperbelt	371,125	450,843	39.8	42.5	5.3	6
Eastern	305,198	342,161	53.2	62.9	29.1	28.1
Luapula	194,962	207,612	58.1	63.7	24.7	28.1
Lusaka	444,418	592,073	30.2	35	2.6	1.9
Muchinga	138,763	174,832	49.5		20.7	11.9
Northern	220,561	253,779	56.9	62.2	24.7	21.6
Northwestern	130,803	164,141	53	71.8	24.3	19.1
Southern	292,179	338,259	44.4	50	21.9	13.9
Western	180,179	199,215	53.4	57.6	18	24.8

Source: National Census of Population and Housing (CSO, 2013c; CSO, 2016a; Chapoto et al., 2015)

[8] Quantities of own produced food consumed were converted in monetary terms by comparing the quantity of own produced with the market value of same product and quantity within the locality. The government's Statistical Office used this for its Living Condition Monitoring Survey of 2015

4.3 Cultural and religious drivers

4.3.1 Culture and religious impacts on agriculture and ecosystems

Dietary requirements and methods for ensuring they are met have been passed on from generation to generation. Taylor (2006) provided a detailed food picture of Zambia's major tribes. There are 74 ethnic groups in Zambia, with each having its food preferences. However, most of the food is provincial rather than tribal. With the decline in some cases in the consumption of indigenous vegetables, farmers have also adjusted to existing agro-ecological conditions to grow particular crops. This decline is evident in some crops that have garnered prominence over others. According to Rajaratnam et al. (2015), though maize has been the leading staple food in Barotseland, the introduction of rice to the region over the past three decades has made the crop rival or surpass maize as the vital cash crop in most areas of the Zambezi flood plain. In addition, farmers have adopted cashew nuts as they find them suitable for the western province's sandy environment (JAICAF, 2008). In the northern part of Zambia, cassava production dominates. Though maize was traditionally introduced into Africa by the Portuguese in the 18^{th} century, it is dominant in the Central and Southern Province. Food legumes, especially groundnuts, are co-dominant with maize (Mofya-Mukuka & Shipekesa, 2013). As well as livestock with a special status in society, most crops are part of traditional events, such as the Kulamba Ceremony of Chewa People (Tembo, 2012; Yoshida, 2016). Hence farmers adjusted their cropping system to suit the requirement of these traditional gatherings.

Generally though, there are no cultural biases for which crop to grow. The only preference relates to gender. Some crops such as groundnuts, cowpeas and pigeon peas are labeled as 'women's crops', (Ojiewo et al., 2018) grown by women in the community. Some tribes have perpetuated certain plant species such as indigenous orchid plants called *Chikanda* and wild mushrooms because they claim they are tasty (Phiri et al., 2015; Taylor, 2006). While there is a cultural bias against growing some crops, little information exists for livestock husbandry. It is well-known that certain religious faiths don't consume meat or keep certain livestock in rural and urban areas (Pérez & García, 2013).

The Bemba cultural system of food production primarily involves the practice of Chitemene (slash and burn) (Schultz, 1976), and has developed a speciality for associating particular soil types with certain crops. For example, the Bembas identified different soil types (for example, sandy soils) near plateaus for growing crops such as millet, sorghum, legumes, groundnuts, cassava and sweet potatoes. According to Holden (1993), the rich red clay loam was considered suitable for food crops such as sorghum, while the black soil near riverbanks of flood plains, swamps and small dambos was used for cultivation and was not easily exhausted. The refuse type of soil (Umufundo) was considered fertile and used for growing maize and cucurbits in what was known as Mputa gardens. Kapekele (2006) reports that although the Bemba practised the Chitemene system, the practice was also conducted in "sequences", suggesting the use of crop rotation. These rotations were practised on the rich red loamy soil on communal land, often with a ten-year cycle for finger millet, sorghum, groundnuts, cucurbits, peas and beans. Schultz (1976) reports other rotations such as cassava with sweet potatoes or millet. However, it is presumed that northern Zambia has lost more than 35% of its biomass due to this type of traditional farming method, representing about 43,000km^2 of forest land over the past 40 years (Kapekele, 2006). With many small-scale farmers being involved in this exercise, there is no doubt that the impact left on the environment is vast and devastating. Other adverse effects of slash and burn include loss of biological diversity within the forests, increased water runoff and soil erosion, and soil fertility depletion due to the leaching of nutrition.

The Tonga people comprise about 89% of the southern province's population, and the remaining 11% is shared by the other 73 ethnic groups in the country (CSO, 2013c, 2018b). The Tonga people initially shifted cultivators who practised subsistence agriculture combined with cattle raising before colonial rule (Vogel, 1987). Slash and burn agriculture and its extensive land requirement compelled farmers to move into favoured microenvironments. The practice promoted the expansion of land for cultivation, and after the 9th century AD, opportunities emerged, such as the use of animals and herding of cattle for prestige. The major crop that they cultivated was local maize, grown on the fertile plateau soils. It was also possible for the Tonga people to keep cattle because the plateau was free from the tsetse fly. Other subsidiary gardens were prepared for sorghum and pulses (Anthony & Uchendu, 1970; Dixon-Fyle, 1976). Tonga custom allowed individuals to acquire land for cultivation in several ways. Firstly, an individual acquired land by clearing virgin or regenerated and unclaimed land. Secondly, the land was obtained by transference of rights from one individual to another, temporarily or permanently. Thirdly, the land was acquired by inheritance and by taking his own vacated hut sites and their surroundings (Kanene, 2016.) The "wastelands" of the community formed a shared pool. Any community member was entitled to help themselves as he liked and it was made available for grazing cattle as part of common property resources. The use of cattle manure could have facilitated some families to work the same land for several decades with fallow periods (Vogel, 1987). Researchers have found that the main methods of environmental conservation among the Tonga of Southern Zambia are selective harvesting, totemism and taboos, organic farming, crop rotation and intercropping, the sacredness of water sources (Kanene, 2016).

Food production and systems of land use among the Lozi people are confounded by the presence of the Barotse floodplains (Rajaratnam et al., 2015). According to Namafe (2006), the Lozi social life moves with every change of the waters and associated changes in weather in the Barotse plains of Zambia, indicative of a strong link between humans and their natural environment. The historical experience of the Lozi-speaking peoples of Barotse land (Western Province) shows that the highly complex micro-ecological conditions on the flood plain and upland facilitated the evolution of perhaps the most complex and intense cultivation system in pre-colonial Zambia (Mwananyanda, 2015). In this method, at least six different gardens were prepared:

- *Litongo* (margin gardens) were dry marginal gardens on sandy ridges within the flood plain cropped with maize, cassava, fruit trees (such as pawpaw and pineapples), sugar cane, tobacco and vegetables. The soils are cultivated in perpetuity, and fertility was restored by depositing silt during flooding and cattle manuring
- *Sitapa* (clay-gardens) were moist, developed on clay soils and planted with sweet sorghum and local maize (with early and late maturing varieties)
- *Sishanjo* (drainage gardens) were labour-intensive gardens involving the cultivation of seepage peats found along the ambo margins. The gardens were made by excavating a network of deep drainage canals linked to main water courses and artificial channels. Grasses were cleared and burnt to facilitate the growing of maize and sweet potatoes, and the gardens were cropped with millet, pulses and cucurbits. The shishanjo gardens were cultivated for long periods

- *Mazulu (*mound gardens) were prepared on mounds/ant-hills that occasionally occur in the Barotse plain and provide "the most prized gardens and the only practicable site for building". The mazulu were located in the ecological belt called Bulozi, where they rise above the flood plain and form islands during the flood. These were very fertile and scarce. Each cultivator had only about 0.1 ha–0.2 ha, and only a few households could build huts on these mounds. The Lozis practised crop rotation as all the mounds were fertilised with staked cattle manure. Local maize, sorghum, cucurbits, pulses, cassava, sweet potatoes, yams, Livingstone potatoes, groundnuts, rice, vegetables, fruits and tobacco were all grown
- *Mukomena* (raised beds) were used for root crops, especially sweet potatoes, cassava and Livingstone potatoes
- *Matema* (upland gardens) were prepared on upland in cleared forest and thicket with a greater emphasis on the cultivation of cassava.

These intensive cultivation systems practised by the Lozi on the Zambezi flood plain and the upland made it possible for cultivators to grow a wide variety of crops permanently (del Rio, 2014), contributing to ensuring relative food security. To a more considerable extent, the approach of these food production systems has facilitated continuous cultivation, suggesting that these food production systems were sustainable and resilient, as the communities enjoyed relative food security. However, despite this, elements of vulnerability did always exist, especially those based on possible environmental shocks such as drought, excessive flooding, livestock epidemics, and the impacts of colonial policies (Mwananyanda, 2015). The agro-ecological conditions in the present-day Western Province are suitable. They support various crops, including maize, millet, sorghum, cassava, sweet potatoes, beans, groundnuts, yams, melons and sugarcane.

Luapula Province also uses the Chitemene system for cultivating African finger millet (Eleusine coracana) (Joy, 1993). Finger millet is used in brewing 'chipumu beer' to contribute several B complex vitamins to peoples' diet and cement reciprocal working relationships. When David Livingstone visited Luapula, he observed that the land was very fertile, with many villages and cassava gardens intercropped with beans or groundnuts (Kajoba, 2007). The cereals used in Luapula included millet, cassava and sweet potatoes. However, in the absence of forest, various ridging systems (ibala) are built on small areas planted with combinations of maize, beans, groundnuts and sweet potatoes usually relayed with cassava. These plots are typically tended by women and provide subsistence livelihoods (Joy, 1993). Fishing has long offered a much-needed protein supplement to the diet of people of Luapula, and it is a substantial revenue source. It is also linked to the type of crops grown, with fishing communities preferring to plant crops that require little time tendering, such as cassava, millets and so on (Schultz, 1976).

Zambia's official religion is Christianity (National Assembly, 2016). In this regard, Zambia recognises and upholds the multi-ethnic, multi-racial, multi-religious and multi-cultural character of its people. However, Christian values towards the environment are diversely anchored on different traditions. For example, Greenley (1993) asserts that some Christians believe humans were given a divine mandate to have dominion over the earth and increase in number. Sherkat and Ellison (2007) suggested that Fundamentalist Christian faith may encourage individuals to welcome growing environmental problems as positive signs of the Second Coming of Christ. This group was found by Sherkat and Ellison's (2007) study to oppose international treaties to address climate change, only supporting low-cost environmental policies.

It is possible to suggest that Muslim communities will have a greater focus on environmentalism than Christian communities (Hope & Jones, 2014). Islam has philosophical, ethical and theological overlaps with environmentalism, stewardship and harmonious values. Islamic teaching emphasises living in harmony and in 'balance' with creation and with Allah, who is all-encompassing (Sherkat & Ellison, 2007). It teaches that humans were responsible for acting as custodians of creation and promoting reverence for all forms of life, including the fair treatment of non-human species.

4.3.2 Social value of the environment

Placing a value on the environment is essential because it helps make a case for effectively protecting it. The pleasure of having a clean environment has resulted in some trade-off between environmental protection and the economic use of the environment. The economic concepts of 'willingness to pay' and 'willingness to accept' are central to the valuation of the environment. Environmentalists have also complained that people tend to have too high a discount rate, which militates against environmental protection. For example, tree growing is a long-term venture, and if the future values of the trees and timber are discounted at too high a rate, no one will invest in reforestation. Zambia Forestry Action Programme (ZFAP) activities were developed to reduce deforestation for non-timber products and prevent erosion (Kalinda & Bwalya, 2014; Turpie et al., 2015).

According to ZEMA (2017), economic considerations have guided traditional development concepts to exploit resources. In this regard, the focus has been on the maximum financial benefits, paying little concern for the side effects of development initiatives. Consequently, this scenario has led to environmental deterioration and high unforeseen costs that outweigh anticipated benefits. Wide-ranging negative impacts have manifested in ecological disturbances, including habitat destruction, loss of animal and plant species, desertification, soil loss and prevalent floods. The degrading environment raises concerns about global warming, deforestation and pollution. These factors present short and long-term negative impacts that the SNDP (MNDP, 2017) attempts to address. These include: climate change, ozone layer depletion, deforestation, agricultural land degradation, atmosphere and waterway pollution, and loss of habitat and biodiversity (Mweembe, 2008). Neverthless Sitali (2014) observed that the level of awareness in Zambia about environmental issues is strengthened by increasing environmental awareness activities.

For a long time, the Zambia government was solely responsible for addressing environmental issues. However, in recent years institutional reforms and strategies have moved towards cross-sectoral coordination that includes the government, NGOs and cooperating partners. In these strategies, increasing awareness in society on the significance, severity, cross-cutting and complex nature of environmental issues has aimed to limit negative impacts of environmental degradation in Zambia. To enhance these strategies, the government integrated Environmental Education into the primary school curriculum in the 1990s (Sitali, 2014) as a value-added recipe for changing people's attitudes and behaviours towards the environment. As citizens become more environmentally aware, the need to use resources such as electricity and water sustainably becomes more important. There is some evidence to suggest an increase in environmental awareness. This includes an increase in the number of articles on environmental issues in the print media, and programmes aired on both radio and television, as well as the inclusion of environmental curricula in training courses for journalists. There has also been a growth in the number of queries from the general public on environmental issues by telephone or letters/articles in the media.

Since 1985, Zambia has entered into many conventions, treaties and agreements to protect the environment and biological resources. The government also developed a number of environmental management policies to promote and maintain peoples' welfare, including the Environmental Protection and Pollution Control Act (EPPCA) 1990. They also created ZEMA in 1992. The EPPCA Cap 204 of 1990 recognises the importance of public awareness and education to help facilitate information exchange, and put relevant measures in place through donor support. This led to the establishment of the Zambia Network for Environmental Educators and Practitioners in 2002. Other bodies include the National Environmental Action Plan (NEAP) established in 1995, the National Conservation Strategy adoption in 1985, the creation of the Ministry of the Environment and Natural Resources (MENR) in 1991, and the introduction of the Wetlands Conservation Programme, and the Zambia Forestry Action Programme (ZFAP).

In order for NEAP to be successful, Environmental Education is needed. This promotes behavioural change by motivating people to act responsibly. Participating public institutions include the Ministry of Tourism and Arts (MoTA), the Ministry of Lands and Natural Resources (MLNR), the Ministry of Water Sanitation and Environmental Protection (MWSEP), ZEMA, Species Protection Commission, and government departments. Activities include public gatherings, formal environmental education in schools, workshops, and communication through a public announcement by ZANIS, electronic and print media. The need for promotion and encouragement of environmental protection measures was recognised by other institutions such as the Zambia Institute of Environmental Management, the World Wide Fund for Nature, and the National Parks and Wildlife Services Department.

However, measuring the environmental awareness level of a population is a challenge. One way is to measure a person's exposure to the natural environment or a place, and evaluate what opportunities this creates for awareness potential. Another way is through the environmental programmes that reduce human activities (Ogunbode & Arnold, 2012). The availability of environmental education, awareness campaigns, targeted programmes and the number of stakeholders in different groups may determine the success of measuring environmental awareness.

Increasing awareness of environmental problems has prompted the start of several environmental movements. Concerned individuals and organisations have written books, held meetings and made recommendations for overcoming the perceived challenges. However, it was only in the mid-1970s that United Nations Educational, Scientific, and Cultural Organization (UNESCO) made global environmental education a high priority. The goal of Environmental Education in Zambia is to develop a population that is aware of and concerned about the environment and its associated problems. This will create a community of stewards with knowledge, skills, attitudes, motivations and the commitment to work individually and collectively towards environmental solutions. A hands-on learning approach raises interest and awareness of environmental problems for many students and may significantly affect environmental attitudes (Makoba, 2014).

However, most Zambian youths choose to gain an income from natural resources rather than protect the environment (Youth Map, 2014). Youths in rural areas mentioned the importance of cutting trees for firewood and charcoal and felt sustainable alternatives would be needed to halt deforestation. In general, several youths put income and survival needs above environmental concerns. Some youth groups, such as the Zambia Youth Development in Monze and YEN Zambia, educate young people about environmental degradation and tree planting programmes in promising practices. Such programmes involve young volunteers who advocate for sustainable environmental practices within communities. Given the financial hardships youths face, protecting the environment is not a high priority for them in the short term.

4.4 Science and technology drivers

4.4.1 Key technologies affecting agricultural development

Several technologies are affecting agricultural development in Zambia and the impact on its ecosystems is discussed in the sections below.

Intensification of maize-based farming systems

Maize production and marketing have become priority sectors to diversify the economy of Zambia. In this sector initiative, input and output subsidies are provided. FISP was created to provide subsidised inputs to farmers and the FRA was created to handle marketing (Chapoto et al., 2015a). It is estimated that 50% of the agricultural budget goes towards inputs and outputs. Zambia relies heavily on a general fertiliser recommendation of one-size-fits-all across geographic locations and crops to ensure these programmes reach farmers equitably. This strategy has resulted in uniform inorganic fertiliser recommendations. Consequently, the government has continued to invest heavily in Compound D fertiliser, which is unsuitable for large parts of Zambia where the soils are acidic, thus affecting the soil biodiversity.

The environmental impact of maize mono-cropping is associated with nitrate leaching, affecting groundwater, especially where farmers resort to manuring or applying large quantities of nitrogen fertilisers. There is a close connection between nitrogen fertilisation for maize and the residual soil-nitrate values remaining in the soil after the harvest. Nitrogen fertilisation above the optimal nitrogen supply, especially, leads to an apparent increase in the risk of nitrogen being leached from the soil. Poorly managed soil fertigation methods would lead to underground contamination and affect soil biodiversity, besides reducing yields in the long run. In certain areas (above all those with permeable sandy soils), drastic measures are certainly needed to protect the groundwater long term. Improved fertilisation techniques could reduce leaching to improve absorption of a higher proportion of the plant's available nutrients, including nitrate. As such, the fertiliser quantity spread on maize fields should be regulated. Continuous maize cropping decreases soil chemical quality – the rate of decrease is more significant with ploughed fields than those farmed using no-till methods. It also reduces farmers' ability to use natural pest cycles, leading to an increased need for pesticides (Killebrew & Wolff, 2010). Lack of balanced fertiliser application destabilises the composition of nutrients and reduces the productivity of the soil. For example, fertiliser application that is heavily dependent on urea deprives the soil of specific minerals (JAICAF, 2008). Evidence suggests that reduced habitat for insects and wildlife is associated more with monoculture systems, affecting biodiversity (Killebrew & Wolff, 2010). In monoculture, the balance between pollinating agents such as bees, flies, moths, birds and insects is disrupted. Compared to polyculture, crops under monoculture tend to be less resilient to pests and diseases (Day et al., 2017).

Tillage systems

The conventional tillage system aims to plough regularly and deeply, thereby loosening the soil, promoting drainage, improving aeration, controlling weeds and mixing residues. Some practices such as mono-cropping and conventional tillage promote soil degradation. Aagard (2007) asserts that crops grown on soils that use conventional farming methods are degraded and highly susceptible to total failure in seasons of insufficient rainfall. Earlier, Siacinji-Musiwa (1999) estimated that 30% of smallholder farmland is degraded in conventional tillage.

In contrast, preparing land by hand and ox-drawn plough is common in sub-Saharan Africa, although commercial farms increasingly use tractor-powered tillage tools. Some scholars have attributed tillage to loss of soil structure, fertility and greenhouse gas emissions (Killebrew & Wolff, 2010). Tillage reduces soil organic matter, making soils less able to absorb and retain water and more prone to erosion and runoff. Many of tillage's environmental impacts stem from its detrimental effects on soil organic matter (SOM), the portion of soil that originates from animals and plants. An important indicator of overall soil quality, SOM provides many benefits to crops, such as protecting against erosion by binding and stabilising soil particles together, providing carbon and energy for soil micro-organisms, enhancing storage and transmission of water and nutrients, preventing soil compaction, and storing carbon from the atmosphere.

The SOM is reduced via oxidation of organic matter under the intensive tillage systems, causing the soil to be liable to compaction, absorb and retain water poorly, and be more prone to water loss from evaporation and rapid runoff. The soil may become susceptible to wind and water erosion, negatively affecting aeration and water quality available for crop uptake. This condition also reduces the soil micro-organisms, negatively impacting the nutrient cycling and regulating services these communities provide.

Conservation Agriculture

When correctly employed, conservation farming can improve the crop yields of several annual crops grown under rainfed systems (Haggblabe & Tembo, 2003; Mwansa, 2016). Conservation farming retains crop residues in the field, it uses minimum tillage, and promotes intercropping of crops with legumes. All these practices aim to improve soil organic matter and soil fertility, with minimum soil disturbance to limit soil erosion, and cut labour time for planting (Mbata-Zulu et al., 2016; Muchabi et al., 2014). It is also meant to increase returns to labour, purchased inputs, and profits. The promotion of Conservation Agriculture as a practice that improves water harvesting, soil fertility, and consequently crop productivity among small-scale farmers (including farmers in other parts of Southern Africa such as Zimbabwe and Malawi) has been around since the 1990s (Aagaard, 2007; Zulu-Mbata et al., 2016). According to Kasalu-Coffin et al. (2011), Conservation Agriculture can sustain high crop productivity and improve people's livelihoods amid the adverse effects of climate change. This practice is important for millions of farmers in Zambia and sub-Saharan African countries with climate-dependent farmers. Conservation Agriculture presents several benefits to soil health, but these benefits vary and are affected by management practices and the agro-ecological regions (Maccabi et al., 2014).

The three underlying principles of Conservation Agriculture are:

- Retention of crop residues
- Minimum tillage and minimum soil disturbance
- Intercropping and crop rotations.

Conservation farming employs integrated sustainable soil and water management techniques. It may be "generally defined as any tillage sequence that minimizes or reduces soil and water loss and achieves soil cover of at least 30 percent using crop residues". Operation forms such as animal draught power, manual and motorised power with either reduced or no-tillage of the soil are used in Conservation Agriculture. In order to avoid tillage, farmers use seeding equipment to place seeds without disturbing soils and crop residues. For minimum tillage, rip lines and basins are prepared for planting crops by tilling 15% of the land. Modern Conservation Agriculture in Zambia emerged as a by-product of technology transfer by large-scale commercial farmers (Bartle et al., 2010). Small-scale farmers living in low rainfall areas borrowed conservation farming techniques from large-scale farmers who had adopted these foreign minimum tillage techniques for their use much earlier.

The Conservation Agriculture technology was formally introduced to smallholder farmers in Zambia in 1996 by the CFU and the ZNFU, following the drought of 1995. The Zambia second National Policy of 2016–2021 promotes conservation farming in Zambia (MoA, 2016a), and it has been identified as one of the strategies to mitigate climate change by the MoA through climate change adaptation and mitigation. The Conservation Agriculture Programme is the most extensive programme currently being implemented by the CFU and Conservation Agriculture brings about many physico-chemical benefits on the soil, such as improving water movements, higher microbial activity, and soil respiration rate, which all translate into enhanced crop productivity. Improved soil respiration rate is an indication of the presence of organic matter and increased microbial activity.

Mechanisation of crop production systems, including the use of animal draught power

Increasing land under cultivation will invariably increase the demand and adoption of improved technologies and inputs. Additionally, mechanisation is also expected to address the challenge of poor returns to fertiliser application practices (MoA, 2013). Zambia's use of animal power covers Southern, Western and Eastern regions where this technology was introduced more than 90 years ago and is now common (Kaoma-Sprinkles & Maenad, 2000). In these areas, small-scale farmers have been able to own and cultivate relatively large tracts of land compared to farmers elsewhere, such as in the northern part of the country, where the use of draught animal power remains largely insignificant. In the past ten years, there has been a marked improvement in cattle rearing in Northwestern, Northern and Muchinga Province. The use of animal power has started to emerge, though farmers opt for more tractor-drawn in those areas. According to CSO (2017), Northwestern, Northern and Muchinga Provinces accounted for 2.6%, 2.3%, and 1.3% of the total cattle population in the country (3,456,668), respectively. Saasa (2003) suggested increasing Zambia's productivity by investing in animal draught power (Oxenisation). However, due to the myriad of animal diseases, especially East Coast Fever, the government and other cooperating partners have been introducing donkeys as an alternative source of animal draught power since the 1990s. However, this has not yielded much success (Hamoonga, 2015). Before the outbreak of East Coast fever, the average hectarage per oxen use was 3.4, but the introduction of donkeys as alternative to cattle in farming made Southern Province increase production, becoming a "food basket" in Zambia.

Integrated Soil Fertility Management

Integrated Soil Fertility Management (ISFM) combines agronomic practices relating to crops, mineral fertilisers, organic inputs and other amendments tailored to different cropping systems, soil fertility status and socioeconomic profiles (Roobroeck et al., 2016). Practising ISFM enhances the stability of yields under adverse rainfall variations. The uptake of nitrogen fertilisers and C sequestration by crops and soil has reduced greenhouse gas emissions. Better soil fertility management could result in high yields while avoiding adverse effects such as soil acidity and micronutrient toxicity. Acidity mitigating measures include tailored application methods, the use of supplementary inputs such as lime and phosphorus enhancers, or some combination of pH mitigation and management practices (Shitumbanumaet al., 2013).

Moreover, investments to identify the appropriate fertilisers for the various soil conditions and farming systems in Zambia will be necessary. A combination of investment in agricultural research and promotion programmes will be needed for soil acidity mitigation systems to achieve these goals. ISFM is a sustainable way of increasing soil fertility through traditional and new technologies (Sishekanu et al., 2015).

Agroforestry technologies

World Agroforestry (ICRAF) has developed knowledge practices that ensure food security and environmental sustainability and has resulted in the leverage of agroforestry practices globally. ICRAF has been conducting agroforestry research in and for all of the developing tropics. In Zambia, the knowledge produced by ICRAF enables the Zambian government, development partners, and farmers to use the power of trees to make farming and livelihoods more environmentally, socially and economically sustainable (Ajayi et al., 2003). One of the agroforestry technologies widely adopted in the subsistence-agricultural region of eastern Zambia is the improved fallow, which was introduced to improve soil fertility within a short span of two to three years. Other agroforestry technologies include enhanced biomass transfer, fodder banks, woodlots and indigenous fruit tree production. Since 1997, these technologies have been deliberately promoted through the public extension system, international and national research institutions, non-governmental organisations, and community-based organisations (Kabwe, 2010).

Cost-effective irrigation technologies

Despite the abundance of arable land in Zambia, the MoA (MoA, 2016a) estimates that just 14% of land is suitable for agricultural production. Less than 30% of the land has irrigation systems. Still, some scholars have reported considerable irrigation system development potential in the country (Mendes et al. 2014), and in this regard, the overhead centre pivot is the preferred irrigation system. Several irrigation types of equipment and service providers are on the market. Suppliers are typically local branches of international operations capable of providing after-sales technical services for the imported equipment. The government in Zambia has encouraged actors by removing import duty on irrigation equipment (MoF, 2013).

Investment opportunities exist in the irrigation sector, directly through commercial agriculture and indirectly through supply chains with the horticulture vegetable, sugar and winter maize supply chains being well serviced (MoA, 2016a; MNDP, 2017). SNAP and SNDP support irrigation technologies for small-scale and medium-scale farmers by relaxing rules related to accessing finance, helping to return the capital invested in these technologies within several crop cycles. Poutiainen & Mills (2014) reported new dams to increase irrigation facilities for farmers under the World Bank-funded IDSP project. In addition, Zambia has seen investments by emergent and commercial farmers in modern irrigation technologies, such as drip lines for vegetable production, micro-jets, and bubblers for tree crop production, and overhead centre pivots for arable crops and sugarcane production. Mendes et al. (2014) reported new fruit, sugarcane, vegetables and wheat production investments. These initiatives have led to a dramatic escalation in the value of imported irrigation equipment, with an annual average growth rate of 40% in three years up to 2012. The investment reached more than US$70 million, with commercial farmers accounting for most imports, particularly the overhead centre pivots at 45% and gate valves for water supply making up 39%. Commercial farmers drive the expansion of irrigation in Zambia, allowing the supply and service companies to take advantage of the market opportunities.

The wetlands and inland dambos cover about 100,000 ha, located in peri-urban and rural areas. Small-scale farmers use these to produce vegetables and maize in the dry season for household consumption and income (Mendes et al., 2014). These farmers use a combination of tools and equipment that include buckets, watering cans, treadle pumps and motorised pumps to water the crop. Improved access to a range of generators and electrical power pumps, and the recent fall in the prices of motorised pumps has led to the increased use of treadle and motorised pumps for irrigation. The motorised pumps are often sold at a discounted price compared to treadle pumps. One of the private sector actors involved in the irrigation market is the International Development Enterprises (IDE), an international non-profit organisation that works in the irrigation supply chain. IDE focuses on low-income producers engaging in irrigated horticulture using appropriate technologies (Mendes et al., 2014). IDE also promotes group funding as an opportunity to share early-stage risk in the small-scale irrigation subsector. Since its inception in 1997, IDE Zambia has been developing the treadle pump alongside the low pressure or low-cost micro drip irrigation technologies for small-scale farmers. This has enabled several small-scale vegetable growers to access irrigation facilities.

Integrated Pest Management

Integrated Pest Management (IPM) technologies aim to suppress pest populations below the economic injury level (EIL) using different environmentally-friendly techniques such as cultural, physical, biological and biopesticides. At the same time, chemical control is the last resort (Muniapan, 2015). IPM considers all pest control methods integrated with measures that prevent or minimise pest populations' expansion. IPM can lead to healthy crops by minimising possible agro-ecosystem disruptions and encouraging natural pest control mechanisms. It also helps reduce or minimise risks to human and environmental health by keeping pesticides to environmentally acceptable levels.

Zambia has been extensively applying pestcides in cash crop production such as cotton and horticultural crops. In this farming practice, farmers tend to use several synthetic pesticides to control different pests (Matthews, 1996). The IPM can be used to manage invasive species that have been introduced to reduce risks while maximising benefits and reducing costs. It is a good management tool kit for invasive pests such as *Tutu absolute* in tomatoes (CABI, 2017) and Fall

Army worm (Prassana et al., 2018). The requirement for adoption of IPM in farming systems is emphasised by the MoA (MoA, 2016a) and donors such as the World Bank, which supports safe, effective and environmentally-sound pest management aspects, such as the use of biological and environmentally-friendly control methods (MNDP, 2019).

Biotechnology

Cassava (*Manihot esculenta* Crantz) is usually propagated vegetatively using cuttings and is a staple root crop in most parts of Africa. Cassava is the fourth essential and cheapest staple food crop after maize, wheat and sorghum in Zambia, mainly found in the AER III. However, cassava production in Southern Africa is susceptible to various diseases such as Cassava brown streak disease (CBSD) and Cassava mosaic disease (CMD). The cassava brown streak virus (CBSV) causes CBSD, and CMD is caused by several whitefly-transmitted begomoviruses (Bisimwa et al., 2012). CBSD and CMD cause enormous losses to cassava production. Other diseases that affect cassava production include the African cassava mosaic virus in Mozambique, South Africa, Swaziland, Zambia and Zimbabwe (Berry & Rey, 2001). The East African cassava mosaic virus was also reported in that region. The South Africa cassava mosaic virus was detected only in South Africa and Swaziland. Fondong (2017) reported mixed effects attributed to cassava mosaic Geminiviruses in the stem cuttings causing more damage than single infections (Thresh et al., 1994).

Tissue culture is a biotechnology technique used to produce virus-free cassava. In this technique, tissue culture regeneration techniques and selection methods are used in plant propagation. Some practices incorporate genetic engineering and plant molecular markers. For example, the ZARI scientists in Zambia, with their international collaborators, have set up protocols for genetic engineering aimed at overcoming inherent heterozygous problems, inbreeding depression, the polygenic and recessive nature of many desirable traits. By using tissue culture, scientists have been able to produce high-yielding, virus-resistant cassava cultivars. Under the Cassava Commercialisation component of the Skills Development and Entrepreneurship Project Supporting Women and Youths (SDEP-SWY), funded by AfDB and coordinated by CEEC, ZARI has been producing CMD-free planting materials distributed to farmer groups in Luapula and North-western Provinces (AfDB, 2015). The project aims to support the cassava value chain in Luapula, Northern and Northwestern Provinces, with market development interventions extending to Lusaka and Copperbelt Provinces, considering the proximity to the Copperbelt and Congo where large markets exist.

Use of ICT

Good communication systems between various agricultural development actors are essential for transferring new and improved agricultural technology. These tools include email, internet, phone, radio and TV. Previously the government has relied on radio/television broadcasts, printed materials, and mainstream extension services to disseminate information. Agriculture programmes for small-scale farmers were initiated as early as the mid-1960s with assistance from UNESCO. In that system, some radio programmes, ‘Radio Farm Forum Groups’, were set up in rural communities across the country, with the motto of ‘Listen, Discuss and Act’. In recent years, the International Institute of Communication for Development (IICD) and the Department of National Agricultural Information Services (NAIS) have provided financial support to develop an internet-based platform. This allows farmers to use mobile phones to send questions on their most pressing farming problems. NAIS receives queries and provides appropriate answers within the shortest time possible. According to Zambia Information Communications Technology Authority, there were 2.2 million unique subscribers to mobile cellular providers in 2015 (ZICTA, 2015). It is estimated that in 2018, there were more than 15.4 million active cellular phone subscribers and 9.8 million mobile broadband users in Zambia. In terms of age distribution, 41.3% of the users were below 24 years. Thus, the appropriate use of ICT technologies in agriculture can improve productivity and competitiveness, as recognised in both SNAP and SNDP (MoA 2016a; MNDP, 2017).

The government wants to make mobile phone communication reach all corners of the country so that everyone can communicate and access the benefits of ICT technologies. The MoA included several agriculture value chains and explored social media platforms such as WhatsApp and Facebook in extension service delivery. They have been piloting an SMS and web-based extension service platform to facilitate information sharing with and among farmers. They can use this to help with managing crop pests such as *Tuta absoluta* in tomatoes, to information on prices in the input and product markets, and publicise agricultural events such as agric fairs and shows, and so on. Using mobile messaging, weather index insurance for farmers is being implemented across the country, together with the e-voucher system for the FISP (MoA, 2016a). The FISP electronic voucher initiative implemented by the MoA since the 2015/2016 farming season has opened a window of opportunity for smallholder farmers to diversify their farming enterprises (Hamasaka, 2016). Apart from improving beneficiary targeting and promoting timely access to inputs by increasing private sector participation, the e-voucher programme has the potential to accelerate the diversification of the smallholder sector by allowing farmers to purchase a wide range of recommended inputs such as veterinary drugs, agricultural equipment, livestock, poultry and fingerlings. Market information services (MIS) delivered through mobile phone SMS platforms help increase household incomes, reduce marketing costs and improve the social welfare of small-scale farmers. They also reduce costly and time-intensive travel associated with the marketing of agricultural produce. The SMS platform is also useful in rural areas as most small-scale farmers do not have computers and are computer illiterate, but almost all of them have mobile phones and can operate them with ease.

4.5 Physical, biological and chemical drivers

4.5.1 Ecosystems, food systems and climate impacts

a. Impact of climate change on ecosystem and food systems

Like many countries in sub-Saharan Africa, Zambia is impacted negatively by climate variability arising from increasing temperatures, variations in rainfall and possible increases in the frequency and intensity of weather events (Irish Aid, 2016). Climate change brings adverse effects on socio-economic development, particularly for the vulnerable sectors of the economy. In this regard, forestry and water resources have been altered, affecting food security and human health. It is estimated that since 1960 the temperature has increased by 1.3°C (an average of 0.29°C per decade) (USAID, 2012). Daytime temperatures have also increased above 30◦C between 1980 and 2010. The increase in the frequency and intensity of floods is another challenge impacting agriculture. According to Mulenga et al. (2016), the rising temperature has affected crop yield due to stunted growth.

Climate models for the period 2010 to 2015 predicted that Zambia would experience variability in rainfall patterns and temperatures beyond 2015 (Mulenga et al., 2015). The variability depends on the model, but there is consensus that the country will experience a warming effect and decreased rainfall, affecting evapotranspiration (Mulenga et al., 2015). The growing seasons for crops will be shorter, directly affecting crop yields. According to McSweeny et al. (2010), the mean annual temperature in Zambia is projected to increase by 1.6 to 5.5°C by the 2090s and 1.5 to 2.5°C under any emission scenario. The provinces that will be affected most are those in Southern and Western Zambia. It is also projected that the frequency of hot days and hot nights are likely to increase under climate change scenarios. The projections also show a decrease in rainfall pattern and amount between September and November, rising from December through January. On an annual basis, models do not predict any significant increase in rainfall. The monthly variability in intensity and length of rain affects seasonal crops.

Models also indicate that climate will adversely affect livestock. Pests are likely to thrive under increased temperatures that will threaten crops and livestock. Evidence suggests there will be a breakout of new pests that will spread and consequently increase animal diseases, particularly in mid-latitude areas (Epstein et al., 1998; Gommes & Fresco, 1998; IPCC, 2007). IPCC (2007) reported a bluetongue disease affecting sheep and goats, spreading from the tropics to the mid-latitudes. Agriculture will be affected in various ways, including (i) the need for more expensive resources to curb the spread for most resource deficient farmers; (ii) the resistance of pests and diseases to most chemical products will affect yield and livestock productivity.

Consequently, combining these factors will negatively impact the households dependent on agriculture as their primary source of household income. Women in rural populations will be most affected. According to CSO (2018a), the agricultural sector accounts for about 67% of the labour force, most of whom work as subsistence farmers or farm workers, and who are primarily women. It is estimated that 90% of them are in informal farming (CSO, 2011). With rural poverty levels around 83% (CSO, 2016d), the continued alteration of the climate will have a marked general negative effect on the country, with severe consequences for the rural population that depend solely on agriculture for survival.

b. Parts of the Zambian economy affected by climate change

i. Food security

In the past 20 years, the frequency of drought and unevenly distributed rainfall in the country's farming regions in Central, South and Southwestern Zambia have resulted in crop loss and food insecurity (USAID, 2012). Climate change will reduce agriculture productivity and negatively impact food security due to crop failure. For example, the drought of 1992 resulted in a substantial crop failure. In the northern part of Zambia, floods continue to inundate farmlands, destroy crops and lose livestock, thereby threatening food production (Irish AID, 2016; McSweeney et al., 2010). Climate change will bring about altered agronomic conditions such as thermal regimes, growing periods, soil properties and precipitation that will hitherto affect food security. However, the different agro-ecological zones of the country will experience different effects of climate change, with AER I being more severely impacted than other agro-ecological zones. Climate change will magnify the already low crop yields experienced by smallholder farmers, for example, maize, 1.2 MT/ha, which are the lowest compared to other African countries (FAO, 2010), and similarly, low livestock numbers (Phiri et al., 2013). This trend towards common crop and animal productivity will lead to widespread food insecurities. Projections indicate that crop yields from rain-fed agriculture will decline by up to 50% by 2020. This reduction in agriculture production will significantly contribute to the existing high poverty levels in rural areas. According to Thurlow et al. (2008), models predicted that the country could lose about US$4.3 billion in agriculture GDP in a period of ten years from 2006–2016 due to the adverse effects of climate change.

ii. Reduced cultivatable and rangeland

The continued rise in temperatures, dwindling rainfall, and increasing evapotranspiration are expected to cause more areas to become arid, reducing crop and livestock production. This situation will further lead to increased pressure on land, which may trigger conflict and risk national security. If the government does not take corrective measures, there will be reduced grazing land and cropland, alongside other factors such as limited extension services or poor seeds. Other noticeable effects will be further reductions in yield resulting in national food insecurity. Of the three agro-ecological zones, the negative impact of climate change will be felt most in AER I. Farmers will have to develop coping strategies such as reducing livestock herds to sizes that can be sustained, using different crop varieties and switching crops; and reducing farmland sizes under cultivation (Phiri et al., 2013). The results of all these effects will be reduced crop and livestock production. Though the projected reductions in cultivatable land and rangeland are unknown, they are likely to be high.

iii. Livestock losses

High livestock mortality is caused by the virulent strains that change farming systems. Grazing land for livestock will be severely affected by low rainfall patterns, resulting in frequent migrations of pastoral farmers to areas with greener pastures. Consequently, migration will encourage the transfer of diseases, especially from wildlife to livestock. According to Nambota et al. (1994), wildlife are carriers of livestock diseases, such as a malignant form of Theileriosis that broke out in Monze District in 1977/78. Foot and Mouth Disease is thought to originate from buffaloes and diseases such as rabies, rinderpest, trypanosomiasis and anthrax are common (Nambota et al. (1994).

Apart from providing draught power, livestock farming generates organic manure, a vital source of income. The traditional sector is responsible for the largest population of livestock farming in Zambia, comprising 64% of sheep, 90% of pigs and 97% of goats. As a result of resource limitations, this sector's improvement is earnestly hindered. The infestation of livestock diseases and limited extension services are among the major setbacks to the sector's productivity. The tick-borne diseases, African swine fever, Theileriosis, Anaplasmosis, Newcastle Disease, Foot and Mouth Disease, Contagious Bovine Pleuro Pneumonia, and Trypanosomiasis are the economically significant livestock diseases in Zambia. Climate change will directly or indirectly modify the infestation of livestock by these diseases coupled with inadequate nutrition, causing a reduction in livestock populations. This situation will further result in reduced food for resource-poor rural communities and reduced household income.

In Zambia, most livestock is indigenous and has evolved and adapted to harsh environmental conditions such as high temperatures, endemic diseases and poor feed. According to the Zambian Livestock Development Plan (2000–2004), the country has encouraged the replacement of indigenous breeds with exotic breeds over the past 30 years. The result of this selection pressure against local breeds will be the loss of unique adaptive characteristics suited for climate change. The sector should be climate resilient to minimise effects such as loss of rangelands, the rising rates of pathogen transmissions, and possibly, increasing the quantity of infective forms of pathogens.

iv. Water resources

The frequent occurrence of droughts, flash floods and high temperatures in Southern-western parts of Zambia are evidence of climate change that negatively impacts water resources. Although water supply from the surface and underground in Zambia is sufficient, surface water is not distributed evenly across the country. For example, the southern region experiences water shortages compared to other areas (Fumpa-Makano, 2011; MTENR, 2010, USAID, 2012). While the 2006–07 floods affected more than 1,443,583 people in 41 districts across Zambia, the 1991–92 droughts were the most severe. According to Lekprichakul (2008), the droughts of 2004–2005 damaged crops in two-thirds of Zambia, compelling the government to import food. Floods affected 238,254 people in 39,709 households in the 2009/10 season (MTENR, 2010). It is likely that heavy rains are likely to cause floods and siltation of rivers and streams, affecting water resources. The reduction in the flow and volume of rivers, streams and lakes in some parts of the country have affected the accessibility and availability for various end uses (id, 2016). In flood situations, water pollution from fertilisers and chemicals becomes inevitable, affecting human health. Water resources are also affected by industrial and anthropogenic pollution, and increased demand for water sources for household, agricultural and industrial use.

v. Health

Public health is also affected by climate change, with floods spreading waterborne diseases such as diarrhoea, cholera, respiratory infections and malaria (Winthrop et al., 2018). For example, USAID (2012) found that cholera and diarrhoea outbreaks were strongly associated with the quantity of precipitation and inadequate drainage systems. Health problems caused by climate change are compounded by insufficient healthcare facilities, high poverty levels, inadequate water supply and sanitation, food insecurity and poor nutrition (Kasali, 2008).

Increasing numbers of people with HIV/AIDS strain the budget of public health service provision in Zambia. Added to the list of problems are vector-borne diseases interrelated with AIDS, such as dengue, yellow fever and sleeping sickness, all sensitive to temperature and humidity changes (ITUC, 2012). Chronically poor environmental conditions (environmental degradation) or environmental stress (extreme climate events) create conditions pertinent to the development and spread of infectious diseases through migration and food shortages, forcing people to indulge in activities or behaviours for survival that they would otherwise not have engaged in.

vi. Mining

Industrial pollution to air, soil and water is a characteristic of mining industries across the globe. Evidence shows that mining pollution affects human health. In Zambia, the mining industry is located in the Copperbelt and Northwestern Provinces and they are, therefore, the country's most polluted regions. The mining industry is a large electricity consumer, but disruptions caused by frequent load shedding threaten this industry (Slunge & Wingqvist, 2010). Mines also consume vast amounts of fossil fuels while coal-fired smelters generate greenhouse gas emissions, highlighting new challenges for the government related to environmental and social safeguards, licensing, control and enforcement.

vii. Tourism

Tourism is a growing industry in Zambia with the potential to contribute significantly to the GDP. Zambia has National Parks and GMAs perfect for wildlife tourism and hunting, waterfalls and rapids, and national monuments that attract tourists (Laohasinnarong et al., 2015), as well as livelihood activities for households near parks and GMAs (FEWSNET, 2014). Climate change and variability impact the water resources needed for wildlife in parks and GMAs that negatively impact tourism (Fumpa-Makano, 2011). A healthy ecosystem is necessary for tourism to thrive, but evidence suggests that such ecosystems and habitat have been threatened by climate change and anthropogenic activities (MLNR, 2009; Lindsey et al., 2014). To support the tourism industry, the development and maintenance of infrastructure (energy, roads, water and services) are needed while maintaining the ecosystem integrity of tourist sites.

viii. Energy supply

The energy mix in Zambia includes biomass energy (74%), electricity (16%) and petroleum (10%) (Ng'andwe et al. 2015). Woodfuel is the main component of biomass energy, of which charcoal production accounts for the most significant proportion. According to Dlamini et al. (2016), charcoal accounts for 75% of the energy requirement in the country. Gumbo et al. (2013) reported that charcoal production contributes 3.7% to Zambia's GDP. However, due to its inefficient production process, charcoal production has been identified as one of the significant drivers of deforestation in Zambia, contributing to climate change (Vinya et al., 2012; Shakacite et al., 2016). The projected reduction in forest cover (Shakacite et al. 2016) will decrease biomass energy production due to unsustainable tree harvesting for charcoal production and reduced tree growth due to climate change. The drought frequency reduces water resources and tree growth. In addition, the rising temperature will cause abnormal evapotranspiration from dams (eg, Kariba dam and Kafue gorge) that will affect hydroelectricity generation. Floods will cause considerable impacts on power generation as well.

ix. Infrastructure and transport

Climate change brings about extreme weather patterns such as increasing temperatures and floods. According to Slunge and Wingqvist (2010), the railway, road and bridge infrastructure is negatively affected by climate change. Increasing temperatures will cause railway lines to buckle and floods will cause bridges to collapse. A negative impact on the road infrastructure would affect economic development (Chinowsky et al., 2015). There is a need to assess risks posed by climate change to existing infrastructure and change the design standards for certain types of infrastructure to incorporate a changing climatic regime, as noted in the SNDP.

c. Impact on vulnerable ecosystems

i. Forests and grasslands

Forest lands (evergreen, deciduous, forest woodlands and plantations), other wooded lands (eg, grasslands) and other lands (eg bare lands) are of ecological, economic and social importance in Zambia. The forest cover in Zambia is estimated at 60% (Forestry, 2016). These land resources provide goods and services to communities and industry, supporting human health and livelihood

(Shakacite et al., 2016). Forest and woodland ecosystems are habitats for flora and fauna that attract local and foreign tourists (Forestry, 2016). Climate change associated with warmer temperatures and reduced rainfall patterns may lead to the loss of forest cover (vegetation loss). So will drought, floods, soil erosion and a combination of factors such as unsustainable use of wood fuel and land conversion to agriculture and infrastructure development (USAID, 212; Shakacite et al. 2016).

ii. Wildlife

Protected areas in Zambia include 20 National Parks, two wildlife sanctuaries, one bird sanctuary, and 36 GMAs covering more than 30% of the country's land area. The size of the National Parks is estimated at 6.3 million ha, GMAs cover 16.6 million ha, and 115 game ranches cover 578,100 ha (MoTA, 2018; Sichilongo et al., 2012). Evidence suggests that climate change brought about increases in water scarcity and reduced the quality of fodder for wildlife (Slunge and Wingqvist, 2010; USAID, 2012). Consequently, the habitats and ecosystem for wildlife have been altered, compelling wildlife to migrate into areas with human settlements and affecting their diversity and abundance (Slunge & Wingqvist, 2010). For example, crocodiles and elephants migrate to human settlements and agriculture fields during flood episodes, causing human/wildlife conflicts.

iii. Recent climate trends in Zambia

Since 1960, temperatures in Zambia have increased by 1.3°C, a decadal increase of 0.29°C on average, while annual rainfall has decreased by 1.9mm per decade (Winthrop et al., 2018). The winter season has been warmer, while the frequency of hot days increased by 43 per annum from 1963 to 2003. Arslan et al. (2014) reported rising temperatures in the Southern Africa region ranging from 0.6 to 1.4 °C by 2030. Their predictions were based on Global Climate Models (GCM) covering 1980–2000 to 2020–2040.

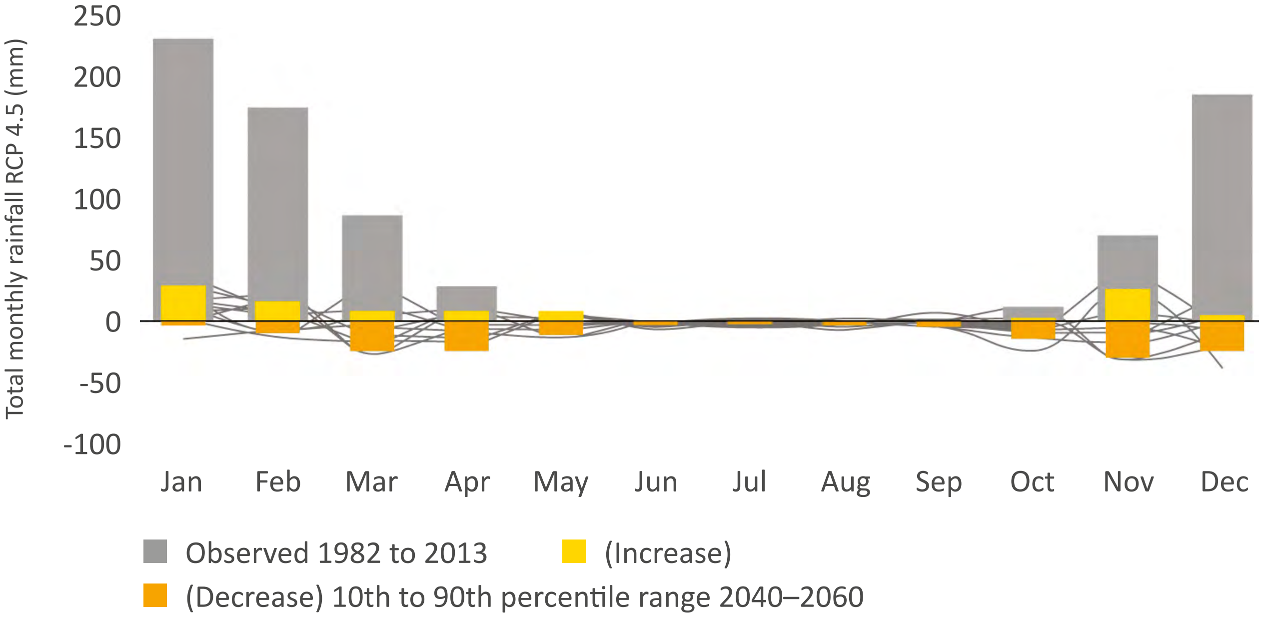
No significant increase in the frequency of heavy rainfall events has been observed since 1960 (Irish Aid, 2016). When comparing the effect of climate change on the agro-ecological regions, Saasa (2003) reported that AER II and III might remain very productive with high maize yields, compared to AER I. The recent trends indicate that droughts experienced in 1992, 1994, 1995, 2002 and 2005 impacted maize yields in Zambia. The predicted climate trends associated with the reduction in precipitation, short growing seasons, warming and floods will result in poor quality of products, low fodder production, increased animal diseases, increased aridity and overall low productivity across regions. In this regard, changes such as the switching of farming systems that encourage more cash crops and early maturing maize varieties have become necessary. Thurlow et al. (2011) predicted that the variability in rainfall is likely to affect agriculture more significantly compared to long-term changes in temperature, reducing maize yield by 30%. And Arslan et al. (2014) suggested a general decline in crop yields in the absence of adaptation measures. Based on specific models in Zambia, Kanyanga et al. (2013) say significant warming would affect AER I, while decreased annual rainfall trends will affect AER I and II, and increased rainfall trends will affect AER III. As a result of these projected impacts, maize yield losses will concentrate in Southern and Eastern provinces where most maize production occurs. The situation underlines the importance of understanding how climate change impacts yields and encourages the practice and understanding of Climate-Smart Agriculture (CSA) practices (Kanyanga et al., 2013).

d. What are likely future weather patterns based on downscaled climate models for Zambia?

Climate projections

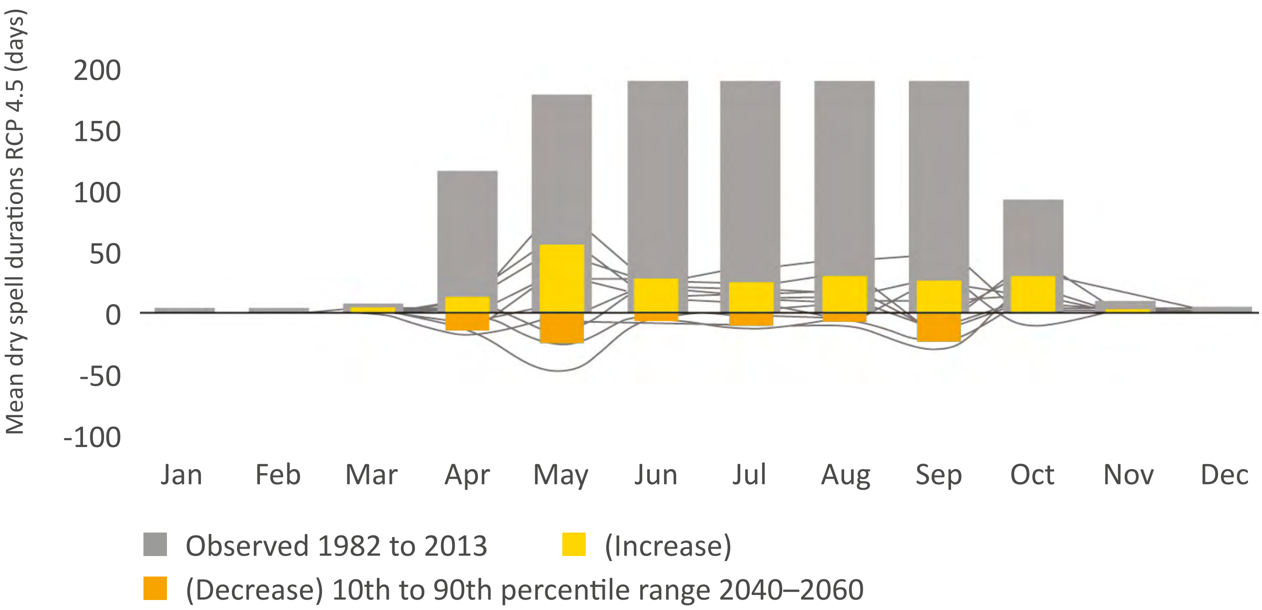
There are two sources of Global Climate Model (GCM) projections applied in Zambia, namely: models available through the CMIP5 archive, under the United Nations Intergovernmental Panel on Climate Change (IPCC) in its Fifth Assessment Report (AR5) (IPCC, 2014) and a series of 'downscaled' climate projections for Lusaka province (Figures 27 and 28).

Figure 27. Downscaled total projections for total rainfall in Lusaka



Source: Creese & Pokam, 2016

Figure 28. Downscaled total projections for a dry spell in Lusaka



Source: Creese & Pokam, 2016

The likely future weather patterns will be associated with an increase in temperature by 1.2 to 3.4^{O}C and more pronounced in western and southern regions of Zambia. These regions are predicted to have an increase in the number of hot days and nights. There will be no substantial increase in annual rainfall, but the model predicted a decrease from September through November and an increase from December to January. Regarding regional trends, the National Adaptation Programs of Action of Zambia predicted a reduction in rain in AER I and II in southern and central provinces and increased precipitation in AER III. The heavy rainfall events are likely to increase. These trends will impact negatively on the forest, water, energy, wildlife and other sectors of the Zambian economy.

According to Ndebele-Murisa et al. (2013), nine models were employed to predict the possible future climate of Lake Kariba in North-western Zimbabwe under the Intergovernmental Panel on Climate Change's (IPCC) A2 and B1 emission scenarios for the near (2046–2065) and far future (2081– 2100). The models predicted a drier climate with an average decrease in rainfall ranging from 3% to 27.46%. However, the models indicated an increase in the early rain in October, November and March under scenario A2, with an increase in minimum and maximum temperatures of 3.17–3.42ºC. Based on the polynomial (order 3) model, the implications of climate change indicated a decline in sardine fish production (*Limnothrissa miodon* (commonly known as Kapenta). This situation suggests a need for strategies for fishery management in Lake Kariba.

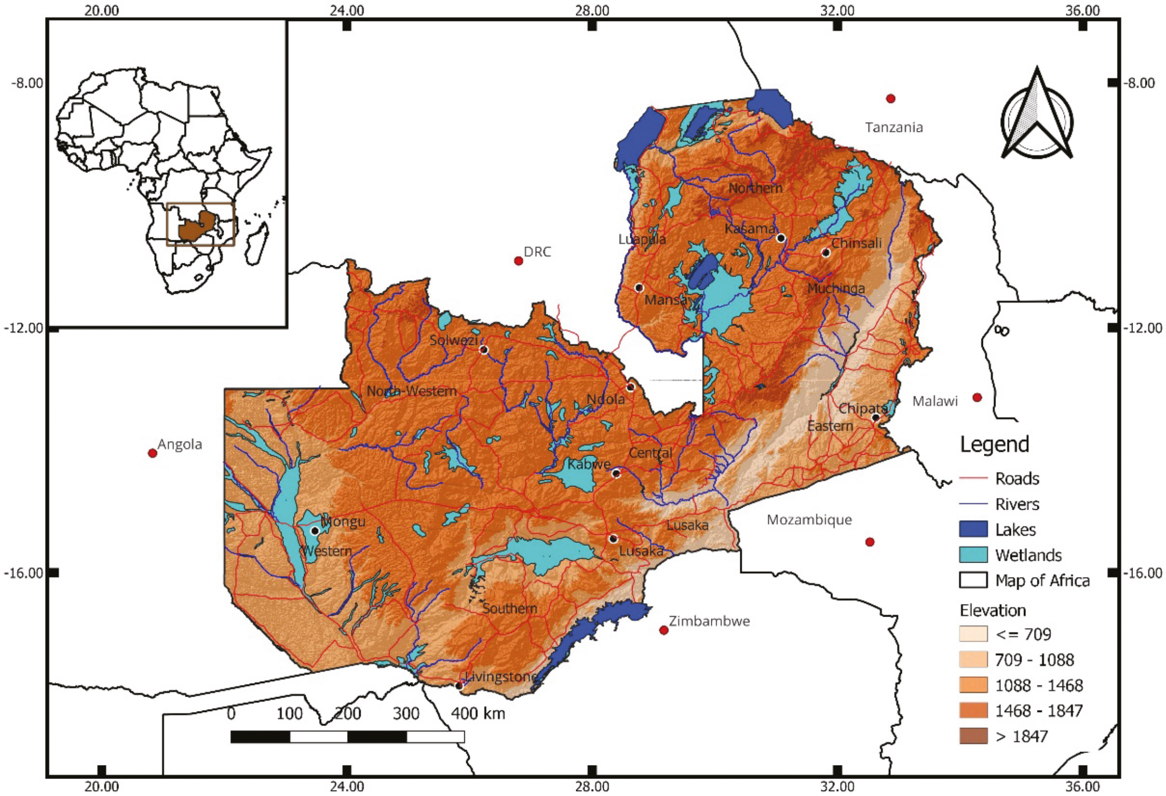
Analysis of crop sensitivity to climate shocks shows that maize will be among the most negatively affected crops, with significant yield reductions due to anticipated future climate patterns. This decline has policy implications and requires the country to implement policies and programmes that support diversification into other crops such as cotton, cassava and sunflower by smallholder farmers. This will minimise the effect of future climate variability and change. In terms of adaptation, smallholder farmers are likely to move away from the current cropping pattern of growing more local maize to growing more hybrid maize and other drought-tolerant crops such as cotton, sunflower and cassava. However, these strategies will only partially mitigate the effects of climate variability and change. Therefore, this strategy requires larger-scale adaptation measures such as heat-tolerant seed varieties, agricultural investments in research and extension, policies to reduce risks for smallholder farmers and enhance their adaptive capacities (for example, weather index-based insurance, access to credit).

Zambia has great potential to contribute towards mitigating climate change through prudent management of its forest resources, given its vast forest cover. Prudent management of forests resources requires a comprehensive understanding of the drivers of deforestation and designing policies and programmes to curb deforestation and forest degradation. Other potential mitigation options include agroforestry, afforestation and forest restoration. There is increasing evidence on the drivers of deforestation in Zambia, with agricultural land expansion and wood fuel, primarily charcoal, being the two most important drivers. Hence, there is a need for multi-sectoral policies and programmes to improve agricultural productivity to meet growing food demands, raise forest rents, and create alternative livelihood sources to curb deforestation and forest degradation. More research is needed on the carbon sequestration potential of agroforestry, afforestation conservation agriculture, and forest restoration in Zambia. Further, there is a need for energy policies and programmes to promote alternative fuel sources. Various policy instruments such as tax incentives or subsidies, and alternative cooking fuel sources like liquid petroleum gas, are attractive to reduce charcoal demand.

4.5.2 Impacts of topography and agro-ecological regions on agriculture development

Plateaus, hills and mountains characterise most of Zambia's land (Figure 29). The lowest elevation is found along the Zambezi river at 329m above sea level and the highest at 2,339m in the Mafinga Hills. Most of the land in Zambia is arable, suitable for agriculture production of various crops (AU/NEPAD, 2013).

Figure 29. Map of Zambia showing physical features



The mechanisation of agriculture depends entirely on the topography of the land. Topography affects agriculture as it relates to soil erosion, difficulty of tillage and poor transportation facilities. On rough, hilly lands, the use of agricultural machinery is impossible. The central plateau areas of Zambia are the most productive regions, and soil is easy to work. The suitability of the soils has been well documented over the years (MACO, 2003). Wetlands, including the dambos, are essential for the livelihoods of many small-scale farmers. They cover about 5% (3.6 million ha) of Zambia's total land area (MLNR, 2018).

Given that precipitation and temperature influence agriculture, climate change in all the agro-ecological regions will produce direct and indirect negative impacts. For example, JAICAF (2008) reported that AER II experiences minimum and maximum average temperatures of 9°C and 23°C in July, respectively; 17°C and 26°C in January respectively, and an annual average rainfall above 800mm (JAICAF, 2008; MoA, 2015). According to JAICAF (2008), these conditions support commercial agriculture production activities concentrated in the region.

The AER I is characterised by high temperatures and a high frequency of droughts. As a result, Campbell (2010) observed a gradual shift of commercial production to AER II and III and use of drought tolerant sorgum, cowpeas and millet in AER I (AU/NEPAD, 2013). It is estimated that 42 million ha of land suitable for agriculture is located in AER II and III, with rainfall ranging from 800mm to 1,400mm per annum (MoA, 2016a). Most plantation crops such as pineapple, coffee, tea and eucalyptus trees are located in AER III, the region with the highest rainfall.

Zambia accounts for about 60% of the water resources in Southern Africa, making it ideal for significant corporate agricultural investments (AU/NEPAD, 2013; ZDA, 2014a) such as Nakambala Sugar Estates in Mazabuka and Masstock in Chiawa. The Kafue sugarcane estate across the central region is located in this area. Due to the abundance of water, the Luapula river and some wetlands such as Luena plains, new sugarcane plantations have been created in AER III. To the west of the country, cashew nut and mango are grown, as these prefer the Kalahari sandveld (ZDA, 2011).

4.6 Socio-political drivers

4.6.1 Key policies driving agricultural production systems

i. Seventh National Development Plan (MNDP,2017)

The Seventh National Development Plan (SNDP) (GRZ, 2017) is the central guiding policy for the agriculture sector in Zambia, anchored on the strategic vision of becoming a prosperous middle-income nation by 2030. In this plan, Zambia's plan for sustained economic growth and socio-economic transformation is driven, among other things, by agriculture, tourism, manufacturing and mining. The SNDP aspires to accelerate development across all economic sectors, encourage diversification and create a resilient economy. The primary outcomes are job creation and economic diversification; reduced developmental inequalities; poverty and vulnerability alleviation; improved human development and an improved environment for governance to enable an inclusive and diversified economy. The SNDP recognises agriculture as a critical driver of a diversified economy and ingredient to poverty reduction in Zambia, with two major leverage effects. First, the overall process of structural transformation will be achieved by improving farmers' incomes, which will support rural demand, resulting in new activities and local economic diversification. Second, increasing agricultural outputs will lead to the development of downstream and upstream activities. In this way, value chains will be cemented, resulting in the expansion of the agro-industries – important sources of job creation and an opportunity for further diversification of the economy. Additionally, organic fertiliser presents a competitive advantage over chemical fertiliser in relation to costs. It will reduce import bills from chemical fertiliser, improve export revenues from organic products and enhance local value addition in organic fertiliser production.

The main focus in the agriculture sector has been crop production. However, due to urbanisation, increased incomes and population growth, there is a never ending demand for other products such as livestock-derived products and fish. This offers an opportunity for agricultural diversification. Fish is a source of livelihood for people near water bodies and provides high-quality animal protein and opportunities for aquaculture and other related industries. Therefore, as rains become less predictable and erratic due to climate change, diversification in agriculture will be central in enhancing productivity, offering inputs to the manufacturing and agro-processing sector for increased contribution to foreign exchange earnings and resilience to emerging challenges. Incorporating climate-smart techniques is vital to becoming resilient to natural shocks such as drought and weakening seed and animal varieties resulting from climate change. Agro-diversification and development will thus be based on comparative and competitive advantages in line with the government's Green Revolution agenda.

The main policy instrument influencing agriculture is the Second National Agricultural Policy 2016 (SNAP), supported by the National Food and Nutrition Policy, the National Water Policy, the Biosafety Policy, the National Policy on Environment, and the National Forestry Policy. These are outlined below:

ii. Second National Agricultural Policy 2016 (MoA, 2016a)

This Policy provides policy guidelines for the development of the agriculture sector in Zambia. SNAP was formulated to address issues and challenges that emerged while implementing the 2004–2015 National Agricultural Policy (NAP). It also considered the current trends in the agriculture industry. Some of these challenges include:

- low agricultural productivity among small-scale farmers
- inefficient input and output agricultural markets
- decreasing rate of growth of agricultural exports
- poor small-scale farmer access to productive agricultural resources and services to increase production and
- weak entrepreneurial skills

The SNAP of 2016 provides guidelines for the development of the agricultural sector in Zambia. The policy incorporates several related economic activities in agriculture production, including research and extension services; irrigation promotion; agro-processing and value addition; agricultural marketing and trade; and livestock and fisheries development. It also addresses the institutional and legislative framework, private sector participation, support to co-operatives and other farmer organisations, and cross-cutting issues such as gender mainstreaming, HIV and Aids, and climate change mitigation. The policy is operationalised by the SNAP Implementation Plan 2016–2020 (MoA, 2016b). The plan provides an environment that encourages the participation of stakeholders in the sector, aimed at contributing effectively to national economic growth and development. SNAP provides for sustainable food and nutrition security, particularly poverty reduction, employment creation and the GDP.

iii. National Food and Nutrition Policy (MoH, 2008)

In Zambia, both rural and urban households are vulnerable to food insecurity. Food provision is directly linked to agriculture for rural households, while crop production risk is a primary determinant of food insecurity. Insufficient food production capacity, lack of income diversification, and unfavourable climatic conditions are the main causes of food insecurity for rural households. For urban households, on the other hand, earning a wage or being self-employed guarantees the purchase of their food needs. Hence they are more susceptible to insufficient income and price increases for food and other necessities, such as fuel and housing. The principal goal of the National Food and Nutrition Policy is to “achieve sustainable food and nutrition security and to eliminate all forms of malnutrition to have a well-nourished and healthy population that can effectively contribute to national economic development”.

Policy objectives include:

- addressing household food production
- encouraging nutrition diversification
- use of appropriate food processing technologies, especially for female-headed households
- introducing proper food crop storage methods and market access.

iv. National Water Policy (MEWD,2010)

Water (whether rain-fed or irrigated) is a prime factor in producing adequate food for the country’s agriculture sector. Water is also necessary for livestock production and sustenance of the fishing and aquaculture industry. Agriculture is given priority in the government’s planning for social and economic development, attracting considerable government investment. Therefore, the security of water supply for agriculture will secure food and other agricultural products. Water use for irrigation is steadily increasing due to the government policy of promoting agriculture development and is likely to be higher than estimated. According to the National Irrigation Strategy and Plan, the total irrigated area in Zambia is estimated at about 100,000 ha, comprising 52,000 ha under formal (commercial) and 48,000 ha under informal (subsistence) farming. These figures are far below Zambia’s estimated irrigation potential of 400,000 ha.

v. Forestry policy (MLNREP,2014)

Given that the degradation of forests is primarily due to inappropriate management regimes and policies, and unsustainable harvesting systems, the government developed the National Forestry Policy. This aims to sustainably manage Zambia’s forest resources and simultaneously meet the growing local needs for fodder, fuelwood, non-wood forest products and timber. This policy encourages the Joint Forest Management system, which is anchored on the active participation of local communities in the management and use of forest resources at all levels of decision making, implementation, monitoring and evaluation. This plan means changing land use from forest reserves to agriculture in some instances to increase agriculture production. The preferred option of increasing agriculture production via increased hectares of land is not viable. Therefore, the Khartoum declaration of March 2007 re-affirmed the commitment by the 2003 AU summit in Maputo to allocate at least 10% of a nation’s budget to agriculture and rural development to ensure food security. The policy gives guidance on agroforestry technologies that could be undertaken to reduce the unnecessary expansion of farmland into forests, while promoting agriculture productivity. It calls for the development, promotion and implementation of holistic strategies at the forestry sector and subsector levels that integrate conservation, development and management of forest resources with other sectors such as crop and livestock production.

vi. Environmental Policy (MTENR, 2009a)

The Environmental Policy in Agriculture is aimed at promoting environmentally-sustainable practices in crop and livestock production. It encourages practices that maintain the ecological integrity of agricultural lands by applying appropriate technologies and management techniques. The guiding principles include:

- Improving farming systems
- Increasing security of land tenure to limit the expansion of cropland
- Developing policies and legislations that encourage local communities and NGOs towards sustainable agriculture
- Proper coordination of the NAP with other policies, for example, land, water and natural resources
- Incorporating environmental costs such as soil erosion, loss of fertility and soil improvement costs in NAP
- Encouraging water conservation practices in NAP
- Providing guidelines for the use of organic and inorganic fertilisers.

vii. Biotechnology and Biosafety policy (MoHE, 2017)

This policy's aim is to protect Zambia's biosafety and humans from the possible adverse effects of genetically modified organisms. A National Biosafety Authority was established under the Ministry of Higher Education to coordinate all issues about GMOs. It was aimed at establishing a biosafety framework in the country and monitoring impacts of genetically modified organisms on the environment and human health.

viii. Patriotic Front – Manifesto (PF, 2016)

The ruling Patriotic Front (PF) remained committed to making the agriculture sector the mainstay of Zambia's economy, with agriculture employing more than 70% of the labour force. In addition, agriculture is the primary source of livelihood for more than 80% of the population in rural parts of the country, contributing 20% to GDP. The manifesto spells out what the PF aimed to achieve while in government. The party is convinced that investment, both public and private, coupled with the implementation of growth-promoting policies in this sector, shall positively impact the lives of Zambian people.

The 2nd Patriotic Front government (2016–2021) aimed to pursue policies that:

- encourage investment and stimulate an agrarian revolution
- sustain rural development
- promote agricultural research and development, and agricultural education
- provide extension and farmer support, and agricultural credit and finance
- ensure agricultural input supply
- promote agricultural mechanisation
- promote prudent management, and use of water resources, and ensure access to land and land tenure systems
- enhance agricultural production and productivity
- create an environment that encourages the flourishing of commodity markets and ensures producers are paid economical prices
- guarantee national and household food and nutrition security
- identify and manage critical weather vulnerabilities.

4.6.2 Characteristics of the land tenure system

a. Systems of Tenure

Land in Zambia is vested in the President (Land Act, 1995). There are two categories of land in Zambia:

1) Customary Land

About 94% of all land in Zambia is held under this customary land tenure system (Chitonge et al., 2015). This system falls under the control of traditional authority (Chiefs, Headmen and so on). Under customary law, the land is held by individuals, families, clans or communities from generation to generation, without temporal limitation (Sitko et al., 2015). Customary tenure applies to individual plots, forest land, common land within a village and communal grazing land.

Most smallholder subsistence farmers cultivate customary land held in common ownership with the community, although farmers' rights are individualised (Sitko et al., 2015). The traditional land does not have formal documentation (certificates, titles), and the landholders do not pay land tax. Customary land is home to the country's protected areas, the wildlife estate, National Parks and GMAs, and 74% of Protected Forest Areas.

2) State Land

All land not held under customary tenure is deemed state land, comprising only 6% of land in Zambia. Though historically meant for white settler farmers, this land can be grouped into industrial, commercial or residential land by the District Councils. According to their jurisdictions, most urban areas, mining areas, protected areas, land along rail lines, and land free of tsetse fly infestation during colonial times were classified as state land, much of which has been privatised through leaseholds (Chitonge et al., 2017).

The state grants four types of leases:

- a 10-year Land Record Card
- a 14-year lease for unsurveyed land
- a 25 to 30-year Land Occupancy License for residential settlements
- a 99-year leasehold for surveyed land. The conversion of customary land to leaseholds requires the chief's approval and any individual whose interests will be affected by the conversion.

The area of agricultural land in Zambia is estimated at 32.06% (World Bank, 2014). A large portion of this falls under customary control. Occasionally, land in the customary area can be converted to leasehold, making it possible for it to be used as collateral. Under the 1995 Act, the land is now valuable and can be sold even without improvement. The creation of farm blocks indicates that another 1 million ha of previous customary land had to be converted into state land for the project (Samboko et al., 2017).

4.6.3 Decision makers and influencers

Chapoto et al. (2015a) report that the post-independence agriculture policies focused on maize production to narrow the gap between rural and urban dwellers as the first strategy. Under a single-party governance system, subsidised maize was supplied cheaply to the urban population while farmers received a high sales price. Second, some powerful lobby groups – including the ZNFU, MAZ and some large fertiliser companies that have been supplying the government with fertilisers under FISP – lobby for policy changes that benefit their constituency with disregard for the negative effects on the agricultural sector. Unfortunately, the disjointed and ad hoc changes to the sector based on desires of the powerful lobby groups have not helped the country to achieve meaningful growth in agricultural productivity, poverty reduction or broad-based economic growth. Third, the Executive (Cabinet/State House) was found to wield the most power in commanding the other actors in the sector.

Respondents identified a so-called 'command triangle' that holds the key for sustainable policy changes in the agricultural sector (Chapoto et al., 2015b). This command triangle consists of the President, Minister of Finance, and Minister of Agriculture and Livestock. The line of command, especially with the actors in the triangle, is extremely convoluted and unclear, making it very hard to determine where an order originates and to hold particular actors and institutions accountable for their actions. The NGOs and Smallholder Farmers Agency have recently joined forces in lobbying the government to administer FISP. However, periodic government involvement in maize and fertiliser marketing has added to market insecurity and a low-performing agricultural sector.

It is clear that the MoA is not the only player in driving the agricultural policy agenda; several state and non-state actors are consulted (Neubert et al., 2011). The non-state actors include the private sector and civil society (Haapanen & Waller, 2007). To generate the political consensus needed to boost agricultural production – in particular, conservation agriculture as a priority – it is also critical to marshal the knowledge and human and technical capacities of all stakeholders (Aerni, 2013). The performance of non-state actors is evident in the provision of agricultural services such as extension, input supply and markets (Aerni, 2013; Christoplos, 2010). While the government has provided the enabling environment for the private sector to flourish, the uptake has been slow, especially for local companies. NGOs and foreign firms have naturally filled the gap.

The Zambian government has always facilitated markets for certain agriculture crops (Chapoto et al., 2015a; Phiri, 2016). According to Chapoto et al. (2015a), such interventions respond to demands from one or more interest groups in society. In the colonial era, the state was interested in European agriculture and later on in African agriculture (Chapoto et al., 2015b). For example, in 1936, the Maize Control Board (later called Grain Marketing Board – (GMB)) was founded (Eidsvoll, 2011). The boards provided affordable food to people in the urban area and kept real wages low in the mining sector (Phiri, 2016). The demand for maize produced by settler farmers along the rail lines was assured. Following the GMB, the Rural Agricultural Marketing Board (RAMB) was founded some years later (McEwan, 2003; Wichren et al., 1999). The board's function was mainly to procure maize from rural areas when the grain marketing board failed to meet the total maize demand. The two boards remained in existence after independence in 1964, holding a monopsony position and buying agriculture products from farmers. The boards set prices, but these prices showed seasonal and regional variances. In 1969, the National Marketing Board merged the two boards (Phiri, 2016) with a monopsony status. It was responsible for buying all agriculture products sold to the state-owned enterprises and the public. The only products that the board did not purchase were cotton, milk, beef, pork and horticultural products.

In the 1974/75 season, the producer and consumer price of maize in the country were fixed throughout the season (Wichren et al., 1999). In that arrangement, farmers received price and market guarantees, and fertiliser and seed at subsidised prices. In the 1980s, the scheme could not be sustained due to the unmanageable increase in government debt (Rakner, 2003). 1n 1995, The FRA was established under the Act of Parliament, Cap 225 of the laws of Zambia (National Assembly, 1995). As a result of this Act, the National Marketing Board and Zambia Cooperative Federation was replaced by the FRA in 1996. The FRA Act was amended by government in 2005, giving the Agency the additional mandate of marketing crops. Its establishment resulted from the various social and economic reforms of 1991 by the MMD government that created a market-oriented economic system in Zambia (Rakner, 2003). Consequently, the agricultural sector, including marketing of agricultural produce, was liberalised.

The government's involvement in the agricultural sector was then restricted to

- Ensuring the food reserves are maintained
- Offering overall support for the market
- Providing significant information on markets
- Providing small-scale farmers with agricultural credit facilities.

The MoA and the MFL are the two ministries tasked to implement government policy (MoA, 2016b; MNDP, 2017). In addition, there are several other key actors in the agriculture sector (Table 25). The government's executive arm made a deliberate and consistent effort to depoliticise the agricultural sector, especially the maize sub-sector, to achieve broad-based growth and improved sector coordination. It pushed for policy reforms in a coordinated fashion to ensure the interests of various actors in the sector are aligned with the aspirations of the ruling party (PF, 2016). The government has embarked on the recapitalisation of Nitrogen Chemical of Zambia Ltd to make fertilisers more readily available to the farmers (MNDP, 2017). The political liberalisation of the 1990s that re-introduced multiparties and civil liberties in Zambia did not increase the larger population's political and economic participation. Instead, liberation resulted in a decline in income, increased cost of living and redundancies across sectors. Rural people, especially farmers, were expected to fulfil the election period promises by the ruling party. Most of them became disappointed soon after the elections.

According to Rakner (2003), the rising numbers of non-governmental associations and several opposition parties since 1991 have constrained the freedom of expression and weakened the ability of associations to lobby with the government of the day. This arrangement has had negative consequences for any meaningful growth in the agricultural sector and the government's aspirations to involve communities and private actors in agriculture. Since the 1990s, no links have been formed between Zambian economic interests and the party system. Party formation and politics are centred on personalities, individual ambitions and ethnic relations, and opposition parties remain exceedingly weak. According to some scholars, the opposition parties lack meaningful agenda to challenge the ruling party's manifesto pledges on the economy and other reforms. Continued executive dominance, coupled with organisational proliferation and a weakly institutionalised party system, means the electoral channel does not function as a credible 'threat' to the incumbent government. As a result, the MMD government (1991–2011) has ignored the voices of business, labour and agriculture (Fashoyin, 2008; Rakner, 2003). Echoing findings from the comparative literature, interested coalitions located within government and bureaucracy, are more influential than independent interest associations looking to oppose or postpone reforms.

Table 25. List of key actors in the agricultural sector

Type of Institution	Institution Name
Public Institutions	Food Reserve Agency (FRA)
	Farmer Input Support Program (FISP)
	Ministry of Agriculture (MoA)
	Ministry of Agriculture and Livestock Stock Monitoring Committee
	Ministry of Fisheries and Livestock (MFL)
	Ministry of Commerce and Trade Industry (MCTI)
	Ministry of Finance and Economic Development (MoFED)
	Parliamentary Committee on Agriculture and Lands
	Parliament
	Cabinet
	State House
Quasi-Government	Public Universities
	National Science and Technology
	National Institute for Scientific and Industrial Research (NISIR)
Private Institutions	Research Institutions
	Zambia Farmers Union
	Smallholder Farmers Association
	Grain Traders Associations
	Millers Association
	Cotton Ginneries
	Agro-Processing Companies

Type of Institution	Institution Name
Regional bodies	Common Market for Eastern and Southern Africa (COMESA)
	Southern African Development Community (SADC)
International Organisations	UN Agencies – UNDP/FAO/WFP
CGIAR	CIMMYT/IITA
Others	Consumers
	Retailers
	Small-scale Farmers
	Commercial Farmers
	Commercial Banks
	Civil Society/NGOs

Source: Chapoto et al., 2015b

4.6.4 Agricultural research and extension landscape

Several institutions have been established to conduct agriculture in the country, listed in Table 26.

Table 26. The major institutions involved in agricultural research and their mandate

Institution	Location	Mandate
Zambia Agriculture Research Institute (ZARI)	One of 7 departments within the Ministry of Agriculture located in Chilanga. Founded in the 1950s. ZARI anchors R&D in Crops and Soil in Zambia	The department's overall objective is to provide high-quality, appropriate and cost-effective services to farmers, generating and adapting crop, soil and plant protection technologies
School of Agricultural Sciences	The University of Zambia. Located at its Great East Road Campus	Produces agricultural professionals in animal science, plant science, soil science, agricultural economics, nutrition, and food sciences. It conducts research critical to the agricultural sector
School of Veterinary Sciences	The University of Zambia. Located at its Great East Road Campus	Produces agricultural professionals in veterinary sciences. It conducts research critical to animal health and production

Institution	Location	Mandate
National Institute for Scientific Research (NISIR)	NISIR is a government institution set up by the Science and Technology Act No. 26 of 1997 through the Statutory Instrument No. 73 of 1998 (NISIR, 2018). Headquarters – Lusaka	To conduct and promote scientific, technological, and industrial research in Zambia; to carry out research in civil, mechanic, chemical, electronic and electrical engineering, nuclear science, textile technology, energy resources, industrial chemistry, food science, material science, and natural products, information science, cartographic and location analysis. Specifically, in the agriculture sector – biotechnology, food science, toxicology and natural products
School of Natural Resources	Copperbelt University – Kitwe, Copperbelt Province	To produce adequately trained and equipped professionals in wood science, forestry, and wildlife, agro-forestry and fisheries, and a human resource workforce
School of Agriculture and Natural Resources	Mulungushi University – Kabwe	Provides tertiary agriculture education and conducts basic and applied research
Natural Resources Development College	Lusaka	Limited research in crops and animal and fish production besides providing training for diploma-level agriculture workforce
Mpika and Monze Colleges of Agriculture	Located in Mpika (Muchinga Province) and Monze (Southern Province)	Limited research in crops, animal and agroforestry research besides providing training for diploma-level agriculture workforce
Central Veterinary Research Institute (CVRI)	This unit is found in the Ministry of Fisheries and Livestock Balmoral, Chilanga	CVRI is responsible for providing solutions to the livestock business through innovative veterinary services, covering various technical disciplines, including training, research and epidemiology. Through its services, the CVRI contributes towards safeguarding Zambia's animal and public health by providing timely and accurate diagnostic laboratory support
Fisheries research unit	Department of Fisheries, Chilanga	Researches the management of forest resources

Institution	Location	Mandate
Forestry Department	Ministry of Lands, Natural Resources and Environment Protection	Conducts research in forest management and related issues
Indaba Agricultural Policy Research Institute – Advocacy and Policy Research (IAPRI, 2018)	Located in Lusaka. Created in 2011 as a private research institute	Provides policy solutions through research and outreach services to transform Zambia's agricultural sector to achieve sustainable broad-based pro-poor growth
Research Trusts – Golden Valley Agricultural Research Trust	Golden Valley Research Trust (GART), located at Chisamba. Created in 1994 by the Government of the Republic of Zambia and Zambia Farmers Union	It aims at contributing towards agricultural development in Zambia through strengthening the agricultural industry by playing an important role in research and development, extension services, farmer training; and seed technology and production
Cotton Development Trust	(MACO) and the private sector-driven cotton industry and governed by an independent board of Trustees	Strengthen the cotton industry by playing an important role in research and development, extension services, farmer training, and seed technology and production
IITA – Southern Hub	Member of CGIAR. Headquartered in Ibadan, Nigeria. In Zambia it is located in Lusaka's Ngwerere Area.	Its main priority is ensuring a secure food future for sub-Saharan Africa. Its key research themes include staple food crops, including banana and plantain, cassava, cowpea, maize, soybean and yam
FAO	UN Agency. Country Office Lusaka.	Through technical cooperation projects/ assistance, it has been involved in research on fruit fly, larger grain borer containment and control (1998–2002), fall armyworm, conservation farming (CASU 2013–2017)

The main institutions providing extension/advisory services in Zambia are divided into public and non-public sectors.

Public sector

The MoA represents the public sector through the NAIS and the MFL (Ministry of Agriculture, 2018). Other public sector institutions include the University of Zambia School of Agricultural Sciences and other education and research institutions, the Department of Veterinary and Livestock Development, the Department of Fisheries, and the Department of Cooperatives and Marketing (MoA, 2018).

Through its international mandate, FAO offers technical assistance and resources to the government to enhance the delivery of agricultural extension services. For example, CASU-FAO Project (2013–2018) researched at least 315,000 small-scale follower farmers (FFs) and more than 21,000 new or existing conservation agriculture lead farmers (LFs) (FAO, 2016). MoA personnel, agro-dealers, financial institutions, research institutions, agro-entrepreneurs and other CA stakeholders are direct and indirect beneficiaries.

Non-public sector

(a) Private sector firms

The market reforms of 1991 set in motion policies to support the development of Zambia’s private sector (Rakner, 2003). The private sector established agricultural forums, such as the Agricultural Consultative Forum (ACF) in partnership with government institutions. Their specific objective was to bring innovative techniques to farmers. The forum launched the Agriculture Sector Investment Program (ASIP) in 1998 aimed at improving food security and domestic economic development (ACF, 2012). ASIP provides a stakeholder platform for agricultural policy dialogue and the fostering of public-private partnerships in Zambia’s agricultural sector. The interest of the private sector and farmer producer association is represented by the Agri-Business Forum, responsible for facilitating the development and application of innovative approaches for smallholders. Some private firms directly involved in agricultural-related activities, including the provision of extension services, include the Zambia Cotton Ginners Association, Grain Traders Association of Zambia, Zambia Export Growers Association, and Zambia Seed Traders Association.

(b) Non-governmental organisations and other donors

NGOs have been complimenting the government in the delivery of extensions on specific agricultural programmes. Many of them have assisted farmers, particularly smallholder farmers, in crop and animal production, processing and marketing. They are an essential partner in the development of the agriculture sector. Associated with the growth of local NGOs in the country, the past three decades have been relatively rapid. Still, their capacity to work with rural communities remains limited (Farrington & Saasa, 2002). According to Farrington and Saasa (2002), NGO capacity-building in management skills and financial mobilisation is paramount for Zambia to benefit. Other skills needed by NGOs include project planning, appraisal, implementation, monitoring and evaluation. The Non-Governmental Organisations Coordination Council (NGOCC) Technical Services committee has therefore been trying to equip some NGOs with these necessary skills to harmonise their activities. It is no secret that with the advent of democracy and liberalisation, the donor community has viewed NGOs as being prudent in using donors' resources for development.

Some NGOs registered in Zambia include: World Vision, ADRA, Total Land Care, CARE International, Catholic Relief Services, Oxfam, Anglican and Catholic dioceses, Musika, Prevention Against Malnutrition (PAM), Environment Conservation of Zambia, COMACO, Foundation for Sustainable Development, People Act Foundation, and Programme Urban Self Help (PUSH) among others.

(c) Farmer-based organisations and cooperatives

Smallholder farmers make up the majority of the agriculture sector in Zambia. These farmers have organised themselves at a local level into membership-based institutions such as associations, unions, cooperatives and so on. Given that smallholder farmers are disadvantaged in accessing inputs, extension services and markets for their produce, they mainly organise themselves around a common interest – pooling their resources and facilitating access to credit and farm inputs. The main ones are the ZNFU (www.znfu.org.zm), the CFU (www.conservationagriculture.org), Farmer Organization Support Program (FOSUP), National Peasants and Small-Scale Farmers Association, Zambia Cooperative Federation, and OPAZ – Organic Producer Association of Zambia, Tobacco Growers Association, and Zambia Export Grower Association.

What agricultural development pathways do they promote?

The institutions pursue several pathways that are conceptualised by the demand-supply relationships between the farmers, research, extension agents and development partners. The World Bank outlines four pathways including technology generation, knowledge dissemination, human capital development and policy advocacy (improving the policy environment through trade and regulatory policy reforms) (Goyal & Nash, 2016).

Surveys, scoping studies and desktop studies tend to lead to innovations and the generation of technologies to increase productivity and minimise production risks. The technologies are developed through agreed scientific techniques. They are frequently tested on-farm with farmers and at times with NGOs, then upscaled and disseminated through various pathways such as demos, field days, agriculture shows, mass media and so on, so that they reach larger audiences. In addition, research institutions carry out specialised studies, for example to investigate the prevailing market systems (input supply and value chains); agricultural diversification (farming systems, breeding, agricultural practices, input systems and value chains); natural resource management and governance; property rights and livelihoods; human nutrition and health-foods for consumers; farmer and farm workers protection (farming systems, agricultural practices and input systems); education (agricultural skills); food waste and food supply (food policy analysis, markets and value chains, farming systems, breeding and farming practices); and food safety and national food and agricultural policy (Tomich et al., 2019).

A development pathway may be a dynamic concept that requires regular monitoring and evaluation to ensure the right impact on the ground and for everyone. For instance, shifting from subsistence farming to market-oriented farming may have consequences for the resilience of farmers to future economic shocks. It is thus essential that research provides solutions to these critical and complex subjects. Poverty dynamics studies may reveal inequalities along the development process. Also, while some issues may disappear, new ones may emerge. It is important to stay tuned in to prospective threats/challenges, such as climate change, urbanisation, increasing water scarcity and land grabbing. The research outputs might be taken on directly by producers – farmers, extension services (public and private), aggregators, agro-processors, or to frame government policy.

Communication and adult learning psychology are the delivery systems to the public in Zambia (MoA, 2016c). The Participatory Extension Approach provides extension services under four main paradigms as follows:

- *Technology Transfer*: using agricultural shows, field demonstrations, field days, extension materials, and presentations to convince farmers to adopt new technologies
- *Problem-solving*: assisting individuals in finding solutions to the problems that constrain farmers to improve productivity and overall unit performance
- *Education*: proactive informal education that seeks to assist individuals and groups in understanding their situations better and making choices, and taking actions to improve their conditions
- *Human development*: facilitate and stimulate farmers' ability to solve problems

The main channels for extension services delivery in Zambia are through Farm Institutes, Livestock Service Centres and Farmer Training Centres, and the network of agricultural blocks and camps for fisheries, crops and livestock.

Determination of research priorities

Priority setting is approached through the following;

- Internal at MoA – assessment of research problems and issues by select representatives of research institutions/department
- Synthesis of materials and information from existing strategies, programmes and documents from various forums and meetings relevant to Zambia
- More comprehensive consultations with some key actors within the agriculture sector and with various experts
- Multi-stakeholder consultative forum whose outcomes are aligned with both SNAP (MoA, 2016a) and National Development Plan (MNDP, 2017). Stakeholder involvement in sector programmes during all stages of the programme cycle is critical to ensuring greater ownership of a demand-driven and sustainable development process.

How do researchers engage with farmers?

To increase farmer participation in research, agricultural researchers frequently use on-farm (Roo et al., 2017) and participatory research (Katsui & Koistein, 2008). These enable researchers to have more interaction with the farmers and other technology end-users. On-farm trials are used to scale up agricultural technologies. They have also been used as a means to understand and foster widespread technology adoption by smallholder farmers. On-farm trials and participatory research form the core of farming system research (Schiere et al., 2012). Farming system research studies are designed to involve and learn from the farmers, drawing on the understanding of the diverse and complex environments in which they operate so that technological developments can be tailored to suit their circumstances, building where possible, on their indigenous technical knowledge. Learning from farmers is a piecemeal, fragmented and iterative process requiring repeated interaction between researcher and farmer over an extended period (Odhong, 2017). Therefore, the technologies are evaluated with the farmer and in the light of their goals. There are constant visits to growers in the field by the research team, which also attends regional meetings to recognise specific needs in research within production areas. Since the 1990s, researchers have been conducting rural livelihood studies (Kent & MacRae, 2010). Households in the rural areas of Zambia have diverse livelihood coping strategies in response to the range of constraints and risks they face. Rural livelihood studies help families identify impediments to cope with these constraints and foster a living within their circumstances.

How are technologies and innovations disseminated?

Extension and information-sharing are essential to the attainment of agricultural development in any country. Since 1964, Zambia has established an effective extension and information system (MoA, 2016). The MoA uses radio/television broadcasts and printed materials, including newspapers, in parallel with the mainstream extension services such as field days, seed fairs, agricultural shows and farmer visits, to name a few, to deliver effective agricultural extension messages (Nnoung & Swanson, 2018). The UNESCO-assisted broadcasting services have been using radio programmes targeted at local small-scale farmers since as early as the mid-1960s. Several radio listening groups called ‘Radio Farm Forum Groups’ were set up in rural communities across the country. Farmers were encouraged to attend radio programmes with the motto of ‘Listen, Discuss and Act’. Equally, the MFL uses the same traditional ICTs, namely, radio, television and print media, to disseminate technical information and news to the livestock farming and fishing communities.

The government has been encouraging the inclusion of appropriate use of ICT to scale up extension and advisory services (MoA, 2016c). This has the added advantage of encouraging the involvement of youths in agriculture. Given the higher penetration rate of mobile technology, mobile phones and other devices with internet capability are being promoted to provide certain types of information to farmers. The use of these tools in agriculture is encouraged. Some agricultural projects and NGOs have equipped extension staff with appropriate ICT equipment and training. For example, the department of NAIS, with financial and technical support from the International Institute of Communication for Development (IICD), has developed an internet-based platform that enables farmers to send questions on agriculture and receive answers using their mobile phones (Kahilu, 2011). Furthermore, the Ministry has established agricultural information centres in selected provincial centres, for example, Kasama, to enable farmers to access agricultural technical information closer to their doorsteps (Steinen et al., 2007; IICD, 2006). Another model of communicating farmer-tailored extension messages has been through awareness campaigns/rallies, farmers’ training workshops, and farmer field schools (MoA, 2016c).

4.6.5 Key policies for the protection of forests and other habitats, and biodiversity

The conservation of biological diversity and environmental protection is operated by more than 30 legislative instruments, enacted three decades ago in Zambia. The environment and natural resources management framework is anchored in the National Conservation Strategy of 1985, National Environmental Action Plan of 1994, the National Policy on the Environment of 2007, and the Environmental Protection and Pollution Control Act of 1990 for legislation. Related policies and legislation on forestry, wildlife, agriculture and fisheries are vital for protecting forests, other habitats and biodiversity.

The National Policy on the Environment (NPE) (MTENR, 2009a) provides a framework for the sustainable management of Zambia's environment and natural resources to ensure they can continue to support the needs of the current and future generations, without compromising either. The NPE serves as a practical guide for environmental management. It symbolises society's commitment to Zambians and the outside world, maintaining principles of sound resource use, social justice, equitable resource allocation and care for the environment. When biotic resources are used, it ensures they are used wisely, sustainably and consistent with maintaining ecosystems and ecological processes. The NPE and associated legislation are enforced by ZEMA.

The National Forestry Policy 2014 ensures sustainable forest resource and ecosystem management (National Assembly, 2017b). The guiding principles of the National Forestry Policy are to "*ensure forest reserves and other forest areas' productivity, integrity and development potential are maintained; to ensure sustainable management of forest ecosystems and biodiversity application through scientific and indigenous technical knowledge.*" The Department of Forestry implements the National Forestry Policy in the MLNR.

Wildlife is a renewable resource that has unique economic properties based on consumptive and non-consumptive use. The advantage of a wildlife industry is that it contributes significantly to the national economy, socio-culture and biological values of National Parks. Zambia has adopted a management plan that is ecologically and economically sound and enshrined in the National Wildlife Policy (MoTA, 2018). The National Wildlife Policy is executed by the Department of National Parks and Wildlife. The plan guides all elements in the wildlife sector and is fundamental to a coordinated wildlife industry.

The National Wetlands Policy (MLNR, 2018) promotes a coordinated approach to the management and conservation of wetland ecosystems in Zambia. Wetlands are important sites for biodiversity, soil erosion prevention and a valuable habitat for mammals and birds. Wetlands are also a rich source of fish, as well as grazing ground for livestock.

SNAP (MoA, 2016a) is implemented by the Ministries of Agriculture, and Fisheries and Livestock, and is focused on the following:

- Promoting sustainable land management technologies (including conservation agriculture, appropriate stock densities)
- Promoting afforestation, community wood lots and agro-forestry
- Promoting the use of renewable energy resources (solar, biogas and wind)
- Promoting energy efficient technologies in agricultural processing and production

- Strengthening co-management of inland and transboundary fisheries resources
- Decentralising capture fisheries management to communities
- Promoting the sustainable use of rangeland (grassland ecosystem) and pastures for livestock production
- Promoting sustainable fishing methods and programmes, and appropriate technologies/ procedures for sustainable use of fisheries resources
- Promoting integrated agriculture, especially among smallholder farmers
- Developing water harvesting, storage and usage infrastructure
- Promoting characterisation, conservation and sustainable use of indigenous animal genetic resources, including climate change resilient indigenous breeds (establishing bio-diversity conservation centres).

The Fisheries Policy directives fall within SNAP 2016–2021. They are aimed at "*increasing fish production and promote sustainable utilization of fishery resources to contribute to the economy through generation of employment, income, and improved availability of fish.*" The proposed policy encourages sustainable fisheries management and stakeholder participation (especially the participation of local communities) in the capture fishery and aquaculture. In general terms, the policy supports the objectives of an NPE.

4.6.6 National institutional framework

Local government

Since Zambia gained independence on 24 October 1964, several decentralisation reforms have been implemented to transform the provincial, district and local governance structure in Zambia (Chikulo, 2014). Following the multi-party elections of 1991, the government planned to improve efficiency and accountability by transferring responsibilities from the central government to the local government through decentralisation strategies. In the decentralisation process, the government drew a line between the governing party and the state. Secondly, by introducing measures designed to strengthen democratic control and increase accountability of elected local authorities – as enshrined in the Constitution of Zambia Act (No. 1) 1991 and the Local Government Act (No. 22) 1991 – it further distinguished the ruling party, civil service and the state. It additionally repealed the Local Administration Act (No. 15) 1980 (Chikulo, 2000; Crook et al., 2001), introducing a dual administrative system at the district level. In this structure, the field administration of central government line ministries was represented at the district level and local authorities.

In 1993, the government adopted the Public Sector Programme (Cabinet Office, 2012a), which aimed to improve the public sector's quality, delivery, efficiency and effectiveness. The programme consisted of three components: restructuring the line ministries, management and human resource improvement, and decentralising and strengthening local government. It also sought to underpin the local government sector within the new pluralist framework by introducing a programme of decentralisation involving the devolution of administrative functions to the nine provinces and selected responsibilities to elected local authorities. Decentralisation reforms aimed to design and implement policies that provided effective decentralised but democratic and accountable provincial and district governance (Cheema, 2007). In the Public Sector Programme, selected functions would be devolved to local authorities "as their management capacities improved" (Chikulo, 2014). The Provincial and District Development Committees were formed to coordinate the development activities between the local authority, line departments, donors and NGOs through Cabinet Circular No. 11995 (Cabinet Office, 1995). The committees are made up of provincial heads and chaired by the Provincial Permanent Secretary. At the district level, the composition includes local government officials, NGO representatives, private sector representatives and councillors. They are chaired by the Council Secretary/Town Clerk, with the Directorate of Planning providing the secretariat (Cabinet Office, 2014).

Although significant policy framework and institutional changes at the district level were realised following the reforms, challenges such as political interference and lack of finance persisted, rendering the District Development Committees ineffective. According to the Cabinet Office (2014), the committees lacked the legal mandate, and local municipalities lacked control over them. As a result, holistic, integrated planning at the district level is lacking. Therefore, the current institutional, legal and regulatory challenges continue to undermine the effectiveness of district and local governance in the country (Gumboh, 2012). In addition, central government transfers of its financial management functions to district and local government are still very low. There is also a lack of effective integrated planning and management. Consequently, the district and local authorities have no financial capacity to deliver their mandate and provide sustainable levels of service delivery. This problem could be attributed to the tendencies characteristic of the one-party state era. Meanwhile, there is no guarantee that successive governments will be committed to transferring functions to local government.

The primary objective of the National Decentralization Policy launched in 2004 and revised in 2011 (Cabinet Office, 2012b), was to empower the people by achieving a *"fully decentralized and democratically elected system of governance. According to Chulu (2014), such a system of governance is characterized by an open, predictable, and transparent policymaking and implementation process, effective local community participation in decision-making development and administration while maintaining sufficient linkages between the central government and the periphery"* (Chulu, 2014).

Another vital point to note is that the amended constitution provides the Executive Mayor or Chairperson as the local municipality or district council head (National Assembly, 2016a; 2019). They are appointed by councillors and have a legal mandate from the Local Government Act 1991 (Chitembo et al., 2014). The functions of the officeholder sometimes conflict with those of the District Commissioner, a political appointee. There is a conflict between the political appointees, the councillors (elected by the residents) and the Town Clerks. The office of the District Commissioners undermines the autonomy of the local authorities and is filled mostly by friends of the ruling party (Chikulo, 2014). The President appoints the District Commissioners and they are therefore used by the ruling party for political functions such as voter mobilisation during the election campaigns. They are not effective at protecting residents due to their allegiance to the appointing authority. Therefore, as a result of this setup, the effectiveness of District Development Committee governance is undermined.

Corporate governance

According to Cheema (2007), the principles of corporate governance and liberal philosophy, anchored under the multi-party political systems, have been applied by the government to decentralise public services since 1995. With a corporate governance system, communities are allowed to participate as they are included in organisational structures and arrangements, such as management boards (Momba, 2007; Mwanawasa, 2016). In this way, communities and local authorities share a sense of ownership that improves service delivery quality (Chiwele, 2002).

Public financial management

Issues of public financial management and other related matters are dealt with by relevant offices – Auditor-General and Accountant-General (National Assembly, 2017a). The Public Finance Management Act of 2018 (National Assembly, 2018) spells out how public 'monies' should be dealt with. It further states that a surcharge equivalent to the loss or wasteful expenditure should be imposed on the controlling officer for failure to perform duties assigned by the Act. It also recommends to the secretary to the treasury that disciplinary action be taken. It also provides that the Auditor-General must audit the accounts of any statutory cooperation in accordance with the provisions of the Public Audit Act of 2016 (National Assembly, 2016c). This Act stipulates that the Auditor-General shall carry out performance and specialised audits and shall prepare a report on the audit for submission to the National Assembly.

Corruption

Corruption is an obstacle to the development of any society and the general welfare of the people (Claros, 2013; GRZ, 2009). Corruption continues to be a significant hindrance to good governance and development in Zambia. After independence in 1964, the successive ruling governments have put up various social, legal, institutional and economic reforms to improve governance to bring about good public service delivery and positive contributions to social and economic development. Zambia's Anti-Corruption Act 2012 is the principal anti-corruption law (ICS, 2017) that has not been implemented. It criminalises attempted corruption, active and passive bribery, extortion, bribing a foreign official, abuse of office and money laundering. Corruption is punishable by a fine, forfeiture of any benefit gained from the corruption offence, including money, and a prison term of up to 14 years upon first conviction. Chêne (2014) linked corruption with poverty and found it to be a significant problem in Zambia, despite several anti-corruption watchdogs and rigorous changes in the law, for example, Anti-Corruption, Drug Enforcement Commission and Office of the Public Protector (National Assembly, 2016a). The public sector remains the most severely affected. Reviewing corruption trends in Zambia from 1964 to 2017 shows that corruption has increased since the transition into multiparty democracy and the subsequent economic liberalisation of 1991. It remains widespread and systemic in the country because of a lack of political will to fight it, lack of transparency and accountability, poor enforcement of the law, and a rampant culture of political patronage.

Performance and Environment Audit

The Auditor General's Office conducted the Performance and Environmental Audit to evaluate and report government programmes and activities against best practices (Office of Auditor-General, 2016). One such report is the Performance Audit Report on Sustainable Forest Management in Zambia, whose objective was to assess the effectiveness of the MLNR in ensuring sustainable exploitation and effective forest management.

4.6.7 Policies and institutions

Influence of international policies, institutions, treaties and goals on Agriculture and Environment

Zambia has ratified several global environmental and agricultural-related conventions that enhance the country's aspiration to make agriculture, forestry and fisheries production more sustainable. These treaties assist the development of national agriculture, rural transformation, employment, and social protection policies and programmes, aimed at poverty reduction. This is achieved by designing the right policies, programmes and legal frameworks to promote food security and nutrition. International frameworks also indirectly encourage sufficient financial resources, institutional reforms and – importantly – adequate human capacities.

Some of these conventions are:

Convention on Biological Diversity

Zambia is a signatory to the UN Convention on Biological Diversity under the Agenda 21 – Global Programme of Action on Sustainable Development (Rio de Janeiro, 3–14 June 1992) and ratified on 28 May 1993. After that, the country embarked on the establishment of the NBSAP (MTENR, 2009b). The National Biodiversity Strategy and Action Plan-2 (2015–2020) (MLNREP, 2015a) is designed to assess the current status of biodiversity, as well as the threats causing its degradation. It includes the strategies needed to ensure the sustainable use and conservation of biodiversity within the framework of the socio-economic development of the country. At the national level, every Zambian has access to appropriate information concerning the environment held by public authorities, including information on hazardous materials and activities in their communities. There are opportunities available to participate in relevant decision-making processes. Through ZEMA, the government has facilitated and encouraged public awareness and participation by making information widely available. For those seeking redress, they ensure that citizens have access to judicial and administrative proceedings. The actions run concurrently with the political term of office, that is, five years upon domestication. The country was also able to develop the National Environment Policy (MLNR, 2009).

Convention on Wetlands: Ramsar Convention

The Convention on Wetlands, known as the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Ramsar Convention on wetlands was operationalised on 28 December 1991 in Zambia. The country has eight sites as Wetlands of International Importance (Ramsar Sites), with a surface area of 4,030,500 ha. To support the Ramsar Convention demands, Zambia has also developed a National Policy on Wetlands (MLNR, 2018).

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The main objective of CITES in Zambia is "to promote effective conservation of the world's endangered species of wild plants and animals by regulating international trade in these species". Therefore, Zambia is obligated to follow the requirements of CITES by the running the Convention and by further enacting legislation to domesticate the Convention. As a state Party, the country is also obliged to participate in the Conventions Conference of the Parties, which is its supreme decision-making body (National Assembly, 2010).

SADC Protocol on Wildlife and Law Enforcement

This enables Zambia to enter bilaterally with SADC countries in the Trans-Frontier Conservation Area (TFCA) treaty to protect their common biological resources in a unique conservation and development area along the countries' boundaries, for example, Zambia and Malawi. A TFCA is defined in the SADC Protocol on Wildlife Conservation and Law Enforcement (1999) as a component of a large ecological region that straddles the boundaries of two or more countries, encompassing one or more protected areas as well as multiple resource use areas. TFCAs are founded to collaboratively manage shared natural and cultural resources across international boundaries for improved biodiversity conservation and socio-economic development. The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and the IUCN list all conservation areas worldwide (IUCN, 2014). SADC views TFCAs to create an enabling environment for local participation in decision-making processes. It aims to increase opportunities for investment in income-generating activities for communities to improve local economies – resulting in poverty reduction. Through a unique level of regional cooperation among participating countries, well-managed TFCAs further promote the sustainability of ecosystems and their capacity to provide the necessary goods and services required to support the region's sustainable development. Additionally, TFCAs often seek to establish a complimentary network of formal and informal protected areas across the landscape, linked through corridors. These ensure the continued existence of migratory wildlife species that are otherwise becoming increasingly isolated due to habitat loss and fragmentation.

Stockholm Convention on Persistent Organic Pollutants

The convention entered into force in 2004. Zambia became a signatory in May 2001 and ratified the Convention on 5 October 2006. The Convention specifies provisions that each Party must undertake to reduce or eliminate intentional production and use of persistent organic pollutants, such as Aldrin, Chlordane, Dieldrin, Eldrin, Heptachlor, Hexachlorobenzene, Mirex, Toxaphene, and PCBs. Additionally, Parties to the Convention must eliminate PCBs in equipment such as transformers, capacitors and other receptacles containing liquid stocks by 2025.

Bamako Convention on the Ban of Import into Africa and the control of the Transboundary Movement and Management of Hazardous Waste within Africa

New Partnership for Africa's Development (NEPAD) is a programme of action aimed at developing the African continent, adopted by the assembly of heads of states and governments in Africa. This programme promotes and provides sound environmental management of hazardous waste, technology transfer, information dissemination, research and consulting on the sound management of all hazardous waste among the African States. The environmentally sound management of chemicals, including persistent organic pollutants, is a crucial issue under the environmental initiative in Chapter 38 of the NEPAD Plan of Action.

Abuja Declaration

Zambia committed itself to the Roll Back Malaria (RBM) principles and strategy in 1999. In 2000, it reaffirmed its commitment to the RBM by becoming a signatory to the Abuja Heads of State Declaration on RBM. Zambia has committed to use DDT only for malaria vector control purposes to meet the Abuja Declaration commitments.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal

The Basel Convention was adopted in 1989 in response to concerns about toxic waste produced in industrialised countries being dumped in the developing world and countries with economies in transition. It entered into force in May 1992, and Zambia became a party in 1994. In its initial phases, the Convention focused on drawing up controls for transboundary movements of hazardous wastes across international frontiers and developing criteria for environmentally sound waste management. Recently, however, it has emphasised the full implementation of treaty agreements, promoting environmentally sound waste management and minimising the generation of all such wastes.

Strategic Approach to International Chemicals Management

Since 2002 Zambia has been part of the process to bring about a strategic approach to international chemicals management, following the Johannesburg World Summit on Sustainable Development. The Summit committed member countries to minimise adverse impacts of chemicals on the environment and human health. In this regard, the UN harmonised system for classification labelling of chemicals was adopted during the International Conference on Chemicals Management in 2006. The system provides a framework for classifying chemicals according to the hazards they pose to humans and the environment.

Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

The Rotterdam Convention was adopted in 1998 following numerous concerns related to the potential risks posed by hazardous chemicals and pesticides. In the 1980s, UNEP (United Nations Environment Programme) and FAO (Food and Agriculture Organization of the United Nations) developed voluntary codes of conduct and information exchange systems resulting in the Prior Informed Consent (PIC) procedure introduced in 1989. It entered into force in February 2004. The Rotterdam Convention aims to protect human health and the environment during trade in certain hazardous chemicals and pesticides. It establishes an international mechanism to regulate the trade of pesticides and industrial chemicals listed in its Annex III. Certain hazardous chemicals and pesticides have been banned or severely restricted for health or environmental reasons, upon notifications of final regulatory actions by the Parties within the scope of the Rotterdam Convention. The Convention encourages using chemicals in an environmentally sound manner, exchanging information about chemical characteristics, establishing a national decision-making process on importing and exporting chemicals, and disseminating these decisions to Parties to the convention. Zambia acceded to the treaty on 8 January 2011.

United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty adopted on 9 May 1992 and entered into force on 21 March 1994. The UNFCCC's objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The framework sets non-binding limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms.

The Parties to the convention have met annually since 1995 in Conferences of the Parties (COP) to assess progress in dealing with climate change. In 1997 the Kyoto Protocol was concluded and established legally-binding obligations for developed countries to reduce greenhouse gas emissions in 2008–2012. The 2010 United Nations Climate Change Conference produced an agreement stating that future global warming should be limited to below 2.0°C (3.6 °F) relative to the pre-industrial level. The Protocol was amended in 2012 to encompass the period 2013–2020 in the Doha Amendment, which as of December 2015 had not entered into force. In 2015 the Paris Agreement was adopted, governing emission reductions from 2020 through commitments of countries in Nationally Determined Contributions, lowering the target to 1.5°C. The Paris Agreement entered into force on 4 November 2016.

The Zambia Country Study on climate change established that in 1990 Zambia contributed 3.4 million tonnes of CO_2 to the atmosphere, which accounted for about 1% of Africa's total emissions. About 88% of these emissions were attributed to energy use. Industrial processes – mainly cement and lime production and use – accounted for 12% of CO_2 emissions. In the energy sector, transportation contributed 29.5% of total CO_2 emissions, followed by mining with 15.8%. Biomass fuels, waste and agriculture were the primary sources of CH_4. In 1990 a total of 457,000 tonnes of CH_4 were emitted into the atmosphere. Agriculture – predominantly through enteric fermentation – contributed 20%, followed by biomass burning with 16.5% and waste with 10%. Total N_2O emissions mainly from agriculture amounted to 3,570 tonnes of H_2O under land-use change and forestry. About 59.4 million tonnes were released through forest clearing, biomass decay and on-site burning. However, because of the large woodland potential, in 1990 there was a net balance of 60 million tonnes of CO_2 out of all emissions.

Although the amount of CO_2 emitted from sources in Zambia may be minor on a global comparative basis, a greenhouse gas mitigation has been devised to manage CO_2 emissions. In the domestic and industrial sectors, mitigation options have been selected based on surplus hydroelectricity (at 500 MW) and localised deforestation, mainly for agriculture and charcoal production (Gumbo et al., 2013).

The primary energy sources are firewood and charcoal in the domestic sector, with firewood accounting for 70% of energy demand (ZDA, 2014b). Charcoal is used in urban and peri-urban areas, whereas firewood is used in rural households (Gumbo et al., 2013). Only about 10% of the population has access to electricity. This diffusion rate calls for concerted efforts towards electrification to replace charcoal stoves with electric stoves. Thus, the mitigation options in this sector include electrification of households to substitute electricity for charcoal stoves, introducing coal briquettes, production of more efficient charcoal stoves, and improved traditional kilns. These options are aimed at reducing the pressure on forest degradation and reducing CO_2 emissions from charcoal production.

Zambia currently has a national electrification rate of 18.8%. While electrification has reached 47% of urban households, rural electrification still lies very low at 3.3%. Only 15.8% of the population has access to modern cooking fuel and almost 60% still rely on fuelwood. In the industrial sector, where boilers and furnaces are in use, mitigation options considered are energy substitution and conservation. These include substituting heavy fuel oil and diesel-fired boilers with electric boilers, extending the national electric power grid to remote areas to replace diesel generators, and replacing diesel pumps used for pumping crude oil with electric pumps. In the area of energy conservation, substituting a dry process for cement production is considered.

In the forest sector, the mitigation options considered are afforestation and improved natural vegetation management, improving CO_2 uptake. In addition, Zambia can meet its wood needs and enhance agricultural productivity by implementing agroforestry practices based on scientific and indigenous knowledge (Chileshe, 2001). Zambia signed the Convention on 11 June 1992 and ratified it on 28 May 1993. The Convention entered into force on 21 March 1994.

Vienna Convention for the Protection of the Ozone Layer

Zambia is Party to the Vienna Convention, which demands that each Party establish and operationalise control measures in Ozone Depleting Substances (ODS) production and consumption. The Convention was adopted by the Conference on the Protection of the Ozone Layer. Like many other sovereign states, Zambia planned to address issues involving protecting the ozone layer in 1990 and the London Amendments in 1994.

In agriculture, Zambia is a signatory to some conventions. They are being domesticated and implemented through the MoA and MFL. In agriculture, most of the conventions are promulgated by FAO and domesticated in national policy and law. These conventions include:

International Plant Protection Convention

The International Plant Protection Convention (IPPC) is an international plant health agreement established in 1952. It aims to protect cultivated and wild plants by preventing the introduction and spreading of pests. It sets out standards (so-called ISPMs) that regulate safe plant and plant products movement to prevent the spread of plant pests and diseases. Zambia's ability to trade internationally and ensure food security hinges on its compliance with IPPC obligations. ISPMs Standards are also necessary as they help exporters demonstrate the safety of their products. The FAO, including the IPPC secretariat, has assisted Zambia in improving its phytosanitary capacity for the designated national institutions to implement the agreed IPPC procedures and standards. FAO hosts the IPPC Secretariat as an Article XVI Body. The IPPCS is located in the Agriculture and Consumer Protection Department and is associated with its work. Zambia ratified the IPPC on 24 June 1986.

The Joint FAO/WHO Meeting on Pesticide Residues (JMPR)

Since 1963, the JMPR has met annually to carry out scientific evaluations of pesticide residues in food. JMPR advises on acceptable levels of pesticide residues in food in international trade. The aim is to evaluate the risks associated with the use of pesticides. It is the main advisory body of the International Codex Alimentarius Commission and recommends maximum residue levels in food and feed commodities. It also provides guidelines on the setting of Maximum Residue Limits. JMPR guides the Joint Meeting on Pesticide Specifications to establish pesticide product quality parameters for regulatory and trade purposes. It reviews the chemistry and composition of pesticides data, metabolism in farm animals and crops, pesticide use patterns, environmental fate, methods of analysing pesticide residues and processing studies, and assesses associated toxicology data.

International Red Locust Control Organisation for Southern Africa (IRLCOSA)

Established on 14 September 1970, in Kampala (Uganda), by Governmental Agreement, it came into force on 1 January 1971, in succession to International Red Locust Control Service (IRLCS), set up on 22 February 1949, in London (UK). It promotes and undertakes effective control of significant populations of red locust in recognised outbreak areas in the territories of Contracting Governments; offers services to coordinate and reinforce national action in the region against red locust swarms that escape from recognised outbreak areas; and undertakes control of migrant pests in member countries, including armyworm, grain-eating birds and tsetse flies. It maintains an air unit, ground transport and research facilities, initiates monitoring activities, and conducts training programmes for plant protection personnel in member and neighbouring states. Collaborative projects include the laboratory screening and field testing of candidate insecticides, conducting surveys and controlling locusts in outbreak areas.

The International Treaty on Plant Genetic Resources for Food and Agriculture

The International Treaty on Plant Genetic Resources for Food and Agriculture, also known as the International Seed Treaty, is a comprehensive international agreement in harmony with the Convention on Biological Diversity, which aims at “guaranteeing food security through the conservation, exchange and sustainable use of the world’s plant genetic resources for food and agriculture (PGRFA)”, as well as the fair and equitable benefit sharing arising from its use. It also recognises farmers’ rights, subject to national laws to:

- “the protection of traditional knowledge relevant to plant genetic resources for food and agriculture;
- the right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture; and
- at the national level, the right to participate in making decisions on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture”.

The Treaty establishes the Multilateral System of Access and Benefit-sharing to facilitate plant germplasm exchanges and benefit-sharing through the Standard Material Transfer Agreement. The Treaty, which was entered into force on 29 June 2004, “allows governments, farmers, research institutes and agro-industries to work together by pooling their genetic resources and sharing the benefits derived from their use”. Zambia ratified the treaty on 13 March 2006.

Comprehensive African Agriculture Development Programme

The second Africa Union Assembly held in Maputo, Mozambique in July 2003, signed a declaration on Agriculture and Food Security. The Maputo Declaration called for the implementation of the new Pan-African flagship programme of the New Partnership for Africa’s Development (NEPAD): The Comprehensive African Agriculture Development Programme (CAADP) (AU/NEPAD, 2013). The CAADP was seen as the vehicle to stimulate production and bring about food security among the continent’s people. The AU member countries committed to allocating at least 10% of national budgetary resources to agriculture to achieve 6% growth. As a result, by 2013, following ten years of CAADP implementation, agriculture had risen to the top of the political agenda, 40 countries had signed a CAADP Compact, and two-thirds of those had formulated a National Agriculture Investment Plan (NAIP) or a National Agriculture and Food Security Investment Plan.

Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods (AU, 2014)

The AU member states committed to the Principles and Values of the CAADP Process to; enhancing investment finance in agriculture; ending hunger in Africa by 2025; halving poverty by the year 2025, through inclusive agricultural growth and transformation; boosting intra-African trade in agricultural commodities and services: enhancing resilience of livelihoods and production systems to climate variability and other related risks and mutual accountability to actions and results. The SNAP was written to address these main thematic areas at national level and use the same timeframe. The Malabo Declaration re-affirmed the commitment to the Principles and Values of the CAADP Process:

- "enhance investment finance in agriculture by upholding 10% public spending target and operationalization of Africa Investment Bank;
- commitment to end hunger on the continent by 2025 by doubling productivity (focusing on inputs, irrigation, mechanization);
- reducing post-harvest losses at least by half, and reduce stunting to 10%;
- to half poverty by 2025, through inclusive agricultural growth and transformation and sustain annual sector growth in agricultural GDP at least 6%;
- establish and/or strengthen inclusive public-private partnerships for at least five (5) priority agricultural commodity value chains with strong linkage to smallholder agriculture;
- create job opportunities for at least 30% of the youth in agricultural value chains and ensure preferential entry and participation by women and youth in gainful and attractive agribusiness;
- commitment to boosting intra-African trade in agricultural commodities and services, triple intra-Africa trade in agricultural commodities and fast track continental free trade area and transition to a continental common external tariff scheme;
- commitment to enhancing the resilience of livelihoods and production systems to climate variability and other shocks by ensuring that by 2025, at least 30% of farm/pastoral households are resilient to shocks; and
- commitment to mutual accountability to actions and results through the CAADP Result Framework".

The SADC Regional Agricultural Policy (SADC, 2014)

The Policy acknowledges the importance and existence of SADC policies and protocols with an indirect or direct effect on agriculture in the region. The SADC policies and protocols include Annex on Sanitary and Phytosanitary (SPS); Protocol on Law Enforcement and Wildlife Conservation; Protocol on Fisheries; Protocol on Transport; Protocol on Shared Water Courses; Protocol on Gender and Development; Protocol on Forestry; Protocol on Environment and the SADC Industrialisation Policy; Communication and Meteorology; and the SADC Water Policy. The policy takes entirely into account relevant commitments and interventions identified in these frameworks. It embraces every vital international and continental strategic framework that impacts or is impacted by forestry, agriculture and fisheries, including the African Union, NEPAD, CAADP and the United Nations Millennium Development Goals. The main objective of the goals is to add to socio-economic development and the growth of sustainable agriculture.

Its specific objectives are to:

- Improve international and regional trade and accessibility to markets of agricultural products
- Improve productivity and competitiveness in sustainable agriculture
- Improve public and private sector involvement and investment in the value chains of agriculture, and
- Reduce the economic and social vulnerability of the population in the SADC, in terms of food and nutrition security and the varying climatic and economic environment.

The policy will be reviewed every five years as systems and capacities are strengthened and developed. Without ignoring interventions with longer-term implementation timeframes, the policy has put up a phased implementation approach that allows, in its early stages of implementation, to focus on areas that can most quickly address some of the region's agricultural challenges.

Agenda 2063 (AU, 2015)

The African Union Heads of State Summit in 2013 made a commitment to eradicate poverty in one generation and build shared prosperity through a social and economic transformation of the continent by 2063. Agenda 2063 encapsulates Africa's Aspirations for the Future and identifies critical flagship programmes that can boost Africa's economic growth and development, and lead to the continent's rapid transformation. It also identifies key activities to enact in its 10-year Implementation Plans, ensuring that Agenda 2063 delivers quantitative and qualitative Transformational Outcomes for Africa's people. The goals of Agenda 2063 are underpinned by a desire to create a prosperous continent based on inclusive growth and sustainable development. It envisaged this could be achieved through an integrated continent that is:

- "politically united based on the ideals of Pan-Africanism and the vision of Africa's Renaissance or 'Ubuntu';
- a continent of good governance, democracy, respect for human rights, justice, and the rule of law;
- peaceful and secure; with a strong cultural identity, common heritage, shared values, and ethics;
- a continent with modernized infrastructure, with all the necessities of life such as water, sanitation, energy, public transport, and ICT; and
- African economies that are structurally transformed create shared growth, decent jobs, and economic opportunities for all".

The development of the agricultural sector and sustainable management of Africa's natural resources are critical to Agenda 2063. This includes ensuring Africa must strive to increase its agricultural productivity by promoting Smart Agriculture in the face of climate change, and optimising water use and the environment through shared competencies and infrastructure across the continent. Among the goals of Agenda 2063 is to promote the blue economy as a national policy in the area of sustainable fisheries and use of marine resources. It also aims to reposition the agricultural sector to effectively achieve the aspirations embedded in Agenda 2063 which are to promote shared competencies; promote the right to education; enhance policy convergence in agriculture; and address emerging politics of climate change. Other aspirations include achieving modern agricultural production systems that are productive, improve value, and contribute to farmer and national prosperity. Furthermore, the activities undertaken across the continent should ensure collective food security and sustainably manage Africa's unique natural endowments, environment and ecosystems, including its wildlife. It should promote wildlands that are healthy, valuable and protected, with climate-resilient economies and communities. As such, Zambia's developmental agenda and policy framework has fused itself in the continental 50-year development blueprint dubbed Agenda 2063, a structural transformation encompassing the SNDP, SNAP and NAIP.

Sustainable Development Goals

The Sustainable Development Goals (SDG), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. There are 17 Goals built on the successes of the Millennium Development Goals, and include new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interconnected – often, the key to success will involve tackling issues more commonly associated with another. The SDGs work in the spirit of partnership and pragmatism to make the right choices to improve life sustainably for future generations. They provide clear guidelines and targets for all countries to adopt in accordance with their priorities and the environmental challenges of the world at large. In Zambia for example, the SNAP has been aligned to SDG1 (no poverty), SDG2 (zero hunger), SDG9 (industrial innovation and infrastructure) and SDG12 (responsible consumption and production); while the National Policy on Environment is aligned to SDG7 (affordable and clean energy), SDG9, SDG13 (climate action) and SDG15 (life on land). These are meant to ensure good public delivery, cost-effective implementation, precautionary environmental effectiveness, policy integration, transparency, accountability and international cooperation.

4.6.8 Main disconnects in relation to agriculture and ecosystems

Agriculture is the most dominant land use on Earth and will remain so as the world's population and global food demand rise. The increase in population poses a challenge to the natural environment, as agricultural activities require access to natural resources. Thus, the environment is often harmed by agriculture's external impacts and expansion. Using land resources for agriculture prioritises crop and livestock production over the many other benefits that natural ecosystems provide and that agriculture displaces, including biodiversity, carbon storage and water purification (Tanentzap et al., 2015).

Agriculture is integral to the physical and economic survival of every human being. Its problems are complex, multidimensional and multilevel, involving many actors. Every community and country desires agricultural sustainability, and has led to the enactment of many policies and laws to produce food for the generations ahead. However, agricultural sustainability is complex and needs to cover the whole food chain, from production to consumption. Contemporary agriculture involves managing land in ways that conflict with the healthy functioning of ecosystems (level fields, no rest period, use of toxic chemicals, reductions of biodiversity and so on). Yet agriculture depends on the healthy functioning of ecosystems (Shennan, 2007). In many African countries, including Zambia, there is a worrying disconnect between the true cost of food production and its retail price (Scialabba et al., 2015c). Consequently, food appears to be cheaper when produced at a great environmental cost regarding greenhouse gas emissions, air and water pollution, and habitat destruction. Such food can appear to be cheaper than more sustainably-produced alternatives.

The status of the agricultural production base is characterised by some disconnects between agriculture and the environment. Modern farming methods have degraded soil, leading to massive fertiliser use. Human activities have significantly disturbed water, carbon and nitrogen cycles, impacting global climate change, which in turn is and will impact agricultural productivity and challenge sustainability (Honfoga, 2018).

Agriculture’s demand for land drives the conversion of natural habitats, and this is arguably its highest environmental cost. Converting land for agriculture is estimated to account for 80% of global deforestation. About 53% of terrestrial species assessed as threatened by the IUCN are negatively impacted by agriculture. It also reduces the size of the terrestrial carbon sink. Global simulation models predict that 24% and 10% less carbon is stored in vegetation and soil, respectively, than if present-day landscapes retained their natural vegetation. Agriculture also contributes more to other forms of environmental degradation than any other economic sector. Between 30%–35% of global greenhouse gas emissions come from agriculture (Foley et al., 2011), and crop irrigation accounts for 70% of the world’s freshwater withdrawals (FAO, 2015a). The use of synthetic nitrogen fertiliser has increased nearly 21-fold since 1950, and more nitrogen is now added to agricultural soils than from natural processes (Bouwman et al., 2013). Phosphorus from fertiliser and livestock manure (MacDonald et al., 2011), pesticides (Rohr et al., 2008) and nanoparticles (De Santiago-Martín et al., 2015.) are also increasing the levels of pollution in the environment. Additionally, bad agricultural practices bring about soil degradation, leading to reduced crop productivity and increased demand for nutrients, water and land conversion.

Climate extremes in the natural environment occasionally cause natural disasters. These include high temperatures, high winds, dry spells, flash floods and cyclones. In Zambia, though the cold waves are rare, frost may occur on the valley floors. Heavy rains and high winds occur, likely leading to storm surges and floods. This situation may cause extensive damage to crops, leading to loss of life and property and also loss of quality of life. At sub-sectoral level, the damage to crops and animals would inevitably lead to widespread food insecurity and loss of productivity. Water and sanitation may lead to water contamination, increased water-borne diseases, reduced irrigation, and at an ecosystem/environment level, the destruction of biodiversity.

How to overcome the disconnect between agriculture and the environment?

Solutions for limiting agriculture's environmental costs are increasingly well understood. These include reducing land clearance by improving yields of existing crops, minimising excess nutrient and water use, and shifting production from livestock towards crops (Foley et al., 2011). When implemented for only a few commodities, these practices benefit the environment significantly (West et al., 2014). According to Tanentzap et al. (2015), there are several potential solutions to overcoming the disconnect. Firstly, regulating the use of pesticides or abstracting water by enforcing penalties and conditions placed on financial support to farmers. Secondly, using community-based approaches that support farmers and local stakeholders to work collectively in addressing environmental impacts. And finally, by using economic instruments that pay farmers directly for adopting practices that minimise environmental impacts and provide non-commodity outputs beyond those required by existing regulations. Tariffs can also be used to internalise environmental costs.

Barriers to overcoming them

While policies exist, however, failure to put them into effect has resulted in ecosystem degradation (Kalaba, 2016). Forests provide essential sources of livelihood income for rural people and provide safety nets in times of need. In particular, rural households depend on forest and woodland resources to meet their energy needs, for construction and roofing materials, livestock fodder, wild foods that support a healthy diet and so on (Forestry Department, 2016). Zambia estimated that forest income accounts for between 20 and 60% of total household income (subsistence and cash) in the different study sites. Single forest products such as caterpillars, charcoal and honey may even provide more cash than agriculture. However, most forest products are traded as raw materials, and value-addition is rarely done. In addition, the existence of poor infrastructure, uncoordinated markets, and weak institutional capacity within the forestry department and local communities' structures are major constraints in the management and usage of these natural resources (Malambo & Syampungani, 2008).

Often there is limited access to financial services by forest-based enterprises. A conducive policy environment could support forest-based enterprises and increase direct government income at the national level. However, the complexity, enforceability and cost of implementing regulations that could minimise deforestation in developing countries like Zambia is a challenge. Where compliance is linked to payments, clear environmental standards and operational guidance are required at the farm level. Payments must also incorporate regional and sectoral variation in the cost of compliance (Tanentzap et al., 2015).

Where approaches are community-based – delivering social and/or short-term economic benefits to individual farmers – the lack of these benefits limits uptake of amicable environmental solutions. Lack of delivery on expected environmental outcomes in the short term may lead to farmers retiring the least profitable land that is often the poorest quality, limiting environmental benefits.

4.6.9 Narratives and assumptions driving the agricultural and conservation policy agenda

Agriculture stands out as the future key driver of Zambia's economy, second to mining (MoA, 2016a). Zambia's potential is enormous given abundant land, water, climate and affordable labour force. The Zambian agriculture sector comprises crops, livestock and fisheries, with maize as the most cultivated crop. Other major crops include cotton, soybeans, tobacco, groundnuts, paprika, sorghum, wheat, rice, sunflower seeds, coffee, sugar, fruits, other vegetables and flowers. Its role is well articulated in both SNAP and the SNDP. The narrative about factors driving the agricultural development is outlined in Table 27.

Table 27. The narrative and assumptions about agricultural development

Narrative	Assumptions
Ensuring food and nutrition security	Improved production and productivity at the farm level increases outputs and availability of nutritious and healthy diets
Enabling rural investment – rural public goods	To ferry produce to markets, the government has to invest in physical infrastructure, human development, research and extension
Job creation	Agriculture is the largest employer; in Zambia, about 70% of the rural population
Agricultural and rural transitions	Agricultural development can help facilitate structural change by producing food for urban consumers and raw materials for industries. It supports the sector if agricultural productivity rises and the unit cost of food falls since this moderates demand for wages. It is transforming small-scale farmers, making them more efficient. Increasing income would lead to wealth redistribution and improved livelihoods (redistribution with growth). The efficiency of small-scale farms in land use: the inverse ratio of size and yield – due to a large pool of cheaper household labour the cost ratios are lower than large farm per unit output. Rural transition is based on the transition from agrarian to industrial, centred on manufacturing, as the land gets concentrated in large commercial undertakings

Narrative	Assumptions
Rural market development	Some agricultural and food supply chains are increasingly dominated by supermarkets, processors and exporters who bring logistical expertise but often demand more farmers. Improving rural markets can occur by replacing private supply with direct government provision to farmers; however, costs can be high and driven by political goals. The alternative is to promote collective and private institutional innovations (for example, contracting, farmer associations, training input dealers backed by inventory credit) – promoted by agri-businesses and NGOs and sometimes encouraged by some seed funding from governments and donors
Use of agricultural technology	Improvements to agricultural technology have been a powerful driver of growth – use of high-yield varieties, manufactured and other external inputs, and transgenic varieties (especially in areas currently marginal for farming) to achieve sufficient production for future populations. Low external input will be needed if farming is to stay within environmental limits. Policy reforms and improved practices and technologies, such as pest-resistant varieties, biological pest control, precision farming, and crop diversification, are helping to stem the loss of biodiversity following the adoption of HYVs; inappropriate use of fertilisers and pesticides have polluted waterways, poisoned agricultural workers and killed beneficial insects and wildlife
The role of gender	Many women are engaged in agriculture and food supply chains as farmers, labourers, traders and processors. Women, however, are often at a disadvantage compared to men, typically having less access to land and water, less education and formal skills, less time to farm owing to domestic duties, fewer contacts with the world beyond the village, and less influence over the use of household resources. Therefore, closing gender gaps in agriculture requires: strengthening women's rights to land, giving them better access to inputs, equipment and technical knowledge through appropriate extension and market information, raising their education and skills, and providing care centres for children. Gender empowerment can be more elusive, and over-simplified gender analysis should be avoided
Environmental sustainability and climate change	Intensification of agriculture increased environmental costs. Moreover, continuing greenhouse gas emissions mean that the climate is warming and will continue to do so for most of this century. Rising temperatures will also cause more extreme and variable weather patterns, change the incidence of pests and diseases, and threaten low-lying coastal lands due to sea level rises. Faced with a changing climate, agriculture needs to adapt to such changes and mitigate emissions arising from agriculture

Source: Adapted from Wiggin et al. 2015

Because of existing concerns about climate change and food security, Conservation Agriculture has emerged as a well-supported and central component of the agricultural sector development strategy across sub-Saharan Africa, including Zambia (Abdulai & Abdulai, 2016). The practice has long been heralded by the international agriculture and development community as a sustainable approach to farming and adapted in southern Africa from the Zimbabwean commercial farming sector to smallholders (Haggblade & Tembo, 2003). In the agricultural sector, Conservation Agriculture is being seen as central to national agricultural policies and the activities of non-governmental organisations alike, justified based on a variety of success claims about its ability to increase productivity (and therefore enhance national food security), its low input requirements, and its contribution to climate change mitigation and social empowerment (Ngombe & Kalinda, 2015). Its benefits over conventional agricultural systems are now reasonably understood and underpin the efforts towards 'upscaling' Conservation Agriculture and increasing rates of adoption among smallholder farmers nationwide (Ngombe et al., 2017; Whitfield et al., 2015). It is these assumptions and narrative-based studies that must be unpacked to develop appropriate policy responses. Hence the need for researchers to revisit assumptions and critically assess the practical benefits associated with this practice, to appropriately target policy action undertaken to increase its adoption.

Several papers and literature exist on the performance of Conservation Agriculture in sub-Saharan Africa, including in Zambia and this is illustrated by the high number of papers presented at the Africa Conservation Agriculture Congress held in Zambia in March 2014. Narratives about Conservation Agriculture in Zambia are outlined in Table 28.

Table 28. The narratives and assumptions about Conservation Agriculture

Narrative	Assumptions
Land degradation, soil and water conservation	• Minimum tillage practices prevent plough pans, while improved soil structure increases infiltration and water and nutrient holding capacity • Planting basins increase soil moisture storage and availability, enhancing drought resilience • Crop rotations allow for nitrogen fixation, which organically fertilises the soils, and allows moisture and nutrients to be drawn from different soil depths • Mulching, or organic soil cover, helps to prevent topsoil weathering and erosion, with mulch decay contributing to increases in the organic matter content of topsoil
Rising input cost – reducing input dependency	• Improved soil conditions may reduce N and phosphorus (P) deficiencies. Planting holes or basins allows for inputs to be carefully targeted rather than broadcast across the field. Land preparation (ripping, dibble-stick planting, or basin digging) is associated with reduced labor and machine-hours

Narrative	Assumptions
Food insecurity – increased food production	• Reduced yield gaps and increased aggregate national production, improved availability and affordability of food • More stable production under varying environmental conditions
Emissions from agriculture and deforestation – climate change mitigation	• Prevention of soil erosion and the maintenance of cover crops, and particularly where it is practised in conjunction with fertiliser trees, increases C sequestration and storage • Reduced reliance on inputs reduces agriculture-associated emissions • Improved agricultural practices and productivity reduce land abandonment rates and pressure on forested areas, reducing emissions from deforestation
Social marginalisation – empowering women	• Increased productivity and reduced cost on inputs represent increased profitability and pathway out of poverty • Women are empowered because of the associated shift in the labour burden away from land preparation

Source: Adapted from Whitfield et al. (2015)

5. Conclusion

Zambia has abundant natural resources but they are being depleted at alarming rates, negatively impacting agriculture and other sectors of the economy. Despite the high biophysical potential to diversify agricultural production, maize remains the dominant production system, covering approximately 2.7 million ha. There are several ecological services that forests provide, including: the regulation of water regimes by intercepting rainfall and regulating its flow through the hydrological system; the maintenance of soil quality and the provision of organic materials through leaf and branch fall; the limiting of erosion and protection of soil from the direct impact of rainfall; modulating climate, and being critical components of biodiversity both in themselves and as a habitat for other species.

The continued degradation of the forests poses a serious threat to Zambia's biodiversity, particularly agrobiodiversity, despite the high economic growth experienced in recent years. While agricultural development is highly beneficial to the national economy, it is one of the main drivers of deforestation – together with mining, human settlement, wood logging and industrialisation. These natural resources support rural livelihoods and investment opportunities that hold potential for national socio-economic development. They provide an essential source of livelihood for rural communities. In particular, poorer households are more dependent (44%) on local forests for food and energy sources. Poorer households also have a greater dependence on wild plants for medicinal purposes and food. The growing urban population has also increased the demand for wood fuel and charcoal, leading to more wood logging. While policies are in place to manage this, their enforcement has been inadequate.

This desktop survey recommends the following:

- Zambia must recognise the importance of land tenure and ownership to ensure sustainable natural resource management and mitigation of or adaptation to climate change, especially concerning customary lands, which account for nearly two-thirds of forest land
- Government must accelerate the pace of adopting the relevant legislation and forest policies that ensure agricultural expansion does not happen at the expense of biodiversity loss
- There is a need for more awareness among policymakers, local communities and other stakeholders so that natural habitat for different biodiversity is not lost
- The role of forests in the economy must be well documented and disseminated to create awareness among non-agricultural sectors that may not understand the contributions that agrodiversity makes to climate-resilient agricultural systems.

6. References

Aagaard, P (2007) Conservation Farming & Conservation Agriculture. Handbook for Hoe farmers in Agro-Ecological regions I &IIa – Flat Culture. CFU, Lusaka.

Abdulai, A & Abdulai, A (2016) Examining the impact of conservation agriculture on environmental efficiency among maize farmers in Zambia. *Environmental and development Economics*, 1–5.

Abedi-Lartey, M, Dechmann, D, Wikelski, M, Scharf, A & Fahr, J (2016) Long-distance seed dispersal by straw-coloured fruit bats varies by season and landscape. *Global Ecology and Conservation*, 7, 12–24.

ACC (2009) National Anti-Corruption Policy. Anti-Corruption Commission, Lusaka, Zambia.

ACF (2012) Profile: The Agricultural Consultative Forum. Lusaka.

Adams, M (2003) Land tenure policy and practice in Zambia: issues relating to the development of the agricultural sector. DFID.

Aerni, P (2013) Assessment of current capacities and needs for capacity development in agricultural innovation systems in low income tropical countries. Synthesis Report. FAO, Rome.

AfDB (2010) 2011–2015 Country Strategy Paper (CSP). African Development Bank Group. Lusaka.

AfDB (2013) African Development bank approves US$18 million for Livestock Infrastructure in Zambia. https://www.afdb.org/en/news-and-events/afdb-approves-us-18-million-for-livestock-infrastructure-in-zambia-12033/

AfDB (2015) Skills Development and Entrepreneurship Project Supporting Women and Youth Appraisal Report. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Boards-Documents/Zambia_-_AR-Skills_Development_and_Entrepreneurship_Project_Supporting_10_2015.pdf

AfDB (2018) African Economic Outlook. African Development Bank.

Aizen, M & Harder, L (2009) The global stock of domesticated honeybees is growing slower than agricultural demand for pollination. *Current Biology*, 19(11), 915–918. https://doi.org/10.1016/j.cub.2009.03.071

Aizen, M, Garibaldi, LA, Cunningham, SA, Klein, A & Ecotono, L (2008) Long-term global trends in crop yields and production reveal no current pollination shoratge but increasing pollinator dependency. *Current Biology*, 18(20), 1572–1575. https://doi.org/10.1016/j.cub.2008.08.066

Aizen, M, Garibaldi, LA, Cunnigham, SA & Klein, A (2009) How much does agriculture depend on pollinators? Lessons from long-term trends in crop production. *Annals of Botany*, 103(9), 1579–1588. doi: http://dx.doi.org/10.1093/aob/mcp076

Ajayi, O, Akinnifesi, F, Mullila-Mitti, J, DeWolf, J & Matakala, P (2006) Adoption of agroforestry technologies in Zambia. Paper presented at the Agricultural Consultative forum (ACF) and Stakeholders' Workshop, 07 December 2006. Lusaka.

Ajayi, O, Franzel, S, Kuntashula, E & Kwesiga, F (2003) Adoption of improved fallow technology for soil fertility management in Zambia: Empirical studies and emerging issues. *Agroforestry Systems*, 59, 317–326.

Akayombokwa, I, van Koppen, B & Matete, M (2015) Trends and Outlook: Agricultural Water Management in Southern Africa Country Report. Lusaka. http://www.iwmi.cgiar.org/Publications/Other/Reports/PDF/country_report_zambia.pdf

Alamu, E, Gondwe, T, Akello, J, Sakala, N, Munthali, G, Mukanga, M & Maziya-Dixon, B (2018) Nutrient and aflatoxin contents of traditional complementary foods consumed by children of 6–24 months. *Food Science & Nutrition*, 6(4), 834–842.

Anthony, K & Uchendu, V (1970) Agricultural Change in Mazabuka District, Zambia. Stanford University, *Food Research Studies in Agricultural Economics, Trade and Development*, 9(3), 215–267.

Araki, S (2007) Ten Years of Population Change and The Chitemene Slash-and-Burn System around the Mpika area, Northern Zambia. *African Study Monographs Supplement*, 34, 75–87.

Archer, C, Pirk, C, Carvalheiro, L & Nicolson, S (2014) Economic and ecological implications of geographic bias in pollinator ecology in the light of pollinator declines. *OIKOS*, 123(4), 401–407.

Arslan, A, McCarthy, N, Lipper, L, Asfaw, S & Cattaneo, A (2013) Adoption and Intensity of Adoption of Conservation Farming Practices in Zambia. ESA Working Paper No. 13-01.

Arslan, A, McCarthy, N, Lipper, L, Asfaw, S, Cattaneo, A & Kowke, M (2014) Food security and adaptation impacts of potential climate smart agricultural practices in Zambia. FAO, Rome. http://www.fao.org/3/a-i4365e.pdf

Aslan, C, Zavaleta, E, Tershy, B & Croll, D (2013) Mutualism Disruption Threatens Global Plant Biodiversity: A Systematic Review. *PLoS ONE*, 8(6), e66993. https://doi.org/10.1371/journal.pone.0066993

Asseffa, W (2016) Agrobiodiversity conservation practices and gender consideration in Sinana District, southeastern Ethiopia. MSc thesis in Ecosystem and Biodiversity Conservation. Bale-Robe, Ethiopia, Madda Walabu University.

AU (2015) Agenda 2063. African Union Commission, Addis Ababa.

AU (2014) Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. Addis Ababa.

AU/NEPAD (2013) Zambia Agriculture Investment Opportunities Brief. CAADP Investment Facilitation Programme.

Bank of Zambia (2016) Monetary Policy Statement: July – December 2016. Lusaka, Zambia.

Bank of Zambia (2019) Monetary Policy Statement February 2019. Lusaka, Zambia.

Bartel, C, Lim, M & Sampath, G (2010) The Technology and Innovation Report 2010: Enhancing food security in Africa through science, technology and innovation. United Nations Publication Unctad /Tir/2009, New York and Geneva.

Bbalo, G (2015) Context of the study: Cattle restocking as a significant means of addressing the rights to food in Zambia. Ministry of Fisheries and Livestock, Lusaka.

Bellemare, M (2012) As You Sow, So Shall You Reap: The Welfare Impacts of Contract Farming. *World Development*, 40(7), 1418–1434.

Benson, T (2004) Africa's Food and Nutrition Security Situation: Where Are We and How Did We Get Here? International Food Policy Research Institute, Washington DC.

Berry, S & Rey, M (2001) Molecular evidence for diverse populations of cassava-infecting begomoviruses in southern Africa. *Archives of Virology*, 146, 1795–1802.

BirdLife International (2018) Country profile: Zambia. www.birdlife.org/datazone/country/Zambia

Birdwatch (2019) Research, species protection and development. Lusaka. www.birdwatchzambia.org/research-species-protection-and-development/

Bisimwa, E, Walangululu, J & Bragard, C (2012) Occurrence and Distribution of Cassava Mosaic Begomovirus Related to Agro-ecosystems in the Sud-kivu Province, Democratic Republic of Congo. *Asian Journal of Plant Pathology*, 6 (1), 1–12.

Blaser, WJ (2013) Impact of woody encroachment on soil-plant-herbivore interactions in the Kafue Flats floodplain ecosystem. DISS. ETH No. 21068, submitted for the degree of Doctor of Sciences at ETH Zurich.

Bonaglia, F (2008) Sustaining Agricultural Diversification. Business for Development. OECD. Business for Development Series.

Bondeau, A, Smith, PC, Zaehle, S & et al (2007) Modelling the role of agriculture for the 20th century global terrestrial carbon balance. *Global Change Biology*, 13, 679–706.

Bouwman, L, Goldewijk, KK, Van Der Hoek, KW, Beusen, AH, Van Vuuren, DP, Willems, J, Stehfest, E (2013) Exploring global changes in nitrogen and phosphorus cycles in agriculture induced by livestock production over the 1900–2050 period. *Proceedings of the National Academy of Sciences* USA, 110, pp. 20882–20887 pmid 21576477.

Bunyolo, A, Chirwa, B & Muchinda, M (1995) Agro-Ecological and Climatic Conditions. In S Muliokela (Ed.), Zambia Seed Technology Handbook, (pp. 19–23). Lusaka Zambia: Ministry of Agriculture, Food and Fisheries, Berlings Arlöv, Sweden.

CABI (2017) Tomato leaf miner. Pest Management Decision guide: Green and Yellow List. Plant wise, Lusaka.

Cabinet Office (2014) Decentralization Implementation Plan 2014–2017. Government of the Republic of Zambia, Decentralization Secretariat, Lusaka.

Cabinet Office (1995) Cabinet Circular No. 1 of 1995. Cabinet Office, Lusaka.

Cabinet Office (2012a) Strategy for Public Service Transformation Programme for Improved service delivery 2013–2018. Public Service Management Secretariat, Management Development Division, Cabinet Office, GRZ. http://www.cabinet.gov.zm/wp-content/uploads/2018/01/Strategy-for-Public-Service-Transformation-Programme-March-20121-003-1.pdf

Cabinet Office (2012b) Revised National Decentralization Policy – Empowering the People. Cabinet Office, Lusaka.

Campbell, D, Fiebig, M, Mailloux, M, Mwanza, H, Mwitwa, J & Sieber, S (2011) Zambia Environmental Threats and Opportunities Assessment. USAID, Washington DC.

Carvalheiro, L, Kunin, W, Keil, P, Aguirre-Gutiérrez, J, Ellis, W, Fox, R, DeVries, W (2013) Species richness declines and biotic homogenisation have slowed down for NW-European pollinators and plants. *Ecology Letters*, 16(7), 870–878.

CBD. https://www.cbd.int/agro/whatis.shtml

Chabwela, HC (2017) The Habitat Structure of Lukanga Ramsar Site in Central Zambia: An Understanding of Wetland Ecological Condition. *Open Journal of Ecology*, 07, 406–432. doi:10.4236/oje.2017.76029.

Chapoto, A (2014) The Political Economy of Food Price Policy in Zambia. In Pinstrup-Andersen (Ed.), Food Price Policy in an Era of Market Instability: A Political Economy Analysis. doi: 10.1093/acprof: oso/ 9780198718574.003.000.

Chapoto, A & Chisanga, B (2016) Zambia Agricultural Statistic Status Report 2016. IAPRI.

Chapoto, A & Jayne, T (2009) Effects of Maize Marketing and Trade Policy on Price Unpredictability in Zambia. Food Security Collaborative Working Papers 54499. Michigan State University, Department of Agricultural, Food, and Resource Economics.

Chapoto, A, Banda, D, Haggblade, S & Hamukwala, P (2011) Factors Affecting Poverty Dynamics in Rural Zambia. Working Paper No. 55. Food Security Research Project, Lusaka.

Chapoto, A, Chisanga, B & Kabisa, M (2017) Zambia Agricultural Statistic Status Report 2017. IAPRI.

Chapoto, A, Chisanga, B, Kuteya, A & Kabwe, S (2015a) Bumper Harvests a Curse or a Blessing for Zambia: Lessons from the 2014/15 Maize Marketing Season. IAPRI Working Paper No. 93. Indaba Agricultural Policy Research Institute, Lusaka.

Chapoto, A, Zulu-Mbata, O, Beaver, M, Chisanga, B, Kabwe, S, Kuteya, A, Sitko, N (2016) Rural Agricultural Livelihoods Survey 2015 Survey Report. Indaba Agricultural Policy Research Institute, Lusaka. http://www.iapri.org.zm

Chapoto, A, Zulu-Mbata, O, Hoffman, B, Kabaghe, C, Sitko, N, Kuteya, A & Zulu, B (2015b) The Politics of Maize in Zambia: Who holds the Keys to Change the Status Quo? IAPRI Working Paper 99.

Cheema, S (2007) Linking Government and Citizens Through Democratic Governance. In D Rondinelli (Ed.), Public Administration and Democratic Governanace: Governments Serving Citizens. 7th Global forum on Reinventing Government Building Trust in Government 26–29 June 2007, (pp. 29–51). Vienna, Austria.

Chêne, M (2014) Zambia: Overview of corruption and anti-corruption. Transparency International. https://www.u4.no/publications/zambia-overview-of-corruption-and-anti-corruption.pdf

Chidumayo, E (1987) A shifting cultivation land use system under population pressure in Zambia. *Agroforestry systems*, 5(1), 15–25.

Chidumayo, E (1992) The utilisation status of dambos in southern Africa: a Zambian case study. In T Matiza & H Chabwela (Ed.) (pp. 105–108). International Union for Conservation of Nature, Gland.

Chidumayo, E (1997) Miombo ecology and management: An introduction. Intermediate Technology Publishers, London.

Chidumayo, EN (2012) Development of reference emission levels for Zambia. Report prepared for FAO-Zambia Integrated Land Use Assessment (ILUA) Phase II project. Lusaka, Zambia.

Chidumayo, EN (2013) Forest degradation and recovery in a miombo woodland landscape in Zambia: 22 years of observations on permanent sample plots. *Forest Ecology and Management*, 291, 154–161.

Chidumayo, EN & Njovu, F (1998) Ecological screening of forest areas in the PFAP area, Zambia. Provincial Forestry Action Programme, Ndola.

Chidumayo, E & Aongola, L (1998) Zambia biodiversity strategy and action plan: The country study report. IUCN, Lusaka.

Chikowo, R (2016) Zambia: Description of Cropping Systems, Climate and Soils in Zambia. Application of the GYGA approach to Zambia. www.yieldgap.org/Zambia

Chikulo, B (2000) Decentralization for good governance and development: The Zambian experience. *Regional Development Dialogue*, 21(1), 26–48.

Chikulo, B (2014) Decentralization Reforms in Zambia 1991–2010. *Journal of the Scientific Society*, 40(1), 95–105.

Chileshe, A (2001) A Brief on the Forestry Outlook Study Forestry Department, Ministry of Environment and Natural Resources. http://www.fao.org/forestry/FON/FONS/outlook/Africa/AFRhom-e.stm

Chinowsky, P, Schweikert, A, Strzepek, N & Strzepek, K (2015) Infrastructure and climate change: a study of impacts and adaptations in Malawi, Mozambique, and Zambia. *Climatic Change*, 130, 49–62. doi: 10.1007/s10584-014-1219-8

Chipeta, GB, Sibalwa, D & Mpolomoka, D (2014) Profiling community of practices in Southern Province, Zambia. Zambian Open University, Lusaka.

Chirwa, M, Mrema, J, Mtakwa, P, Kaaya, A & Lungu, O (2015) Smallholder farmers' perceptions on groundnut (Arachis hypogaea L.)-based cropping systems: A case study of Chisamba District, Zambia. *Journal of Agricultural Extension and Rural Development*, 7(11), 298–307. doi:10.5897/JAERD2015.0738

Chitembo, A, Sakala, J, Mukwena, R, Mwasile, F, Zulu, J, Lolojih, P & Mbolela, M (2014) 50 Years of Local Government in Zambia. Local Government Association of Zambia, Lusaka.

Chitonge, H (2015) Customary Land at a Crossroads: Contest for the Control of Customary Land. *SADC Law Journal*, 4(1), 45–67. doi:10.13140/RG.2.1.2124.0161

Chitonge, H, Mfune, O, Umar, B, Kajoba, G, Banda, D & Ntsebeza, L (2017) Silent privatisation of customary land in Zambia: opportunities for a few, challenges for many. *Social Dynamics*, 43, 1, 82–102. doi:10.1080/02533952.2017.1356049

Chiwele, DK (2002) Local Governance, Participation and Accountability the Zambia Case Study. A presentation made at European Forum on Rural Development Cooperation Agropolis. Montpellier, France. 4–6 September, 2002.

Chiwele, D, Muyatwa-Sipula, P & Kalinda, H (1996) Private Sector Response to Agricultural Marketing Liberalisation in Zambia: A case study of Eastern Province Maize Market. Nordiska Afrikanstitutet Research Report No. 107.

Chomba, G (2004) Factors affecting smallholder farmers' adoption of soil and water conservation practices in Zambia. Michigan State University MSc Agric. Economics.

Christoplos, I (2010) Mobilizing the potential of rural and agricultural extension. FAO, Rome.

Chu, J, Yong, K & Phiri, D (2015) Large Scale Land Acquisitions, Displacements and Resettlements in Zambia. Policy Brief 41. Cape Town: Institute for Poverty, Land and Agrarian Studies, Faculty of Economic and Management Sciences, University of Western Cape. http://www.plaas.org.za

Chulu, D (2014) Decentralization Policy of Zambia: An Investigation of effort and constraints in its implementation in Mambwe district. Master of Administration Thesis. University of Zambia. Unpublished.

CIA (2015) Central Intelligence Agency Library Publications. www.cia.gov/library/publications/the-world-factbook/geos/za.html

CIA (2018) Country Profile-Zambia. CIA Factbook. www.cia.gov/library/publications/the-world-factbook/docs/countryprofile.html

CIAT: World Bank (2017) Climate-Smart Agriculture in Zambia. CSA Country Profiles for Africa Series. International Center for Tropical Agriculture (CIAT), Washington DC.

Claros, A (2013) Removing Impediments to Sustainable Economic Development the Case of Corruption. World Bank Policy Research Working Paper 6704.

Coche, A (1998) Supporting aquaculture development in Africa: research network on integration of aquaculture and irrigation. A report prepared for the Inland Water Resources and Aquaculture Service of the FAO Fisheries Department ACCRA. CIFA Occasional Paper No. 23 CIFA/OP23. http://www.fao.org/3/X5598E/X5598E00.htm

Collier, E (2017) Zambia Maize Market Fundamentals. USAID Funded Famine Early Warning Systems Network (FEWS NET).

Cooper, T, Wanneburgh, A & Cherry, M (2017) Atlas data indicate forest dependent bird species declines in South Africa. *Bird Conservation International*, 27(3), 337–354. doi.org/10.1017/S095927091600040X

Corlett, R (2017) Frugivory and seed dispersal by vertebrates in tropical and subtropical Asia: An update. *Global Ecology and Conservation*, 11, 1–22.

Creese, A & Pokam, W (2016) Africa's climate: Helping decision-makers make sense of climate information. Future Climate for Africa report 2016. Cape Town.

Crook, R, Manor, J, Chiwele, D & Pelekamoyo, G (2001) Local Governance and Decentralisation in Zambia, Final Report to The Netherlands Development Organisation, Ministry of Local Government and Housing and the Donor Reference Group. Institute of Development, Brighton.

CSO (2016c) Post Harvest Survey 2014–2015 Agriculture Season (Small and Medium Scale farms). Central Statistics Office, Lusaka.

CSO (2011) Labour Survey Report (2008). Labour Statistics Branch, Central Statistics Office, Lusaka.

CSO (2011b) Living Conditions Monitoring Survey. Central Statistics Office, Lusaka.

CSO (2012–2017) National Accounts. Central Statistics Office, Lusaka. http://zambia.opendataforafrica.org/ZMNACT2016/national-accounts

CSO (2013a) Labour Survey Report (2012). Labour Statistics Branch, Central Statistics Office, Lusaka.

CSO (2013a) Population and Demographic Projections 2011–2035. Central Statistical, Lusaka.

CSO (2013b) Population and Demographic Projections 2011–2035. Central Statistical Office, Lusaka.

CSO (2013c) Census of population and housing Characteristics Report. Central Statistical Office, Lusaka.

CSO (2013c) Labour Force Survery Report (2012). Labour Statistics Branch, Central Statistical Office, Lusaka.

CSO (2014–2016) Post Harvest Survey 2011/12; 2012/13; 2013/14; 2014/15 Agriculture Seasons (Small and Medium Scale Farms). Central Statistical Office, Lusaka.

CSO (2014–2016) Post Harvest Survey 2011–12; 2012–13; 2013–14; 2014–15 Agriculture Seasons (Small and Medium Scale Farmers). Central Statistical, Lusaka.

CSO (2014a) Post Harvest Survey 2011–2012 Agriculture Season (Small and Medium Scale Farms). Central Statistics Office, Lusaka.

CSO (2014a) Post Harvest Survey 2011–2012 Agriculture Seasons (Small and Medium Scale Farmers). Central Statistical Office, Lusaka.

CSO (2014b) Post Harvest Survey 2012–2013 Agriculture Season (Small and Medium Scale Farms). Central Statistical Office, Lusaka.

CSO (2014b) Post Harvest Survey 2012–2013 Agriculture Seasons (Small and Medium Scale Farmers). Central Statistical Office, Lusaka.

CSO (2015) CSO Monthly Bulletins, January-December. Central Statistical Office, Lusaka.

CSO (2016a) Labour Survey Report (2014). Key Indicators, Central Statistics Office, Lusaka.

CSO (2016b) Post Harvest Survey 2013–2014 Agriculture Season (Small and Medium Scale Farms). Central Statistical Office, Lusaka.

CSO (2016b) Post Harvest Survey 2013–2014 Agriculture Seasons (Small and Medium Scale Farmers). Central Statistical Office, Lusaka.

CSO (2016c) Post Harvest Survey 2014–2015 Agriculture Seasons (Small and Medium Scale Farmers). Central Statistical Office, Lusaka.

CSO (2016d) 2015 Living Conditions Monitoring Survey Report. Central Statistics Office, Lusaka.

CSO (2018a) 2017 Labour Force Survey Report. Central Statistics Office & Ministry of Labour and Social Security, Lusaka.

CSO (2018b) Zambia in Figures 2018. Central Statistical Office, Lusaka.

CSO (2019) Post Harvest Survey 2017–2018 Agriculture Seasons (Small and Medium Scale Farms). Central Statistical Office, Lusaka.

CSPR (2005) Targeting small scale farmers in the implementation of Zambia's Poverty Reduction Strategy GRZ. Paper (PRSP) Civil Society for Poverty Reduction: An Assessment of the Implementation and Effectiveness of the Fertilizer Support Programme. Lusaka.

Curtis, S, Hattori, A, Fehringer, J, Markiewicz, M, Lubungu, M & Mackenzi, A (2015) Impact Evaluation of Gender and Groundnut Value Chains *In:* Zambia Baseline Report. USAID Feed the Future FEEDBACK project, Westat Rockville, MD 20850.

CUTS (2016) Zambia Food Reserve Agency Pricing Mechanisms and the Impact on Maize Markets. CUTS, Jaipur.

Daily Mail (2017) Mansa to have a sugar plantation. https://www.daily-mail.co.zm/mansa-to-have-a-sugar-plantation/

Daka, D (1998) Livestock sector in Zambia: Opportunities and Limitations. FAO/IAEA Int. Conf. on Area-Wide Control of Insect Pests, Penang, May 28 to June 2, 1998.

Daley, E (2011) Gendered Impacts of Commercial Pressures on Land. Commercial Pressures on Land project report, Rome, Italy: International Land Coalition.

Darkoh, M (2003) Regional perspectives on agriculture and biodiversity in the drylands of Africa. *Journal of Arid Environments*, 54(2), 261–279. https://doi.org/10.1006/jare.2002.1089

Day, M, Gumbo, D, Moombe, K, Wijaya, A & Sunderland, T (2014) Zambia country profile: Monitoring, reporting and verification for REDD+. Occasional Paper 113. CIFOR, Bogor, Indonesia. doi: 10.13140/2.1.2815.7121.

Day, R, Abrahams, P, Bateman, M, Beale, T, Clottey, V, Cock, M, … Witt, A (2017) Fall Armyworm: Impacts and Implications for Africa. *Outlooks on Pest Management*, 28, 196–201. https://doi.org/10.1564/v28_oct_00

De Santiago-Martín, A, Constantin, B, Guesdon, G, Kagambega, N, Raymond, S & Galvez, R (2015) Bioavailability of engineered nanoparticles in soil systems. *Journal of Hazardous, Toxic, and Radioactive Waste.* doi:10.1061/(ASCE)HZ.2153-5515.0000263.

del Río, T (2014) Farming systems characterization in three communities from the Barotse floodplains, Zambia: Relating landscape with production and diversity. MSc. Organic Agriculture Minor Thesis Report Nutrition Sensitive Landscape project CGIAR research programs AAS and A4NH, WUR, Netherlands.

Devendra, C (2012) Climate Change Threats and Effects: Challenges for Agriculture and Food Security. ASM Series on Climate Change, Academy of Sciences, Malaysia.

Dixon, J, Gulliver, A & Gibbon, D (2001) Farming Systems and Poverty: Improving Farmers’ livelihoods in a Changing World (Summary). FAO and World Bank, Rome.

Dixon-Fyle, M (1976) Politics and Agrarian Change Among the Plateau Tonga of Northern Rhodesia, c. 1924–63. Degree of Doctor of Philosophy of the University of London Thesis, London.

Dorosh, P, Dradri, S & Haggblade, S (2010) Regional trade and food security: Recent evidence from Zambia. In A Sarris & J Morrison (Eds.). FAO & Edward Elgar, Cheltenham & Northampton, MA.

Eardley, C, Gikungu, M & Schwarz, M (2009) Bee conservation in Sub-Saharan Africa and Madagascar: diversity, status and threats. *Apidologie*, 40(3), 355–366. doi:10.1051/apido/2009016.

Eastwood, R, Lipton, M & Newell, A (2010) Farm size. In R Evenson & P Pingali (Eds.), Handbook of Agricultural Economics, 4, 3323–3397. Burlington: Academic Press. doi: 10.1016/S1574-0072(09)04065-1.

Egawa, C (2017) Wind dispersal of alien plant species into remnant natural vegetation from adjacent agricultural fields. *Global Ecology and Conservation*, 11, 3–41.

Eidsvoll, P (2011) Investigating the farm size-productivity relationship in Zambian food production. Master thesis (Environmental and Development Economics). University of Oslo.

Eliste, P, Mwanakasale, A, Purcell, T, Van Gent, R, Siegel, P & Nielsen, J (2007) Zambia Smallholder Agricultural Commercialization Strategy. Report No. 36573-ZM. World Bank.

Epstein, P, Diaz, H, Grabherr, G, Graham, N & Martens, W (1998) Biological and physical signs of climate change: focus on mosquito-borne diseases. *Bulletin of the American Meteorological Society*, 79, 409–417.

Esterhuizen, D (2015) Zambia: Agricultural Economic Fact Sheet. Foreign Agricultural Service, United States of America Embassy. https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Agricultural%20Economic%20Fact%20Sheet_Pretoria_Zambia_10-5-2015.pdf

Evans, AE, Giordano, M & Clayton, T (Eds.) (2012) Investing in agricultural water management to benefit smallholder farmers in Zambia. AgWater Solutions Project country Synthesis Report. Colombo, Sri Lanka: International Water Management Institute (IWMI) Working Paper 150. doi: 10.5337/2012.212

Ezilon.com (2009) The Physical Map of Zambia. http://www.ezilon.com

FAO and IAEA (2014) Genetic characterization of indigenous cattle breeds in Zambia – which way forward? http://www-naweb.iaea.org/nafa/news/2011-zambia-cattle-breeds.html

FAO (2003) National Aquaculture Sector Overview Fact Sheets: Zambia. Text by Maguswi, CT. In: FAO Fisheries and Aquaculture Department, Rome. http://www.fao.org/fishery/countrysector/naso_zambia/en

FAO (2005) Aquastat Country Profile – Zambia. FAO, Rome. Italy.

FAO (2007) The Plan of Action of the African Pollinator Initiative. FAO, Rome.

FAO (2010) Nutrition country profiles: Republic of Zambia. FAO, Rome. http://www.fao.org/ag/agn/nutrition/Zmb_en.stm19

FAO (2015a) AQUASTAT database. FAO, Rome. http://www.fao.org/nr/water/aquastat/data/

FAO (2015b) FAO Statistics Database. FAO, Rome. http://www.fao.org/faostat/en

FAO (2016) Mid-term evaluation of the Conservation Agriculture Scaling-up (CASU) project. GCP/ZAM/074/EC. Rome.

FAO (2017) GIEWS Country brief: Zambia. FAO, Rome.

FAO (2019) FAO Production Statistics: Zambia. FAO, Rome. http//www.fao.org/faostat/en/#country

Farrington, J & Saasa, O (2002) Drivers for Change in Zambian Agriculture Defining What Shapes the Policy Environment. Final Report submitted to: Department for International Development.

Fashoyin, T (2008) “Employment relations in Zambia”. *Employee Relations*, 30 (4) 391–403. https://doi.org/10.1108/01425450810879367

Fessehaie, J, das Nair, R, Ncube, P & Roberts, S (2015) Growth promotion through industrial strategies: ZAMBIA. International Growth Centre, London School of Economic and Political Science, London, IGC Working Paper.

FEWSNET (2004) Zambia Annual Harvest Assessment Report. Washington.

FEWSNET (2014) Zambia livelihood zones and Descriptions. Famine Early Warning Systems Network, Washington. http://v4.fews.net/docs/Publications/Guidance_Application%20of%20Livelihood%20Zone%20Maps%20and%20Profiles_final_en.pdf

Foley, J, Ramankutty, N, Brauman, K, Cassidy, E, Gerber, J, Johnston, M, Siebert, S (2011) Solutions for a cultivated planet. Nature, 478, 337–342. pmid: 21993620.

Fondong, V (2017) The Search for Resistance to Cassava Mosaic Geminiviruses: How Much We Have Accomplished, and What Lies Ahead. *Frontiers in plant science*, 8, 408. doi: 10 3389/fpls.2017.00408.

Forestry Department (2016a) Ministry of Lands Natural Resources and Environmental Protection, Integrated Land Use Assessment Phase II – Technical Paper 1, Classification of Forests in Zambia. Food and Agricultural Organisation of the United Nations, Ministry of Foreign Affairs, Finland, Lusaka, Zambia.

Forestry Department (2016b) Ministry of Lands Natural Resources and Environmental Protection, Integrated Land Use Assessment Phase II – Technical Paper 2, Biodiversity Report for ILUA II. Food and Agricultural Organization of the United Nations, Ministry of Foreign Affairs of Finland, Lusaka.

Forestry Department (2008) Ministry of Tourism, Environment and Natural Resources, Intergrated Land Use Assessment Report 2005–2008. In: MTENR (ed.). Lusaka.

Foster, V & Dominguez, C (2010) Zambia's Infrastructure: A Continental Perspective Country Report. The International Bank for Reconstruction and Development / The World Bank.

Fumpa-Makano, R (2011) Integrating Climate Change Issues into National Forest Programmes and Policy Frameworks. Forests and Climate Change. Background Paper for the National Workshop, Zambia April 27–28, Tuskers Hotel, Kabwe.

Fuseini, I, Battersby, J & Jain, N (2019) The characteristics of the urban food system in Kitwe.

Garrity, D, Dixion, J & Boffa, J (2012) Understanding Farming Systems: Science and Policy Implications. Food Security in Africa Bridging Research and Practice Sydney, 29–30 November, 2012. https://aifsc.aciar.gov.au/sites/default/files/understanding_african_farming_systems_report_for_aifsc_conference.pdf

Gemmill-Herren, B, Aidoo, K, Kwapong, P, Martins, D, Kinuthia, W, Gikungu, M & Eardley, C (2014) Priorities for Research and Development in the Management of Pollination Services for Agriculture in Africa. *Journal of Pollination Ecology*, 12(6), 40–5.

Genschick, S, Kaminski, A, Cole, S, Tran, N, Chimatiro, S & Lundeba, M (2017) Toward more inclusive and sustainable development of Zambian aquaculture. Penang, Malaysia: CGIAR Research. Program on Fish Agri-Food Systems. Program Brief: FISH-2017-07.

German, L, Gumbo, D & Schoneveld, G (2013) Large-scale land acquisitions: Exploring the marginal lands narrative in the Chitemene system of Zambia. *QA – Rivista dell'Associazione Rossi-Doria*, 2(2013), 109–135. doi:10.3280/QU2013-002005.

Gerssen-Gondelach, S, Wicke, B & Faaji, A (2015) Assessment of driving factors for yield and productivity developments in crop and cattle production as key to increasing sustainable biomass potentials. Energy and Food Security, 4, 35–76. https://doi.org/10.1002/fes3.53

Giller, K & Palm, C (2004) Cropping Systems: Slash-and-Burn Cropping Systems of the Tropics. *Encyclopedia of Plant and Crop Science*, 363–366. doi:10.1081/E-Epcs 120010540

Glenn, C (2006) Earth's Endangered Creatures. http://earthsendangered.com

Goldewijk, K, Beusen, A, van Drecht, G & de Vos, M (2011) The HYDE 3.1 spatially explicit database of human-induced global land-use change over the past 12,000 years. *Global Ecology Biogeography*, 20, 73–86.

Goma, F, Drope, F, Zulu, R, Li, Q, Chelwa, G & Banda, J (2015) The Economics of Tobacco Farming in Zambia. University of Zambia School of Medicine and Atlanta and the American Cancer Society, Lusaka.

Gommes, R & Fresco, L (1998) Everybody complains about climate. What can agricultural science and the CGIAR do about it? FAO, Rome.

Goyal, A & Nash, J (2016) Reaping Richer Returns Public Spending Priorities for African Agriculture Productivity Growth. World Bank.

Grebmer, K, Bernstein, J, Patterson, F, Sonntag, A, Klaus, L, Fahlbusch, J, Hammond, L (2018) Global Hunger Index. Forced Migration and Hunger. Concern Worldwide, Dublin/Bonn.

Greenley, A (1993) Religion and attitudes towards the environment. *Journal for the Scientific Study of Religion*, 32, 19–29.

Grogan, K, Birch-Thomsen, T & Lyimo, J (2013) Transition of Shifting Cultivation and its Impact on People's Livelihoods in the Miombo Woodlands of Northern Zambia and South-Western Tanzania. *Human Ecology*, 41, 77–92. doi:10.1007/s10745-012-9537-9.

GRZ (2009) National Anti-Corruption Policy. Government of the Republic of Zambia, Cabinet Office, Lusaka.

Gumbo, D, Moombe, K, Kandulu, M, Kabwe, G, Ojanen, M, Ndhlovu, E & Sunderland, T (2013) Dynamics of the Charcoal and Indigenous Timber Trade in Zambia: A Scoping Study in Eastern, Northern and Northwestern Provinces. Occasional Paper 86. CIFOR, Bogor, Indonesia. http://www.cifor.org/Publications/pdf_files/OccPapers/OP-86.pdf

Gumboh, S (2012) Decentralization Policy Implementation in Zambia. A Reality or Mere Political Rhetoric? Gumboh, S (2012) Decentralization Policy Implementation Scholarly Research Paper (undergraduate).

Guo, L & Gifford, R (2002) Soil carbon stocks and land use change: a meta-analysis. *Global Change Biology*, 345–360.

Haapanen, T & Waller, M (2007) Civil Society in Zambia and Mozambique. KEPA's Working Papers 17.

Haggblade, S & Nyembe, M (2008) Commercial Dynamics in Zambia's Cassava Value Chain. FSRP Working Paper No. 32. Lusaka.

Haggblade, S & Tembo, G (2003) Conservation farming in Zambia. EPTD Discussion paper no. 108.

Hall, R, Tsikata, D & Scoones, I (2017) The pros and cons of commercial farming models in Africa. The Conversation. https://theconversation.com/the-pros-and-cons-of-commercial-farming-models-in-africa-76355

Hamasaka, P (2016) FISP Electronic Voucher programme to promote diversification. Musika Newsletter June (2016), Lusaka. www.Musika.org

Hamoonga, W (2015) An Assessment of Animal Draught Power in Agricultural Production: A case of Matondo Village-Kalomo District. B.Ed. Diss, UNZA.

Hampwaye, G, Nel, E & Rogerson, C (2007) Urban agriculture as local initiative in Lusaka, Zambia. Environment and Planning C: *Government and Policy*, 25, 553–572.

Hamududu, B & Ngoma, H (2018) Impacts of Climate Change on Water Availability in Zambia: Implications for Irrigation Development. IAPRI Technical Paper No. 7. doi:10.13140/RG.2.2.10265.72805.

Holden, S (1993) Peasant household modelling: Farming systems evolution and sustainability in northern Zambia. *Agricultural Economics*, 9, 241–267.

Honfoga, B (2018) Diagnosing soil degradation and fertilizer use relationship for sustainable cotton production in Benin. *Cogent Environmental Science*, 4, 1422366. https://doi.org/10.1080/23311843.2017.1422366

Honig, L & Mulenga, B (2015) The Status of Customary Land and the Future of Smallholder Farmers under the Current Land Administration System in Zambia. IAPRI Working Paper 101.

Hope, A & Jones, C (2014) The impact of religious faith on attitudes to environmental issues and Carbon Capture and Storage (CCS) technologies: A mixed methods study. Technology in Society, 38, 48–59.

HRW (2017) Forced to leave: Commercial Farming and Displacement in Zambia. https://www.hrw.org/report/2017/10/25/forced-leave/commercial-farming-and-displacement-zambia

ICS (2017) US Department of State: Investment Climate Statements for 2018. Washington.

IDLO (2011) Legal preparedness for REDD+ in Zambia. International Development Law Organisation, Rome. http://www.idlo.org/Publications/LegalPreparednessREDDZambia.pdf

Ihemeremadu, N & Alexander, L (2017) A Gendered Perspective on Deforestation, Climate Change, and Environmental Legislation in Zambia. Southern African Institute for Policy and Research. Occasional Papers Series.

IICD (2006) Strengthening the agricultural information flow and dissemination system of the National Agricultural Information Services in Zambia. Project Proposal. The Hague.

IMF (2017) Zambia: International Monetary Fund Staff Report on the 2017 Article IV Consultation—Debt Sustainability Analysis. Washington, USA.

IPCC (2007) Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Summary for Policy Makers. IPCC Secretariat, FAO, Rome.

IPCC (2014) Climate Change Synthesis Report Summary for Policymakers. UNFCCC.

Irish Aid (2016) Zambia Climate Action Report. Irish Embassy, Lusaka.

Issahaka, F, Battersby, J & Jain, N (2018) The characteristics of the urban food system in Kitwe, Zambia: A focus on the retail sector. In J Battersby & V Watson (Eds.), Urban Food Systems governance and poverty in African cities (pp. 195–207). Routledge, New York.

ITUC (2012) HIV/AIDS, health, climate change and sustainable development – making the links for the trade union response. Background paper on HIV/AIDS for the Rio+20 Conference 20–22 June.

IUCN (2014) International Union for Conservation of Nature [IUCN] Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org

JAICAF (2008) Agriculture and Forestry in Zambia: Present situation and issues for development. 3F Akasaka KSA Bldg, 8-10-39 Akasaka, Tokyo, Japan.

Jain, S (2007) An Empirical Economic Assessment of Impacts of Climate Change on Agriculture in Zambia. The World Bank Development Research Group Sustainable Rural and Urban Development Team, Washington DC. Policy Research Working Paper 4291. http://econ.world.org

Jayne, T, Chamberlin, J & Headey, D (2014b) Land pressures, the evolution of farming systems and development strategies in Africa: A synthesis. *Food policy*, 48, 1–17.

Jayne, T, Chamberlin, J, Traub, L, Sitko, N, Muyanga, M, Yeboah, F, Kachule, R (2016) Africa's changing farm size distribution patterns:the rise of medium-scale farms. *Agricultural Economics*, 47(2016) supplement 197–214.

Jayne, T, Chapoto, A, Sitko, N, Nkonde, C, Muyanga, M & Chamberlin, J (2014a) Is the Scramble for Land in Africa Foreclosing a Smallholder Agricultural Expansion Strategy? *Journal of International Affairs*, Spring Issue, pp. 35–53.

JICA (2016) Country Gender Profile: Zambia Final Report. Tokyo, Japan.

Johnson, S (2010) The pollination niche and its role in the diversification and maintenance of the southern African flora. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1539), 499–516. doi:10.1098 /rstb.2009.0243.

Joy, P (1993) The Crisis of Farming Systems in Luapula Province, Zambia. *Nordic Journal of African Studies*, 2(2), 118–140.

Jurgens, N, Strohblach, B, Lages, F, Schmiedel, U, Finckh, M, Sichone, P, P, Z (2018) Biodiversity observation-an overview of the current state and first results of biodiversity monitoring studies. *Biodiversity and Ecology*, 6, 382–396.

Kabamba, H & Muimba-Kankolongo, A (2009) Adoption and impact of conservation farming on crop productivity among smallholder farmers in Kapiri Mposhi District of Zambia. *Journal of Animal and Plant Sciences*, 3 (2), 205–214.

Kabwe, G (2010) Uptake of agroforestry technologies among smallholder farmers in Zambia. PhD Thesis. Lincoln University.

Kahilu, D (2011) The impact of information and communication technology service (ICTs) among end users in the ministry of agriculture and cooperatives in Zambia. *Journal of Development and Agricultural Economics*, 3(7), 302–311.

Kajoba, G (2007) Vulnerability and resilience of rural society in Zambia: from the view point of land tenure and food security. RIHN Resilience Project Report 72–96.

Kalaba, F (2016) Barriers to policy implementation and implications for Zambia's forest ecosystems. *Forest Policy and Economics*, 69(C). 40–44.

Kalinda, T & Bwalya, S (2014) Utilization of Forest Products and Services for Livelihoods among Households in Zambia. *Research Journal of Environmental and Earth Sciences*, 6(2), 102–111.

Kalinda, T & Chisanga, B (2014) Sugar Value Chain in Zambia: An Assessment of the Growth. Asian *Journal of Agricultural Science*, 6(1), 6–15.

Kalinda, T, Bwalya, S, Mulolwa, A & Haantuba, H (2008) Use of Integrated Land Use Assessment (IlUA) data for Environmental and Agricultural Policy Review and Analysis in Zambia. FAO and the Forestry Department, Ministry of Tourism, Environment and Natural Resources, Zambia.

Kanene, K (2016) Indigenous practices of environmental sustainability in the Tonga community of southern Zambia. *Jàmbá Journal of Disaster Risk Studies*, 8(1), a331. http://dx.doi.org/10.4102/jamba.v8i1.331

Kapekele, E (2006) Determinants of slash and burn the case of Chitemene farming system in Zambia. University of Pretoria MSc. Thesis Agricultural Economics.

Kasali, G (2008) Climate Change and Health. Capacity Strengthening in the Least Developed Countries (LDCs) For Adaptation to Climate Change (CLACC). Working Paper 2.

Kasalu-Coffin, E, Afenyo, J & Mutiro, V (2011) Smallholder conservation agriculture Rationale for IFAD involvement and relevance to the East and Southern Africa region. IFAD, Rome.

Kasanda, E (2017) Gender and decision-making in agriculture: A case study of groundnuts farmers in Zambia. Kansas State University. Master of Agribusiness Degree.

Kasaro, D & Siampale, A (2015) Zambia's forest reference emission level for the UNFCCC. A presentation at the Global Landscape forum, COP21 on 5th November, 2015.

Katsui, H & Koistinen, M (2008) The participatory research approach in non-Western countries: practical experiences from Central Asia and Zambia. *Disability & Society*, 23(7), 747–757. doi:10.1080/09687590802469248

Kent, R & MacRae, M (2010) Agricultural livelihoods and nutrition — exploring the links with women in Zambia. Gender and Development, 18(3), 387–409.

Keyser, J, Thapa, S & Dixie, G (2012) Agribusiness Indicators: Zambia. World Bank, Washington DC.

Khonje, M, Mkandawire, P, Manda, J & Alene, A (2015) Analysis of adoption and impacts of improved cassava varieties in Zambia. The 29th Triennial Conference of the International Association of Agricultural Economists (IAAE). Milan, 8 to 14 August.

Killebrew, K & Wolff, H (2010) Environmental Impacts of Agricultural Technologies. Evans School Policy Analysis and Research (EPAR), University of Washington. EPAR Brief No. 65.

Kissinger, G, Herold, M & de Sy, V (2012) Drivers of deforestation and forest degradation: A synthesis report for REDD + policymakers. Lexeme Consulting, Vancouver.

Kodamaya, S (2011) Agricultural policies and food security of smallholder farmers in Zambia. African *Study Monographs, Supplement*, 42, 19–39.

Kodamaya, S (2015) Fertilizer and irrigation in improving smallholder food security. The case of one village in Central Zambia. *Quarterly Journal Geography*, 66, 239–254.

Krishnan, A & Petersburs, T (2017) Zambia Jobs in Value Chains: Opportunities in Agribusiness. World Bank, Washington DC.

Kunda, F (2012) Status and priorities of soil management in Zambia. Report of the "GSP Workshop "Managing Living Soils" FAO headquarters, Rome, 5–7 December.

Labonté, R, Lencucha, R, Drope, J, Packer, C, Goma, F & Zulu, R (2018) The institutional context of tobacco production in Zambia. Global Health, 14(1), 5. doi: 10.1186/s12992-018-0328-y

Laohasinnarong, D, Goto, Y, Masahito Asada, M, Nakao, R, Hayashida, K, Kajino, K, Namangala, B (2015) Studies of trypanosomiasis in the Luangwa valley, North-eastern Zambia. Parasites & Vectors, 8, 497.

Lay, J, Nolte, K & Sipangule, K (2018) Large-Scale Farms and Smallholders: Evidence from Zambia. Kiel Working Paper Nr. 2098.

Le Quéré, C, Andrew, RM, Friedlingstein, P, Sitch, SH, Pongratz, J, Pickers, PA, … Ciais, P (2018) Global carbon budget (2018). *Earth System Science Data*, 10, 2141–2194. doi: https://doi.org/10.5194/essd-10-2141-2018

Lekprichakul, T (2008) Impact of 2004/2005 Drought on Zambia's Agricultural Production: Preliminary Results Vulnerability and Resilience of Social-Ecological Systems RIHN Research Project 1-3FR. Inter-University Research Institute Corporation, National Institutes for the Humanities.

Likando, K, Nyoni, M & Ngwenyama, D (2010) 2009 IBA status and trends report, Zambia. Zambian Ornithological Society, Lusaka.

Lindahl, J (2014) Towards better environmental management and sustainable exploitation of mineral resources. SGU-rapport 2014, 22.

Lindsey, P, Barnes, J, Nyirenda, V, Pumfrett, B, Tambling, C, Taylor, W & Rolfes, M (2013) The Zambian wildlife ranching industry: scale, associated benefits, and limitations affecting its development. *PLOS ONE*, 8(12), e81761.

Lindsey, P, Nyirenda, V, Barnes, I, Becker, M, McRobb, R, Tambling, C, t'Sas-Rolfes, M (2014) Underperformance of African Protected Area Networks and the Case for New Conservation Models: Insights from Zambia. *PLOS ONE*, 9.e94109. http://10.1371/journal.pone.0094109

Liu, B & Mwanza, F (2014) Towards Sustainable Tourism Development in Zambia: Advancing Tourism Planning and Natural Resource Management in Livingstone (Mosi-oa-Tunya) Area. *Journal of Service Science and Management*, 7, 30–45.

Lofgren, H, Robinson, S & Thurlow, J (2003) Copper crisis and agricultural renaissance in Zambia: an economy-wide analysis. In 2003 Annual Meeting, August 16–22, 2003, Durban, South Africa (No. 25805). International Association of Agricultural Economists.

Lubungu, M & Mofya-Mukuka, R (2012) The Status of the Smallholder Livestock Sector in Zambia. Submitted to the Parliamentary Commmittee on Agriculture. Technical report No. 1. http://www.iapri.org.zm

Lubungu, M, Nicholas, J, Sitko, N & Hichaambwa, M (2015) Analysis of Beef Value Chain in Zambia: Challenges and Opportunities of Linking Smallholders to Markets. Indaba Agricultural Policy Research Institute (IAPRI), Lusaka. Working Paper No. 103. 4.

Lungu, J (1998) Mixed crop-livestock production systems of smallholder farmers in sub-humid and semi-arid areas of Zambia. FAO/IAEA Int. Conf. on Area-Wide Control of Insect Pests, Penang, May 28 to June 2, 1998.

Lunstrum, E & Ybarra, M (2018) Deploying Difference: Security Threat Narratives and State Displacement from Protected Areas. *Conservation and Society*, 2018, 16, 114–24.

Mabeta, J, Mweemba, B & Mwitwa, J (2018) Key drivers of biodiversity loss in Zambia. Biodiversity Finance Initiative (BIOFIN)-Zambia Policy Brief #3.

MacDonald, G, Bennett, E, Potter, P & Ramankutty, N (2011) Agronomic phosphorus imbalances across the world's croplands. *Proceedings of the National Academy of Science* 108, 3086–3091. pmid: 21282605.

Mackenzie, C (2014) Forest Governance and Timber Trade Flows Within, to and from Eastern and Southern African Countries: Zambia Study.

MACO (2004) National Irrigation Policy and Strategy. Ministry of Agriculture and Cooperatives (MACO) Lusaka, Zambia.

MACO (2002) Developments in Fertilizer Marketing in Zambia: Commercial Trading, Government Programs, and the Smallholder Farmer. Agricultural Consultative Forum Food Security Research Project. Lusaka, Zambia. Working Paper No. 4.

MACO (2003) Crop suitability Rating of Agro-ecological Regions. Ministry of Agriculture and Cooperative, Department of Agriculture, Technical Services Branch, 2003.

Makoba, C (2014) Environmental awareness among key actors of selected Zambian Schools of Nchelenge District in Luapula Province. M.Ed. thesis. The University of Zambia.

MAL (2013) Zambia National Agriculture Investment Plan 2014–2018. Ministry of Agriculture and Livestock, Lusaka.

MAL (2015) Investment opportunities in Agriculture. Ministry of Agriculture and Livestock, Lusaka.

MAL (2017) Irrigation Development Support Project Brochure. Ministry of Agriculture and Livestock, Lusaka.

Malambo, F & Syampungani, S (2008) Opportunities and challenges for sustainable management of miombo woodlands: The Zambian perspective. *Working Papers of the Finnish Forest Research Institute*, 98, 125–130.

Mason, N & Jayne, T (2009) Staple Food Consumption Patterns in Urban Zambia: Results from the 2007/2008 Urban Consumption Survey. FSRP Working Paper No. 42.

Mason, N, Jayne, T & Mofya-Mukuka, R (2013) A Review of Zambia's Agricultural Input Subsidy Programs: Targeting, Impacts, and The Way Forward. Indaba Agricultural Policy Research Institute (IAPRI) Lusaka. IAPRI Working Paper No. 77.

Matakala, P, Kokwe, M & Stats, J (2015) Zambia National Strategy to reduce emissions from deforestation and forest degradation (Redd+). Lusaka.

Matenga, C (2016) Out-growers and Livelihoods: The Case of Magobbo Smallholder Block Farming in Mazabuka District in Zambia. *Journal of Southern African Studies*, 43(3), 551–566. doi:10.1080/03057070.2016.1211402

Matenga, C & Hichaambwa, M (2017) Impacts of land and agricultural commercialisation on local livelihoods in Zambia: evidence from three models. The Journal of Peasant Studies, 44 (3), 574–593. doi:10.1080/03066150.2016.1276449.

Matthews, G (1996) The importance of scouting in cotton IPM. Crop Protection, 15(4), 369–374.

Matthews, R, Holden, J, Volk, J & Lungu, S (1992) The potential of alley cropping in improvement of cultivation systems in the high rainfall areas of Zambia I. Chitemene and Fundikila. *Agroforestry Systems*, 17, 219. https://doi.org/10.1007/BF00054149

Maxwell, S, Fuller, R, Brooks, T & Watson, J (2016) The ravages of guns, nets and bulldozers. *Natur*e, 536, 143–145.

Mayer, A & Rietkerk, M (2004) The Dynamic Regime Concept for Ecosystem Management and Restoration. BioScience, 54. doi:10.1641/0006-3568(2004)054[1013:TDRCFE]2.0.CO;2.

Mayer, A-M (2015) Potential for Nutrition–Sensitive Conservation Agriculture in Zambia. Final version edited by Concern Worldwide. https://doj19z5hov92o.cloudfront.net/sites/default/files/resource/2015/05/potential_for_nutrition-sensitive_conservation_agriculture_in_zambia.pdf

McCartney, M, Rebelo, L-M, Mapedza, E, de Silva, S & Finlayson, C (2011) The Lukanga Swamps: use, conflicts and management. *Journal of International Wildlife Law and Policy*, 14, 293–310.

McEwan, M (2003) Macro and micro factors influencing livelihood trends in Zambia over the last thirty years. Literature Review, CARE Southern and Western Africa Regional Management Unit (SWARMU).

McSweeney, C, New, M & Lizcano, G (2010) UNDP Climate Change Country Profiles: Zambia.

Melin, A, Rouget, M, Midgley, J & Donaldson, J (2014) Pollination ecosystem services in South African agricultural systems. *South African Journal of Science*, 110, 25–33. doi:10.1590/sajs.2014/20140078.

Mendes, D, Paglietti, L, Jackson, D & Chizhuka, F (2014) Zambia: Irrigation market brief. FAO Investment Centre.

MENR (2000) National Biological Diversity Strategy and Action Plan 2000–2010. Ministry of Environment and Natural Resources, Lusaka.

MEWD (2010) National Water Policy. Ministry of Energy and Water Development, Lusaka.

MEWD (2007) Energy Policy. Ministry of Energy, Lusaka.

Meyer, A, Holt, H, Selby, R & Guitian, J (2016) Past and Ongoing Tsetse and Animal Trypanosomiasis Control Operations in Five African Countries: A Systematic Review. *Neglected Tropical Diseases.* 10–12, e0005247. doi:10.1371/journal.pntd.0005247.

Mingochi, D & Luchen, S (1997) Traditional vegetables in Zambia: genetic resources, cultivation and uses. In L Guarino (Ed.), Traditional African Vegetables. Promoting the conservation and use of underutilized and neglected crops. *Proceedings of the IPGRI International Workshop on Genetic Resources of Traditional Vegetables in Africa: Conservation and Use*, 29–31 August, 1995. ICRAF-HQ, Nairobi, Kenya: Institute of Plant Genetics and Crop Research, Gatersleben/International Plant Genetic Resources Institute, Rome.

MLNR (2018a) National Policy on Wetlands. Ministry of Land and Natural Resources, Lusaka.

MLNR (2018b) Forestry Department. Ministry of Lands, Natural Resources and Environmental Protection, Lusaka. http://www.mlnrep.gov.zm

MLNREP (2015a) United Nations Convention on Biological Diversity Fifth report. Ministry of Lands, Natural Resources and Environmental Protection, Lusaka, Zambia.

MLNREP (2015b) Zambia's Second National Biodiversity Strategy and Action Plan 2015–2025 (NBSAP-2). Ministry of Lands, Natural Resources and Environmental Protection, Lusaka.

MLNREP (2008) Ministry of Lands, Natural Resources and Environmental Protection. Lusaka.

MLNREP (2014) Ministry of Lands, Natural Resources and Environmental Protection: Zambia National Forestry Policy. Lusaka.

MLNREP (2014) Second national communication to the United Nations Framework Convention on Climate Change 2000–2004. Ministry of Lands, Natural Resources and Environmental Protection, Lusaka.

MNDP (2017) Seventh National Development Plan (SNDP). Ministry of National Development Planning, Lusaka.

MNDP (2019) Transforming Landscapes for Resilience and Development in Zambia Project: Integrated Pest Management Plan. Ministry of National Development Planning, Lusaka.

MoA (2013) National Agriculture Investment Plan (NAIP) 2014–2018. Ministry of Agriculture, Lusaka.

MoA (2014) Ministry of Agriculture Luapula Province Department of Agriculture Annual Report. Mansa.

MoA (2016a) Second National Agricultural Policy. Ministries of Agriculture, and Fisheries and Livestock. Lusaka.

MoA (2016b) Second National Agricultural Policy Implementaion Plan (2016–2020). Ministries of Agriculture, and Fisheries and Livestock, Lusaka.

MoA (2016c) National Agricultural Extension & Advisory Services Strategy. Ministry of Agriculture, Lusaka.

MoA (2016d) Second National Rice Development Strategy (2016–2020). Ministry of Agriculture, Lusaka.

MoA (2017) Ministry of Agriculture Stock Monitoring Committee Meeting Report. Lusaka.

MoA (2018) Departments within the Ministry of Agriculture. Ministry of Agriculture. http://www.agriculture.gov.zm

MoF (2013) Minister of Finance 2014 Budget Speech to National Assembly. Ministryr of Finance, Lusaka.

MoF (2015) Minister of Finance 2016 Budget Speech to National Assembly. Ministry of Finance, Lusaka.

Mofya-Mukuka, R & Mofu, M (2016) The Status of Hunger and Malnutrition in Zambia: A Review of Methods and Indicators. IAPRI Technical Paper No. 16.

Mofya-Mukuka, R & Shipekesa, A (2013) Value Chain Analysis of the Groundnuts Sector in the Eastern Province of Zambia. IAPRI Working Paper No. 78;.

MoH (2008) National Food and Nutrition Policy. Ministry of Health, Lusaka.

MoHE (2017) National Biotechnology and Biosafety Policy. Ministry of Higher Education, Lusaka.

Momba, M (2007) Administrative Reforms and the Search for Efficient Delivery of Public Service: The Challenges Facing Health and Educational Boards. In J Momba & M Kalabula (Eds.), Governance and Public Services Delivery in Zambia. OSSREA Documentation Centre. Addis Ababa.

MoTA (2018) National Parks and Wildlife Policy. Ministry of Tourism and Arts. Lusaka.

Moyo, S (2016) Family farming in sub-Saharan Africa: its contribution to agriculture, food security and rural development. International Policy Centre for Inclusive Growth (IPC-IG) Working Paper No. 150.

MTENR (2009a) Ministry of Tourism, Environment and Natural Resources: The National Policy on Environment. Lusaka.

MTENR (2009b) United Nations Convention on Biological Diversity Fourth National Report. Ministry of Environment and Natural Resources, Lusaka.

MTENR (2010) National Climate Change Response Strategy (NCCRS) Zambia. Ministry of Tourism, Environment & Natural Resources, Lusaka.

MTENR (2012) The Forest Estate as at 31 December 2011. Forestry Department, Forest Management, Unit, Ministry of Tourism, Environment and Natural Resources.

Muchabi, J, Lungu, O & Mweetwa, A (2014) Conservation Agriculture in Zambia: Effects on Selected Soil Properties and Biological Nitrogen Fixation in Soya Beans (Glycine max (L.) Merr). *Sustainable Agriculture Research*, 3(3) 28–36.

Mukungu, M (2002) Effect of cowpea planting date and row arrangement on crop growth and yield in maize (Zea mays L.) and cowpea intercrop (Vigna unguiculata L (Walp). University of Zambia. MSc Thesis.

Mulenga, B, Ngoma, H & Tembo, S (2015) Climate Change and Agriculture in Zambia: Impacts, Adaptation and Mitigation options. In A Chapoto & NJ Sitko (Eds.), Agriculture in Zambia: Past, Present, and Future. Indaba Agricultural, Lusaka.

Mulenga, B, Wineman, A & Sitko, N (2016) Climate Trends and Farmers' Perceptions of Climate Change in Zambia. Mulenga, B, Wineman, A & Sitko, N (2016) Environmental Management, 59 (2). doi:10.1007/s00267-016-0780-5.

Mulenga, C (2013) The State of Food Insecurity in Lusaka, Zambia. AFSUN Food Security Series, (19).

Mulenga, D (2017) Reduction in FISP beneficiaries causes panic among farmers. https://www.africanfarming.com/reduction-fisp-beneficiaries-causes-panic-among-farmers/

Mulenga, D (2018) Zambia's tobacco production hits all-time low. www.africanfarming.com/

Mulungu, K & Ng'ombe, J (2017) Sources of Economic Growth in Zambia, 1970–2013: A Growth Accounting Approach. *Economies*, 2017, 5, 15. doi:10.3390/economies5020015.

Mungoma, C & Mwambula, C (1996) Drought and low N in Zambia: The problems and a breeding strategy. In G Edmeades, M Bänziger, H Mickelson & C PenaValdivia (Ed.), Developing Drought- and Low N-Tolerant Maize: Proceedings of a Symposium, March 25–29, 1996, CIMMYT, EL Batan, MEXICO. CIMMYT (International Wheat and Maize Research Center) and UNDP (United Nations Development Programme).

Muniapan, R (2015) The role of Integrated Pest Management in USAID's Feed the Future Initiative. Horticulture Innovation Annual Meeting Lusaka, June 8.

Murray, M & Mwengwe, E (2005) Food security and markets in Zambia. CARE International, Lusaka. https://odihpn.org/magazine/food-security-and-markets-in-zambia/

Musuka, G, Sililo, S & Kefi, A (2017) Fish Imports and Their Contribution towards Feeding an Ever-Growing Population in Zambia. *Innovative Techniques in Agriculture*, 1.2 (2017), 107–115.

Musumali, M, Heck, S, Husken, S & Wishart, M (2009) Fisheries in Zambia: An undervalued contributor to poverty reduction. The WorldFish Center/The World Bank. Policy Brief 1913.

Mwale, W, Mwila, G, Zulu, E, Mingochi, D & Chita, W (1996) Zambia: Country report to the FAO International Technical Conference on Plant Genetic Resource. Liepzig.

Mwanamwenge, M & Harris, J (2017) Agriculture, food systems, diets and nutrition in Zambia: Sustainable diets for all. Discussion paper, Hivos and IIED.

Mwananyanda, L (2015) Cattle Husbandry and Trade in Bulozi, a Historical Perspective C. 1880–1973. University of Zambia, Master of Arts in History Diss.

Mwanawasa, C (2016) A Case Analysis of the Viability of the Current Regulation and Enforcement Mechanisms of Corporate Governance in Zambia. Master's Degree in Commercial Law (LLM). University of Cape Town. Unpublished.

Mwansa, F (2016) Assessing the Potential of Conservation Agriculture to off-set the Effects of Climate Change on Crop Productivity using Crop Simulations Model (APSIM).

Mwansa, FB (2016) Assessing the Potential of Conservation Agriculture to off-set the Effects of Climate Change on Crop Productivity University of Zambia, Department of Plant Science. MSc. Diss.

Mweembe, O (2008) Environmental Knowledge. Attitudes and Practices of High School Teachers in Zambia. A case study of selected schools of Lusaka City. M.Ed. thesis. The University of Zambia.

Mwila, G, Nguni, D & Phiri, A (2008) Zambia: Second Report on the State of Plant Genetic Resources or Food and Agriculture. FAO Commission on Plant Genetic Resources, FAO Rome.

Nalishebo, S & Halwampa, A (2015) Eurobonds Repayment: Limiting The Risk of Default. ZIPAR Policy Brief No. 17.

Namafe, C (2006) Environmental Education in Zambia: A Critical Approach to Change and Transformation. Lusaka: University of Zambia Press.

Nambota, A, Samui, K, Sugimoto, C, Kakuta, T & Onuma, M (1994) Theileriosis in Zambia: etiology, epidemiology and control measures. *Japanese Journal of Veterinary Research*, 42(1), 1–18.

Namonje-Kapembwa, T & Chapoto, A (2016) Agricultural Technology Adoption in Zambia: Are Women Farmers Being Left Behind? IAPRI Working Paper 106.

Namutowe, J (2013) Tobacco Industry – Zambia's Emerging Income Earner. Times of Zambia. http://allafrica.com/stories/201307310638

National Assembly (1995) The Food Reserve Act Chapter 225 of the Laws of Zambia. National Assembly, Lusaka.

National Assembly (2016b) Report of the Committee on Lands, Environment and Tourism on the National Assembly Approval of the Proposal to Ratify the Paris Agreement on Climate Change for the First Session of the Twelfth National Assembly Appointed on 6th October, 2016. National Assembly, Lusaka.

National Assembly (2010) Ministerial Statement: Zambia's participation to the 15th Conference of Parties to the Convention in International trade in Endangered Species in Wild Fauna and flora (CITES), 13–25 March, Doha, Qatar. National Assembly, Lusaka. http://www.parliament.gov.zm/Sites/default/files/images/publication_docs/Ministerial%20Statement-%20Tourism.pdf

National Assembly (2011) Environmental Management Act No. 12 of 2011. Lusaka. http://www.parliament.gov.zm/sites/default/files/documents/acts

National Assembly (2016a) Constitution of Zambia (Amendment) Act of 2016. Lusaka. http://www.parliament.gov.zm/sites/default/files/documents/amendment_act/Constitution%20of%20Zambia%20%20%28Amendment%29%2C%202016-Act%20No.%202_0.pdf

National Assembly (2016c) The Public Audit Act, No. 29 of 2016. http://www.parliament.gov.zm/sites/default/files/documents/acts/The%20Public%20Audit%20Act%20No.%2029%20of%202016.pdf.

National Assembly (2017a) Public Financial Management Handbook. National Assembly, Lusaka. http://www.parliament.gov.zm/sites/default/files/publications/Tenth_version_of_National_Assembly_Public_Financial_Management_Handbook.pdf

National Assembly (2017b) Report of the committee on Agriculture, Lands and Natural Resources on the Report of the Auditor General on Sustainable Forest Management for the Second Session of the Twelfth National Assembly. National Assembly, Lusaka.

National Assembly (2017c) Ministerial Statement on the Crop Forecasting Survey Results for the 2016/2017 Agricultural Season and The Food Balance Status for the 2017/2018 Marketing Season by The Hon. Minister of Agriculture, Ms Siliya. National Assembly, Lusaka. http://www.parliament.gov.zm/sites/default/files/images/publication_docs

National Assembly (2018) The Public Finance Management Act of 2018. Lusaka. http:///www.parliament.gov.zm/sites/default/files/documents/acts

National Assembly (2019) The Local Government Act no. 2 of 2019, Lusaka. http:///www.parliament.gov.zm/sites/default/files/documents/acts

NBSAP (2015) Zambia's Second National Biodiversity Strategy and Action Plan 2015–2025. Ministry of Lands, Natural Resources and Environmental Protection, Lusaka.

Ndebele-Murisa, M, Hill, T & Ramsay, L (2013) Validity of downscaled climate models and the implications of possible future climate change for Lake Kariba's Kapenta fishery. *Environmental Development*, 5 (2013), 109–130. https://doi.org/10.1016/j.envdev.2012.11.009

Ndiyoi, M, Bangwe, L & FASAZ (2009) Agricultural Water Management Solutions: The Situational Analysis in Zambia. IWMI and Farming Systems Association of Zambia. Colombo, Sri Lanka: International Water Management Institute. http://awm-solutions.iwmi.org/Data/Sites/3/Documents/PDF/CountryDocs/Zambia/Situation%20Analysis%20Brief%20Zambia.pdf

Nelson, V (2000) Zambia Feeder Roads Research Project Rural Transport Policy Toolkit: Livelihoods Profile for North and Luapula Provinces. Transport Research Laboratory, Natural Resources Institute, UK. NRI Working paper – Report 2494.

Neubert, S, Kömm, M, Krumsiek, A, Schulte, A, Tatge, N & Zeppenfeld, L (2011) Agricultural development in a changing climate in Zambia. German Development Institute/Deutsches Institutfür Entwicklungspolitik (DIE) Studies No. 57. Bonn.

Newbold, T, Scharlemann, JP, Butchart, S, Sekercioğlu, CH, Alkemade, R, Booth, H & Purves, D (2013) Ecological traits affect the response of tropical forest bird species to land-use intensity. *Proceedings of the Royal Society*, 280, 20122131. http://dx.doi.org/10.1098/rspb.2012.2131

NFNC (2007) Improved Complementary Foods Recipe Booklet: Family Foods for Breastfed Children in Zambia. National Food and Nutrition Commission, Government of the Republic of Zambia and The Food and Agriculture Organization of the United Nations, Lusaka.

Ng'ombe, J, Kalinda, T & Tembo, G (2017) Does adoption of conservation farming practices result in increased crop revenue? Evidence from Zambia. *Agrekon*, 56(2), 205–221. doi:10.1080/03031853.2017.1312467.

Ng'ombe, K & Kalinda, T (2015) A stochastic frontier analysis of technical efficiency of maize production under minimum tillage in Zambia. *Sustainable Agriculture Research* 4(2), 31–46.

Nhlane, R (2016) Diversification towards agro-processing in Zambia: A CGE analysis of financial and fiscal incentives. Stellenbosch University, Master of Science (Agricultural Economics) Thesis.

Nicholas, J, Sitko, N, Chamberlin, C & Mulenga, B (2015) Unpacking the Growth of Medium-scale Farms Zambia: What Are the Implications for the Future of Smallholder Agriculture? IAPRI Working Paper No. 100. http://www.iapri.org.zm

NISIR (2018) National Institute for Scientific and Industrial Research. http://www.nisir.org.zm

Nnoung, A & Swanson, B (2018) Extension and Advisory Services in Zambia. IFPRI. http://www.worldwide-extension.org/africa/zambia/s-zambia

Nolte, K (2014) Rural investments under poor land governance in Zambia. *Land Use Policy*, 38, 698–706.

Ntalasha, S, Mweene, C, Silumesi, P, Phiri, N, Solami, K, Manda, H, Phiri, C (2004) A High School Geography Textbook of Zambia and the Sub-region. Ndola: Times Printpark (z) Limited.

Nyanga, PH (2006) Impact of Agricultural Policy Changes on Household Food Security Among Small-Scale Farmers in Southern Zambia. Norwegian University of Life Sciences. MSc. Thesis.

Nyrienda, V, Kaoma, C & Nyirongo, S (2018) Farmer-wildlife conflicts in rural areas of eastern Zambia. *Biodiversity and Ecology*, 6, 251–256.

Odhong, J (2017) The renaissance of farming systems research in Africa. https://africa-rising.net/2017/11/30/the-renaissance-of-farming-systems-research-in-africa

Office of Auditor-General (2014) Report of the Auditor General on the management of environmental degradation caused by mining activities in Zambia. Office of Auditor-General, GRZ, Lusaka.

Office of Auditor-General (2016) Performance Audit Report on Sustainable Forest Management in Zambia. Office of the Auditor-General, Lusaka.

Ogunbode, C & Arnold, K (2012) A Study of Environmental Awareness and Attitudes in Ibadan, Nigeria, Human and Ecological Risk Assessment: *International Journal*, 18(3), 669–684.

Ojiewo, C, Rubyogo, J, Wesonga, J, Bishaw, Z, Gelalcha, S & Abang, M (2018) Mainstreaming Efficient Legume Seed Systems in Eastern Africa: Challenges, opportunities and contributions towards improved livelihoods. Rome.

Oladapo, O, Yinusa, M, Bangwe, L, Martin, F, Chimatiro, S, Jere, N & Diop, B (2013) Aquaculture Enterprise Development Project. African Development Bank, Lusaka.

Ollerton, J, Winfree, R & Tarrant, S (2011) How many flowering plants are pollinated by animals? *Oikos*, 120 (2), 321–326. https://doi.org/10.1111/j.1600-0706.2010.18644.x

OPPAZ (2006) Development of the Local Market for Organic Products in Zambia. Lusaka. Organic Producers and Processors Association of Zambia, Lusaka.

Palerm, J, Sierevogel, T & Hichaambwa, M (2010) Strategic Environmental Assessment (SEA) of the Sugar Sector in Zambia. Report Prepared for the Delegation of the European Union in Zambia, Lusaka. https://europa.eu/capacity4dev/public-environment-climate/documents/strategic-environmental-assessment-sea-sugar-sector-zambia-2010

Paremoer, T (2018) Regional Value Chains: Exploring Linkages and Opportunities in the Agro-Processing Sector Across Five SADC Countries (July 1, 2018). CCRED Working Paper No. 4/2018. http://dx.doi.org/10.2139/ssrn.3244307

Pejchar, L, Pringle, R, Ranganathan, J, Zook, J, Duran, G, Oviedo, F & Daily, G (2008) Birds as agents of seed dispersal in a human-dominated landscape in southern Costa Rica. *Biological Conservation*, 14, 536–544. doi: 10.1016/j.biocon.2007.11.008.

Pérez, G & García, A (2013) Nutritional Taboos among the Fullas in Upper River Region, The Gambia. *Journal of Anthropology*, 2013, Article ID 873612. //doi.org/10.1155/2013/873612.

PF (2016) Patriotic Front Manifesto 2016–2021. Lusaka.

Phiri, D, Zulu, D, Lwali, C & Imakando, C (2015) Using Edible Tubers, Root and Bulbs as Drivers of Community Based Natural Resource Management in Zambia*. International Journal of Agriculture, Forestry and Fisheries*, 3(5), 175–181.

Phiri, J, Moonga, E, Mwangase, O & Chipeta, G (2013) Adaptation of Zambian Agriculture to Climate Change – A Comprehensive Review of the Utilisation of the Agro-Ecological Regions. A Review for Policy Makers. ZaAS, Lusaka.

Phiri, R (2016) A History of the National Agricultural Marketing Board (NAMBOARD) in Promoting Food Security in Zambia, 1969–1989. MA (History) Thesis, UNZA.

PLARD (2010) Programme for Luapula Agricultural and Rural Development Programme Document Phase II 2011–2015. Mansa.

Poutiainen, P & Mills, A (2014) Mainstreaming Gender in the Irrigation Development Support Programme — Case Study Zambia. The World Bank, Washington DC.

Prasanna, B, Huesing, J, Eddy, R & Peschke, VM (2018) (eds):Fall Armyworm in Africa: A Guide for Integrated Pest Management, First Edition. Mexico, CDMX: CIMMYT.

Prior, AJ (1982) Various aspects of cultivation: village technology for crop production. Mount Makulu. Chilanga.

Rajaratnam, S, Cole, S, Fox, K, Dierksmeier, B, Puskur, R, Zulu, F, Situmo, J (2015) Social and gender analysis report: Barotse Floodplain, Western Province, Zambia. Penang, Malaysia: CGIAR Research Program on Aquatic Agricultural System.Program Report: AAS-2015-18.

Rakner, L (2003) Political and Economic Liberalisation in Zambia 1991–2001. The Nordic Africa Institute. https://www.cmi.no/publications/1682-political-and-economic-liberalisation-in-Zambia

Ramsar.org (2018) https://www.ramsar.org

Rasmussen, P, Zamba, C & Chirwa, E (2015) African Economic Outlook: Zambia. In Shimeles, A, Odusola, A & Leibfritz, W (Co-ordinators) African Economic Outlook Lusaka /Paris/New York: African Development Bank/ OECD/ UNDP.

Rebelo, L-M, McCartney, M & Finlayson, C (2010) Wetlands of sub-Saharan Africa: distribution and contribution of agriculture to livelihoods. Wetlands Ecology and Management, 18, 557–572. doi:10.1007/s11273-009-9142-x.review.com//countries/zambia-population/.

Richards, K & Belleck, S (2016) Malnutrition in Zambia: Harnessing social protection for the most vulnerable. Save the Children, London.

Ritchie, M (2008) Environmental Considerations in Agricultural Development in Luapula Province. Volume 1. Programme for Luapula Agricultural and Rural development (PLARD). Publication No. 7, Mansa.

Rocca, V (2016) Gender and Livelihoods in Commercial Sugarcane Production: A Case Study of Contract Farming in Magobbo, Zambia. PLAAS, LACA working paper 136.

Rohr, J, Schotthoefer, A, Raffel, T, Carrick, H, Halstead, N, Hoverman, J, Beasley, V (2008) Agrochemicals increase trematode infections in a declining amphibian species. *Nature*, 455, 1235–1239 pmid: 18972018.

Roo, N, Anderson, J & Krupnik, T (2017) On-farm trials for development impact? The organisation of research and the scaling of agricultural technologies. *Experimental Agriculture*, 1–22. doi:10.1017/S0014479717000382

Roobroeck, D, Van Asten, P, Jama, B, Harawa, R & Vanlauwe, B (2016) Integrated Soil Fertility Management: Contributions of framework and practices to Climate-Smart Agriculture. doi:10.13140/RG.2.1.1695.2400.

Ross, S & De klerk, M (2012) Groundnut Value Chain and Marketing Assessment in Eastern Province, Zambia. Conservation Farming Unit: 23B Twin Palm Road, Kabulonga, Lusaka. www.conservationagriculture.org

Saasa, O (2003) Macro study: Agricultural intensification in Zambia: The Role of Policies and Policy Processes. African Food Crisis – The relevance of Asian models Project, Lund University and The Institute of Economic and Social Research University of Zambia.

SADC (2014) Regional Agricultural Policy. SADC Secretariat, Gaborone. www.fao.org/agriculture/crops/thematic-sitemap/theme/treaties/en

SADC/NVAC (2018) ZAMBIA Vulnerability Assessment Committee Results 2018. Regional Vulnerability Assessment & Analysis Programme. Gaborone.

SAHIMN (2005) Zambia key geographical features. Southern Africa Humanitarian Information Management Network. https://reliefweb.int/map/zambia/zambia-key-geographical-features

Samboko, P, Zulu, B, Hichaambwa, M & Kuteya, A (2017) Are Farm Blocks a Viable Development Model for Smallholder Farming in Zambia? IAPRI Working Paper No. 129.

Sardinis, A (2014) Zambia: The First 50 Years. I.B. Tauris.

Schiere, J, Darnofer, I & Duru, M (2012) Dynamics in farming systems: of changes and choices. In I Darnhofer, D Gibbon & BB Dedieu (Eds.), Farming Systems Research into the 21st Century: The New Dynamic (pp. 337–363). Springer.

Schultz, J (1972) Land Use in Zambia Part I: The Basically Traditional Land Use Systems and their Regions. Weltforum Verlag-Munchen.

Schultz, J (1976) Land Use Map of Zambia (Landnutzungskarte von Zambia). *Erdkunde*, 30(2), 144–152. http://www.jstor.org/stable/25641735

Scialabba, N, Hardwicke, R, Baldock, C & Burks, E (2015) Natural Capital Impacts in Agriculture Supporting Better Business Decision-Making. FAO, Rome. http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Natural_Capital_Impacts_in_Agriculture_final.pdf

Serlemitsos, J & Fusco, H (2003) Zambia: Post-Privatization Study. World Bank, Washington DC. https://openknowledge.worldbank.org/handle/10986/20225

Shakacite, O, Chungu, D, Ng'andwe, P, Siampale, A, Chendauka, B, Vesa, L & Roberts, W (2016)) Integrated Land Use Assessment Phase II – Report for Zambia. FAO and the Forestry Department, Ministry of Lands and Natural Resources, Lusaka, Zambia.

Shanungu, G (2009) Management of the invasive Mimosa pigra L. in Lochinvar National Park, Zambia. *Biodiversity*, 10, 56–60.

Shawa, J (2014) Farm Block Development Program, FBDP. Ministry of Agriculture and Livestock, Lusaka.

Shennan, C (2007) Biotic interactions, ecological knowledge and agriculture. Philosophical Transactions of the Royal Society B: Biological Sciences, 363 (1462). http://doi.org/10.1098/rstb.2007.2180

Sherkat, A & Ellison, C (2007) Structuring the religion-environment connection: identifying religious influences on environmental concern and activism. *Journal for the Scientific Study of Religion*, 46, 71–85.

Shitumbanuma, V, Simfukwe, P, Kalala, D, Kaninga, B, Gondwe, B, Nambala, M, Mutegi, J (2013) Integrated Soil Fertility Management in Zambia. The Soil Health Consortium, Lusaka.

Siacinji-Musiwa, JM (1999) Conservation tillage in Zambia: Some technologies, indigenous methods and environmental issues. In P Kaumbutho & T Simalenga (Eds.), Conservation tillage with animal traction. Animal Traction Network for Eastern and Southern Africa (ATNESA), Harare, Zimbabwe.

Sichilongo, M, Mulozi, P, Mbewe, B, Machaya, C & Pavy, JM (2012) Zambia Wildlife Sector Policy: Situation Analysis and Recommendations for a Future Policy. World Bank, Washington DC. https://openknowledge.worldbank.org/handle/10986/11917

Sikamo, J, Mwanza, A & Mweemba, C (2016) Copper mining in Zambia – History and Future. Journal of the Southern African Institute of Mining and Metallurgy, 116, 491–496.

Sikuka, W & Bonsu, K (2017) The supply and demand for sugar in Zambia. USDA Foreign Agricultural Services Pretoria, RSA.

Simson, H (1985) Zambia a Country Study. Scandinavian Institute of African Studies, Uppsala, Sweden.

Simwinji, N (1997) Summary of existing relevant socio-economic and ecological information. Report to IUCN on Zambia's Western Province and Barotseland.

Sinkala, Y, Simuunza, M, Muma, J, Pfeiffer, D, Kasanga, C & Mweene, A (2014) Foot and mouth disease in Zambia: Spatial and temporal distributions of outbreaks, assessment of clusters and implications for control. Onderstepoort Journal of Veterinary Research, 81(2), Art. #741. doi: http://dx.doi.org/10.4102/ojvr.v81i2.741

Sishekanu, M, Mabengwa, M, Makungwe, M, Gondwe, B, Banda, F, Siulemba, G, … Mutegi, J (2015) Integrated Soil Fertility Management Training Manual for Zambia Agricultural Extension Workers. The Zambia Soil Health Consortium.

Sitali, N (2014) Environmental knowledge and practices of selected Zambian primary school teachers of Lusaka district. M.Ed (Environmental Education) Thesis, University of Zambia.

Sitko, N & Chamberlin, J (2015) The Anatomy of Medium-Scale Farm Growth in Zambia: What Are the Implications for the Future of Smallholder Agriculture? *Land*, 4, 869–887. doi:10.3390/land4030869.

Sitko, N & Jayne, T (2014) Structural Transformation or Elite Land Capture? The Growth of "Emergent" Farmers in Zambia. *Food Policy*, 48, 194–202.

Sitko, N, Chamberlin, J & Hichaambwa, M (2015) The Geography of Customary Land in Zambia: Is Development Strategy Engaging with The Facts? Indaba Agricultural Policy Research Institute, Lusaka, IAPRI Working Paper 98.

Slunge, D & Wingqvist, G (2010) Zambia Environmental and Climate Change Policy Brief. University of Gothenburg.

Smalley, R (2013) Plantations, contract farming and commercial farming areas in Africa: A comparative review. Working Paper 055. www.future-agricultures.org

Smith, R, Stewart, K, Abruzzese, L & Powell, R (2018) Global Food Security Index 2018: Building resilience in the face of rising food-security risks. The Economist Intelligence Unit limited, London.

Sprague, D & Oyama, S (1999) Density and distribution of Chitemene fields in a Miombo woodland environment in Zambia. *Environmental Management*, 24, 273–280. https://doi.org/10.1007/s002679900232

Stienen, J, Bruinsma, W & Neuman, F (2007) International Institute for Communication and Development (IICD). How ICT can make a difference in agricultural livelihood. The Commonwealth Ministers Reference Book.

Strategic Shift (2019) A picture of Zambia's Agricultural Sector. Strategic Shift Zambia Limited, Lusaka. http://www.strategicshift.net/the-case-for-zambia.html

Stringfellow, R (1996) Smallholder out grower schemes in Zambia Research Report completed under ODA Crops Post-Harvest Programme. Project Number A0439. NRI, UK.

Stromgaard, P (1989) Adaptive Strategies in the Breakdown of Shifting Cultivation: The Case of Mambwe, Lamba, and Lala of Northern Zambia. *Human Ecology*, 17(4), 428–444.

Tanentzap, A, Lamb, A, Walker, S & Farmer, A (2015) Resolving Conflicts between Agriculture and the Natural Environment. *PLoS Biol*, 13(9), e1002242. http://doi.org/10.1371/journal.pbio.1002242

Taylor, S (2006) Customs and culture of Zambia. Greenwood Press.

Tembo, M (2012) Satisfying Zambian Hunger for Culture: Social Change in the Global World. Xlibris Corp.

Tembo, S & Sitko, N (2013) Technical compendium: descriptive agricultural statistics and analysis for Zambia. Indaba Agricultural Statistics for Zambia, Lusaka.

Thierfelder, C, Heinrich, G, Lewis, D, Mwila, M & Bekunda, M (2017) Intercropping strategies under CA: Africa RISING science, innovations and technologies with scaling potential from ESA-Zambia. CGIAR Africa Rising.

Thresh, J, Fishpool, L, Otim-Nape, G & Fargette, D (1994) African cassava mosaic virus disease: an underestimated and unsolved problem. *Tropical Science*, 34, 3–14.

Thurlow, J, Zhu, T & Diao, X (2008) The Impact of Climate Variability and Change on Economic Growth and Poverty in Zambia. International Food Policy Research Institute. Washington DC. http://www.ifpri.org/publication/impact-climate-varivariability-and-change-economic-growth-and-poverty-zambia

Thurlow, J, Zhu, T & Diao, X (2011) Current Climate Variability and Future Climate Change: Estimated Growth and Poverty Impacts for Zambia. UNU-WIDER, Helsinki, Finland. [WIDER Working Paper No. 2011/85]. https://www.gov.uk/dfid-research-outputs/current-climate-variability-and-future-climate-change-estimated-growth-and-poverty-impacts-for-zambia

Tomich, T, Lidder, P, Coley, M, Gollin, D, Meinzen-Dick, R, Webb, P & Carberry, P (2019) Food and agricultural innovation pathways for prosperity. Agricultural Systems, 172, 1–5. https://doi.org/10.1016/j.agsy.2018.01.002

Topps, J & Oliver, J (1993) Animal foods of Central Africa. Technical Hand Book No. 2, *Zimbabwe Agricultural Journal*, 1–154.

Trading Economics.com (2017) Zambia annual growth rate. https://tradingeconomics.com/zambia/gdp-growth-annual

Turpie, J, Smith, B, Emerton, L & Barnes, J (1999) Economic value of the Zambezi Basin Wetlands. Report prepared for IUCN Zambezi Basin Wetlands Conservation and Resource Utilization Project, IUCN Regional Office for Southern Africa.

Turpie, J, Warr, B & Ingram, J (2015) Benefits of forest ecosystems in Zambia and the role of REDD+ in a Green Economy Transformation. UN-REDD+ Programme. UNEP.

UNCTAD (2006) Investment Policy Review: Zambia. UNCTAD/ITE/IPC/2006/14. United Nations, Geneva and New York.

UNDP (2015) Human Development Report for Zambia 2015. Lusaka: United Nations Development Programme, Lusaka.

USAID (2012) Climate Change Adaptation in ZAMBIA. Lusaka. https://www.climatelinks.org/sites/default/files/asset/document/zambia_adaptation_fact_sheet_feb2012.pdf

Vinya, R, Syampungani, S, Kasumu, E, Monde, C & Kasubika, R (2012) Preliminary Study on the Drivers of Deforestation and Potential for REDD+ in Zambia. A consultancy report prepared for

Forestry Department and FAO under the national UN-REDD+ Programme, Ministry of Lands & Natural Resources, Lusaka.

Vogel, J (1987) Iron Age farmers in South Zambia: some aspects of spatial organization. *African Archaeological Review*, 5, 159–170.

West, P, Gerber, J, Engstrom, P, Mueller, N, Brauman, K, Carlson, K, Siebert, S (2014) Leverage points for improving global food security and the environment. *Science*, 345, 325–328. pmid:25035492.

Whitfield, S, Dougill, A, Dyer, J, Kalaba, F, Leventon, J & Stringer, L (2015) Critical reflection on knowledge and narratives of conservation agriculture. *Geoforum*, 60, 133–142.

Wichren, R, Hausner, U & Chiwele, D (1999) Impediments to Agricultural Growth in Zambia. IFPRI TMD Discussion Paper no. 47. Washington DC.

Wiggins, S, Farrington, J, Grist, N, Henley, G, Keats, S, Locke, A, Poulton, C (2015) Agricultural development policy: a contemporary agenda Second Edition. GIZ and ODI, London.

Winthrop, M, Kajumba, T & McIvor, S (2018) Zambia Country Climate Risk Assessment Report Irish Aid. Resilience and Economic Inclusion Team, Policy Unit.

World Bank (1994) World Development Report: Infrastructure for Development. Oxford University Press, New York.

World Bank (1996) World Development Report: From Plan to the Market. Oxford University Press, New York.

World Bank (2004) Zambia Country Economic Memorandum: Policies for Growth and Diversification. Volume I. World Bank, Washington DC.

World Bank (2007) Competitive Commercial Agriculture in Africa (CCAA) – Zambia competiveness report. The World Bank Environmental, Rural and Social Development Unit Africa Region, Washington DC.

World Bank (2011) Irrigation Development Support Project – Project Appraisal Document. World Bank Country Office, Lusaka, Report 58264-ZM.

World Bank (2018a) The 11th Zambia Economic Brief: An Agro-Led Structural Transformation. World Bank, Washington DC.

World Bank-SCD (2018b) Systematic Country Diagnostic Report – Republic of Zambia. Report No. 124032-ZM. Washington DC.

World Population Reviews (2018) Zambia Population. http://worldpopulationreview.com/countries/zambia-population/

Worldometers (2018, March 23) Zambia Population. http://www.worldometers.info

WTO (2002) International trade statistics 2002. World Trade Organisation, Geneva.

Yoshida, K (2016) Museums and Community Development: With Special Reference to Zambian Cases. In N Sonoda (Ed.), New Horizons for Asian Museums and Museology, (pp. 187–200). doi: 10.1007/978-981-10-0886-3_14

Youth Map (2014) A Cross-Sector Analysis of Youth in Zambia. International Youth Foundation. https://www.iyfnet.org /sites /default /files /library /Youth Map-Zambia_Analysis.pdf

Zambia Daily Mail (2014) State launches $115 million investment support fund (ISF) under the irrigation development and support project. http://www.daily-mail.co.zm /state-launches-115m-support-fund/

Zambia Daily Mail (2017) Farm blocks to boost agro sector. https://www.daily-mail.co.zm/farm-blocks-to-boost-agro-sector/

ZambiaInvest.com (2017) Zambia Agriculture Statistics. http//www.Zambia Invest.com/ agriculture

Zambian Parliament (2018, March 24) http://www.parliament.gov.zm

ZDA (2011) Zambia Development Agency. Agro Processing Sector Profile 2011. Lusaka. www.zda.org.zm

ZDA (2014a) Zambia Development Agency: Agriculture Sector Leaflet. Lusaka.

ZDA (2014b) Zambia Energy Sector Profile, Zambia Development Agency. Lusaka.

ZEMA (2017) Environmental Awareness and Public Participation Baseline Survey in Selected Districts report. Zambia Environmental Management Agency, Lusaka.

ZICTA (2015) Survey on access and usage of ICTs by household and individuals. Zambia Information and Communications Technology Authority, Lusaka.

ZIEM (2012) An Environmental and Social Impact Assessment for Musakashi River Catchment and its Tributaries: an independent impact assessment of industrial mining waste pollution in Chambishi. Zambia Institute of Environmental Management, Lusaka.

ZIPAR (2016) Budgetary implications of Agriculture, Fuel and Electricity subsidies. Report submitted to The Committee of Supply on the Estimates of Revenue and Expenditure, National Assembly. Lusaka.

Zulu-Mbata, O, Chapoto, A & Hichaambwa, M (2016) Determinants of Conservation Agriculture Adoption among Zambian Smallholder Farmers. Indaba Agricultural Policy Research Institute (IAPRI), Lusaka, Working Paper No. 114.

Sentinel

Social and Environmental Trade-Offs in African Agriculture

This report provides a contextual analysis of the agriculture sector in Zambia conducted for the Sentinel project in 2018-19. It serves as a useful reference document reviewing the country's various land uses, past and current drivers and environmental impacts of agricultural development, the habitats most affected by agriculture expansion, and the socio-economic benefits and costs of agricultural development. The report analyses assumptions surrounding Zambia's agricultural and conservation policy agenda.

Download this report at www.sentinel-gcrf.org

Sentinel is an interdisciplinary research project seeking to address the challenge of achieving 'zero hunger' in sub-Saharan Africa, while at the same time reducing inequalities and conserving ecosystems.

www.sentinel-gcrf.org

Sentinel/International Institute for Environment and Development
Third Floor, 235 High Holborn, London, WC1V 7DN, UK
Tel: +44 (0)20 3463 7399
Email: info@iied.org
www.iied.org

Sentinel is funded by UK Research & Innovation (UKRI) through the Global Challenges Research Fund (GCRF) programme for 'Growing research capability to meet the challenges faced by developing countries' ('GROW'). Grant Ref: ES/P011306/1. However, the contents of this document are the sole responsibility of the authors and do not necessarily reflect the position of our funders.