CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Tropical AgriSciences

Socio-economic barriers in the adoption of Holistic Management as a way of combating land degradation in Zimbabwe

MASTER'S THESIS

Prague 2020

Author: BcA. Trinity Tatenda Moyo, BA

Supervisor: doc. Ing. Miroslava Bavorová, Ph.D.

Co supervisor: Ing. et Ing. William Nkomoki, Ph.D.

Declaration

I hereby declare that the thesis entitled ‘Socio-economic barriers in the adoption of Holistic and Management as a way of combating land degradation for farmers in Zimbabwe’ independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague date

.....

Trinity Tatenda Moyo

Acknowledgements

I was able to complete this study with great satisfaction because of the contributions made by the following individuals and groups of people, in various capacities and contributions.

I would like to thank doc. Ing. Miroslava Bavorová, Ph.D., who worked as my supervisor and William Nkomoki, Ph.D. (co supervisor) at Czech University of Life Sciences. They have been instrumental in shaping this research, starting from the conception of the research until completion. Had it not been their effort to guide me all the way through I would not have achieved this.

Thank you to the Department of International Relations and Department of Science, Research and Doctoral Studies of FTZ for mobility support. The financial support was very instrumental in facilitating my travel to make my research possible.

Thank you to Chikukwa Ecological Land Use Community Trust (CELUCT) for providing me with the accommodation during the research, for giving me access to their files related to the study, pictures, reports and some of their interns to assist me as enumerators in data collection during the field work.

My colleagues in Zimbabwe: David Murata and Mandlethu Ngwenyu for assisting me effortlessly in identifying the study area, photo documentation during field work and engaging the organisations.

I would also like to thank all the farmers in Chikukwa for their participation and help during my days in the field.

Finally, my family; Paula and Tariq Moyo for the continued support during my time at Czech University of Life Sciences and while I was executing this research in Chikukwa. To God be the Glory!

Abstract

Land degradation is the gradual or a permanent decline in the productive capacity of the land being utilized. The impact of land degradation is challenging to smallholder farmers in developing countries such as Zimbabwe due to anthropogenic, natural, and environmental factors. The complex and diverse nature in small holder farming systems has been under perceived and undervalued. This has resulted in the neglect and exclusion of small holder farming systems in modern technologies addressing land degradation issues which gives room for the study conducted, where ability to change and adopt production practices is investigated. This study sought to address the factors affecting the adoption of Holistic Land and Livestock Management practices – rotational grazing and feeding livestock on land- by smallholder farmers. For this research a total of 126 small holder farmers in Chikukwa community were interviewed using structured questionnaire. The data analysis methods used include descriptive statistics, chi square test and logistic regression. The study results showed that the farmers have problems with water erosion and low soil nutrients. The results of the logistic regressions on factors affecting adoption of adoption of feeding livestock on farmland showed that government information and internet had influences in the adoption of the practice. The results of the logistic regression on factors affecting adoption of rotational grazing revealed that gender sensitivity is important, print media and trainings on HLLM have a critical role to play in farmer productivity and adoption of Holistic land and livestock management practices.

Key words: Land degradation, holistic management, livestock management, factors, barriers

Contents

List of tables

List of figures

List of the abbreviations

ACHM	Africa Centre for Holistic Management
FAO	Food and Agricultural Organisation
FTLR	Fast Track land Reform Programme
HM	Holistic Management
HLLM	Holistic Land and Livestock management
ICTs	Information Communications and Technologies
LDN	Land Degradation Neutrality
OECD	Organisation for Economic Co-operation and Development
TTLs	Tribal Trust Lands

1. Introduction

Land degradation is a natural or human-induced process that negatively affects the land (Zorn & Komac 2013), it refers to the processes that negatively affect the land's natural functions of water, energy, and nutrient acceptance, storage, and recycling, leading to a decline in land productivity (Engelen et al. 2004). Land degradation in this study is looked at as a result of anthropogenic actions whereby human management and economic activities have largely led to the destruction of the environment through pollution of air, water and land degradation. Agriculturally based activities have also exacerbated the continuous destruction of the land through use of chemical fertilisers and pesticides leading to the deterioration of plant growth, decline of land productivity and soil quality. Soil quality also known as soil health, can be defined as "the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health"(Tous et al. 2005). In the context of this research, soil quality is viewed as the ability of the farm soils to maintain crop growth for the small holder farmers, good water drainage and afford post-harvest feed for the livestock. The effects of land degradation while happening at a local and small-scale level, they have far and wide-reaching effects. While it leads to land non productivity, this will in turn led to food insecurity at family level. This will cause smallholder farmers to give up cultivation on their land to seek alternative livelihoods thereby threatening community and national food security and stability.

With a fast-growing world population, demographics indicating the total number of humans currently living was estimated to be at 7.7 billion as of November 2018 (United Nations World Meter 2019). The Joint Research Centre in 2018 noted that pressure on land and soil over the past 20 years has increased dramatically, with over 75% of the land area being already degraded and facing desertification. Land degradation and climate change are estimated to lead to a reduction of global crop yield by about 10% by 2050 (European Commission Joint Research Centre 2018). The effect will be great on Sub Saharan Africa which is home to 25% of the world's poorest population where 60% of the people depend on livestock as a livelihood (Neely 2009). With this overwhelming evidence indicated above, the impact will be greatly felt on the African continent which

is already facing a dire situation with poverty and food security. At this rate unsustainable land use is a problem that needs urgent address through adoption of conservative farming methods and grassland regenerative strategies.

Greater efforts need to be moved towards addressing the land degradation issues if the small holder farmers and their communities are to have stability. It has become a general assessment that population pressure and unsustainable agricultural practices as main sources of land degradation, while not giving much attention to the socio economic and environmental effects on land degradation. Innovations such as sustainable agriculture, agroecology, land regenerative technologies like the HLLM have the potential to minimise land degradation, improve land health through carbon sequestration, drought resilience, food security and financially viable communities (Savory 2016). However, to address these issues the centre of the technologies should be on the adoption, sustainability, and applicability of the technologies within distinct societies.

Zimbabwe is an agriculturally based economy, where any compromise in agriculture can be a distress to the national food security (Nyoni 2012). Recently agriculture output in zimbabwe has been on constant decline. This is due to political economic reasons and also partly to do with the poor eratic rainfall which is a constant reminder of the effect of climate change on food security (Hebinck & Matondi 2015). Many rural communities in Sub-Saharan Africa and Zimbabwe are suffering from the lurking dangers of land degradation, poverty, drying of wells and rivers, crop failures and livestock deaths and increasing spread of infectious diseases (Engelen et al. 2004). One way of ensuring food security is ensuring utilisation of land at commercial or subsistance (Mugandani & Wuta 2012). Rural poverty has direct correlation with poor land and agriculture, existing scientific evidence indicate that in adopting Holistic Land Livestock Management practices there is great opportunities in dealing with land degradation in grasslands and farms lands (Savory 2016). Land as a resource is vulnerable to mismanagement by human beings for as long as the human population still sees itself above the ecosystem (Savory 2016). This directly results environmental to demise and land degradation which will inevitable lead to land dessertification.

Adoption of new technologies in agriculture is very critical to both academic and policy makers worldwide particularly in tropical and sub tropic countries where food security

remains elusive. Great innovations have not been accepted by small scale farmers as these innovations do not fit well into the heterogeneous smallholder systems which need specific solutions. The complex and diverse nature in small holder farming systems has been under perceived and undervalued. This has resulted in the neglect and exclusion of small holder farming systems which becomes the point of departure of this study where ability to change and adopt production practices is investigated**.** Livestock and wildlife have been at the end of the stick and getting blamed for causing desertification and climate change whereas the livestock and pastoral systems can play a major role in mitigating the land degradation and climate change problems and reducing vulnerabilities to such changes through the adoption of appropriate technologies and management systems (OECD 2001). Contemporary development discourses must note the complex nature of the natural environment and its own ability to adapt to changes within itself without human interference. When managing natural resources there must be a realisation on the interdependence of the environment and its inhabitants, reductionist thinking approaches in decision making is not the best approach.

2. Literature Review

This chapter focuses on academic research that has been done to build evidence and knowledge around understanding smallholder farmers, contextualization of land degradation, regenerative agriculture and holistic management and planned grazing. This section traces the grassroots of holistic management and planned grazing, its effectiveness in achieving the restoration of ecological sanity and reverse impacts of desertification, overgrazing and drying of water sources. Difference sources are consulted for an in-depth reflection and appreciation of the phenomena under investigation.

2.1. Smallholder agriculture and rural livelihoods

Global agriculture has shifted in different phases, from subsistence through to market-oriented agriculture over time. However, what has remained constant, silent, and less appreciated is the role which small holder farmers have played in food security and rural livelihoods. The majority of the poor population and food insecure people are found in the rural set up where they practice small scale agriculture as the main source of livelihood. FAO (2010) note that the often farm scale is measured in terms of the farm size and classify farmers into small and large. For example, several analysts classify smallholders based on a threshold size of 2 hectares. However, across countries, the distribution of farm sizes depends on several agro ecological and demographic conditions, as well as on economic, and technological factors (FAO 2015). Two hectares in an arid region of Sub Saharan Africa do not produce as much as two hectares of good quality land in the Black Sea region. According to the FAO (2018), average small farm sizes have significant productivity differences across countries. These differences arise due to soil quality, technology, and productive assets such as irrigation (Urho et al. 2019). In general, farms in Asia are irrigated, while African agriculture is rain fed, as is agriculture in most of Latin America (FAO 2015).

FAO (2010) stresses that the differences in smallholder farms between countries often reflect differences in the stages of development across countries due to the evolution of the small farm being intrinsically related to the process of economic development. However, across all stages of development, smallholders operate their farms as entrepreneurs operate their firms, or at least they try (Nkomoki et al. 2018). Different

scholars have come up with different working definitions on smallholder farmers for example Todaro and Smith (2009) describe smallholder farmers as owning small plots of land on which they practice subsistence farming relying on family labour. According to Ellis (2000) one key characteristic of smallholder farmers is that they have access to land as means of livelihood whilst relying primarily on family labour for production. They raise capital from multiple sources and invest in productive assets; for many of them even a spade or a bicycle are important assets (McMahan et al. 2016). They make decisions, take both risks and profits. Agriculture involves many decisions: What to plant, which inputs to use and how, when to plough, to seed, to harvest; how much to keep for consumption in the household and how much to sell to raise cash, or how much to store (McMahan et al. 2016). Smallholders farmers often make these decisions in an economic environment in which markets do not function well, if at all, since they are subsistence based and that is also subject to many risks, such as adverse weather and price surges this play a major role on the decision making on investments for their families and human capital objectives, such as education and health (Muchadeyi et al. 2007).

In today's modern markets smallholder farmers face a variety of adverse constrains which they need to overcome. Commercialization and the transformation of food supply chains, best reflected by the rise of supermarkets in the developing world, offer new opportunities for smallholder farmers (Peel & Stalmans 2018). The FAO (2018) reports after a comparison of nine different countries across the world concludes that, across the developing world, smallholders farm in diverse agro-climatic systems which together with their assets and skills, shape their economic lives. Markets and the extent to which they are functioning well, also play a determining role, differences in endowments and markets give rise to disparities among farmers in terms of their integration in the economy (Abiodun 2017).

In the adoption of technologies moral concern and environment concerns are very critical. According to Mzoughi (2011), compared with conventional farmers how use chemical fertilizers, organic farmers are significantly more concerned about doing 'the right thing' a proxy for moral concern. In a study conducted by Mzoughi (2011), it was realised that farmers who show relatively high concern for others and score highly on empathy–sympathy are more likely to adopt conservation tillage to participate in voluntary forest preservation or wetland restoration. Gyeltshen (2010) notes that moral concern affects

other farmers' behaviours, such as adopting practices enhancing animal welfare (Dessart et al. 2019). Environmental concern to a larger extent has high relationship with an affected associated with environmental problems (Schultz et al. 2005). In this line it can be noted that environmental concern influences both pro-environmental behaviour in the general population (Bamberg 2003) and farmers' adoption of sustainable practices (Läpple & Van Rensburg 2011). For example, farmers who embrace the use of sustainable practices are more likely than conventional farmers to be worried about water quality (Läpple & Van Rensburg 2011). When a farmer feels emotionally connected to nature there is high correlation with conservation behaviour, such as the adoption of native vegetation protection measures. A farmer may not feel personally obliged to change their lifestyle and current practices if they consider themselves as already to have sacrificed or doing enough to protect the environment. Moral and environmental concerns influence farmers' adoption of sustainable practices, as people in general seek coherence between behaviour and concern to avoid dissonance (Gyeltshen 2010).

2.2. Contextualising land issues in Zimbabwe

Zimbabwe as a country is laid upon a controversial land issues which dates to settlement of Europeans in Africa. Prior to the settlement of foreign settlers, traditionally the country had communal attitudes towards land ownership and when the settlers occupied individual ownership systems where introduced (Mkodzongi & Lawrence 2019). Land was considered the collective property of the community with a chief as the head. The men had decision making powers on their segmented farms. The natives settled freely across the lands and practiced subsistence farming. However, when the British settlers occupied the lands in 1890 after small resistance the natives where driven off the lands into the Tribal Trust Lands (TTLs) (Mkodzongi & Lawrence 2019). The TTLs created 2 lasting problems: Firstly areas reserved for the white minority was characterised of the most fertile lands in agricultural ecological region 1, 2 and 3 (see table 2 on agro ecological regions classification in Zimbabwe) were also the ratio of land to settlers was high so much that some of the land was lying idle. Secondly in TTLs the land was very poor and due to the high population, the land was overused (Scoones et al. 2011). The topsoils were depleted, vegetation cover was stripped leading to high degradation and land infertility.

The arrangement continued through to until the 1980 independence which was subsequently followed by the Land Reform Programme (LRP) which was characterised by the willing seller willing buyer law (Scoones et al. 2011). This method was not successful due to the lack of economic power of the natives and no settlers were willing to sell off their land. The LRP was abandoned for a politically motivated Fast Track Land Reform Program (FTLRP) which was characterised by violence and non-regulation. To sanitise this the Ministry of Lands declared all lands from crop to wildlife conservancies as state property in 2004. Farms deeds were replaced by 99-year leases. All this impacted the country negatively considering that the country realises a significant proportion of the GDP on agriculture (Nyoni 2012). The natives have remained in TTLs which are now known as reserves up to this day with the depleted lands although a considerable number have been resettled.

Table 1 Land distribution in Zimbabwe by agriculture and non-agriculture activities

Category	Total area (million ha)	Proportion of total area (%)	Proportion of arable land (%)
Non-agricultural			
State forests	0.9	2.6	-
Urban and other	0.2	0.6	-
Sub total	1.1	3.2	-
Agricultural			
Large-Scale commercial farms (LSCF)	12.7	37.1	38.3
Small-scale commercial farms (SSCF)	1.4	4.1	4.3
Communal areas	16.4	48	49.5
Resettlement areas	2.6	7.6	8.0
Sub total	33.1	96.7	100.0
Total	34.2	100.0	100.0

Adopted from (Moyo, et al 1993) in (Hebinck & Matondi 2015)

2.3. Climatic, agro-ecological regions and farming systems in Zimbabwe

The main livelihoods in the different provinces and districts are defined by the agro-ecological zones (Mugandani & Wuta 2012). At one extreme, the districts in Manicaland where Chimanimani falls in has tracts of Zone I and Zones IIB suitable for crop production and patches of Zones III, IV and V that support mixed agricultural production. The Mashonaland Provinces (East, West and Central) have large tracks falling in Zone II

(A and B) that are suited to crop production Masvingo Province shares some ecological characteristics with Matabeleland which is Zones IV and V southern region of Zimbabwe, but also with patches characterised by Zone III. Meanwhile Midlands Province lies mainly in Zones III and IV. At the other extreme Matabeleland South fall in Agro-ecological Zones IV and V and those in Matabeleland North fall predominantly in Zone IV. Livestock dominates the livelihoods in the two provinces (Mugandani & Wuta 2012).

2.4. Land degradation in Zimbabwe

Land is a source of wellbeing for present and future generations as it provides a wide range of ecosystem services that sustain human needs. 48% of Africa's population depends on agriculture and yet the sector has been on a constant decline due to land degradation. Land degradation can severely influence livelihoods by limiting the availability of vital ecosystem services which include food and water, thereby increasing the risk of poverty and leading to forced migration (Vlek & Khamzina 2017). Land degradation also leads to deterioration of soil fertility, carbon sequestration capacity, wood production and ground water recharge with significant social and economic costs to the country (Global Mechanism of the UNNCCD 2019). The state of land whether it is improving, or degrading can to a larger extent influence the impact of the country's economic growth on the alleviation of poverty, make land an accelerator or decelerator of poverty eradication (Barbier & Hochard 2016). Poverty in Zimbabwe was estimated to affect 84% of rural population in 2010. Between 2000 and 2010 the number of people living on degrading agricultural land grew exponentially by 32 000 people representing an increase of over 30% over the decade.

The annual cost of land degradation in Zimbabwe is estimated at 382 million United States Dollars (World Bank 2017). This is equal to 6% of the country's Gross Domestic Product (GDP). Returns of acting against land degradation are estimated at $3 USD for every dollar invested in restoring degraded land in Zimbabwe (Munaz et al. 2018). Assessments of the cost action against land degradation through restoration and sustainable land management practices versus the cost of inaction highlight the strong economic incentive for bold actions against land degradation (Munaz et al. 2018).

2.5. Zimbabwe national voluntary land degradation neutrality targets

The Land Degradation Neutrality (LDN) is part of the Sustainable development Goal 15, Life on land target 15.3 on land degradation neutrality. Zimbabwe is among the other 28 Africa countries which set a national voluntary LDN target and formulated measures to achieve LDN. According to (Munaz et al. 2018) of the Republic of Zimbabwe on national land degradation neutrality targets:

At national scale the country aims to improve land cover of forest, wetlands, shrubs, grassland, and sparsely vegetated areas by 70% in 2030 compared to 2008. LDN to be achieved by 2030, compared to 2008 in 2017 an additional 10% (3,905,700 hectares) of the country's total land area has been improved (Ministry of Environment 2017).

The specific targets being to avoid, minimise and reverse land degradation

1. Reforestation with local and exotic species on 6,455,250 hectares of forest converted to shrubs and on 215,050 hectares of forest converted to cropland.
2. Use conservation farming and agroforestry practices to improve cropland productivity on 361,250 hectares of cropland showing stable but stressed productivity and early signs of decline.
3. Embark on land/catchment reclamation/restoration on 5,580 hectares of grazing and cropland affected by gully erosion.
4. Enforce laws and regulations, embark on awareness programmes targeting illegal miners and rehabilitate 3,798.60 hectares affected by illegal mining.
5. Reduce the 8,857.92 hectares of land affected by alien species through chemical and mechanical control methods.
6. Enforce construction of conservation works, encourage conservation agriculture, and build capacity for farmers to improve 1,083,825 hectares of degraded arable lands.
7. Improve wetland management and restoration of 270,080 hectares of the country's severely degraded wetlands (Munaz et al. 2018).

2.6. Regenerative agriculture

Regenerative agriculture is a process or management technique designed to enhance the functioning of the core ecosystem cycles of energy, water, or mineral by enhancing biological function. In other words, it is any technique that makes the land healthier year after year (Rhodes 2013). In a quest to feed an ever growing population in the world currently sitting at 7 billion estimated to be at 10 billion by 2050, there is no one ultimate solution which can be implemented to curb this surge, there is a dire need to revisit the agricultural strategies that no longer work and re-invent and innovate into newer strategies. Researchers view climate change and land degradation as an inevitable reality what differs is the extent at which it is at each various continents at the same time food security issues continue to be on the rise (Melvani 2016). Poor land use practices and feeding the world with industrial agriculture only is not the solution. Climate exacerbated by excess carbon in the air is rampant and it is no secret that soil, and plants help in sucking this excess carbon from the atmosphere as such through healthy agriculture and regenerative agriculture soil is rehabilitated and excess carbon sucked out. Regenerative agriculture ensures the improvement of agriculture resources rather than destroying or depleting them. It is a holistic systems approach to agriculture that encourages continual on farm innovation for environmental, social, economic, and spiritual wellbeing (Rodale Institute 2014). Regenerative agriculture includes systems of farming that reverse the loss of biodiversity, enrich soils, store carbon, restore watershed health and increase ecosystem services while eliminating the release of toxins and pollutants (Rodale Institute 2014). Regenerative agriculture is evident in different innovations such as, organic annual cropping, no till farming and pasture cropping, HLLM, animal integration, ecological aquaculture, compost and compost tea, Perennial Crops, Agroecology, Agroforestry and Biochar among other innovations (Patiram & Singh 2003). It increases yield efficiency, resilience to climate fluctuation and strengthens health and vitality of all members in communities for generations to come.

According to (Rodale Institute 2014) at the base of regenerative agriculture are four principles:

1. Progressively improve soil, water and biodiversity as part of the whole agro ecosystems.
2. Make holistic decisions that express the essence of each farm and are context specific designs.
3. Ensure development of just and reciprocal relationships amongst all stakeholders
4. Continuous growth and evolution of individual forms and communities to express their innate potential.

Table 2 Comparison of regenerative agriculture and conventional agriculture

Holistic Management/Regenerative agriculture	Conventional land management/ Industrial agriculture
Healthy soil as carbon sink	Depleted soil as carbon source
-More ground cover	-Less ground cover
-More roots	-Fewer roots
-More carbon stored in soil	-Less carbon stored in soil
-More water retention in topsoil	-Less water retention in topsoil
-Recovering groundwater levels	-Depleting ground water
-Less erosion	-More erosion
-More bio productivity	-Less bio productivity
-More diversity	-Less diversity
-Less carbon in the atmosphere	-More carbon in the atmosphere

Adopted from (Patiram & Singh. 2003)

A healthy farmland and grassland require farmers to have good awareness of environment issues which will benefit their crops and lead to food security. Various scientific works on the environment have great agreement on such issues and number of the scientific findings indicating that there is strong relationship between awareness, environment and environmental issues (Makate et al. 2016). Holistic Land and Livestock Management is part of regenerative agriculture approaches which have become critical in modern day agriculture. Much of current production model is about farmers trying to impose our ideas

and will on nature, use of pesticides, tilling of fields, use of synthetic fertilisers rather than feeding the soil. Reduction and elimination of tillage, infiltration rates, water holding capacity and nutrient cycling will improve cover to small holder farms leading to an increase in biodervisty, protect and grow topsoild, pump more carbon into the soil, feed soil biology and allowing the intergration of livestock onto cropland. The combination of livestock and land management results in an exponential increase in healthy functioning of the soil leading to increased harvest outputand animals that thrive on them post harvest (Savory 2016).

Environmental friendly decisions could overally lead to healthy lands leading to good yields (Savory 2016). Healthy environments recover even after facing prolonged harsh conditions and settle back into a fragile but enduring balance. Makate et al. (2016) note that the knowledge and attituteds of the people is the core element for improved natural envornments for better living. Attitudes acts as another dimension that mirror how individuals view their surrounding environment and as such their regard for environmental issues. Positive attitudes result in individuals or farmers playing a significant role in preserving the environment.

2.7. Understanding Holistic Land and Livestock Management

Many rural communities in Sub-Saharan Africa are suffering from the lurking danger of desertification, poverty, drying of wells and rivers, crop failures and livestock deaths and increasing spread of infectious diseases (Engelen et al. 2004). Research conducted by conservationists have concluded that Zimbabwe will be transformed into a desert in a period of 35 years if practical and robust measures are not implemented immediately. Africa Centre for Holistic Management (2005) points out that desertification produces a vicious circle of biodiversity disruption where food insecurity and poverty are the major highlights of the system. Savory (2016); Savory Institute (2016) argues that using livestock presents itself as an option to restore land in areas facing the possible danger of desertification, Savory's thesis is backed by his belief that imitating the nature of movement by animal herds, the soil regenerates and allowing biodiversity to increase. Summarily, the Africa Centre for Holistic Management (ACHM) in Zimbabwe has been mimicking movement of animal herds in planning the grazing of livestock to mimic nature there by the process begins to cover bare soil and restore biodiversity.

The ACHM which offers supports for holistic management efforts through dissemination of information on holistic management planned grazing in Africa, with a special focus on Zimbabwe was established in 1992. This planning process addresses the problem of land desertification using well managed livestock to restore land and water sources (Africa Centre for Holistic Management. 2005).

Allan Savory developed the Holistic Management (HM) an innovation which he argued will reverse desertification and halt climate change while simultaneously reducing poverty and violence. Butterfield, Bingham and Savory (2006) are of the view that it has been claimed that Holistic Land and Livestock Management (HLLM) increases productivity on rangelands and reverses the effects of climate change while allowing carrying capacities of rangelands through doubling the stocking rate (animal units [AU] per area on a given amount of land over a certain time period), primarily through the impact of densely packed animals on primary production (Commission 2012). In HM, belong land management and Holistic Planned Grazing (HPG)which is a type of time-controlled, rotational grazing that utilizes an adaptive versus prescriptive management. In HM, a holistic goal-setting process is used to define the desired quality of life, form of production and future resource base for a landowner. HM teaches people to pinpoint and address the interdependent causes of biological, social and financial deterioration rather than applying quick fix methods (Butterfield, Bingham and Savory 2006). Once the goal is set, adaptive management concerns the time-controlled movement of animals, much like any other adaptive management model for livestock (Hawkins 2017). The continuous movement of livestock at high densities in livestock management (HPG) is thought to mimic natural herd migrations and bunching due to predators, resulting in trampling of the soil and less selective grazing (Hawkins 2017). Savory (1983), named the trampling and movement of animals as animal impact or herd effect where it occurred in especially dense gathering of animals. Peel and Stalmans (2018) notes that the method involves adaptive, high-intensity rotation of animals through many paddocks, and it has been embraced by some but has met with criticism from the academic community. HPG is also known in other terms under different names, and they collectively termed it adaptive grazing in their study (Commission 2012).

Figure 1. Effects of HLLM on the vegetation and soil. Source: CELUCT offices (2019)

2.8. Africa Centre for Holistic Management's role in Land and Livestock Management

In 1998-1999 approximately 70 cattle were re-introduced to Dimbangombe to show that by properly managing them they could restore the land, cattle numbers increased each year, reaching just over 300 at the end of 2009 (Malmberg & Butterfield 2009). This multi-species herd moved through 10 or so unfenced paddocks under Holistic Planned Grazing. To help build up animal numbers in the Dimbangombe herd and to provide relief to community farmers short of forage, ACHM created a "grass bank" in 2003 (Malmberg & Butterfield 2009). Grass bank participants were asked to cover veterinary costs for their animals but were not charged any grazing fees. The only other requirement, added in the drought of 2007, was that animals arrive in good enough condition to survive. That year many livestock owners brought their animals too late (near death), or the animals were so diseased they had to be turned away to avoid contagion (Malmberg & Butterfield 2009). Since its initiation, the grass bank has taken in between 100 and 200 cattle each year (274

in 2007, from 37 families), but in future the aim is to have enough communities under holistic planned grazing that their forage will not run short, even in droughts, and there will be no need for a Dimbangombe grass bank (Peel & Stalmans 2018).

Livestock are used for land restoration by harnessing the power of their hooves to break up hard ground so that air and water can penetrate (Malmberg & Butterfield 2009). Old grass is trampled down, and the soil covered making it less prone to the drying effects of sun and wind. The dung and urine help fertilize the hoof-prepared soil, and their grazing (which is timed to prevent overgrazing and allow adequate time for plants to recover) keeps perennial grasses healthy, greatly minimizing the need to burn and expose soil (Sherren & Kent 2017). In 2004, the mobile overnight kraal (enclosure) was developed on Dimbangombe. Until this time livestock had been kept in a permanent overnight kraal alongside the headquarters on the ranch to protect them from predators, mainly lions. In 2007, the idea was introduced to communities, where the mobile kraal was placed on harvested crop fields at night – remaining in place for about seven days on each section of the crop field so the animals could break up the soil and maize stems with their hooves and deposit nutrient rich dung and urine (Malmberg & Butterfield 2009).

Exponents of HM are of the belief that land cannot be viewed separately from the social, cultural, and economic aspects of a community. The work of ACHM in Dimbangombe has allowed for key collaborations and partnerships with communities and their traditional leadership, villagers in the neighbouring 400,000 ha communal lands from ACHM's Dimbangombe are seen as important partners towards the HPG venture and relationships have been built with them, going further to invite community leaders who serve on the Africa Centre's Board of Trustees (Malmberg & Butterfield 2010).

2.9. Holistic Management benefits as a bi product of human and wildlife conflict mitigation

The potential of HLLM as a soil regenerating technology has been realised as a secondary outcome in other communities where the main goal had been human and wildlife conflict. In Africa, most lions are lost because of conflict with humans and their livestock than from any other natural cause (Mambanje Mobile Cattle Boma Initiative - African Bush Camps Foundation 2019). Livestock in the Hwange community like in any other

Zimbabwe community is an integral part of the community livelihoods as such the Hwange community is situated in the vicinity of the national park and conflict constantly arises as from lion predation on the livestock of the rural community. The community retaliates by killing the lions which in turn affects the tourism sector. As result of this human and wildlife conflict the conservation organisation in partnership with Zimbabwe Hwange national park introduced the Boma technology which is the housing of livestock in bomas overnight which led to highly effective reduction of lion predation. The boma innovation were set up on fallow crop fields where livestock collected from several households can deposit soil nourish manure, urine and tremble on it overnight into the soil. The bomas were moved around the crop field and in different homestead to be naturally fertilised, it was discovered that the area where the bomas were set up the soil was much richer, more nourished and crops grown on mobile boma sites showed improved improvements. According to the Mambanje Mobile Cattle Boma Initiative - African Bush Camps Foundation (2019), the mobile boma initiative has managed to keep the livestock of the Hwange community safe at night and at the same time the villagers have subsequently started using it for soil regeneration and the project has since been replicated in other areas.

Figure 2. A movable kraal. Source: CELUCT offices (2019)

Boma technology

Adopted from :(Mobile Boma – The Soft Foot Alliance Trust, 2019.)

- The Boma technology covers 625m^2 (24 meters of solid canvas wall) and is erected for about a week on crop field before being moved around.
- The Boma technology are made of opaque plastic sheeting PVC (zero visibility) supported by poles and strung around to create a fencing.
- The materials to produce a mobile Bomas cost $400.
- Holds up to 20 cattle (on average 15)
- 2-3 families can share a boma

There various theories dealing with behavioural studies and influences on decision making such in the theory of reason action and theory of planned behaviour which focus on the individual's intention to perform a given behaviour. Intentions are assumed to capture the motivational factors that influence a behaviour, they exists as indicators as to how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behaviour (Makate et al. 2016). The TPB can assist in predicting behaviour surrounding adoption of technologies by local small holder farmers given that the theory TPB has been used by different organisations in predicting behaviour and or influence it. Individuals are driven by behaviour intentions, whose intentions are a function of three determinants which are attitude towards behaviour, subjective norms and perceived behavioural control, upon these determinants behaviour intention is discovered leading to behaviour (Ajzen 2011).

The TPB applied in the environmental issues, assumes that generally actions that are environmental friendly carry a positive normative belief, as such sustainable behaviours are promoted widely as positive behaviours, however complications arise where although there maybe intentions to practice the positive behaviour, perceived behavioural control can be hindered by a variety of constraints such as an individual's belief that their behaviour will not have any impact (OECD 2001). For example, if a farmer intends to follow sustainable farming ways to be environmentally responsible but has no access to

information on sustainable practices or land ownership in this case perceived behavioural control is low and constrains are high, as such the positive behaviour may not occur. An application the TPB in this situation helps in explaining contradictions between sustainable attitudes and unstainable behaviour by small holder farmers(Ajzen 2011). It can be noted that the theory is an important and predictive model in explaining human behaviour.

In a study conducted by (Makate et al. 2016) on the relationship between theory of planned behaviour and climate change various empirical evidence was collected and used to justified the influence of subjective norms and perceived behavioural control have significant associations with behavioural intentions to adapt to climate change and adoption of pro environmental behaviour (Masud et al. 2016). Furthermore , Fishbein and Ajzen (2005) in their work on influence on planned behaviour bring attention to the roles of attitude accessibility, controlled versus automatic information processing, and biases in information processing produced by automatically activated attitudes. Their analyses take specific behaviour as its starting point and tries to identify its important determinants. They suggest that performance of a behaviour follows from such proximal antecedents as behaviour-specific beliefs, attitudes, subjective norms, perceptions of control, and intentions (Fishbein & Ajzen 2005).

Where attitudes toward climate issues empirical evidence collected indicate that attitudes, subjective norm, and perceived behavioural control have positive influence on behavioural intention to adapt or mitigate climate change. Mediating effects of behavioural intention between attitudes, subjective norms and perceived behavioural control and pro environmental behaviour were discovered (Baide 2008). To effectively combat the inevitable effects of climate change pro environmental behaviour minimizes the negative human impacts on the environment, in this context small holder farmer behaviour and understand of their immediate environment is very critical in understand the situations surrounding their farm fertility and its output. Small holder farmers behavioural responses to climate change and land degradation impact are seen in the perceived risks of what threatens individual food security and societal values. However according to (Makate et al. 2016) behavioural responses should be projected towards a better knowledge of environmental issues that influence human attitudes, this assist in

achieving mitigation and adoption choices in various climate conditions across regional context.

Critiques argue that the theory is based on cognitive processing as the main problem, they argue that because the theory ignore an individual's needs prior to engaging in a certain action, these needs have the capacity to affect behaviour regardless of expressed attitudes (Services 1998). For example, a small holder farmer may have knowledge and positive attitudes towards regenerative, sustainable agriculture and yet engage in non-sustainable behaviour because it does not suit his preference. Furthermore, the complexity of human behaviour does not make it easy to predict, an individual's emotions at a decision-making time are ignored despite being very important to the model as emotions influence beliefs and other constructs of the TPB (Makate et al. 2016).

3. Aims of the Thesis

3.1. Main objective

The objective was to assess socio-economic barriers in the adoption of Holistic Management as a way of combating land degradation for small holder farmers in Zimbabwe.

3.2. Specific objectives

- To assess the perceptions of farmers towards the land degradation at their farms
- To identify information sources used by farmers to adopt HLLM
- To analyse the factors influencing the adoption HLLM by small scale farmers

3.3. Research questions

Based on the literature review and indicated study gap, this research by addressing the following research questions, seeks to impact positively on the Zimbabwean small holder farmers and local agriculture.

a) What is the association between land degradation perception by small holder farmers and adoption of HLLM?

b) What are the relevant information agencies and channels preferred by small holder farmers in the study area?

c) What are the factors influencing the adoption of HLLM among small holder farmers?

4. Methods

The research adopted the quantitative method approach. The rationale behind the choice quantitative approach was arrived at after a careful consideration of the nature of variables under investigation (Creswell 2008). The variables in questionnaire included but not limited to the perceptions on farmers to land degradation, identification of information sources used by farmers to adoption of HLLM and analysing the barriers of implementing HLLM to small scale farmers.

The primary data was collected through structured questionnaire, observation and directed interviews method, whereby each questionnaire was directly administered per individual. The quantitative data collected was used to assess the variables in HLLM implementation by farmers, knowledge gathering and access to information by the small holder farmers to the HLLM innovation. The qualitative approach was used to collect information through the key informant interviews from the Chikukwa Ecological Land Use Community Trust (CELUCT) with mainly adopters of HLLM and non-adopters and observation of small holder farms post-harvest.

The methodology was spread and arranged into three chronological phases as indicated in figure 4:

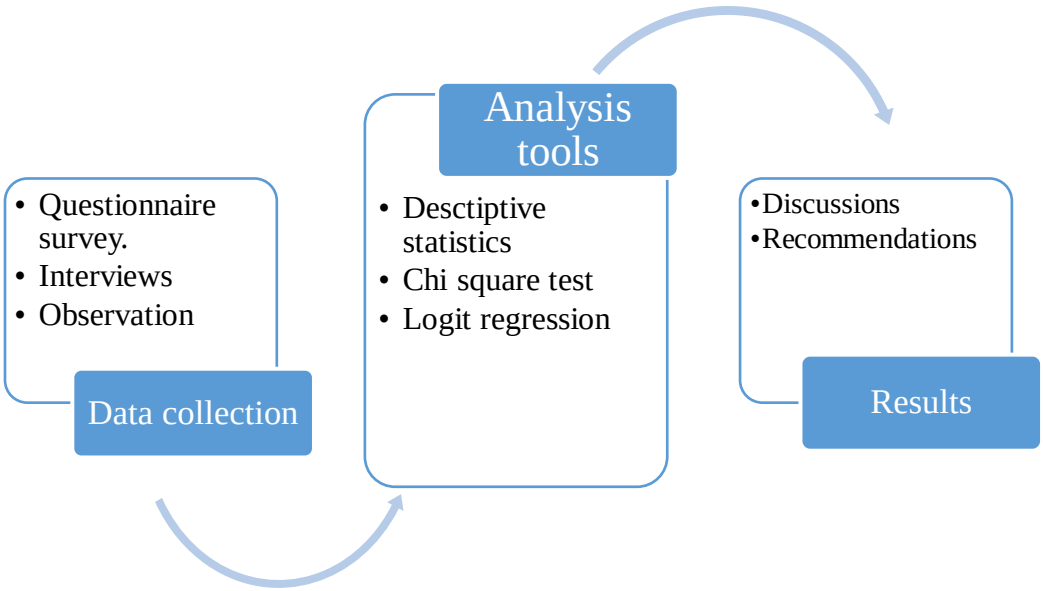


Figure 3. Methodology of the research.

4.1. Description of target groups

The target group of the research were mainly small holder farmers in the locality of Chikukwa both trained and untrained farmers in the HLLM innovation which was implemented in their community through the CELUCT which was also introduced to the programme through ACHM. 7 villages were initially selected. Chikukwa is home to over 4538 people with 857 households with an average of 5 people per household (CELUCT 2017). Within the Chikukwa community are 7 villages namely Mabasa, Munaka, Chitekete, Rujeko, Kubatana, Kwayedza and Jantia. Among these 7 villages 4 (Mabasa, Kubatana, Kwaedza and Jantia) of them are actively involved in Holistic Management. Population distribution of the Chikukwa community is distributed as presented in table 4.

Table 3 Population distribution of the Chikukwa community

Villages	Number of households	Total population
Mabasa	117	558
Kwayedza	109	545
Kubatana	215	1075
Jantia	56	280
Chitekete	150	750
Munaka	98	490
Rujeko	168	840
Total	857	4538

The community is located 25km from Chimanimani town and lies in Agro ecological region 1. The soil types in Chikukwa are generally loam soils in undulating landscapes ranges from wetlands to dry lands.

4.2. Secondary data collection

Scientific articles and journals mainly from online web sources such as Research gate, Science Direct constitute the bulk of the literature reviewed as secondary data, FAO, FAO Stat, World Bank and Zimbabwe government ministry and agencies policy papers as well as Chikukwa community information centres were also used as sources of secondary data.

4.3. Primary data collection

The primary data collection took place between August and September with the bulk of the data collection falling in the month of August 2019. To select the small holder farmers in Chikukwa the multi-stage sampling method was utilised which involved purposive and convenient sampling method. The sampling procedure involved first a purposive approach as out of the seven villages in Chikukwa community the research targeted the villages where the HLLM was implemented. After this deliberate approach it was followed by convenient sampling whereby the groups where divided into 2 groups of trained farmers on HM and non-trained farmers. The sampling procedure was adopted because it helped in minimising sampling errors while ensuring more reliable and representative sample of the desired intention.

Table 4 Sample size distribution

Farmers groups	Innovative technologies	Location	Number of farmers	(%)
Adopters	Using rotational grazing	Chikukwa	91	72.2
	Feeding livestock on land		107	84.9
	Rotational kraaling		21	16.7
Non-adopters	Not using rotational grazing	Chikukwa	35	27.8
	Not feeding livestock on land		19	15.1
	Not using rotational kraaling		105	83.3

Source. Own survey 2020

As indicated in the table from the total of 126 farmers the research managed to interact with 66 farmers adopted HLLM (went through the trainings and implemented) which represent 52.4% and 60 farmers representing 47.6% of the farmers of research sample did not adopt the training (some knew of the trainings chose not to attend).

Figure 4. Chikukwa smallholder farmers trained on HLLM at the Africa Centre for Holistic Management in 2017. Source. CELUCT offices pictures (2019)

4.4. Study Area

Chikukwa Community is in Chimanimani district ward 10 and 11 (a ward is a cluster between 6 – 14 villages). The community is a stretch of approximately 15km set of hills and valleys in the mountainous region of eastern highlands of Zimbabwe in the extremes of the border of Zimbabwe and Mozambique under the chieftainship of Chief Chikukwa.

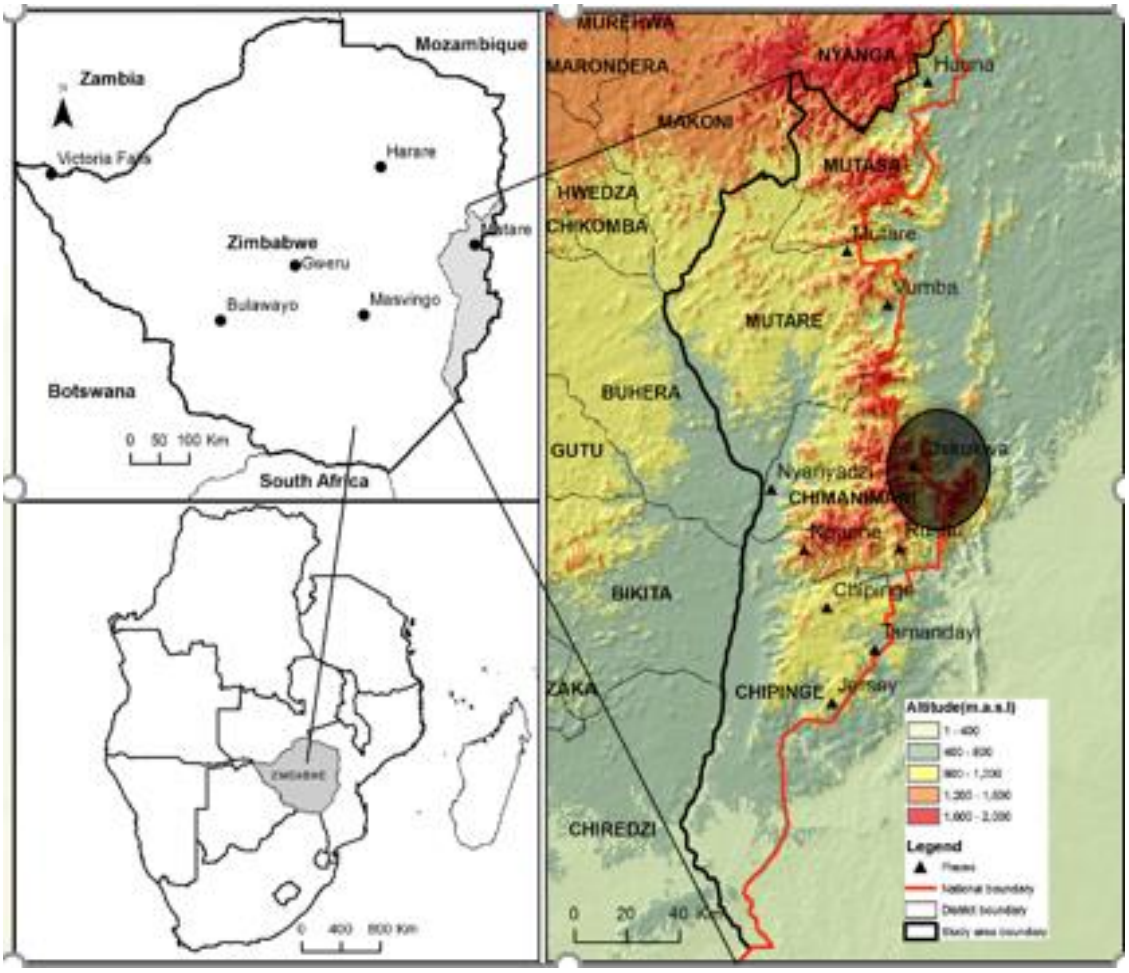


Figure 5. Location and topographic characteristics of the study area (Chemura et al. 2016)

Table 5 Landscape orientation in Zimbabwe

Natural region/Zone	Area km^2	Rainfall (mm/year)	Land area (%)	Region characteristics	Commercial farming system
I	7000	>1000	2	Highest rainfall in the country, specialized and diversified farming and intensive livestock production.	Specialized farming
II	58600	750 - 1000	15	Lower rainfall than region I, region suitable for intensive farming based on crops or livestock production.	Intensive
III	72900	650-800	18	Moderate rainfall with severe mid-season dry spells. Farming systems based on livestock and cash crops.	Semi-intensive
IV	147800	450-650	38	Low and periodic rainfall with severe dry spells during the rainy season. Crop production	Semi-Extensive

				limited to drought resistant crops.	
V	104400	<450	27	Very low and erratic rainfall. No reliable production of even drought resistant fodder and grain crops. Farming based on grazing natural pasture (cattle and game ranching)	Extensive

Adopted from Mugandani and Wuta (2012)

4.4.1. Effects of floods on the study area

By the time the study was carried out, Zimbabwe and Mozambique had just recently (March 2019) hit by a very intense Tropical Cyclone named Idai. Flash floods and landslides triggered by the cyclone destroyed large tracts of corn fields and land in Zimbabwe's agricultural regions of Manicaland and Masvingo provinces (zone I, II and IV) leading to great food insecurity. Farmers worst affected were in Chimanimani and Chipinge in the Manicaland province (zone I and II) were the research site was located. The United Nations in 2019, noted the Cyclone Idai as one of the worst weather-related tragedies in Africa. In Zimbabwe, a total of 50,000 people had been affected and over 20 000 people displaced. Chimanimani alone was the worst hit by the cyclone leading it to being classified as Phase 3 crisis. According to the Inter-Agency Flooding Rapid Assessment Report (2019), most areas received more rains in 2 days (400 mm -500 mm) doubling the normal cumulative seasonal total (approximately over 1000 mm per year) leading to a huge agricultural and livelihoods crisis. Chimanimani district reported the highest number of human loss, most small dams, water channels, crops, small livestock drowned and topsoils was washed away (Chatiza 2019). Much of the agricultural infrastructure and equipment such as irrigation pipes and sprinklers were also swept

away. By the time of this study the Chimanimani district was still in in first stages of recovery from the Cyclone.

Figure 6. The devastations of the Cyclone Idai a family digging up their family members buried (Chatiza 2019)

4.5. Data collection tools and variables

The research was conducted with a combination of questionnaire administering, interviews, key informant interviews and observation. The selection of questionnaire variables was based on the understanding of the desired outcomes of the study. The questionnaire provided the best tool and was the nucleus of the research as it was pivotal in gathering primary factual and authentic data with relation to the targeted population. Due to the targeted number of the sample study, distance between households, 10 Agro-ecology students (Bindura University) interns at the CELUCT centre were taken through a familiarisation workshop and group discussion to familiarise with the questionnaire survey and how the data was intended to be collected. This process was very important in that the students were locals in the area it was easy for them to create rapport with the target group (smallholder farmers) which would increase the validity of the results.

The questionnaire was piloted tested on the first day after the group discussion with the students to randomly selected farmers. The objectives of the research informed the process of selection of variables which were used in the development of questionnaires as well as the discussions during the data collection.

Table 6 Questionnaire variables

Description	Variables
Household head characteristics	Gender Age Academic qualifications Employment status
Farm characteristics	Land size (acres) Number of people working of the farm Number of livestock Land ownership Livestock ownership
Information dissemination to farmers	Importance of various information channels Importance of agencies in information dissemination
Perceptions on HLLM	Adopted or not adopted Post-harvest residue disposal Yields on farm before and after adoption Changes since adoption of HLLM Challenges in HLLM adoption
Perceptions on land degradation	Perceived land degradation on farm Importance of indicators of soil fertility

Source: Own Survey 2020

4.6. Data analysis

Descriptive statistics and Ch square test

The primary data was analysed using the Statistical Package for Social Science (SPSS). Chi square was used to address the research question of accessing the perception of farmers towards land degradation as an influence in adoption of HLLM on the likert scale. Descriptive statistics were also employed to identify the information sources used by farmers to adopt HLLM in their area. The descriptive statistics was opted to provide the analyses as this gave the summarisation of the data of the information source which small holder farmers saw as important.

Logistic regression

Logistics regression was used to analyse the influencing adoption of HLLM. The regression model helps to predict the influences of the variables tested. The Logistic regression model uses binary classification models, the data has two kinds of observations in this context it assists us to understand whether the variables tested have influence or not.

The model in its specific form:

$$y= a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+b_8x_8+b_9x_9+b_{10}x_{10}+b_{11}x_{11}+b_{12}+x_{12}+b_{13}x_{13}+b_{14}x_{14}+b_{15}x_{15}+b_{16}x_{16}+e$$

y = dependent variable (adopter = 1)

a = constant/ intersect

b_1- b_{16} = regression Coefficient

e = error term/ residuals

$x_1 – x_{16}$ = (independent variables as indicated in table 7)

Table 7 Variables used in the Logistic regression model

Variable	Description	Frequency %	min	max	mean
Dependent variable					
a) Feeding livestock on land technology	1- adopter 0- non adopter	107 19	0	1	-
b) Rotational grazing	1- adopter 0- Non adopter	91 35	0	1	-
Independent variables		Hypothesis			
Gender	Household head gender	Gender was hypothesized as having an influence on adoption of innovations (Doss & Morris 2000). Being a male farmer increases the probability of adoption to new innovations than females.			
Age	Household head age	Age was hypothesized to have a negative relationship with the adoption new technologies. The assumption being that the introduction of new innovations within a highly older generation dominated field like agriculture will be slowly adopted while younger generation would likely to embrace new innovations faster.			
Highest academic Qualification	Household head educational background	Education can have a positive effect on adoption. The higher the education the more likely a farmer to adopt new innovations. It can promote the adoption of new innovations by farmers as the farmers get more information and explore new opportunities and willingly try them out.			

Household size	Number of people per household	An addition of a single member of the household decreases the amount of time and financial means the head can devote to other activities on the household. Hence the increase in household size has a negative impact on the adoption of new innovations.
Farmer organisations	Helpfulness of organisations in information dissemination	Farmer organisations hypothetically have a positive influence on adoption of new agriculture innovations since they are important in promoting farmers. The help from farmer organisations directly to the farmers has an increased effect on the probability of adoption of innovations
Conservation organisations	Helpfulness of organisations in information dissemination	Conservation organisations promote sustainable environmental practices. Farmers who get help from conservation organisations have an increased probability to adoption of new sustainable innovations than farmers who do not receive help.
NGOs	Helpfulness of organisations in information dissemination	NGOs as change agents with set quantitative goals are likely to have more influence and helpful on adoption of innovations, they bring into the farmers and remain influential along the adoption process than farmers who do not work with NGOs.
Government	Helpfulness of organisations in information dissemination	Government can facilitate or inhibit adoption of innovation through its policies (Quaddus & Hofmeyer 2007). The more intense the government involvement, the higher the likelihood of potential adoption and embracing of innovations among farmers.
Holistic Management training	The farmer received Holistic	The variable measures the influence of access to training. The hypothesis states that access to trainings on new innovations have a positive

	management training	influence on farmers to adopt innovations than untrained farmers (Singh 2017).
Land Ownership	Household head status on land ownership of land being used	Land ownership provides positive influence. Owners of land view their land as a source of their livelihood and have a high probability to adopt of new innovations to maintain their land than the farmers who do not own their land
Internet	Importance of information channel for the famers	Perceived and existing barriers to ICTs negatively influence the adoption of agricultural innovations by farmers (Al-Ghaith et al. 2010). The more accessible internet is the more likely farmers are to use it as an information source.
Television	Importance of information channel for the famers	The television is an important source of information providing visual information. Rural farmers who have access to television are more likely to use information from television than farmers who do not have a television set.
Other farmers	Importance of information channel for the famers	This variable measures the importance of other farmers as a source of information to other farmers. Farmers who interact with other farmers are hypothesized having a highly probability of adopting new innovations than farmers who do not interact with other farmers
Print media	Importance of information channel for the famers	Print media as a source of information for farmers has a direct effect on the increased probability of adoption of innovations by farmers. Farmers who have access to print media and can read it have higher chances of adopting of innovations.

Mobile phone	Importance of information channel for the famers	Mobile phones have a direct effect on the increased probability of adoption of innovations by farmers. Farmers who have mobile phones through constant communication through mobile phones have an increased chance of adopting new innovations.
Extension Officers	Importance of information channel for the famers	The communication of information on innovations from the extension officers to the farmers influences increased probability of adoption of innovations by farmers.

5. Results and Discussion

5.1. Demographic and farm characteristics

The table 8 below presents the demographic and farm characteristics of the 126 smallholder farmers in the study. The gender distribution indicated that 56.3% of the respondents were males, whereas 43.7% were females. Most of the smallholder farmers indicated that they were fulltime farmers with a representation of 50% of the total sample size, 30.2% of the population being pensioners and with 19.8% of the farmers still employed for wages meaning that farming was also done part time.

Table 8 Demographic and farm characteristics

Variable	Description	Frequency	(%)
Gender	Male	71	56.3
	Female	55	43.7
Employment Status	Full time farmer	63	50.0
	Pensioner	38	30.2
	Employed for wages	25	19.8
Highest academic qualification	No school	3	2.4
	Primary school	33	26.2
	Secondary school	76	60.3
	University	14	11.1
Land ownership	Bought my land	26	20.6
	Inherited the land	79	62.7
	Land resettlement	19	15.1
	Rented	2	1.6
Livestock ownership	Inherited livestock	19	4
	Own livestock	107	96

Own computation. 2020

There is high literacy in terms of the reading and writing as indicated by the distribution of the highest academic qualification as only about 2.4% of total population indicated that they had not received any form of formal education. 26.2% of the farmers had gone through primary education, the highest of the population sample (60.3%) indicated to have received some form of secondary education. 11.1% indicate to have received University education and at the same time involved in part time farming. Most of the smallholder farms in the Chikukwa area as indicated by the results acquired their land through inheritance with 79 farmer (62.7%), followed by 26 (20.6%) of the farmers indicating that they had purchased their land through the headmen, 19 farmers representing 15.1% of the total sample indicating that they acquired their land through resettlement and only 2 (1.6%) indicating that they were renting their land they were using. Most of the interviewed farmers owned their livestock as 85% of the respondents indicated that they had their own livestock while 15% of the respondents indicated they had inherited their livestock from their parents.

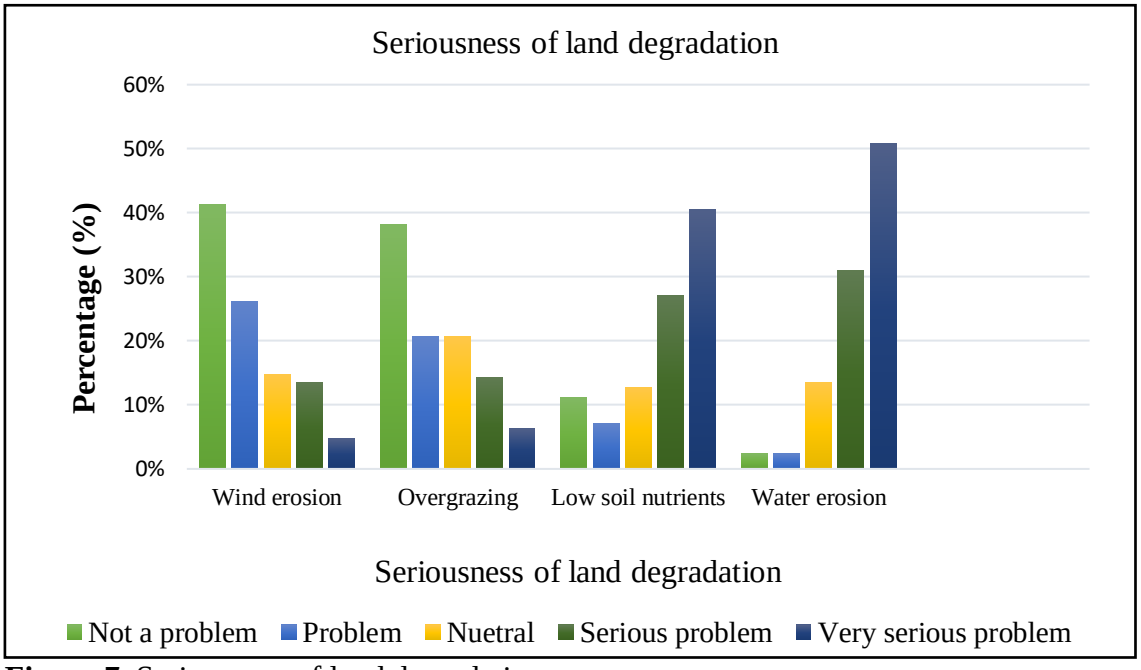


Figure 7. Seriousness of land degradation

Own computation 2020

According to Figure 7, the responses of the small holder farmers as they were asked to specify the seriousness of land degradation on their farms with the provided causes (wind

erosion, overgrazing, low soil nutrients and water erosion). Low soil nutrients and water erosion are serious threats to the farmlands with 40.5% of the respondents regarding low soil nutrients as a very serious problem and 50.8% also indicating that water erosion is a very serious problem and 31% seeing it as a serious problem. In this context it is clear that there is an apparent land degradation within the study area which the research target, the main problem according to the farmers was because of water erosion as a result of lot of water being received and made worse by the Cyclone Idai as according to Inter-Agency Flooding Rapid Assessment Report (2019), which resulted in washing away of topsoil and other soil nutrients leading to low soil nutrients which is indicated to be a problem in Chikukwa community.

The farmers were asked to indicate how they were using the various technologies on their farm to ensure productivity on their farms. Farmers were given 7 options to choose from with fertilizers, organic manure, compost, mulching, crop rotation, reduced tillage, and pesticides and were requested to indicate how often they used any of the technologies on their farm. The figure 8 below shows that farmers have a great reliance on chemical fertilizers and pesticides on their farms as the most regularly used technologies amongst all the options that where presented to them.

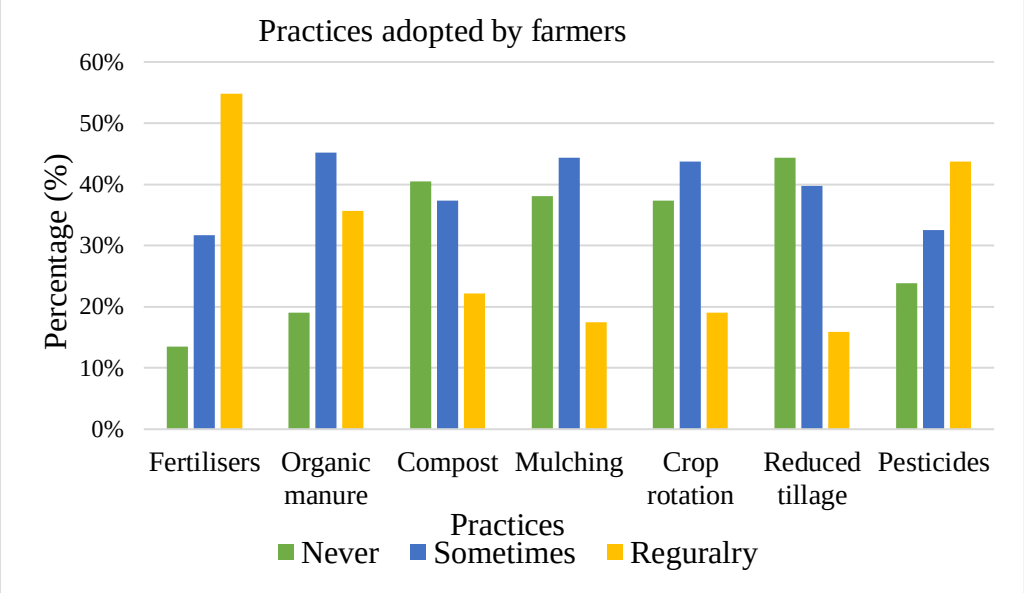


Figure 8. Practices adopted by farmers

Own computation 2020

As indicated in the results presented, while most farmers went through sustainable and regenerative agriculture training which discourage the use of conventional chemical

fertilizers and pesticides with 54.8% of the farmers indicating using fertilisers regularly and 43.7% using pesticides regularly with a high percentage of farmers not using sustainable based practices that help the soil regenerate in the long run. As such it can thus be noted that in every adoption the farmers are bound to make a decision to adopt they assess the risk they face whereby in this situation through chemical fertilizer they realise quick returns since they live on hand to mouth , their yearly yields are very critical in their livelihoods hence they will continue using the fertilizer and pesticides until they find the best alternative which does not live them vulnerable at the same time, information organisations agencies become very critical.

5.1.1. Holistic land and livestock management on farm practices

Through the HLLM technology farmers are taught to follow certain on farm practices which leads to the soil regeneration of their farms and thus realise good yields. On farm practices that farmers are supposed to follow include, grazing method such as farm rotational grazing, handling of post farm residue through feeding livestock on land and livestock enclosure called movable kraals (Boma kraals) respectively.

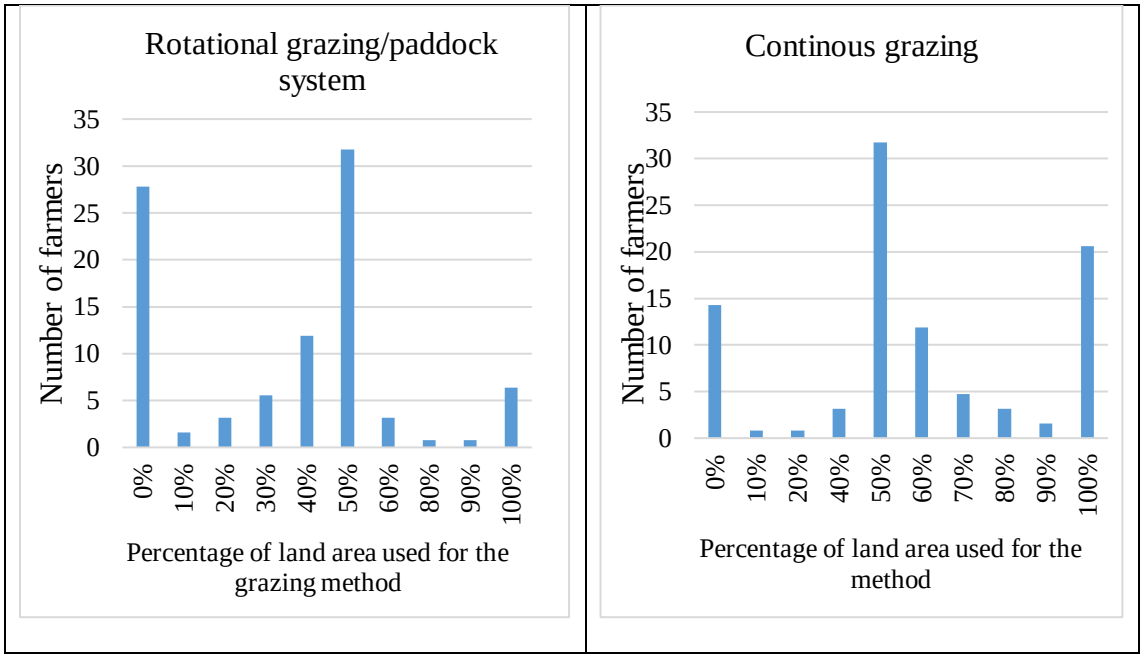
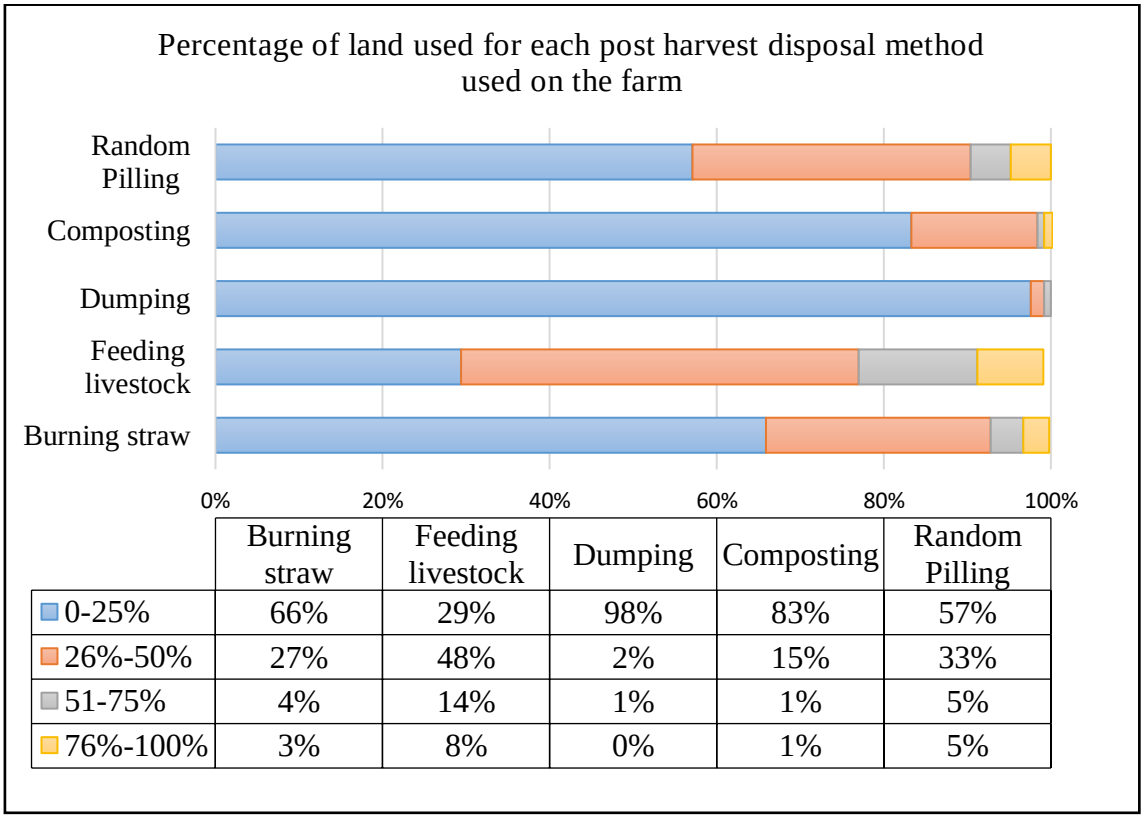


Figure 9. Proportions of rotational grazing methods

Own computation 2020

The farmers were asked to indicate in percentage the portion of usage of the grazing methods they used on their farms with their livestock. Figure 9 indicates the percentage

distribution of how farmers where using the grazing methods. From the evidence collected from the farmers indicated farmers interchanged between rotational grazing which uses the paddock system and continuous grazing where animals enjoyed free grazing without any management. The farmers indigenous knowledge becomes very influential, while farmers adopted to rotational grazing they did not discard the continuous grazing as the rotational grazing requires where there is large portion of lands however the smallholder farmers still have their small pieces of land which can only make the continuous grazing practical and rotational grazing they practice it in communal lands.



	Burning straw	Feeding livestock	Dumping	Composting	Random Pilling
0-25%	66%	29%	98%	83%	57%
26%-50%	27%	48%	2%	15%	33%
51-75%	4%	14%	1%	1%	5%
76%-100%	3%	8%	0%	1%	5%

Figure 10. Post-harvest residue disposal of cultivated land area

Own computation 2020

Farmers were asked on the percentage of their farmland area, various methods that were presented to the farmers which included burning straw, feeding livestock on land, composting and random pilling method. Figure 10 indicates that from the interviewed most farmers field their livestock on the farm as recommended through HLLM. Followed by random pilling and burning of the straw post-harvest. Very few farmers used composting for post-harvest residue disposal. The distribution of the results indicate that

farmers practice different practices while they use feeding livestock they also resort to burning of residue and random pilling this indicates a variety of information sources which may justify why farmers burn residue. The specific 0 figures are presented in the graphs inserted in the appendix 3. The results from the study in (Glendenning 2016) showed that farmers get information from a variety of information however this depends on their ability to accept the information based on their behaviours independently. This is further explored in information sources.

Table 9 Type of livestock enclosure used by farmers

Type of livestock enclosure	Frequency	%
Traditional enclosure (0)	105	83.3
Movable / Boma kraal (1)	21	16.7
Total	126	100

Own computation 2020

Farmers were asked to indicate what kind of livestock enclosure they used for their animals in the night to fence the animals from going astray. Two options where presented, the traditional livestock enclosure (kraal) and the HLLM prescribed Movable kraals also known as Boma kraal. The traditional enclosure remains the most popular form of enclosure and which farmers still use with 83.3% of the farmers indicating that they are using the traditional enclosure and 16.7% accepting using the movable kraal. From the results for example, a smallholder farmer may have knowledge, as indicated in the results the farmers as according to the HLLM the movable kraals are part of the technology farmers where trained however some farmers chose to adopt the movable concept of the kraals but did not use the PVC boma sheets which according to the pricing each cost $400 which is beyond the reach of most smallholder farmers (Mobile Boma – The Soft Foot Alliance Trust. 2019). Some farmers because of lack of this PVC sheet discarded the whole movable kraals concept all together opting to stick with their stationery kraals and utilizing on rotational grazing on their farms and feeding livestock on their lands.

From the way the smallholder farmers approached adoption of the HLLM practices it can be noted that while technologies which in this case is the HLLLM has all the scientific and implementation evidence to its results as a soil regenerative technology for the farmers, the farmers still did not accept the technology in its totality choosing to adopt that which they saw fit and did not adopt some technology (Winstone et al., 2019). This is line with the critique provided on the theory of planned behaviour that because the theory ignore an individual's needs prior to engaging in a certain action, these needs have the capacity to affect behaviour regardless of expressed attitudes (Services 1998). It can be noted that it is ultimately up to the farmer to adopt and implement a practice based on his own view of sustainable agriculture and how it will benefit the farmer himself.

The results from the chi square test (table 10) on the farm perceptions on land degradation for both adopters and non-adopters indicates that there was a statistically significant difference in terms of perception between adopters of HLLM and non-adopters in terms of the perceptions on the effects of land degradation on their farms. This result help in addressing research question 1 on the association between land degradation perception by smallholder farmers and adoption of HLLM. The respondents were given 5 options ranging from 0 to 4 were 0 represented no problem at all and 4 very serious problem. The table indicates the frequency of the responses which came out from the test.

Table 10 Land degradation as a problem

	Feed livestock on land		Rotational grazing	
Land degradation	Non adopters	Adopters	Non adopters	Adopters
No problem at all (0)	1	6	3	4
Problem (1)	4	4	7	1
Neutral (2)	4	16	8	12
Serious problem (3)	4	27	9	22
Very serious problem (4)	6	54	8	52
$\chi 2$	**9.323**	**0.054**	**22.770**	**0.000**

Note: The results are based on the cross tabulations of Pearson's chi2 squared test. Significance level at 1% level.

Own computation 2020

The smallholder farmers who adopted the feed livestock on land practice according to the presented results on table 10 approached acceptable levels of statistical significance with 0.054, this means that there is no significant relationship between the farmers perceptions who practiced feeding livestock and land degradation on their farm. Although 54 of the farmers viewed land degradation on their farm as a very serious problem, 27 viewing it as a serious problem, 16 choosing to be neutral and 5 not seeing it as a problem.

On the other hand, there was a high significance (0.000) on the farmers who practiced rotational grazing and their views on land degradation with 52 farmers indicating that it is a very serious problem, 22 noting that it is a serious problem, 12 farmers being neutral on the matter. This implies that the reason why they practised this innovation was to ensure rehabilitation of their farmlands as they ensured that there is not much stress exerted on singular space on the farm which can result in overgrazing leading to land degradation on their farms. The results indicate a very great influence of perception of farmers to their decisions in adopting HLLM to improve their farms lands.

The results from the chi square test indicated that most adopters of the farmers who practiced rotational grazing although they viewed their farms having problems the use of rotational grazing was not highly significantly connected to issues of land degradation, it

can be noted that the feeding of livestock on their land practice would be just be linked to animal nourishment, protect their livestock from predators ("Mobile Boma – The Soft Foot Alliance Trust" 2019) and postharvest residue disposal methods other than anything else.

On the other hand, farmers who practised rotational grazing understood the effects of overgrazing on the land hence would manage livestock grazing through rotational grazing. These results concur with (Schultz et al. 2005) that environmental concern relates to the affect associated with environmental problems, compared to other dispositional factors, environmental concern is more proximal to the decision to adopt sustainable practices. Also that environmental concern influences both pro-environmental behaviour in the general population (Bamberg 2003) and farmers' adoption of sustainable practices (Läpple & Van Rensburg, 2011). Thus, in this context it can thus be noted that the farmers accept that maintaining a good environment helps maintain better soil structure and organisms as indicated by the HM which are very key to sustain higher yields with less costs.

Also, farmers who faced natural phenomenon (Cyclone Idai) such as experienced in the Chikukwa community and Chimanimani of severe intensity were more likely to take measures against their vulnerability before it happened or to quickly recover adopting regenerative agricultural practices which are part of the HLLM. However, it is also very important to indicate that farmers make choices of adoption as to what fits in their lifestyle based on their livelihoods and immediate surroundings as long it does not have great cost on their finances, human resource and fits their perception. Farmers' perceptions of the benefits and costs associated with a specific agricultural practice are immediately related to the decision-making question as some practices may be entailing high benefits and low costs, while others may be perceived as less profitable.

5.2. Information sources and agencies used by farmers

The second research question on the relevant information agencies and channels preferred by small holder farmers in the study area is addressed. Farmers were asked to indicate their preferred source and agencies of information with regards to the area in which they viewed as important, 6 different options where presented to them which included internet, television, other farmers, print media, mobile phones and extension officers (figure 11) and agencies such as a) farmer organisations, b) conservation organisations, c) non-governmental organisations, d) government, and e) other institutions (figure 12). Each option was given a scale of 5 choices 1 being 'not important at all' up to 'very important' as option 5. The results of the farmers views are presented on figure 11 and 12 respectively.

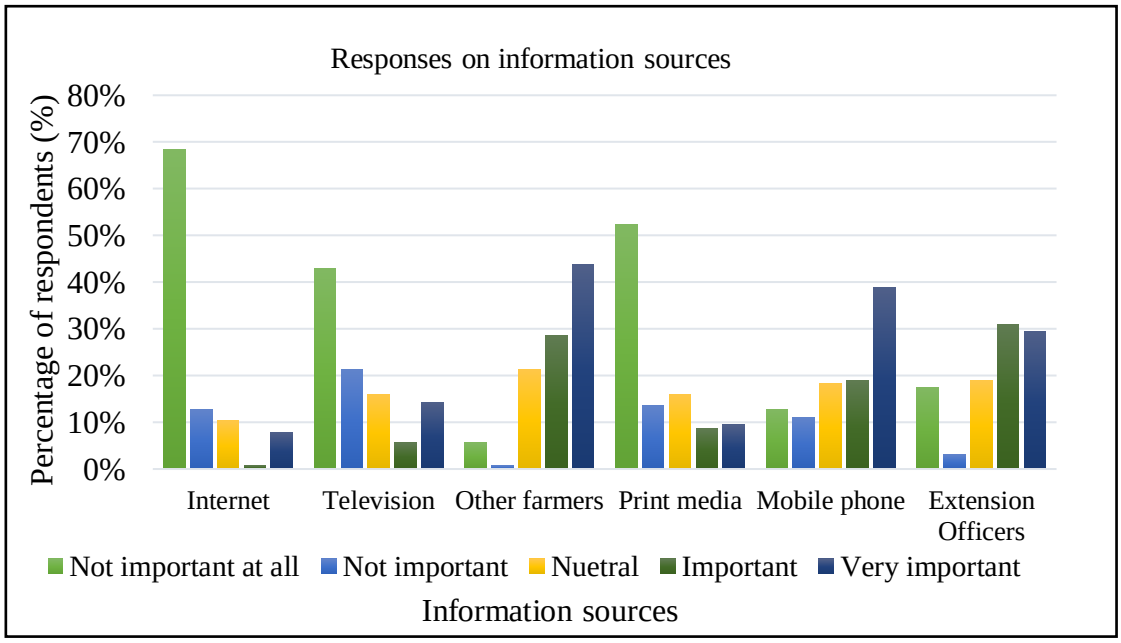


Figure 11. Responses on information sources

Own computation 2020

The results as presented on figure 11 indicate the various responses given by the farmers with regards to the given information sources. The information source presented to the farmers were, television, internet, print media, other farmers, mobile phone, extension officers. Farmers in Chikukwa indicated that other farmers, mobile phone, and extension farmers are the most frequent used mode of information sources. Small holder farmers in Chikukwa indicated that the mobile phone was a relevant source of information with

38.9% and 19% of the sample population engaged in the research noted that it was very important and important respectively. 43.7% of the interviewed farmers noted that information from other farmers as very important, 28.6 % of the farmers noting that it is an important source and also small holder acknowledge extension officers as a relevant source of information with 29.4% and 31% of the small holder farmers indicating that Extension officers are very important and are important respectively.

The small holder farmers were also interviewed on how they viewed the help from agencies in adopting sustainable practices.

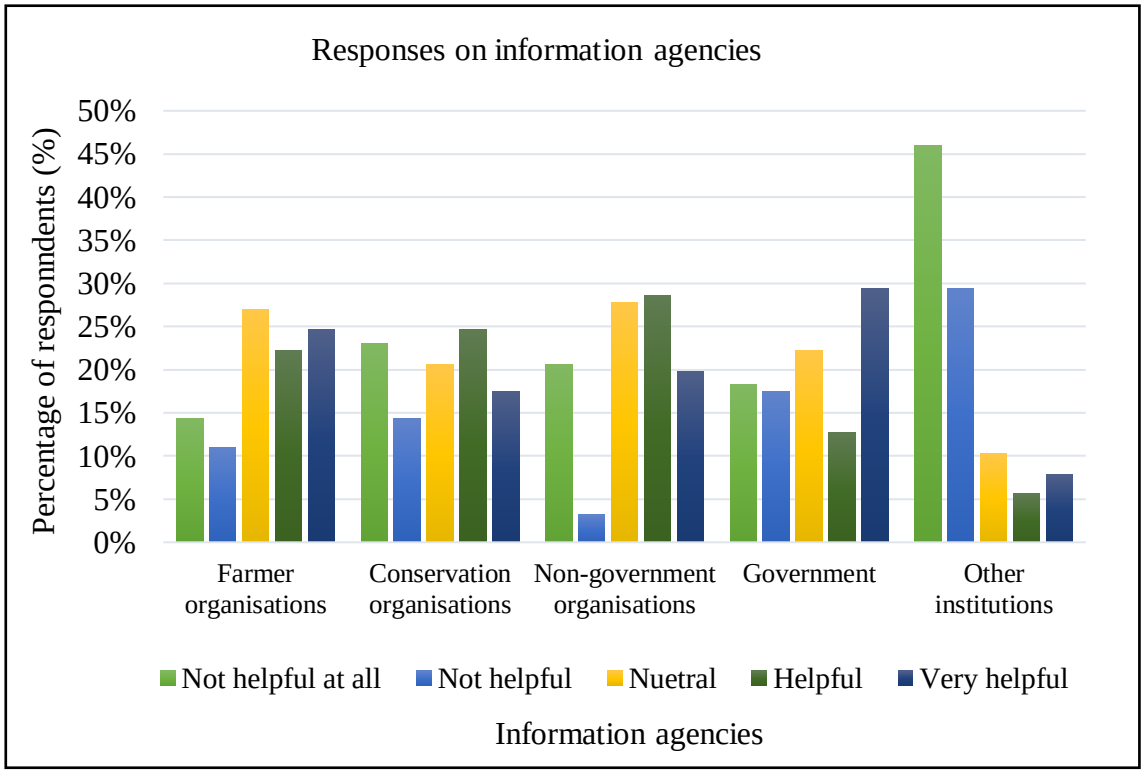


Figure 12. Information agencies

Own computation 2020

Figure 12 illustrates the various results obtained from the smallholder farmer when they were asked how organisations have been offering help on sustainable practices. NGOs as indicated are very influential in helping smallholder farmer accessing sustainable practices information. 32.5% of the farmers indicated that NGOs were very helpful 24.6% noting that NGOs are helpful, 25.4% choosing to be neutral. Conservation organisations have not been successful in offering help to the small holder farmers in Chikukwa area. 37% indicated that conservation organisations were not helpful at all, 4.7 indicating that

they are not helpful. Farmers exhibited high polarisation on views on government assistance, most of the farmers were neutral in explaining the government contribution to help small holder in sustainable practices with a total of 25.2%. These responses were followed by 21.4% of the farmers indicating that government was very helpful while 20.5% of the population indicating that government is not helpful.

From the obtained results from both figure 11 and 12 it is important to note that the flow of information would be confusing and contradicting information which justifies the following of different technologies by farmers. Through the interview the research observed that farmers followed different school of thoughts and where applying all (see figure 8, 9 and 10 on technologies used on farms) and different source preferred. According to the study in Chikukwa farmers indicated that other farmers, mobile phone, and extension farmers are the most frequent used mode of information sources. In some situations as indicate in figure 8 farmers where burning the farm residue as they are taught by the extension officers to burn residue to avoid infection spilling to the next farm season while other farmers through soil scientist and biologists such as Allan Savory recommend livestock feeding on land and the animals excreting back on the farm soil leads to soil nutrients, soil water absorption and healthy livestock there by creating a conflict of ideas to the farmers. Regarding sustainable practices, having easy access to information from local agricultural authorities motivates farmers to adopt organic farming (Kallas, Serra & Gil, 2010) and attending cropping extension activities is strongly associated with the adoption of conservation tillage. As such government plays a pivotal role in the harmonization of the information dissemination through this harmonized information system whereby the famers work entirely with one point of information agency through the extension officer. If conversation, NGOs and another institution has proposed technology or information for the farmers the information must be harmonized in such a manner that it does not confuse the farmers. In this context unified and harmonized information systems is very critical so that farmers do not get mixed information which will also be very critical to farmers to adopt the given technologies.

5.3. Logistic regression (factors influencing adoption of HLLM)

The research discovered a variety of factors which influenced the adoption of HLLM to small scale farmers which serves as the final research question for this study. The sample

comprised of 126 observations where the adoption of feeding livestock on land and adoption of rotational grazing (presented on table 11 and 12 respectively) are used as dependent variables in the two models. These practices were selected because they are part of the Holistic Management technologies which are encouraged for farmers to use on their farms to guard against land degradation and ensure land productivity.

Different independent factors affect the adoption of feeding livestock on land were for model 1 (table 11), government agency as information providers and internet are indicated as influencing its adoption. Model 2 (table 12) shows that the factors that influenced the adoption of rotational grazing are gender, print media and HM training which will be explored further.

Table 11 Logit regression of factors influencing the farmers adoption of feeding livestock on land

Variables	B	S.E.	Wald	Sig.	Exp(B)/odd ratio
HHS	-.058	.183	.101	.751	.943
Age	.021	.035	.352	.553	1.021
Gender	1.087	.678	2.574	.109	2.967
Government	.728	.368	3.922	**.048***	2.072
NGOs	-.275	.294	.880	.348	.759
Conservation organisations	-.117	.353	.110	.740	.889
Farmer organisations	-.453	.357	1.611	.204	.636
Extension officers	-.336	.343	.959	.327	.715
Other farmers	-.440	.440	.997	.318	.644
Print media	-.470	.331	2.020	.155	.625
Internet	-.729	.376	3.760	**.052***	.483
HM training	.057	.937	.004	.951	1.059
Television	.541	.364	2.211	.137	1.718
Highest academic qualification	.559	.490	1.302	.254	1.748
Land ownership	.513	.518	.981	.322	1.671
Constant	4.373	2.951	2.196	.138	79.307

*significant at 0.10. Own computation 2020

Government

The more important the farmers perceives the information from government the more farmers are likely to increase the adoption of feeding livestock on land. This indicates that increase in farmer perception on government information directly to farmers result in 2.1 more chances of farmer adoption of feeding livestock on land. It is thus very valid to argue that government can facilitate or inhibit adoption of innovation through its policies. The more intense the government involvement, the higher the likelihood of potential adoption and embracing of innovations among farmers (Quaddus & Hofmeyer 2007). The influence of government is inevitable, and the role of government remains paramount as an over seer or hands on. The policies of the governments supporting environmentally friendly innovations will go a long way in ensuring he stability and sustainability of environmentally friendly practices. For example through the Ministry of Environment in Zimbabwe in accordance to the Zimbabwe Land Degradation Neutrality policy to enforce construction of conservation works, encourage conservation agriculture and build capacity for farmers to improve 1,083,825 hectares of degraded arable lands, partnering with the local farmers as well as other private institution is very critical if the neutrality policy is to be achieved (Ministry of Environment 2017). Government policing which is farmers sensitive is very critical as indicate in the land degradation neutrality policy to achieve the land regeneration government needs to continue to be influential.

Internet

The model suggest that the more farmers perceive internet as an important source of information the less likely they are to adopt the feeding of livestock on land. There results show that the farmers depending on internet as an important information are 0. 483 less likely to adopt the feeding livestock on land. This is evident in the study due to the less availability of internet access, where generally the community does not have internet connectivity as such, where information is distributed through the internet it is less likely to reach the intended audiences which in this case are the farmers. Furthermore, it brings into the front the economics whereby to access internet has always been viewed as vehicle only for larger organisations and for commercial small business however in agriculture amongst small holder farmers have been left behind due to issues of availability and access. Farmers having to use their money to access the internet which would put a strain

on an already depleted source of income which characterizes small holder farmers as indicated in (FAO 2018). ICT is very critical in the dissemination of information to farmers and government should work very to bringing through ICT systems to farmers and educate them on using ICTs, unfortunately the place of study has limited access to internet connectivity, phone reception which makes it hard for farmers to have access to ICTs. To ensure future positive influence on ICTs government and online service website providers should also work on providing less complicated and user friendly sites that would cater for the farmers with ease in navigation, language and easy access to the most important information and with supporting visual graphics can aid extensively to ensure the embracing of internet as a source of information and ultimately will increase access to information important for adoption.

Table 12 Logit regression of factors influencing the farmers adoption of rotational grazing

Variable	B	S.E.	Wald	Sig.	Exp(B)/odd ratio
HHS	.221	.146	2.271	.132	1.247
Age	.025	.028	.813	.367	1.026
Gender	1.206	.559	4.659	**.031****	3.341
Government	.044	.237	.035	.852	1.045
NGOs	-.120	.210	.326	.568	.887
Conservation organisations	.060	.254	.057	.812	1.062
Farmer organisations	-.234	.268	.767	.381	.791
Extension officers	-.256	.217	1.401	.237	.774
Other farmers	.173	.303	.326	.568	1.189
Print media	-.550	.246	4.994	**.025****	.577
Internet	.389	.345	1.269	.260	1.475
Holistic Management training	2.119	.711	8.874	**.003*****	8.322
Television	-.027	.233	.014	.907	.973
Highest academic qualification	.091	.409	.050	.823	1.096
Land Ownership	.548	.402	1.855	.173	1.729
Constant	-1.553	2.220	.489	.484	.212

*** significant at 0.01, ** significant at 0.05. Own computation 2020

Gender

Gender was hypothesized as having very much influence on adoption of rotational grazing, this means that there are 3.341 more chances for men to adopt rotational grazing than for women to adopt. The hypothesis tested concurs with the findings by Doss and Morris (2000) that being a male farmer increases the probability of adoption to new innovations and that females still faces challenges when compared to males in the agriculture sector. This brings to the fore the need to always differentiate between male

and females in interventions and pay attention to gender as it is influential in the social relationships. This indicates that the female headed household challenges they face maybe more severe than those faced by male, these may take shape inform of economic, social or cultural perceptions (Doss & Morris 2000). Gender sensitivity is needed to be include in trainings and introduction of new agricultural innovations. Females may fail to attend due to the gender roles society dictates to them where by during the training females might also be busy with nurturing children, looking for firewood, and the physical demands of the practices in Holistic Management will need to be explored as whether they can be done by women or they demand a lot of time and energy which will inevitably cancel out women due to the gender blindness of the innovations. It can be noted that there are positives that can be harnessed in the gender differences that can influence adoption if considered, gender diversity can aid to problem solving amongst communities as the inherent differences between male and females would mean that they both drive different outlooks based on perceptions and experienced when these two are put together they avoid premature consensus among farmers and thus increase the quality of the decisions driving innovations ensuring sustainability

Print media

Perception of print media as an important source of information for farmers has a direct effect on the increased probability of adoption of innovations by farmers. From the findings of the study it was indicated otherwise showing that the more farmers perceive print media as an important source have 0.577 chances of not adopting rotational grazing unlike the assumption that farmers who perceive print media as important source of information have higher chances of adopting of rotational grazing. This can be so to a variety of reasons particularly to the situation provided, the local in Chikukwa do not readily have access to print media such as newspapers and fliers and the time to read the information. Nothing more can be as important among farmers than getting the important information to help them. While the farmers exhibited to have the ability to read and write it can only indicate that face to face meetings through trainings are very important channels for them than reading on their own. This is an indication of the changing research habits of information searching and trusting of the information sources amongst farmers (Services 1998). The indication that print media is not as important amongst farmers in the research would mean that the information agencies invest more in trainings

and face to face interaction to achieve the intended results extension officers and other farmers remain critical. Also print media from the farmer organisations should find solutions to provide relevant information with less word on pamphlets, billboards and posters to ensure that farmers would get information without spending more time reading.

Holistic Management training

Training support has significance to influencing adoption of rotational grazing with farmers who attended trainings have 8.322 more chances of adopting rotational grazing than farmers who do not have Holistic Management training. This is in concurrency with (Singh 2017) who indicated the influence of the trainings through the Savory institute that the adoption and improvement on different farmlands was due to the trainings that the farmers where provided. The training provided awareness on land degradation issues, tools and strategies to tackle the land degradation situation and with given case studies of other rehabilitated places (Malmberg & Butterfield 2010). In this context it can be stated that farmer who receive training are more likely to adopt the HLLM and regenerative agriculture skills because they are given the opportunity to explore and understand the issues surrounding land degradation which gives them confidence to adopt the strategies indicated in the intended innovations. Access to trainings on new innovations have a positive influence on farmers to adopt innovations than untrained farmers.

Holistic management teaches people to pinpoint and address the interdependent causes of biological, social and financial deterioration rather than applying quick fix methods (Butterfield, Bingham & Savory 2006). The training had the desired impact on the farmers knowledge on the HLLM innovation and is very critical for the small holder farmer in enhancing productivity. The designing, dissemination and the diffusion of trainings on agricultural innovations holds the key to successfully addressing land degradation issues and rural poverty.

5.4. Limitations of the study

The research was not without its own constrains, the constrains can be summarised as follows:

Due to the cyclone Idai some farmers where not readily available as some were displaced, the study resorted to concentrate with the farmers that where within the available range to which the researcher could travel and get to.

Access to other places proved to be very difficult due to the damaged roads and for lack of transport this made it very difficult to access some of the villages

The distances between villages made it difficult to cover more ground, this manifested in the form of financial constraints.

6. Conclusion

Based on the research, results and discussion conducted it can be concluded that, in the adoption of technologies amongst small holder farmers, farmers outlook of the environment is very critical. Environmental concerns by farmers is very closely related with the need to adoption of environmentally friendly practices and decisions that should first benefit the smallholder farmers livelihood without jeopardising the environment in which they work live within. Any intervention which is sustainable should take the farmers opinion into consideration on their understanding of the existing environment and the need to improve it.

Information channels and sources has been indicated to be very critical. However, it is very important to identify the relevant sources and channels tailor-made to reach the specific targeted audiences, in other words the information sources should be community sensitive and friendly. Farmers in the study indicated that extension officers, other farmers, mobile phone and print media where important sources of information, internet sources will not be of any help unless government intervention through infrastructural development, while organisations such as farmer organisations, NGOs and government were important agencies in the community. Given this it can thus be noted that the best foot forward is for the harmonisation of information systems.

The factors influencing the adoption HM practices to small scale farmers are very widespread and the various channels were explored. Government policy has variety of measures as indicated in the Zimbabwe land degradation neutrality policy to circumvent environmental land degradation, as such the study shows that government policies should support initiatives for full attainment of sustainable livelihoods through partnerships by different organisation which indicated that they are very critical. Gender differences can aid to problem solving amongst communities through complementing each other's strengths. Relevance, suitability, and sustainability of technologies long after their introduction can only be achieved where the community is leading the technology implementation.

6.1. Recommendations

- Farmers in Chikukwa have their own knowledge and perception about their immediate environment and have their own traditional ways of dealing with problems although may not be as effective. As such it is very critical to harness the indigenous knowledge systems which the farmers possess and combine with modern technology.
- Farmers in Chikukwa have been receiving information from various organisations and different channels and the information has been in conflict so much that they end up abandoning the information without fully utilising it. It is imperative for government and private organisations to partner and have a harmonised information system distributed by extension officers to the farmers to ensure smooth flow and adoption of information.
- The trainings on HLLM provided for the farmers are very indicated to have an impact on the productivity and have been adopted at different levels in the community. There it can be recommended to have more trainings of such nature with gender sensitivity to ensure inclusivity.

References

Abiodun OKK and FO. 2017. Innovation for Sustainable Agricultural Growth in Zambia.

Africa Centre for Holistic Management. 2005. Factsheet: Outstanding practice in Agroecology. Available from https://www.worldfuturecouncil.org/wp-content/uploads/2019/01/Zimbabwe_Africa-Centre-for-Holistic-Management-2005-Factsheet-OPA-2019.pdf (accessed May 29, 2019).

Ajzen I. 2011. The theory of planned behaviour: Reactions and reflections. Psychology and Health **26**:1113–1127.

Al-Ghaith W, Sanzogni L, Sandhu K. 2010. Factors Influencing the Adoption and Usage of Online Services in Saudi Arabia. The Electronic Journal of Information Systems in Developing Countries **40**:1–32.

Baide JMR. 2008. Barriers To Adoption of Sustainable Agriculture Practices in **24**:297–308.

Bamberg S. 2003. How Does Environmental Concern Influence Specific Environmentally Related Behaviors? A New Answer to an Old Question. Journal of Environmental Psychology **23**:21–32.

Barbier, E.B, Hochard JP. 2016. No Title. Does land degradation Increase poverty in Devloping Countries? **PLoS One.**

Butterfield, J., Bingham, S., Savory A. 2006. Holistic Management handbook: healthy land, healthy profits4th editio. Island Press, Washington, DC:

Chatiza K. 2019. Cyclone Idai in Zimbabwe:30. Available from www.oxfam.org.

Chemura A, Kutywayo D, Chidoko P, Mahoya C. 2016. Bioclimatic modelling of current and projected climatic suitability of coffee (Coffea arabica) production in Zimbabwe. Regional Environmental Change **16**:473–485.

Commission E. 2012. Holistic Grazing Planning and Reciprocal grazing agreements approach.

Creswell J. 2008. Research Design Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, Inc.

Dessart FJ, Barreiro-Hurlé J, Van Bavel R. 2019. Behavioural factors affecting the adoption of sustainable farming practices: A policy-oriented review. European Review of Agricultural Economics **46**:417–471.

Doss CR, Morris ML. 2000. How does gender affect the adoption of agricultural innovations?: The case of improved maize technology in Ghana. Agricultural Economics (United Kingdom) **25**:27–39.

Engelen VWP van, Mantel S, Dijkshoorn JA, Huting JRM. 2004. The impact of desertification on food security in Southern Africa: a case study in Zimbabwe. Report - ISRIC World Soil Information:vii + 78 pp. Available from http://www.isric.org/isric/webdocs/Docs/ImpactStudyZimbabwe.pdf%5Cnhttp://www.cabdirect.org/abstracts/20073091431.html.

European Commission Joint Research Centre. (n.d.). "New World Atlas of Desertification shows unprecedented pressure on planet's resources." Available from www.sciencedaily.com/releases/2018/06/180621111958.htm.

FAO. 2010. Policies and institutions to support smallholder agriculture. 22nd Session.

FAO. 2015. The economic lives of smallholder farmers. Fao **4**:1–4. Available from http://www.macrothink.org/journal/index.php/rae/article/view/6320%0Ahttp://www.upov.int/edocs/mdocs/upov/en/upov_sym_ge_11/upov_sym_ge_11_10.pdf%0Ahttp://ajae.oxfordjournals.org/cgi/doi/10.2307/1241587%0Awww.iosrjournals.org%0Ahttp://link.springer.com/10.

FAO. 2018. Sustainability Pathways: Smallholders' ecology. Available from http://www.fao.org/nr/sustainability/smallholders-ecology/en/.

Fishbein M, Ajzen I. 2005. The Influence of Attitudes on Behavior. The Handbook of Attitudes:173–222. Available from http://books.google.com/books?hl=en&lr=&id=qoJ5AgAAQBAJ&oi=fnd&pg=PA173&dq=The+Influence+of+Attitudes+on+Behavior&ots=I3vmnYWDce&sig=lASAmi1gqxpMyNlnszyUROK82Fg%0Ahttp://books.google.com/books?hl=en&lr=&id=qoJ5AgAAQBAJ&oi=fnd&pg=PA173&dq=The+influence+of+.

Glendenning C. 2016. Farmers ' Information Needs and Search Behaviors Case Study in Tamil Nadu , Farmers ' information needs and search behaviors : Case study in

Tamil Nadu , India Suresh Chandra Babu , Claire J . Glendenning , Kwadwo Asenso-Okyere , and.

Global Mechanism of the UNNCCD. 2019. Land degradation, Poverty and Inequality. Page Dessertification, Global Mechanism of the United Nations Convetion to Combat. Bonn. Available from www.unccd.int/about-us/global-mechanism%0ACover.

Gyeltshen P. 2010. The dynamics of socio-economic situations of communities in relation to land degradation- Bhutan.

Hawkins HJ. 2017. A global assessment of Holistic Planned Grazing™ compared with season-long, continuous grazing: meta-analysis findings. African Journal of Range and Forage Science **34**:65–75.

Hebinck P and Matondi P. 2015. Rural Development in Zimbabwe Post Land Reform Rural Development Post Land Reform Location. Available from https://www.researchgate.net/publication/283496739%0ARural.

Inter-Agency Flooding Rapid Assessment Report. (n.d.). Inter-Agency Flooding Rapid Assessment Report.

Kallas, Zein, Serra, Teresa and Gil J. 2010. Farmers' objectives as determinants of organic farming adoption: The case of Catalonian vineyard production. Agricultural Economics **41**.

Läpple, Doris and Rensburg T Van. 2011. Adoption of organic farming: Are there differences between early and late adoption? Ecological Economics **70**:1406–1414.

Makate C, Mango N, Makate M, Masud MM, Al-Amin AQ, Junsheng H, Ahmed F, Yahaya SR, Akhtar R, Banna H. 2016. Climate change issue and theory of planned behaviour: Relationship by empirical evidence. Journal of Cleaner Production **113**:104027. Elsevier Ltd. Available from http://dx.doi.org/10.1016/j.jclepro.2015.11.080.

Malmberg, A. and Butterfield J (2010. 2010. Holistic management of livestock, Zimbabwe, 2001 – 2009. Available from http://www.fao.org/fileadmin/user_upload/nr/sustainability_pathways/docs/Holisti

c management of livestock Zimbabwe.pdf (accessed May 29, 2019).

Malmberg A, Butterfield J. 2009. Holistic management of livestock , Zimbabwe , 2001 - 2009. http://www.fao.org/fileadmin/user_upload/nr/sustainability_pathways/docs/ Accessed 22 October 2018.

Mambanje Mobile Cattle Boma Initiative - African Bush Camps Foundation. (n.d.).

Masud MM, Al-Amin AQ, Junsheng H, Ahmed F, Yahaya SR, Akhtar R, Banna H. 2016. Climate change issue and theory of planned behaviour: Relationship by empirical evidence. Journal of Cleaner Production **113**:613–623.

McMahan K et al. 2016. Securing Water for Food annual report: November 2016 - October 2017. Available from https://securingwaterforfood.org/wp-content/uploads/2017/11/SWFF_AnnualReport2017_ForWeb_final.pdf.

Melvani K. 2016. Handbook for Regenerative Agriculture R egenerating sand to loam.

Ministry of Environment. 2017. Water and Climate of the Republic of Zimbabwe, National Land Degradation Neutrality Targets. Republic of Zimbabwe. Harare.

Mkodzongi G, Lawrence P. 2019. The fast-track land reform and agrarian change in Zimbabwe. Review of African Political Economy **46**:1–13. Taylor & Francis.

Mobile Boma – The Soft Foot Alliance Trust. (n.d.).

Muchadeyi FC, Wollny CBA, Eding H, Weigend S, Makuza SM, Simianer H. 2007. Variation in village chicken production systems among agro-ecological zones of Zimbabwe. Tropical Animal Health and Production **39**:453–461.

Mugandani R, Wuta M. 2012. Re-Classification of Agro-Ecological Regions of Zimbabwe in Conformity With Climate Variability and Change. African Crop Science Journal **20**:361–369.

Munaz P, Ali M, Radloff P, Yao Z. 2018. Investing in Land Degradation Neutrality: Making the Case:1–16.

Mzoughi N. 2011. Farmers adoption of integrated crop protection and organic farming: Do moral and social concerns matter? Ecological Economics. **70**:1536–1545.

Nkomoki W, Bavorová M, Banout J. 2018. Adoption of sustainable agricultural practices

and food security threats: Effects of land tenure in Zambia. Land Use Policy **78**:532–538. Elsevier. Available from https://doi.org/10.1016/j.landusepol.2018.07.021.

Nyoni T. 2012. Current and Emerging Youth Policies and Initiatives with a Special Focus on Link to Agriculture Zimbabwe Case Study Draft Report April 2012:1–33.

OECD. 2001. Adoption of Technologies for Sustainable Farming Systems. Wageningen Workshop Proceedings:149.

Patiram BP, Singh K. 2003. Regenerative Agriculture in NEH Region for Sustainability of jhum Land. Researchgate.Net. Available from https://www.researchgate.net/profile/Bhagwati_Bhatt/publication/308918797_Regenerative_agriculture_in_NEH_Region/links/57ff3f4708ae6b2da3c8dd9a.pdf.

Peel M, Stalmans M. 2018. The effect of Holistic Planned Grazing™ on African rangelands: a case study from Zimbabwe. African Journal of Range and Forage Science **35**:23–31.

Quaddus M, Hofmeyer G. 2007. An investigation into the factors influencing the adoption of B2B trading exchanges in small businesses. European Journal of Information Systems **16**:202–215.

Rhodes CJ. 2013. Feeding and healing the world: Through regenerative agriculture and permaculture. Science Progress **95**:345–446.

Rodale Institute. 2014. Regenerative Organic Agriculture and Climate Change:1–24.

Savory A. 2016. Holistic Management Case Studies, Profiles and Articles. Savory Institute:20.

Savory Institute. (n.d.). Restoring the climate through capture and storage of soil carbon through holistic planned grazing. Available from http://www.savoryinstitute.com/media/40739/.

Schultz PW, Gouveia V V., Cameron LD, Tankha G, Schmuck P, Franěk M. 2005. Values and their relationship to environmental concern and conservation behavior. Journal of Cross-Cultural Psychology **36**:457–475.

Scoones I, Marongwe N, Mavedzenge B, Murimbarimba F, Mahenehene J, Sukume C. 2011. Zimbabwe ' s Land Reform A summary of ndings. Zimbabwe's land Reform

Booklet:1–20. Available from www.zimbabweland.net.

Services AT. 1998. Academic Technology Services A Division of Information Technology Services. A Division of Information Technology Services **6654**.

Sherren, K and Kent C. 2017. Who's afraid of Allan Savory? Scientometric polarization on Holistic Management as competing understandings. Renewable Agriculture and Food Systems:1–16.

Singh RK. 2017. Impact of Training on Ti-Ie Adoption of Technology. J. Interacad.:2–4.

Tous R, García R, Rodríguez E, Delgado J. 2005. Architecture of a semantic XPath processor application to digital rights management. Lecture Notes in Computer Science **3590**:1–10.

Urho N, Ivanova M, Dubrova A, Escobar-Pemberthy N. 2019. International Environmental Governance - Accomplishments and Way Forward. Nordic Council of Ministers, Copenhagen, Denmark.

Vlek PLG, A. Khamzina L and T. 2017. Land Degradation and the Sustainable Development Goals: Threats and potential remedies. CIAT Publication No. 440. Nairobi.

World Bank. 2017. World Development Indicators. Available from http://data.worldbank.org/data-catalog/world-development- indicators (accessed May 29, 2019).

Zorn M. and Komac B. 2013. Land Degradation. In: Bobrowsky P.T. (eds) Encyclopedia of Natural Hazards. Springer, Dordrecht.

Appendices

List of appendices

Appendix 1: Confirmation letter for research partnership

CHIKUKWA ECOLOGICAL LAND USE COMMUNITY TRUST

Building Constructive Community Relations

Like Bees We Shall Work

P.O. Box 2029 Chimanimani

Chukukwa Ecological Land Use Community Trust (CELUCT)

P. Bag 2029

Chimanimani

23 August 2019

Dear Sir/Madam

RE: LETTER OF CONFIRMATION FOR MOYO TRINITY T.

This letter hereby confirms that Moyo Trinity *(a student of Czech University of Life Sciences)* was accommodated at CELUCT, a Community based organization within the Chikukwa Community. He was undertaking a Research for his Project on HLLM and Land Degradation in Chikukwa, and a total of 10 CELUCT interns who are studying a Diploma in Agroecology with Bindura University managed to be engaged in the research process to cover 3 villages *(which are Kubatana, Mabasa and Kwaedza)* that have ventured into HLLM projects. The Research commenced from the 10th to the 22nd of August 2019. The student kindly work with us without any queries.

CELUCT is a Community based organization (CBO) which have got the aims of promoting and developing Sustainable rural livelihoods particularly in the agricultural sector, with the development of sustainable Agriculture within and outside Chikukwa being the core. The organization has then adopted the concept of HLLM as a remedy to soil infertility in 2012 and the project is still existing to date, though it has not yet covered the whole of Chukukwa Community. Within the same organization there are also other departments such as the District Schools Programme; that works in supporting school children within the Chimanimani district, and the Peace Programme; which focuses on conflict transformation within the whole district as well.

Yours sincerely

Chituwu Chester C. (Director).

THE DIRECTOR
CHIKUKWA ECOLOGICAL LAND USE COMMUNITY TRUST
(C.E.L.U.C.T)
DATE 23/08/19
P. BAG 2029, CHIMANIMANI
TEL: +263 773 231 572
Email: celuct@zol.co.zw

Appendix 2: Questionnaire

Socioeconomic hindrances in the adoption of Holistic Land and Livestock Management (HLLM) as a way of combating land degradation for small holder farmers in Zimbabwe

Section A. Perception on Land Degradation

1. Do you perceive land degradation on your farm as a problem?				
No problem at all – 0	1	2	3	4–Very serious problem

2. Please specify the seriousness of the problems of land degradation at your farm. No problem at all -0 1 2 3 4 – Very serious problem					
Causes					
Wind erosion					
Overgrazing					
Low soil nutrients					
Water erosion					

3. How important are the following indicators of soil fertility for you as a farmer? Not important indicator - 0 1 2 3 4 – Very important indicator					
Soil colour changes					
Soil texture (ploughing problems)					
Lower yields					
Size of animals					
Decreased vegetation					

Others, pls indicate….					

SECTION B: Perceptions on Holistic Management.

4. Which of the methods do you use for post-harvest residue disposal? Please indicate in percentage of your cultivated area (%) where more than one method is used.

%	Burning straw	Feed livestock on land	Dumping	Composting	Random piling

5. What type of grazing method do you use on your farm? Please indicate in percentage of your cultivated area (%) where more than one method is used.

	Continuous grazing	Rotational/Movable kraals/ paddocks	Zero grazing	Others
%				

What kind of livestock enclosure do you use at your farm	Rational kraal/BOMA	Stationery kraal

6. How often do you use the following technologies on your farm?

Never - 1 Sometimes 3 – Regularly

Fertilizer (chem.)			
Organic manure			
Compost			
Mulching			
Crop rotation			
Reduced tillage			
Pesticides			

7. Did you take a training in Holistic Management practice technology:				**Yes**	**No**
8. Why did you take the training in HM? Rank according to importance. 1 Not important – 5 Very important.					
Improve my finances	1	2	3	4	5
Improve land health	1	2	3	4	5
Eager to learn	1	2	3	4	5
Protect my livestock	1	2	3	4	5
Dragged Along	1	2	3	4	5
9. Have you been using Rotational grazing practice technology:				**Yes**	**No**
10. If Yes, when did you start to use? Year…					
11. How many days do you allow your livestock to graze on your farming land post-harvest per acre:					
12. How many days do you set up a kraal before moving it?					
13. How many livestock do you graze per acre of your farmland post-harvest?					

Adopters

14. What changes do you perceive since adopting the HM technology? 1. Strongly agree to 5. Strongly disagree.					
Improved Soil quality	1	2	3	4	5
Increased yields	1	2	3	4	5
Healthy crops	1	2	3	4	5
Grass cover and diversity	1	2	3	4	5
Water drainage	1	2	3	4	5
15. Yields on your farm before and after introducing the HM	Before: Kg …… or number of 50kgs bags ……..			After: Kg…...or number of 50kgs bags…….	

If you have not used,

For Non-Adopters

16. What reason do you perceive as a challenge in adopting HM practices for you personally? 1. Strongly agree to 5. Strongly disagree.					
Social community pressure	1	2	3	4	5
Difficulty of planning	1	2	3	4	5
Low Openness to change	1	2	3	4	5
Lack of Training	1	2	3	4	5
Lack of Access to financial resources	1	2	3	4	5
Don't see the benefits	1	2	3	4	5

Section C. Information dissemination

17. How important are the following information channels for you to get information on sustainable agricultural technologies?	
Not at all important – 1 2 3 4 5 – Very important	
Internet	1 2 3 4 5
Television	1 2 3 4 5
Other farmers	1 2 3 4 5
Print media (e.g. newspaper)	1 2 3 4 5
Mobile phone	1 2 3 4 5
Extension Officers	1 2 3 4 5

18. How have the following agencies been helpful in informing you about sustainable practices? Rank according to importance. 1. not at all helpful – 5. Very helpful					
Farmer organizations	1	2	3	4	5
Conservation organizations	1	2	3	4	5
Non-governmental organisations	1	2	3	4	5

Government	1	2	3	4	5
Other, …	1	2	3	4	5

SECTION D: Farm characteristics

	Tick relevant box			
19. How many years have you used this land?				
20. Land ownership.	Bought my land	Inherited the land	resettle ment	Rented
21. I have Livestock	Yes		No	
22. If yes, livestock ownership	Own livestock	Parents		
23. If yes, how many livestock do you have? (insert number)	Cows	Goats	lamb	Donkey
24. Please indicate how many people are working on your farm and which gender they have?				
Total number:	Number of male workers:	Number of female workers:		
Family members:	Male:	Female:		
Paid workers:	Male:	Female:		
25. Please indicate the size of your farm (in acres):				
26. How much of the land is arable land (%):				

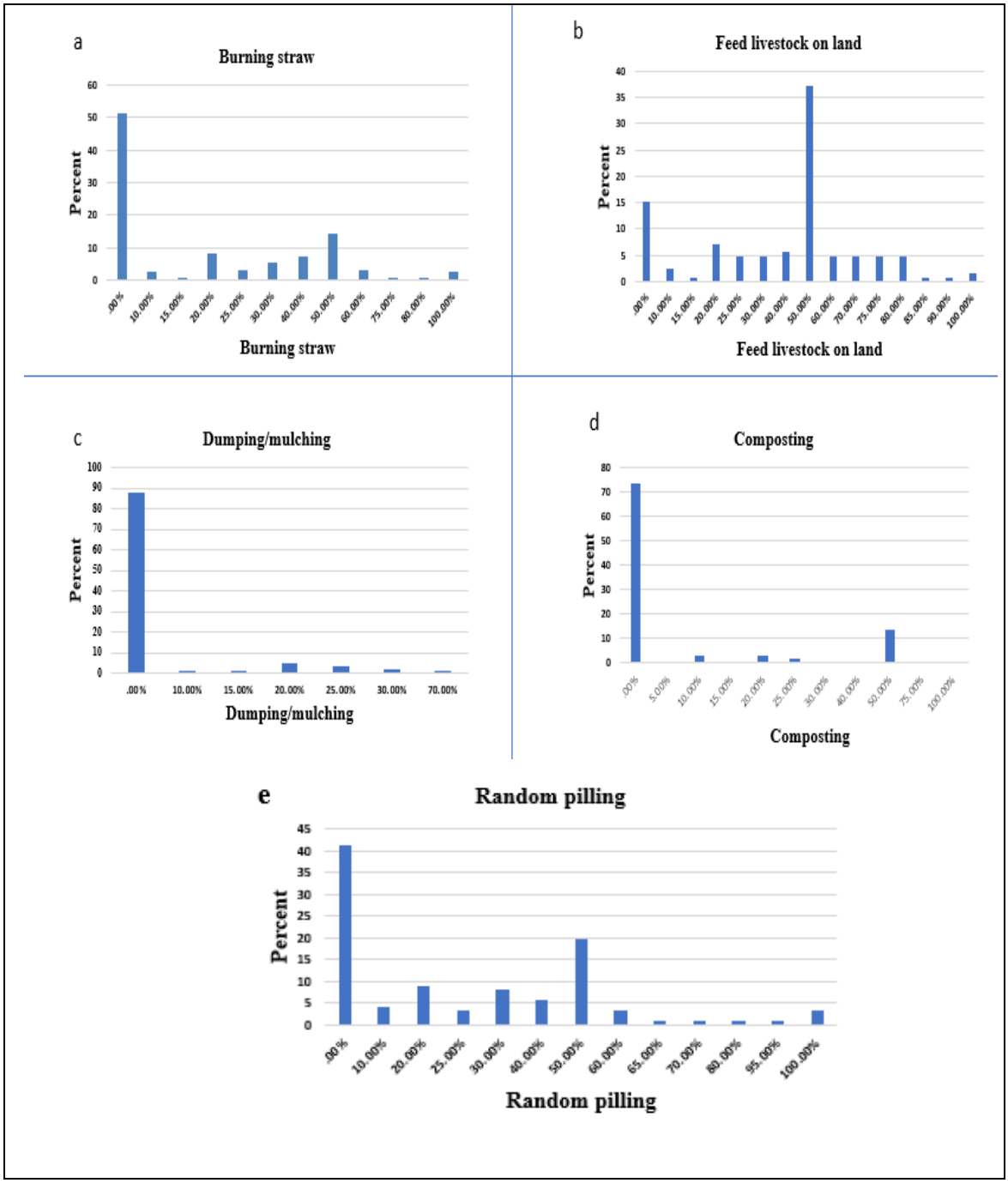
SECTION E. Household head characteristics

	Tick relevant box	
27. Gender	Male	Female
28. Age range		

29. Highest academic qualification	No school	Primary	Secondary	University	Other (Specify)
30. Current employment status	Full time farmer		Pensioner		Employed also for wages

Thank you for your cooperation.

Appendix 3: Methods used post-harvest residue disposal in percentage of cultivated land area.



Appendix 4. Photo documentation of research data collection

Discussion with CELUCT interns studying Agroecology selected to assist in data collection

Interview with a small holder farmer

Farm washed away by Cyclone Idai

Random piling at a farm

Feeding livestock on land practised by small holder farmers

Dumping as another method of post-harvest residue disposal

Burning of farm residue

Movable kraal practice on respondents' farm

Tour in one of the farms where fertile land had been mixed with urine and dung in HLLM practice

Farm produce on selected land by one of the respondents practicing HLLM