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Challenges encountered in conservation farming by subsistance farmers of chikupi resettlent in Kafue District of Zambia

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Abstract
The study investigated the challenges subsistence farmers of Chikupi in Kafue district encountered in conservation farming. It was a simple survey case study design with the objectives to determine the subsistence farmers' knowledge of conservation farming; establish the farmers' source of conservation farming knowledge; and identify the challenges subsistence farmers of Chikupi encountered in conservation farming. Data were collected using structured interview schedules to farmers and interviews with agricultural and Conservation Farming field officers. The findings of the study revealed that most subsistence famers of Chikupi had good knowledge of conservation farming learnt from several organizations including government. The findings showed that the farmers had many challenges with conservation farming like labour intensity of the practice, high cost of labour involved, demand for precision in doing conservation farming, social – economic dynamics and traditional land tenure system. The study concluded that the subsistence farmers of Chikupi resettlement had knowledge of conservation farming but were inhibited from using it by poverty and the social economic dynamics of the community and the land tenure system. The study recommended that the government and other stake holders should address the impediments to enable the settlers use conservation farming practices for human and environmental sustainability.

Keywords: Sustainability, Conservation Farming, Agriculture, Climate change, Innovation, Challenges

Introduction
Changes in the biosphere such as the migration of fauna and innovations made by humans in their habitat and activities can be attributed to climate change. New activities and methods emerged to suit the new climatic conditions in order to sustain both the environment and humans. Through various innovations, humans have changed their relationship with the environment.

The increase in human activities and development of machinery has brought about avenues for improved and sustainable innovations in food production and environmental conservation. Conservation Farming, (CF) also known as Conservation Agriculture (CA), is one agricultural innovation adopted to mitigate environmental degradation while increasing agricultural yields [1]. CA and CF are used to mean one and the same thing and, therefore, are used interchangeably in this paper.

Definition and History of Conservation Farming
Conservation Farming is an agricultural practice that entered Zambia in the 1980s and 1990s from the United States of America (USA) through Brazil and Zimbabwe. It was first investigated in the 1940s in Nebraska, USA where mulch was used to control wind erosion [2]. Arstan *et al.* (2013) acknowledge Haggblade and Tembo (2003) who state that historically, CA was born out of ecological and economic hardships in the United States (U.S.) caused by catastrophic droughts during the 1930s and became more popular among farmers due to rising fuel prices during the 1970's. Large commercial farmers took up minimum tillage technologies to combat the drought-induced soil erosion and save on fuel costs. Around 35% of the total area in the U.S. was cultivated using minimum tillage technologies during 1980's. The CA experience in the U.S. gave impetus to the CA movement in South America (mainly Brazil) and Southern Africa (mainly South Africa and Zimbabwe), where government agricultural research centers established conservation tillage programs to actively promote CA [3].

The Conservation Farming Unit (CFU) in Zambia was conceived in 1995, between Peter Aargaard and Ron Landless a leading commercial farmer in Chisamba area, Central province of Zambia. The two had a keen interest in small-scale agriculture and had close connections with Brian Oldrieve and Richard Winkfield of the Agricultural Research Trust (ART) in Zimbabwe. Both of them were pioneers in the minimum Tillage (min. till) campaign (Aargaard, 2009, Mubambe, 2014) [4].

The Food and Agriculture Organization (FAO) (2006) [5] describes CA as any system or practice which aims to protect soil and water by surface cover (mulch) to minimise runoff, erosion and improve the conditions for plant establishment and growth. They further describe it as a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. Minimum tillage is the bedrock of CA and it was used by African subsistence farmers long before the introduction of the plough by Europeans settlers. This shows that CA can be practiced using simple tools and equipment. Nevertheless, some stakeholders have identified the following principles as common characteristics of CA;

i) Continuous minimum mechanical soil disturbance;

ii) minimum soil disturbance
iii) mulching and minimal burning of crop residues
iv) mixing and rotating crops, especially with legumes
v) timely implementation
vi) precise operations; and
vii) efficient use of input (Aargaard 2005, FAO 2006, GART 2009) [6].

Arstan *et al.* (2013) adopted the list of CF practices from (CFU 2007) as promoted in Zambia to consist of a package of the following practices:

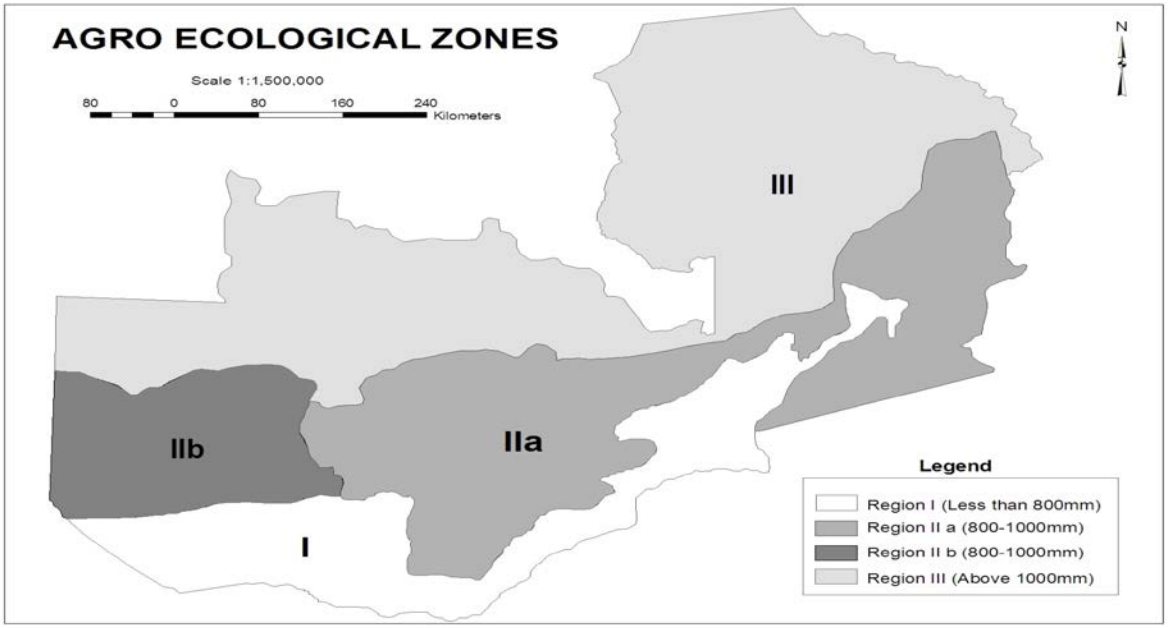
1) Reduced tillage on no more than 15% of the field area without soil\inversion,
2) Precise digging of permanent planting basins or ripping of soil with a Magoye ripper (the latter where draft animals are available),
3) Leaving of crop residues on the field (no burning); and
4) Rotation of cereals with legumes and
5) Dry season land preparation

However, all the stakeholders acknowledge that conservation agriculture is a way of farming that conserves, improves and makes more efficient use of natural resources through integrated management of the available resources combined with external inputs. This study sought to discover the problems that hinder the subsistence farmers of Chikupi from adhering to the CF practices.

Study site

The study was done in the 2014/2015 farming season from September 2014 to April 2015 in Chikupi area fifty kilometers south of Lusaka and twenty kilometers west of Kafue town. Chikupi resettlement lies in Zambia's Agro-Ecological Zone II (AEC) which includes the most productive agricultural land in the country, receiving between 800 and 1000 mm of rainfall annually and covers approximately 42% of the country. AEC II is further subdivided into

AEC IIa and AEC IIb. AEC IIa, in which Chikupi falls, covers the fertile plateaus of Central, Lusaka, Southern and Eastern Provinces while AEC II b covers the sandy areas of Western Province. AEC IIa supports production of a variety of the main food and cash crops like maize, sunflower. Groundnuts and tobacco while AEC II b supports the production of other crops like rice, millet, cashew nuts, timber and vegetables. Figure 1 below is a map of Zambia showing the Agro-Ecological Zones.



***Source**:* www.fao.org.

Fig 1: Map of Zambia showing the Agro Ecological zones.

According to local informants, the people of Chikupi originally came from the mountains of Malundu in Chongwe district East of Lusaka. They were resettled in Chikupi a generally flat plain on the banks of the Kafue River, to give way to the construction of a military training facility in the hills near Mikango barracks in 1974. The Zambian government through Chieftainess Nkomeshya Mukamambo moved over 500 people to the present site in Kafue. This makes

Chikupi resettlement essentially a displacement community created to give way to a development project. Displacement is as a result of acquisition of legally sanctions, while there is no legal framework that governs the process of displacement itself. The land acquisition law protects the sanctioneer of what causes displacement. In the absence of the legal document to ensure accountability on the part of the state, resettled and rehabilitation entitlements promised often by executive order are rarely implemented in their entirety covering all the affected people. The people of Chikupi were not given all the benefits of displacement. They were resettled to continue with their traditional life style under the customary land tenure system where the chief through the headmen allocated land without title. Zambia has a dual land tenure system: the customary and the statutory tenure that apply to the state land. Chikupi resettlement falls under the customary right to the old reserve land which does not confer ownership right but only protection of use and occupation rights. In other words, Chikupi resettlement was once a reserve and cannot be

absolutely owned by an individual or group of them. No wonder Chieftainess Nkomenshya threatened to return her people to Malundu when the government did not honour all the displacement conditions [7]. The chieftainess expected her people to be resettled under the statutory land tenure system as they were moved by the state. Umar, *et al.* (2011) [8] contends that customary land tenure was especially common in Southern and Central Provinces of Zambia. They report that in such set ups no individual has control over the land even in cases where a household did not own livestock, its crop residues were still grazed by other households 'free range livestock'. Traditionally, all fields become communal grazing lands after harvest. Farmers cannot fence off their fields as this would not only be very expensive but would be challenged by their communities [9]. The Chikupi community consists dominantly of subsistence farmers involved in agriculture. The Zambia Land Alliance and the Dan Churches Aid (2005) observe that the majority of Zambians depend on agriculture for their livelihood [10]. The Chikupi resettlement is inhabited by displaced people. The term displacement refers to the movement of population from their place of usual residence to another area. This movement is forced in the sense that in the absence of a project or natural disaster residents would not have chosen to leave the area. The movement can be either internal or international, and is often permanent, though some possibilities of return might exist in certain cases [11]. Issues of Displacement and resettlement are critical in the world as they involve such other things as human rights, governance, participation, and other complexities as rehabilitation.

Many displacement resettlements have been reported in the world. For example the pastoralists of Kenya were displaced to give way to agricultural activities. In Botswana and Namibia groups of San people were displaced and were resettled because of the government schemes and conservation policies. In India and Pakistan families lost their land and livelihood to coal mining and in Lesotho mountain villagers were resettled by Lesotho highlands water projects. Panos London further observes that displacement is commonly associated with conflicts with refugees fleeing their homes. Millions of people are resettled every year in the name of development and progress [12]. In Zambia, Maheba refugee camp in Solwezi district is a large resettlement of people from several countries fleeing from conflicts. Such people endure social and cultural disruption and economic upheavals and a significant number never recovers their former quality of life. Shalala (2013) observes that social relations, support networks and traditional livelihoods are disrupted by relocation, and are hard to restore in different contexts. The strain of change and adaptation and of undergoing what becomes, in effect for many traditional rural communities, a dramatically accelerated process of modernization, tests social structures to their limits. Many break down [13]. He argues that resettlements in many cases have not been successful and have affected farmers' livelihood and production. Family life and agriculture are disturbed by resettlement in some cases this brings a threat to family unity and cooperation. The voices of the affected are rarely heard as they become incapacitated [14].

Theoretical frame work

The study was done within the Diffusion of Innovations (DOI) theory by Roger Clarke (1999) [15]. The theory looks at the conditions that increase or decrease the likelihood that a new idea, product or practice would be adopted by members of a given community or culture. It predicts that media as well as interpersonal contacts provide information and influence opinion and judgment. He identified four stages in the application of the theory namely; invention, diffusion through the social system, time and consequences. This entails that an innovation has to be created, passed to other people through their social system and over time the outcome of it or its influence on their livelihoods would be seen.

In using the diffusion theory, it is vital to note that the potential adopters have three ways of adopting the innovation namely;

i) Optional innovation decision. This is where individuals volunteer to join or participate in the social system and adopt the innovation at their own time as they wish.
ii) Collective innovation decision. Individuals collectively; club or cooperative members decide to participate in the social system; and
iii) Authority innovation. This is a top down approach where those in leadership accept an innovation on behalf of the general membership.

This theory is relevant to the study as it is concerned with how a technological idea, artifact or technique is transmitted from creation to the users. CA was introduced to Chikupi community as an innovation created from outside, introduced to and later to be used by the community. The innovation has to be exposed to the adopters, persuade the adopters to accept, adopters put the innovation to use and confirmation of adopting the innovation is sought.

According to the theory, there are five main factors that influence adoption of an innovation, and each of these factors is at play to a different extent in the five adopter categories.

i) relative Advantage - The degree to which an innovation is seen as better than the idea, program, or product it replaces.
ii) compatibility - How consistent the innovation is with the values, experiences, and needs of the potential adopters.
iii) complexity - How difficult the innovation is to understand and/or use.
iv) triability - The extent to which the innovation can be tested or experimented with before a commitment to adopt is made.
v) observability - The extent to which the innovation provides tangible results (Behaviour Change Models 2013 Online) [16].

The theory of diffusion of innovations was also used alongside the principles of adult learning advanced by Knowles (1980) in Shirur (1997) [17] who contends that one of the principle elements of building up knowledge in adult education is the level of awareness that people posses. This therefore, becomes a prerequisite for knowledge. She further argues that the process of creating awareness among adults involves;

i) Realizing facts
ii) Comparing values;
iii) Integrating and evidencing facts and values as coordinated propositions; and experiencing (p.28) [18].

She also cautions that provision of information or knowledge conceived as important to adult learners neither guarantees assured results in the form of knowledge as seeking neither acts nor gains acceptance of learners. Also mere acquisition of knowledge or what may be called as knowing does not lead to

cause its usage in their personal life and integration with their experiences. Using some of the attributes of the Diffusion of Innovations theory and the principles of adult learning we should be able to explain how the agricultural innovation of conservation farming has been adopted by the community of subsistence farmers at Chikupi resettlement.

Conservation Farming in Zambia

Aargaard (2005) reports that in Zambia, Ron Landless worked with the World Bank office and the farmers' union to popularize CA during the disastrous drought of 1991. He also contends that he and friends worked with the European Union (EU) and the Zambia National Farmers' Union (ZNFU) and donor agencies like NORAD (Norway), SIDA (Sweden) and FINNIDA (Finland) to form the CFU in 1996. Since then, CA has grown from a small pigeon hall office at a private home to a national programme with offices located along Leopard's Hill Road in New Kasama in Lusaka. It has field staff in many parts of the country that support the farmers. It is argued that CF has come a long way and has accumulated huge numbers of practical hands and experiences. Presently in Zambia, there are many families farming from 1 to 30 hectares who vouch that the adoption of CF and the practices associated with it have improved and transformed their lives [19]. The Zambian government has embraced CF as a solution to various problems that beset subsistence farmers in the country. According to Kabwe and Donovan (2004), the government of the Republic of Zambia sought the development of an efficient, competitive and sustainable agricultural sector which would enhance food security and increase small-scale farmers' incomes. These attributes were found in CF. They report that conservation farming was used to mitigate poverty among small scale farmers as well as help to commercialize agricultural programmes [20]. Aargaard (2009) supports this assertion when he observes that CF is more productive, efficient and environmentally friendly. It is a radical change from the way farmers have planted their crops for generations [21].

Reasons of adopting Conservation Farming

Since 1990s, Zambia experienced several drastic weather patterns which resulted into droughts and floods. This pattern was common in many parts of the world and it negatively affected most farmers' production. These experiences in weather demanded more research to help redress the suffering of the people whose main stay is Agriculture. Some people like Brain of Zimbabwe are reported to have even sought divine intervention in order to arrest the poor harvests experienced on the farm he was managing (Kansanshi Social Corporate Responsibility, 2014) [22]. Researchers and farmers looked to conservation farming which had already taken root in Brazil and nearby Zimbabwe.

Lunchen, *et al.* (2012) reports that CA emerged to mitigate the impact of frequent droughts in Zambia. They contend that since the mid-1990s, several programmes were implemented by the Ministry of Agriculture and Livestock (MALS), the Conservation Farming Unit (CFU), Golden Valley Agricultural Research Trust (GART), the World Agro forestry Centre (ICRAF) as well as a number of Non Governmental Organisations (NGOs) and donor agencies. The funding was mainly provided by donors [23]. However, Umar, *et al.* (2011) observe that the promotion of CA by the various stakeholders seemed to differ in agronomy, in the incentives offered to adopters and pedagogically some promoters of CF offered incentives that could not sustain the learners' interest in CF. For example, some farmers offered their fields for demonstration plots year in and year out in order to avoid meeting the cost of inputs. Nevertheless, the emphasis was on promoting CA as an avenue for increasing productivity, reducing soil degradation and lowering production costs [24].

Conventional Farming

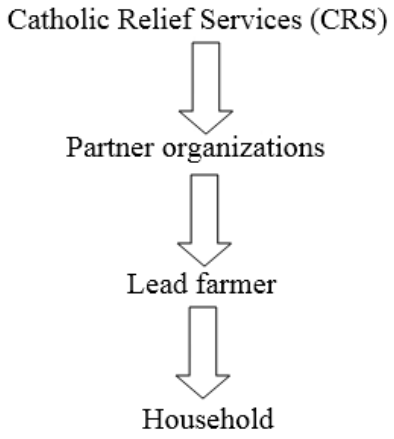
Conventional Farming was a predecessor to CA and it employs tillage methods for land preparation. FAO (2006) [25] describes conventional or arable agriculture as normally based on soil tillage as the main operation using the plough or hand hoe. It became common after the white man introduced such tools as hand hoes and ploughs both animal and tractor drawn. The introduction of these tools made work much easier for the subsistence farmers who before then could only cultivate very small portion of land due to the inefficient tools available. This process, in the long term, leads to reduction of soil organic matter which does not only provide nutrients for the crop, but, it is also, above all else, a crucial element for the stabilization of soil structure. Therefore, most soils degrade under prolonged intensive arable agriculture. It is the effects of these tools on the environment which forced scientists to look for alternative technology to reverse soil degradation and high cost of living. Conventional tillage methods were first questioned in the United States in the aftermath of the dust bowl where the combination of drought, natural removal of vegetation and excessive soil disturbance from ploughing and harrowing destroyed over 100 million acres of farm land and caused extreme hardship for over half a million families. IRIN (2014) [26] acknowledges that conventional tillage methods involve burning plant residues, which degrades soil quality. These traditional methods have been used for generations in Zambia and are seen as having benefits including reducing labour input and destroying pests. Aside from the environmental damage, burning residues exposes the soil to erosion. The picture below shows the effects of conventional farming on maize production. The crop grows with poor stalks leading to small cobs and low yields.

Source: Field survey.

Fig 2: An example of a poor crop from conventional farming practices.

Following the promotion of Conservation Agriculture by several stakeholders, many farmers in Zambia adopted the farming practice. Kaswende (2012) [27] observed that some farmers discovered the merits of CA soon after the lessons. He reports that a few months after only a few lessons from a conservation farming Unit (CFU) Field officer, a couple decided to try out the new farming methods by planting one lima (50m x 50m) of maize. Similarly, a case was reported in Chipata in the Eastern Province of Zambia where a farmer, Mr. Ngoma, learnt about CF from a group of farmers in the neighbourhood who were talking about CF and later he decided to inquire more about it and upon applying the knowledge learnt, he succeeded and had a good yield.

In Zimbabwe, training in CA was provided by the Catholic Relief Services (CRS) where farmers were given technical guidance regarding planting standards such as the number of seeds per station, spacing suitable for their soils, how to keep planting stations weed free to optimize soil use and rotation production of cereal and legume crops and mulching. CRS also promoted CF among vulnerable people under its vulnerable livelihood programme. In this programme, CRS provided training, technical support and resources while its partner organization implemented the programme at community level. These include government stake holders through the agricultural extension service who implement, monitor and evaluate the project for its sustainability. CRS involved 650 vulnerable households who were trained under 6 lead farmers: community members already farming and well respected. The lead farmer model helped to overcome the challenge of reluctance by some community members to use hoes in their work. The training was cascaded through partner organizations to households as illustrated below



Source: Field Survey

Fig 3: CRS training model on CF in Zimbabwe.

The training included record keeping and planning, skills of seed selection, fertilizer, labour rainfall, wages, yield food and transport. Each farmer had a demonstration field. This attracted more farmers in the next season such that some volunteered to join after seeing the results. Finally over 1045 households in 3 districts were practicing CF (Fanelli and Ndumba, 2006) [28].

Aargaard (2009) [29] postulates that without the proper technical advice about improved tillage and planting methods, inputs may go to waste. For this reason, it is necessary to provide farmers with sustainable guidance. He notes that the conservation farming Unit, initiated by the Zambia National Farmers' and backed by a consortium of international donor agencies, had spent a lot of time advocating the use of conservation farming techniques, which encompasses improved tilling and planting methods, crop rotation and intercropping practices. He further notes that the common CF practices adopted in Zambia were crop rotation, minimum tillage within hand-hoe and animal traction systems. It generally involves several key practices such as dry-season land preparation using minimum tillage systems crop residue retention; seed and input application in fixed planting stations. However, Aargaard (2010) [30] added a number of activities he referred to as husbandry practices that together comprise a complete farming system namely;

- Farmers can plant a larger area because they are not moving or turning over the soil before they plant. It saves money and time;
- Farmers can begin to prepare their land as soon as they have harvested. This allows for early planting at the onset of the rains, which is critical for success. This also permits early weeding. Other scholars also observe that as it is recommended with conservation farming, they start land preparation as early as June and when they plant, they do not spend more than four hours on a given day (Kaswende,2012,Kansanshi Plc 2014, GART 2009) ; [31]
- Labour requirement for land preparation is spread over several months rather than being done at once.
- Accurate placement of fertilizers and seed reduces wastage and allows optimal use by the crop;
- Retaining residues reduces soil and water loss, improves infiltration, reduces soil temperatures and, in time, improves soil fertility. It minimizes crop loss and improves food security;
- Planting holes or basins concentrate early rainfall around the seeds, accelerating emergence and improving crop stands;
- Because seeds are planted in the same place each year, residue fertilizer for cereal crops can be taken up by subsequent crops;
- Because the inter-row is never ploughed, weed populations will decline over time as long as weeds are not allowed to seed;
- Rotations with legumes reduce the requirements for artificial fertilizers; and hand hoe CF does not entail the need for purchasing any additional capital equipment by the small holder. It is also easy to understand and apply (P.14) FAO 2006) [32].

Mubambe (2015) reports that CF has been adopted in the Kansanshi Copper Mines Corporate Social Responsibility (CSR) activities in order to enhance food security and income generation for the community. He attests to the fact that CF not only created alternative income generating activities for the beneficiary communities, but also ensures food security among the people of Solwezi in particular and the North western province in general [33].

Mechanisation in conservation farming

A Lot of equipment and tools have been introduced in CF. Lunchen *et al.* (2012) observe that smallholder farmers in Zambia have been encouraged to adopt a hand-dug planting basin system called Conservation farming. They further

contend that activities related to CF are easy for smallholder farmers to do and they help to protect the soil. However, digging the basins each year results in excessive soil disturbance and movement, destroying the system of natural channels built up in the soil profile and having a negative effect on the biota. Further, the labour required in CF should not to be underestimated. CFU estimates the requirement of 60 person days per hectare. As a result only farmers with access to animal draught power or tractor would find the CF attractive. Figure 4 below shows how pot holing in CF is done and the labour it requires to work on a small portion of land [34].

Source: Field Survey.

Fig 4: An example of pot holing in conservation Farming.

Lunchen *et al*. (2012) further contend that CF for small scale farmers can be mechanized. This can be done using ripping and direct seed with draught and tractor power. Many stakeholders including the Food and Agricultural Organisation have sponsored many activities to demonstrate the use of mechanization in CF. They also report that an estimated 1-1.2 million farmers in Zambia, most of whom are smallholders, use simple technologies of hand hoes and oxen but with poor yields. This has been attributed to a number of factors including drought, lack of access to yield enhancing technologies, the use of inappropriate farming techniques which degrade soils and reduce their capacity to sustainably support crop production [35].

CFU recommends modification of the basin CF technology for farmers having access to draught animal power. They recommend the use of the chisel-tined ripper where rip lines are opened in the dry season at the start of the rains. These lines can be ripped again to the depth of 20 cm. At this time, fertilizer and lime are applied by hand to the rip line and covered by light hoeing from the rip line sides. Once the rains arrive, the crops are planted by hand into the prepared furrow.

In order to make CF more manageable by small scale farmers, animal drawn equipment and tools have been developed. The figure below shows how farmers use ox drawn equipment to rip the grounds in CF. Ripping can be said to be lighter than pot holing where a person digs using a hand hoe. Most of the weight in ripping is carried by the oxen that pull the plough.

Source: Field survey.

Fig 5: An example of ripping using an ox - drawn plough.

They argue that with the availability of ox-drawn precision planters the move to practice CA becomes easier. In practicing CA the following mechanization options for small holder farmers are available;

- Ripping with draught animal power. This option offers opportunities for smallholder farmers to expand their fields but not all the farmers have access to draught animals such as oxen and donkeys. Anticliff (2011) also notices that this is the fastest and least labour intensive method but requires that the farmer has access to a ripper and two oxen [36]. use of agricultural contractors. These are generally tractor operators equipped with three-point mounted rippers who offer ripping services to farmers. Planting using draught power planters is in common use. However, GART (2009) reports a new planter is being worked on with an inclined plate, chisel tined animal draught directly manufactured locally. Tractor mounted direct planters are available locally but Brazilian made equipment is favoured; [37] and the control of weeds and management of cover crops. There are three types of control namely: biological, mechanical and chemical using herbicides. Mechanical control measures include slashing, surface scraping by hand hoe and use of animal drawn knife roller. Weed control poses one of the greatest challenges to smallholder farmers in Zambia. The weed burden under CA regimes gradually declines if weeds are constantly removed before they can set seed. Cover crops will suppress weed growth and the non- inversion of the soil means that the weed seed bank available for germination is reduced year on year. Early, frequent and thorough control of weeds, both during the growing season and in the winter period is perhaps the greatest secret to successful CA farming.

However, access to farm machinery is far beyond the reach of most smallholder farmers in Zambia. The machinery is expensive. GART (2009) and CFU (2006) acknowledge that in Zambia, less than 50% of farmers have access to draught power. This means that small holder farmers can only depend on the contractor providers for the facility. In addition, CF is not a perfect solution as it takes much more management than traditional farming and it can cost more because of the need for special tools and chemicals like herbicides [38].

Farmers have long understood the importance of crop rotations-and they are an essential component of CA. Rotations are needed to prevent the build-up of crop-specific pests and diseases, to explore different soil strata for water and nutrients and most importantly the inclusion of legumes in the rotation will add nitrogen. However, in Zambia Maize is still routinely grown as a monoculture crop.

Challenges of conservation farming

Although CF has been widely accepted by many farmers at different levels not only in Zambia but in many other parts of the world, it has its own problems. GART (2009:60) reports that in a project they ran in Namibia, CF manifested several challenges such as;

- Facilitation of 'buy-in' of CA by government extension service;
- Combating the increasing problem of bird damage;
- Facilitating the supply of kraal manure to small holders;
- Ensuring pearl millet seed availability;
- Ensuring the availability of CA up scaling of CA farmer membership;
- Encouraging appropriate and optimal use of government agricultural subsidies;
- Promoting crop residue incorporation;
- Funding the project continuity;
- Promoting legume crop rotation; and
- Provision of exposure to, and training in CA practices for extension Staff [39].

These challenges of CF in Namibia were identified in a project done at micro level and did not point to the smallest agricultural management unit similar to zone 2 of Chikupi camp. The findings of this study should therefore, help to show the challenges in CF at Chikupi resettlement by subsistence farmers as they relate to those reported in other parts of the world.

Statement of the problem Objectives and Significance

From the discussions above it is evident that conservation farming has been embraced by many crop farmers as an intervention to several problems associated with climate change like environmental degradation, poor crop yields and poverty in general. Different CF activities are promoted in many parts of the world including Zambia in an attempt to mitigate the adverse effects of climate change. The question still remains as to what challenges subsistence farmers at a micro level of agricultural management encounter in conservation farming. This study sought to identify these challenges that subsistence farmers of Chikupi resettlement of Kafue District encounter in CF.

The general objective of the study was to find out the challenges Chikupi resettlement subsistence farmers encounter in conservation farming.

The specific objectives of the study were to;

1. Find out the characteristics of subsistence farmers at Chikupi resettlement;
2. Determine the Chikupi resettlement subsistence farmers' knowledge of conservation farming;
3. Identify the common crops grown by the subsistence farmers of Chikupi resettlement;
4. Establish the Chikupi resettlement farmers' source of conservation farming knowledge;
5. Establish the adherence to CF standard practices by subsistence farmers of Chikupi resettlement;
6. Elicit suggestions on how to improve the use of CF among subsistence farmers

The significance of the study was that through its findings it should be able to guide policy on management of agricultural innovations among small scale farmers in resettlement communities like Chikupi in order to mitigate the effects of climate change and achieve high crop productivity. The value and relevance of adult education principles in community development work should equally be appreciated by various stakeholders advocating for rural development and environmental protection.

Study Design and Population

The research was a case study of Subsistence farmers at a micro level of Chikupi. According to Msabila and Nalaila (2013), a case study is a very good method of collecting information about an individual, a family or a group of persons [40]. They acknowledge Young (1949) who describes a case study as a method of exploring and analyzing the life of a social unit, be it that of a person, a family, an institution, cultural group or entire community. In this case, subsistence farmers at Chikupi were used to help us establish differences and similarities in challenges of CF at micro level and those at macro level like those in Namibia and show how this can affect interventions to climate change.

The target population of the study was all the subsistence farmers, the camp officers and all the CFU field officers at Chikupi Agricultural camp of Mungu farming Block in Kafue west. A sample of 60 farmers, one camp officer and one CFU field officer was selected. The total number of respondents was 62. Makasa (2002) observes that camp level is the last line of command and is the lowest point where government officers are placed [40]. However, the camp extension officer divides the camp into 6 to 8 zones. Chikupi resettlement is located in zone 2 of the Chikupi agricultural camp. The population of subsistence farmers in the camp is 1250 and when divided by 8 zones there is an average of 120 subsistence farmers per zone. Thus the 60 subsistence farmers sampled for the study represent 50% of the zone 2 subsistence farmers population.

The 60 subsistence farmers were randomly sampled in order to give every farmer in the zone a chance to participate. Konthari and Garg (2014) support this when they state that simple random sampling from a finite population refers to that method of sample selection which gives each possible sample an equal probability of being picked and each item in the entire population to have an equal chance of being picked [41]. Every subsistence farmer in Chikupi had a chance of being picked hence the use of random sampling.

The data from both groups of respondents were collected using a structured interview guide. The Agricultural Extension officer and CFU field officer administered the structured interviews on the subsistence farmers while one of the researchers interviewed the two officers. The data from the farmers were both qualitative and quantitative while the data from the two officers was all qualitative. Data was analysed using simple percentages for quantitative and identifying common themes for qualitative respectively.

Findings and Discussion of the findings

The findings and discussion in this section are based on the responses from the subsistence farmers and the two MALS and CFU officers at Chikupi resettlement. This is done according to the specific objectives of the study.

Characteristics of respondents

The findings of the study revealed that the majority (73%) of the subsistence farmers at Chikupi resettlement were aged between 21 and 60 years with only very few (3%) falling under 21 and (24%) above 60. Only 17% of the subsistence farmers were single while 78% were married, 2% were divorced and 3% were widowed. About half 50% of the subsistence farmers at Chikupi resettlement had family sizes of between 6 to 10 children and dependants in one household while 6% had 11 or more people and 40% of them had below 6 inhabitants on their homes. The study findings also revealed that most subsistence farmers (63%) lived in extended family system while the rest (37%) were in nuclear families.

The study also discovered that most of the subsistence farmers had at least 20 years of farming experience and all had some training in agriculture. The findings of the study further showed that many (55%) of the subsistence farmers of Chikupi resettlement owned six or more acres of land see figure 5 below. However, only 33% of the subsistence farmers cultivated six and more acres (Table 2).

The findings of the study further revealed that the officers had worked at Chikupi resettlement for 2 and 24 years for CFU field officer and the agricultural camp supervisor respectively. Both officers were involved in teaching CA to subsistence farmers at Chikupi resettlement. The two officers served as evidence that both government and other stake holders were involved in training the subsistence farmers on CF as alluded to by other scholars.

The characteristics of the respondents in the study help us to understand the subsistence farmers at Chikupi resettlement better. In the literature reviewed, we discovered that Chikupi resettlement was established after the settlers were displaced by a government project at Malundu in Chongwe district. The age range of the subsistence farmers shows that some respondents (about 24%) were likely to have been part of the group originally resettled by the government. This means that this group of people was aware of what government had done to assist them settle in the new area including helping them to learn CF.As Luncen *et al*. (2012) indicated that most training in CF took place in the 1990s under various stake holders and government through MALS [42]. Aargaard (2009) also submits that the Zambia National Farmers Union together with other stake holders spent a lot of time advocating the use of conservation farming techniques, which encompasses improved tilling and planting methods, crop rotation and intercropping practices [43]. In Zimbabwe, the Catholic Relief Service participated in delivering and promoting CF among vulnerable groups. It is a common practice wherever there is an innovation to help empower a community. It is therefore, inconceivable that Non-Governmental Organisations and development agencies working to empower communities did not reach Chikupi resettlement to empower such a vulnerable community on this farming innovation on the market.

Further, most (78%) of the farmers were married and many had more than six people living in one house hold. Big numbers are an advantage in the successful practice of CF as it provides the much need labour for the different activities such as weeding and pot holing. The age range is also suitable for difficult tasks in CF as most of the subsistence farmers were in the productive age range of 21 to 60. Given the characteristics of the respondents, it is possible for the subsistence farmer s of Chikupi to carry out CF activities with minimum problems.

Farmers' Knowledge of CF and commonly practiced CF methods

The findings of the study showed that the subsistence farmers in Chikupi area understood climate change to be; unpredictability of the weather pattern over a certain period of time, change in rainfall pattern, and change in weather pattern, abnormal temperatures (very hot and very cold) at unexpected time and reduction or increase depending on the region. The findings also indicated that subsistence farmers of Chikupi resettlement had experienced climatic changes in the following ways; late onset of rains, short and long rainfall seasons, drought and excessive temperatures and floods. This affected their farming activities in various ways such as drop in production, fluctuation in yields and low levels of ground water leading to early drying up of wells and water ponds before the onset of the next rainy season. Many of them could not grow vegetables for their sustenance as irrigation depends on water from shallow wells. Vegetables are also a source of income as farmers sell the produce for households and big markets at Kafue.

The study findings revealed that the subsistence farmers in Chikupi resettlement use different methods of farming such as conventional and conservation. The majority (58%) used conservation farming methods exclusively or jointly with conventional farming while (42%) were exclusively using conventional farming methods. Those using CA methods exclusively made only 23. This shows that many subsistence farmers at Chikupi resettlement were exclusively using conventional farming methods (see table 1).

The subsistence farmers of Chikupi resettlement failed to employ the CA activities as outlined by GART (2009) of minimum soil disturbance, mulching, mix and rotate crops, timely implementation, precise operations and efficient use of inputs [44]. This is not possible as in Zimbabwe CF was successfully implemented among vulnerable people. Chikupi subsistence farmers could only be vulnerable in resources and not in ability. This revelation is contrary to the fact that the subsistence farmers had good knowledge of CA because they did not put that knowledge into practice. It leaves a gap in that they have the knowledge but are failing to put it into practice. This can only be explained by factors such as the cost of inputs like herbicides in practicing CF and the long and continuous activities throughout the year.

Table 1: Farming methods used by subsistence farmers in Chikupi Area.

Farming Method	Number of farmers	Percentage
Conventional	25	42
Conservation	14	23
Both	21	35
Total	60	100

The common practiced CA methods in order of popularity are Zero tillage, crop rotation, pot holing, ripping and organic farming. The respondents indicated that the most preferred

practice in CA is Zero tillage because it is cheap and less laborious.

Table 2: Most practiced CA activities among Chikupi subsistence farmers

CA Method	Number of farmers using it	Percentage Farmers using the method
Crop Rotation	16	26
Ripping	7	12
Pot holing	10	17
Zero tillage	23	38
Organic farming	4	7
Total	60	100

The results of the study show that only between 1 to 10 acres of land is used for CA activities by the subsistence farmers of Chikupi resettlement Majority (73%) of the subsistence farmers use only up to five acres of land while the remainder (27%) use up to 10 acres for conservation farming. The agricultural camp supervisor also acknowledged that the subsistence farmers had good knowledge of CF when he stated;

These people have good knowledge of CF because we teach them every year through demonstration fields dotted all over the zone. When we talk to them, they show that they know the correct way of doing CF. We believe that they have good knowledge As for common practiced CA among subsistence farmers of Chikupi, the CFU field officer and the agricultural camp supervisor indicated that they emphasised the following CA methods; basins, ripping, pot holing, no burning and early land preparation. The officers also explained that the consequences of non-compliance to CA methods were, yield reduction, non-retention of moisture, more weeds and late planting.

The emphasized CF practices by trainers and what the farmers indicated that they were doing are not matched. The officers did not emphasize zero tillage which most of the farmers (38%) were practicing. The farmers instead indicated that they were doing crop rotation in an area where they had small land and the officers were not emphasizing crop rotation. This kind of mismatch between what the subsistence farmers do and what the trainers emphasize can be frustrating to either side. Crop rotation does not have much demand on the farmers apart from the small size of the land.

Only pot holing and ripping were in agreement with what the farmers do and what the trainers emphasize. In a place where land tenure is traditional pot holing and rigging cannot be sustainable. The farmers cannot make these holes and lines in good time before the rainy season because free lance cattle can cover them as they wander around looking for food and water. Umar *et al.* (2011) cautioned that to attempt to make holes early would be to do the same work twice and when the rains start, it would be difficult to do pot holing of a big area. This frustrated the farmers who resorted to easier methods of conventional farming [45].

Common crops grown by the subsistence farmers

The findings of the study further revealed that the common crops grown by subsistence farmers in Chikupi resettlement were; maize, sorghum, groundnuts, sweet potatoes and cow peas while vegetables include cabbage, rape, tomatoes, onion, impwa (a variety of egg plant) and sweet potatoes. Vegetables are usually grown under irrigation while the field crops are rain fed. The main crop grown by the subsistence farmers for both food and cash is maize. Other crops are grown mostly for food to a large extent. Maize is grown on big tracks of land while other crops are grown in smaller gardens on a small scale. However, most crops are inter-cropped with maize and other tall crops. This is appropriate to the purpose for CF which is to give the farmers an increased crop yield, reduced labour, food security, generate income and protect the soil as advanced by several advocates (CFU, 2005, Kaswende 2012, Aargaard 2009, 2010, Kabwe and Donovan 2004, GART, 2009, FAO, 2006, Kansanshi CSR, 2014) [46].

Source of knowledge of conservation farming

Subsistence farmers in Chikupi area indicated that they had learnt conservation farming from organizations such as the Zambia National Farmers' Union, Conservation Farming Unit, Cooperative League of the United States America (CLUSA), and Ministry of Agriculture and Livestock. The subsistence farmers had an opportunity to learn from all the stake holders that promoted CF just as was the case in Zimbabwe where CRS took a lead promoting CF to vulnerable people. The resettlement status of the subsistence farmers of Chikupi made them vulnerable as they had limitation of what they could do with limited resources.

The interviews with the officers also revealed that subsistence farmers were visited at different times and intervals. The MAL camp supervisor visited the subsistence farmers at least twice a month while the CFU field officer visited his clients only after a step in the conservation farming calendar of activities. During the lessons the two indicated that they used participatory methods such as demonstrations, repeats (where the farmer repeats what was demonstrated by the officers). The CFU field officer indicated that he had Lead farmers who had an average of 60 subsistence farmers each to supervise. On the other hand, the camp supervisor indicated that he worked directly with the subsistence farmer. The MAL camp supervisor had been involved in teaching CA for five years while the CFU officer had been teaching for two years. The variation in contacts between the farmers and the trainers raises several points of doubt about the farmers' adherence to CF practices.

The education that the farmers received cannot guarantee good masterly of CF practices well. Subsistence farmers who did not master one stage of CF failed to proceed to the next as their trainers we rarely available to help them. Adults do not like to learn where they are not sure for fear of embarrassing themselves. The spaced attention to subsistence farmers meant that they abandoned what they were taught for fear of failure and uncertainty.

Adherence to CA standard

The study findings revealed that subsistence farmers in Chikupi area practiced CA on a small scale due to lack several

reasons. Among these were lack of implements, the practice was too involving and laborious. The farmers also indicated that they were not conversant with the methods; it is strenuous and time consuming. One of the subsistence farmers expressed these sentiments as follows

Eeci cama pot hole caka boola cilaminya. Alimwi cila dula kaambo ciyanda balimina banji alimwi kufwambaana, Cilaa nchito mpati kapati.Tulicizyi ono Kubota kojisi Bantu antela talakita mbuli bamukuwa. (Chitonga)

"This thing of pot holing which came is strenuous and it is expensive as it needs many people weeding quickly.

It involves a lot of work. We know it but it's better if you have many people or a tractor like the whites". (Translation from Chitonga).

The findings also revealed that most subsistence farmers of Chikupi resettlement had very small plots which made it difficult for them to do CF activities. Many farmers had less than ten acres of land and as such they could not easily practice crop rotation.

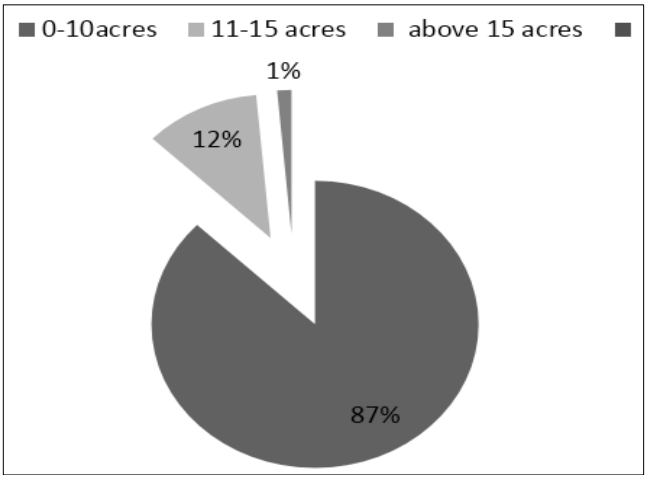


Fig 5: Size of land owned by subsistence farmers at Chikupi resettlement.

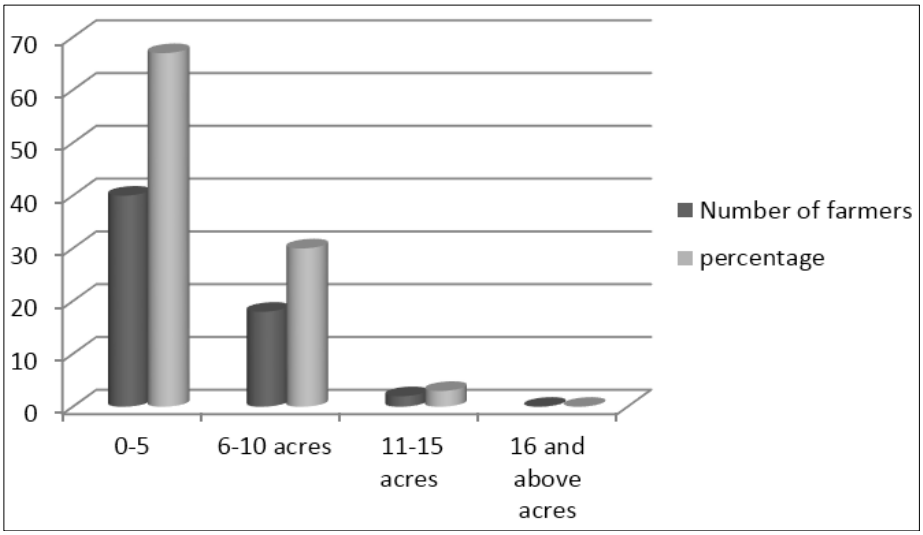


Fig 5: Size of land under cultivation by subsistence farmers in Chikupi area.

This is shown in Figure 5 above. Similarly figure 6 below shows the acreage used for CF by subsistence farmers of Chikupi. Both are small sizes of land that cannot accommodate most CF activities. This became a stumbling block to many subsistence farmers of Chikupi to adhere to CA practices.

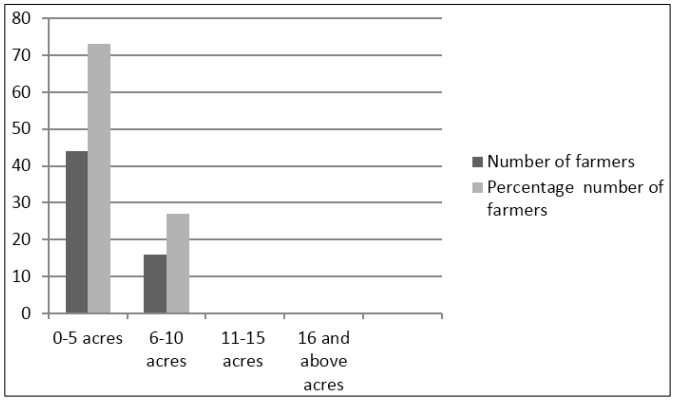


Fig 6: Acre age of land under CA among subsistence farmers of Chikupi resettlement

The subsistence farmers of Chikupi found it difficult to adhere to CA practices because they applied only a limited number of CA practices. Most of them (38%) used zero tillage which required herbicides. Herbicides are expensive and promote mono cropping. Apart from the use of herbicides, zero tillage demands the use of machinery like tractors and animal draught power which the subsistence farmers of Chikupi did not easily access.

GART (2009, CFU 2005 and Umar, 2011) advise farmers to continue working on their land throughout the year when practicing CF. This also created a strain on the farmers who were used to resting after the annual harvest in the conventional farming system. The period of rest had been associated with other social activities which held the community together as a people. For most of them, this was the time of celebrating the rite of passage for their children. This period was also used for growing crops like vegetables which gave the farmers money to help them afford the farming input for the next season.

Work like gardening did not demand as much labour as CA and this gave the farmers to gain their lost energy in readiness for the next season. It was also a period of rest as their animals

were left to wonder as free range eating the crop residues from other people's fields. This window enjoyed by conventional farmers after harvest leads to heavier work later as some necessary operations remain un done until the onset of the rainy season. At this time many other activities needed to be done within a short space of time. However, as Umar *et al.* (2011) observed on the residue management where the land tenure system does not support fencing off one's land to help preserve the crop residue for mulching in the rainy season, the same happens with early digging of pot holes as cattle would cover them during the period of free range feeding. This resulted into having to redo the holes or lines when the rains come. The land tenure system did not allow some of the necessary CA practices to be done after harvesting time.

The small land was always under cultivation of the main food crop maize. This also made farmers not to practice intercropping as recommended in CA. The only intercropping done was the traditional one which involves pumpkins and cucumbers which have no significant contribution to human and sustainability of the environment.

Challenges encountered by subsistence farmers of Chikupi

The challenges subsistence farmers of Chikupi resettlement encounter in CF emanate from their non-adherence to CF practices. According to the findings of the study, the subsistence farmers Chikupi resettlement have problems with practicing CA because it is time consuming, labour intensive, takes long to show good results, needs a lot of preparation of fields, very strenuous, needs precise mastering of practices to have good results, forces one to use herbicides which encourages mono cropping for some years, does not do well in heavy and sandy soils and lack of implements to use. These challenges are similar to the ones GART (2009) [47] reported in Namibia except the challenges from this study focus on the family at zone level which is the smallest unit of agricultural management in Zambia. The study is unique and necessary because of the nature of the settlers who otherwise, should have been looked after differently by the government. The challenges identified by GART in Namibia are at a higher level like country or project.

Umar *et al.* (2011) notes that subsistence farmers' adoption of the CA activities depended on the incentives from the promoters. Some promoters extended incentives to farmers who adopted the CA. The common incentive most farmers got for promoting CA was the supply of free inputs. The farmers received free seed, fertilizer and herbicides when their fields were used as demonstrations plots [48]. This has not been sustainable as the farmers failed to get the same inputs when their fields were no longer used as demonstration plots. The camp officer indicated that farmers were afraid of having their fields used as demonstration plots for fear of witchcraft. The other farmers would be jealous of the one whose fields were chosen as demonstration plots. These are the socio economic dynamics that Lungu (2005) [49] referred to when he stated that the adoption of CA depends on the social and economic dynamics of the people. In such cases, those who had successfully adopted the CA feared to practice due to witchcraft. They feared that this would leave their families without a bread winner. Since they lived on traditional land under the traditional land tenure system, the family might lose their land to another family.

We can therefore summarise the challenges subsistence farmers of Chikupi encountered in CF as poverty which made it difficult for them to afford requisites for successful CF, lack of good and appropriate continuing education on CF, use of non-sustainable methods of teaching CF by trainers and the social and economic ethos of the area.

Suggestions on how subsistence farmers of Chikupi can use CF.

The subsistence farmers of Chikupi made several suggestions on how their challenges of CF can be overcome. They suggested that in order to encourage them to practice CA, farmers should be engaged in other income generating activities to minimize the impact of low yield in the early years of CA and be given loans by government to enable them buy inputs and equipment. These address poverty issues.

The respondents also proposed that farmers should take a lead in their training by training many lead farmers. Although done by CFU, the contact times were not enough. They also proposed the initiation of easier methods of farming. They find most CF practices strenuous and difficult to do.

The respondents suggested increased support visits to farmers. The subsistence farmers further suggested that government and stake holders should introduce methods of farming that can be applied immediately for immediate benefits. They also proposed that farmers should be given loans for buying implements. The subsistence farmers of Chikupi also proposed that more training should be given to farmers to enable them initiate easier CF methods to be practiced in heavy and sandy soils.

Conclusion

The study has established that the subsistence farmers of Chikupi resettlement in Kafue district encounter challenges in CF. These include poverty, inappropriate methods and content of education manner of teaching and the context in which CF is practiced. It is further concluded that CF does not work well in the contexts of traditional land tenure system. It requires controls of the land and the produce residue at individual level.

Recommendations

The study therefore recommends that

1. The government of the Republic of Zambia and its partners in agriculture and environment should harmonise the context and manner in which CF is taught and implemented to communities. The uniqueness of each community should be part of the operational plan in teaching and implementing CF. It is further recommended that CF education should be accompanied with continuing adult basic literacy to help the clients understand the value of the innovation they are being exposed to.
2. The government and stakeholders should harmonise the content of CF in given locations according to scientific research findings;
3. The land tenure system for resettlements should be statutory to enable subsistence farmers respond to demands of CF practices and help protect the environment
4. CF should be promoted with other income generating activities to enable subsistence farmers have a reliable economic base.

5. Education on CF should be accompanied by general adult literacy to help subsistence farmers of Chikupi understand the value of innovations like CF.

List of Abbreviations

CA	Conservation Agriculture
CF	Conservation Farming
USA	United States of America
US	United States
CFU	Conservation Farming Unit
ART	Agricultural Research Trust
FAO	Food and Agricultural Organisation
AEC	Agro-Ecological Zone
DOI	Diffusion of Innovation
EU	European Union
ZNFU	Zambia National Farmers Union
SIDA	Swedish International Development Agency
FINNIDA	Finnish International Development Agency
CRS	Catholic Relief Services
CLUSA	Cooperative League of United States of America
MALS	Ministry of Agriculture and Livestock
NORAD	Norwergian Development Agency
GART	Golden Valley Research Trust
NGO	Non Governmental Organisation
ICRA	World Agro Forestry Centre

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