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PRACTICES AND ADOPTION OF CONSERVATION AGRICULTURE AND ITS IMPLICATION ON FOOD SECRUTITY IN ASSOSA WOREDA BENSHANGUL GUMUZ REGION, WEST ETHIOPIA

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BY

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DECLARATION

This thesis is my original work and has not been presented for MA/MSc degree in any other University and that all the sources and materials used for the thesis have been properly acknowledged.

Declared By: Sisay Kasu

Signature: _____

Date: _____

Place: Addis Ababa University College of Development Studies, Center for Food Security Studies

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge as an advisor.

Dr. Amare Bantider _____ _____

(Advisor) Signature Date

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This is to certify that the thesis prepared by Sisay Kasu Gemechu entitled *Practice and adoption of Conservation Agriculture and its implication on food security in Assosa woreda, Benshanguld Gumuz Region, West Ethiopia* and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Food Security and Development Studies complies with the regulations of Addis Ababa University and meets the accepted standards with respect to originality and quality.

Signed by the examining committee:

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Contents

Abbreviations

BBM- Broad Bed Maker

BoARD -Burau of Agriculture and Development

CA – Conservation Agriculture

CFGB- Canadian Hunger Foundation

CSI- Copying Strategy Index

FAO – Food and Agriculture Organization

FCS- Food Consumption Score

FHE- FH Ethiopia

GHG- Green House Gas

HHDS - Household Dietary Diversity Score

IFAD – International Food and Agriculture Development

MCC- Mennonite Central Committe

MLE- Maximum Likelihood Estimation (MLE)

MoA- Ministry of Agriculture

MT- Minimum Tillage

NGO – Non-Governmental Organization

SLM- Sustainable Land Management

SOM- Soil Organic Matters

SSA - Sub-Saharan Africa

TLU – Tropical Livestock Unit

Abstract

Despite the recent efforts to increase agricultural productivity in Ethiopia, impact of agronomic practices and soil degradation are the major challenge in agriculture. Mainly, conventional tillage based crop production system is highly vurnurable to soil erosion and adverse impact of climate variability. As a result, improving smallholders´agricultural productivity needs the adoption and diffusion of suitable agricultural technology practices. Among these technology conservation agriculture (CA) is being promoted as an option for reducing soil degradation and increase production and productivity. By using socio-economic data of 378 sampled households, this study analyzed level of adoption in terms of practicing the minimum tillage as a major and soil cover and corprotation in combination. Accordingly, out of the total 346 (91.5%) of the farmers are CA adoptors where as 32 (12.5%) of them are not adopting CA. The other intention of the study is to know the kind of farm technology (tools) used by the farmers in practicing CA. The finding of the study shows that 48.7% CA adopting farmers use combination of Hand hoe and Ox drawn plough. Where as 34.7 % use only hand hoe. The observation, KII and FGD done shows that those farmers who have a small plot of land are using hand hoe but as the land size increased farmers are insisted to look for other option such as using ox drawn plough. The other objective of this study the implication of CA on food security status of the CA practicing farmers. To see the implication twelve month adequate food was used since it was easy tool that could be remembered easily by the farmers. The result shows that 92% of the CA adopters responded that they had enough food for the last 12 months where as only 12.5% of the respondants confirmed that they had 12 month sufficient food. The food consumption score was also applied and result shows that about all the CA adoptiong farmers 346 and 9 which (out of 32 non adopting) are acceptable range while 19 (5%) of non adopting farmers are in borderline and the rest 7 non adopting farmers are in poor level clasification. This shows that practicing practicing CA will have positive implication. help the farmers to Accordingly, the food consumption score shows that 94% of the farmers are at acceptable level of food security while 5% of them are at borderline and 1% are under 'poor' category. Regression done to see if the variables will determine the adoption of CA. As a result education level, age, training , farmers field day participation, experience sharing participation, listening to CA radio programing and being a member of garmers group has significantly determine the level of CA adoption.

Keywords/Phrases: Adoption, Conservation agriculture, Contribution, Assosa District.

1. INTRODUCTION .

1.1. Background and justification

Global agricultural production and food security of the smallholders could be severely affected by land degradation and climate variability (erratic rainfall, flood and drought) particularly in Sub-Saharan Africa (Altieri and Nicholls, 2017). Agriculture is also the main deriver of land degradation, it contains 52% from 75% of degraded terrestrial ecosystems mainly as consequence of poor agricultural practices that lead to the decline of soil organic matter and soil health (Pereira and Bogunovic., 2019). Currently, the combination of land degradation and climate variability is making greater risks for smallholders. This poses a challenge of developing innovative technologies to improve agricultural productivity, food security and environmental conservation and ensuring adoption of such technologies (Asfaw, *et al*., 2017.).

Many African countries including Ethiopia, which have high population growth and economy mainly based on weather-sensitive agriculture vulnerable to climate variability, which leads to land degradation, low productivity and poverty in the region (Ward et. al, 2018). Ethiopian agriculture contributes approximately 42 percent of national growth development plan (GDP) whereas, over 95 percent of the annual gross total agricultural production of the country is produced from smallholder farmers with an average farm size ranging from 0.5 to 2 hectares (FAO., 2018). Above, 76% of the total cultivated area of the country is suitable for CA farming, that used to improve agricultural productivity (Kindie Tesfaye, *et al.*, 2015). However, it is mainly incorporated by tillage, which accelerates soil erosion and disturb the quality of essential natural resources such as soil, water, landscape, biodiversity and the associated ecosystem services (Wondwossen, *et al*., 2017). It also highly depend on rainfed farming system, which commonly linked to periodic drought and insufficient rainfall, periodical water logging and high erosion rates during rainy seasons at growing period mainly in vertosols (FAO, 2018).

Accordingly, the recent growing attention has been paid to promoting sustainable climate-smart agriculture (CSA) practices, and notable among them is conservation agriculture (CA) (Justice *et al.*, 2018). Moreover, the adoption and diffusion of CA technologies has become an important issue in adaptation strategies to climate variability, especially as a way to tackle land degradation,

low agricultural productivity and poverty. It is mainly focus on increasing a sustainable agricultural productivity, enhance adaptation and resilience from the micro to the macro level of climate related risks and a reduction of greenhouse gas (GHG) emissions from agriculture (FAO., 2016). In semi-arid area mainly affected by climatic variability, CA may requires a low-investment strategy to increase water productivity and mitigate risks, by breaking the vicious cycle of low rainfall, soil degradation, poor yields and low investments (et al., 2012). However, the adoption intensity and diffusion of CA technologies has been very limited by lack of information dissemination, low facilitate intervention strategies and other different constraints.

Basically, tillage is the practice of working the soil with implements to provide suitable condition to raise crops. It is carried out for a number of reasons: (i) to provide a suitable tilth or soil structure for the plants to establish; (ii) to control soil moisture, aeration and temperature; (iii) to destroy weeds; (iv) to destroy or control soil pests; and (v) to bury or clear rubbish, and incorporate manure into the soil. CA is defined as a cropping system where at least 30% or more of the soil surface covered with crop residue following tillage and planting (Kidane, 2014). These residues protect the soil from water and wind erosion. The practices of CA include no tillage, minimum tillage (MT), plowing using subsoiler, tie-ridge, moldboard and other various techniques. The main reasons of tillage operation can be achieved through the implementation of CA practices. Thus, better rainwater balance and adequate agricultural production could be possible since the mulch will reduce the evapotranspiration and the higher yeild can be achieved since the soil fertility be increased by decomposition of the much and low soil degradation (Tesfaye A., 2012).

Even though, Benishangul Gumuz region has various potential and opportunities to develop sustainable agricultural production system, it is one of the food insecure regions in the country (Seid Sani et al., 2019). The food insecurity situation in the study area was worsened by shortage of technology innovation, impact of climate variability, weed infestation, crop pests and disease and poor field management. The regional current crop growth is mainly based on conventional farming system, which is highly degraded and repeated tillage, complete crop residue removal at harvest, livestock grazing after harvesting, biomass burning, unprotected shifting cultivation (deforestation), use of crop straw for fuel and monocropping specially in Assosa district. In conventional agricultural farming, smallholder farmers use chemical fertilizer and pesticides, with a minor extent of organic production system which disturb agro-ecosystem. Hence, CA is taken as

a solution to reduce agricultural pollution, land degradation and climate related risks, as well as to achieve the goal of climate smart agriculture production in the study area.

In Benishangul Gumuz Regional state in general and Assosa district in particular, the natural resource is becoming highly degraded by unprotected shifting cultivation, expanding of large farm investment, livestock over grazing, conventional tillage based farming systems and soil erosion (BOARD 2016). More of the Regional current crop growth is conventional production (incorporate tillage) system, which use artificial fertilizer and pesticides, and to a minor extent with organic production systems that use 'natural' sources for maintaining soil fertility and pest control. Another obstacle for agricultural production system is adverse effect of climate variability in the region (BOARD, 2017).

In an attempt to increase agricultural productivity and improved food security at both national and household levels, efforts have been underway to generate and disseminate improved agricultural technologies among Ethiopian smallholder farmers. CA is one of the technologies that are being promoted to enhance sustainable agriculture in Ethiopia mainly by non-governmental organizations (NGOs) and international organizations in recent years. Assosa woreda is one of the areas where CA has been practiced aiming at food security. This project has been embraced by FH-Ethiopia which is international NGO. CA project is implemented and financed by Mennonite Central Committee (MCC) and Canadian Food Grains Bank (CFGB) which has started the operation since 2015. This technology is highly appropriate for the areas of Assosa woreda where crop productivity is very low due to erratic rainfall distribution and soil erosion.

1.2. Statement of the Problem

Land degradation and soil erosion are the major serious challenges to smallholder farmers in the in Regions of Ethiopia (Kidane, 2014). Nowadays, rain-fed crop production is becoming a risky venture in Ethiopia. The frequent droughts and rainfall variability because of El Nino effect, soil erosion has been a serious threat to those employed in agriculture (Asmamaw, 2015; Nyssen et al., 2015; Biratu & Asmamaw, 2016). Soil and water conservation via CA application is paramount for sustaining cropland productivity in Ethiopia. In Besnshangul Gumuz region conventional tillage-based agriculture associated with livestock grazing after harvesting, is responsible for soil

degradation and continuous decline in crop yields mainly. The wild fire during the dry season is also one fo the bottleneck for the plantation in Assosa. The private investiment is also causing burning of the natural resource and it is agraviating soil degradation. Since there is relatively ample land compared to other regions , there is a practice of shifting cultivation rather than properly managing the existing land. Eventhught there are positive results of mechanization , there are also various negative impact such as soil compaction and agraviating the soil for erosion since it will pulverize the soil. Due to over utilization of the artificial fertilizer there is high problem of soil acidity. To reduce the soil acidity the regional government is treating it with lime. The pesticides and herbisides have also residual effects and causing a problem on human.

Conventional cultivation practices has resulted globally in land degradation. The main causes of cropland degradation are long time introduced land management cultural practices with repeated plowing, complete removal of crop residue at harvest leaving no soil cover and overgrazing of the crop field (Tesfaye A., 2012). Plowing is labor intensive and therefore limits participation by poor sick or poor elderly farmers and female headed households who lack male labor for such a key farm activity. Conventional farmers must wait until the first rains of the season have softened the soil before they can prepare or plough their land for sowing (Kinde et al., 2014).

Even mild water stress and rainfall distribution variability during the critical crop growing period has resulted in complete failure. Moreover CA is less adopted in the region compared to conventional agriculture (BoARD., 2018). In conventional agriculture, sustainable land management (SLM) practice is limited. In practice farmers are not adopting all principles of CA due to various constraints.

In the study area agricultural activity is mainly traditional and dominated by shifting cultivation. The food security related problems of the region are similar to that of the country. In Assosa worda, there are governmental and nongovernmental organizations currently working on food security issues. However, the prevalence of food insecurity and hunger among households in the district has been a long-standing challenge.

Targeting poor resource farmers such as those without oxen in CA extension can fasten adoption in areas where there is a zero grazing system implemented. Furthermore, whenever there is ample mulch CA will reduce the weed infestation results in decrease the need for women’s and children’s

labor in weeding. Therefore, promoting conservation agriculture is an important intervention towards achieving food security through sustainable farming (Tesfaye et al 2012).

Conservation agriculture (CA) is being promoted as an option for reducing soil degradation, conserving water, enhancing crop productivity, and maintaining yield stability (BoARD 2017). Currently more than 11500 farmers are practicing CA in Assosa and Bambasi weredas to address their food security problems (FHE 2019). In Assosa woreda there are about 6000 CA practicing farmers. Therefore this research is intended to assess the adoption and practice of CA and its implication on households food security in Assosa Woreda.

1.3 Objectives of the Study

1.3..1 General Objective

To study the practice and adoption of conservation agriculture and its implication on food security.

1.3.2 The Specific Objectives

- To identify the relevant and CA practicing principles
- To assess farmers' decision to continue practicing CA in the next season. .
- Identify the factors that determine the adoption of CA practices,
- To assess the implication of CA on food security

1.4 Research Questions

This study attempted to address the following research questions

1. What are the relevant CA practices implemented by smallholder farmers in the study area?
2. What is the perception of the smallholder farmers in the study area on CA technologies?
3. What are the factors that determine the adoption of CA technologies in the study area?
4. Does the CA contribute to the food security of the faremrs in the study area?

1.5 Significance of the Study

The study provides important information regarding the widely proven solution to meeting the challenges of food security and minimizing unfavorable climatic conditions. It may help policy makers to develop evidence based future research, extension, and development programs aimed at benefiting smallholder farmers. Policy makers may gain profit from the research output, since they require micro-level information to formulate policies and strategies so that their effort would be appropriate in meeting the needs of smallholder farmers in particular and to bring significant change in the agricultural sector in general. It will also pave the way for development planners, other researchers and ultimately the farmers to take advantage from it. Thus, the output of the study can be used as an input for researchers, students, experts, NGOs and officials to make further research, to set policies and strategies. It will shade its light on investors who are interested in organic agriculture development as well. The outputs of this study will also be used as a potent tool for development or modification of CA promotion and scaling up strategies for Ethiopian Ministry of Agriculture (MoA) and other bodies which share a common vision in relation to CA such as MCC, CFGB and other humanitarian organizations partners that are engaged in climate smart agrictulure.

1.6 Scope and limitation of the study

The study focused on smallholder farmers in Assosa district and endeavour to assess the perception of communities on implementation of CA technologies, how effectively adopted CA practices were in the study area in terms of improving productivity and reducing food insecurity. It was also attempt to identify factors are influencing the adoption of CA practices in the study area. This study was not attempted to see the influence of the CA practices in reducing emissions of GHG due to limitations in time, logistic and unavailability of laboratory facilities in the vicinity of the study area. The other limitation is that this study was not analysed all determinant factors of implementation of CA and adaptation mechanisms since some of them are not applicable for this specific area.

1.7 Organization of the thesis

The rest of this thesis is organized into five chapters. Chapter two reviews the relevant literature that includes definition of important terms, concepts of adoption, limitation of adoption and diffusion and analytical frameworks employed in adoption studies. In chapter three, brief description of the study area and research methodology are presented. Survey results are discussed in chapter four. Finally chapter five presents the conclusions and recommendations of the study.

2. LITRATURE REVIEW

2.1 Definition and Concepts of Conservation Agriculture (CA)

It is a farming system that promotes maintenance of agro-ecosystems for improve and sustain productivity, increase profits and food security though preserving and enhancing the resource base and the environment. It combines profitable agricultural production with environmental management and sustainability through the simultaneous application of the three interlinked principles Namely: minimal mechanical soil disturbance, permanent biomass soil mulch cover on the ground surface and diversification of crop species. In crop diversification the number of cultivated crop species adjusted by land size at the plot level. According to many researchers documentation there are three main principles of conservation agriculture, which are commonly taken as improve sustainable agricultural productivity and adaptation options to the adverse impact climate variability.

2.2 Principles of Conservation Agriculture

There are three conservation agriculture principles in many literatures; minimum soil disturbance, permanent soil cover and crop rotation (FAO, 2008). The principles are useful elements and are also practiced by any farmer other than CA adopters. Incluiding FAO, a recently published long-term and short term on-farm study has reported, CA systems is profitable crop production system to constant yield more than conventional crop production systems in most of African country mainly in Sub Saharan Africa (FAO., 2016; 2017 and Kassam et al., 2019). The main purpose of conservation agriculture is to make better use of agricultural resources through the integrated management of available soil, water and biological resources such that external inputs can be minimized. Commonly, an individual farmer can be an effective adopter of CA when he/she is practicing minimum tillage and/or one or more of the other principles on his farmland at same time. They vary in terms of mode of application The detail explanation on each of the principles is stated below.

Minimum soil disturbance

Minimum Soil Disturbance is seeding or planting material into untilled soil as an alternative to traditional cultivation by phlouing, in which the soil is broken and then further cultivated to prepare a seedbed for planting crops (David et al, 2014). No-till agriculture represents a comparatively widely adopted management system that aims to reduce soil erosion, decrease input costs, and

sustain long-term crop productivity (Robertson et al., 2018). The Emissions Gap Report 2013 from the United Nations Environment Programme (UNEP) restates the claim that shifting to no-till practices in agriculture, as an alternative to conventional tillage, causes an accumulation of organic carbon in soil, thus mitigating climate change through carbon sequestration. Minimum soil disturbance reduces soil erosion, since the soil is not loosened as is the case with conventional tillage. The reduction in erosion has benefits to the growing crop as well as the environment. In conventional tillage the soil is continuously disturbed, making it easy to be carried by runoff. As the soil is being eroded it also carriers with it soil nutrient which are essential for crop growth. The removal of nutrients impact negatively on the crop as its growth is retarded and a crop that is weak is more susceptible to pests and diseases. The combination of pests, diseases and soil loss due to erosion leads to food insecurity as a result of reduced yields. The reduced erosion by CA also benefits the environment in the sense that it enhances water quality. A number of experiments in semiarid and dry sub-humid location of East and Southern Africa have demonstrated that minimum soil disturbance/minimum tillage practices reduce the risk of crop failure as they increase water productivity and crop yields. These positive results are attributes to the water harvesting effects of minimum tillage practices (Hobbs *et al.,* 2007).

Permanent soil cover

Mulching is a system of covering soil on the ground surface or by retaining crop biomass, root stocks and stubbles and cover crops and other sources of ex situ biomass (FAO., 2018). As mulching material, organic resources (such as crop residues, and other natural resources) are the sources of nutrients, and also achieve a number of other functions such as maintaining soil moisture, improving soil nutrient, and soil organic matter.

Surface soil cover intercepts raindrop energy and protects the surface soil from aggregate destruction: promote infiltration of water and reduces the loss of soil by erosion. The surface crop residues shield the loose soil particles from water and wind erosion. It minimizes soil water losses by evaporation and also helps moderate soil temperature. With in similar time, reduced tillage and mulching residues minimizes soil erosion and increases retention of soil moisture, while incorporating legumes as an intercrop or in a rotation helps with managing organic soil matter and nitrogen (FAO., 2015; 2017 and Kassam et al., 2019). These enhance soil biological activity and promote nitrogen mineralization. It is an important factor, especially in areas where water is limited

as most of it will be used by the growing crop (Hobbs et al., 2007). It also helps to suppress weed infestation as weed seeds are shielded from sunlight, which is frequently required for germination and necessary for subsequent growth. The soil cover improves soil fertility after decay and this reduces the requirement for inorganic fertilizers in the future. The decayed soil cover improves availability of soil organic matter (SOM) in the soil. SOM has a characteristic of improving soil water holding capacity and this is used by growing crops (Giller et al., 2009).

Crop rotation/association

Crop rotation provides an opportunity for nutrient cycling as root at different depths are able to get nutrients from different soil layers. Nutrients that have been lost from the upper layers through leaching and are no longer available to short-rooted crops can be brought back to the surface by using deep-rooted ones in rotation. The diversity crop in rotation enhances a divers flora and fauna such as fungi and bacteria, which are also necessary for transformation of organic material into available nutrients during decomposition. Moreover, it enhances biodiversity and normal biological processes above and below the ground surface, which contribute to increase water and nutrient use of efficiency and improved and sustained profitable crop production (FAO., 2016; 2017 and Kassam *et al*., 2018). The diversity of crops achieved through rotation is also important as a climate change adaptation strategy because it reduces the susceptibility to unforeseen climatic events such as drought, floods and other biophysical occurrences such as pest outbreaks that might lead to crop failure (FAO, 2008).

2.3 Adoption of conservation agriculture

CA adoption is a mental process which consists of several stages and relates to the farmer's decision to accept or reject a particular techniques of CA components. The historical development of CA was primarily established for large-scale commercial farms in America (Thierfelder et al., 2013). But much effort has gone into adopting CA systems for smallholder farmers in developing countries. In 2015/16, CA was cultivated worldwide on about 180 million hactar of cropland, contains about 12.5% of the total global cropland (Steward et al., 2018 and Kassam et al., 2018). CA was informed to be approximately 106 million hactar, reported by 78 countries, an increase in adoption by 42 more countries since 2008/09, respectively (Ward., 2018). The largest extents of adoption are in South and North America, followed by Australia and New Zealand, Asia, Russia

and Ukraine, Europe and Africa. Currently, conservation agriculture is widely promoted across sub-Saharan Africa as a sustainable farming practice that enhances adaptive capacity to climate change and variability (Steward et al., 2018). Becouse they are gradually more vulnerable regions due to the direct and indirect effects of climate variablity, demographic pressure and resource degradation (Tittonell et al., 2012).

In Ethiopia, the promotion of conservation agriculture technology began in 1998 on 77 farmers' plots by Sasakawa Global (SG2000) and Makobu Enterprises integrated with regional agricultural development bureaus (FAO., 2016). At the first year, the average yield of Conservation tillage was similar to the average yield of conventional tillage plots. But, during this introductory period, Jima, Bako and Melkasa research centres were approved CA technologies between 1999 and 2003 on maize, sorghum and teff crops. The research indicated that conservation agriculture plots gave higher yields compared with conventional tillage. The studies also indicated lower production costs for conservation agriculture fields . Then the researchers' evaluaton was increase time to time on farmers' farm plot and research centers' incluing survey researchs.

2.4 Conventional Agriculture versus Conservation Agriculture

Moving from conventional agriculture and environmental management practices to non-conventional ones represents one of the great global challenges in terms of changing habits and mind sets. Measurements of soil organic carbon content show that soils in CA farms have slightly higher organic carbon content, showing an effect of leaving residual litter for increasing soil organic matter (Lanckriet et al., 2012).

Table 1. Comparison between converntional and Conservation Agriculture

	Conventional Agriculture	Conservation Agriculture	Rationale
Tillage	Farmers plough and hoe to improve soil structure and control weed	Direct planting without prior inversion of the soil; planting on the rip line or making holes for planting with a hoe	Ploughing in the long term destroys soil structure and contributes to declining fertility and organic matter levels.
Crop Residues	Farmers remove or burn residue or mix them into the soil with plough or hoe	Crop residue left on the fiel . Planting of cover crops	Crop residue improves soil structure
Mix and rotate crops	the soil is inverted with a moldboard, plough or similar implements	Crop rotation or intercropping is a permanent feature of the cropping system	Helps maintain soil fertility Breaks disease cycles
Soil organic matter	Lower	More	Helps boosting productivity
Soil biological health	Lower	More	Increase soil fertility
Soil temprature	More varable	Moderated	Reduce evaporation of moisture
Soil compaction	Increased	Reduced	Helps airation
Infiltration	Lower	More	Helps to retain moisture
Erosion	Maximum	Minimum	Maintain soil fertility
Cost	More	Lower	Increases profatibilty of farmers

Source: FAO (2009)

2.5 Technology Adoption and Conservation Agriculture

Adoption is viewed as variable representing behavioral changes that farmers undergo in accepting new ideas and innovations in agriculture. The term behavioral change refers to desirable change in knowledge, understanding and ability to apply technological information, changes in feeling behavior such as changes in interest, attitudes, aspirations, values and the like; changes in overt abilities and skills (Ray, 2001).

Adoption is defined as the decision to use a new technology or practice by economic unit on a regular basis. In defining the criteria for adoption, it is also important to remember that although recommendations may be presented to farmers as a package of several practices, some components of the package may be adopted first, others may be adopted later, and some may never find widespread acceptance. The adoption study should therefore ask specifically about each component of the package, bearing in mind that individual components may be adopted at different times or under different conditions.

2.6 Impact of conservation agriculture on farmers' livelihoods

When practiced correctly, CA stabilizes crop yields, thereby increasing household food security, and economic and social wellbeing. Haggblade et al. (2003) reported that early CA adopters increased crop productivity by 30 to 70%. These findings were also noted by Pretty (1998, 2000) in the Butha Buthe and Tebellong districts of Lesotho. Conservation agriculture has been extensively adopted in South America. Research in Brazil and Paraguay compared yields from conventionally tilled and CA managed fields, finding that yields declined 5 to 15% after 10 years under conventional tillage, while fields managed under CA increased 5 to 15% during the same period (Derpsch, 2008a). The same study in Brazil found that over a 17-year period, maize yields under a CA system increased by 86%, soybean yields under a CA system increased by 56%, while fertilizer and herbicides use declined by 30% and 50% for maize and soybeans, respectively. There were also considerable differences in soil erosion for fields managed under CA compared with fields managed using conventional tillage methods (Derpsch, 2008a).

The effects of CA described above such as higher and more stable yields with lower input costs and a better adaptation to dangers of climate change clearly have positive impacts on farmers'

livelihoods. But there are also more direct impacts which have potential to turn around the daily and seasonal calendar and on the long term change the rhythm of farmers' family because of the reduced labour requirements for tillage, land preparation and weeding likely to occur. Especially women may be released from weeding tasks that traditionally were a women's task. More time availability offers real opportunities for diversification options such as for example poultry farming or on-farm sales of produce or other off-farm small enterprise developments that now (with time available) are a real opportunity. An International Food and Agriculture Development (IFAD) and FAO joint study that explored the potential of CA as a labour saving practice found out that the labour inputs in the CA system could be reduced by 75% (in the hand labour/hoe system) when a jab planter was used compared to hand hoe. In the draught animal powers category the CA system (with knife roller and direct seed drill) the labour reduction was 80% (IFAD/FAO, 2004).

Yield growths and sustainability of conservation agriculture (CA) systems largely depend on systematic crop rotations and in situ crop harvest residue management coupled with adequate crop nutrition (Thierfelder and Wall. 2010). It used to avoid risks of total crop failure rather than maximizing yields of one particular crop by using different crop varieties in the same season could be associated with lower expenses and ease of access by farmers (Belaineh Legesse et al., 2013).

2.7 Crops grown by Conservation Agriculture

In diverse agro-ecological conditions, Ethiopia to cultivate a large variety of crops such as cereals like teff, wheat, sourgum, maize and barley; pulses like horse bean, field peas, lentils, chickpeas and haricot beans; oil seeds like sesame, linseed, Niger seed and rapeseed; and different types of fruits and vegetables. The previous studies have shown positive impact of conservation agriculture practices on crop yields, mainly maize, soyabean, sorguem and rice rotation with other legmues crops are commun in many SSA countiries (Giller et al., 2011, Hailemariam Teklewold et al., Makate, et al., 2019). No-till in the context of CA can also lead to increases in soil quality by improving soil structure and enhancing soil bio-logical activity, nutrient cycling, soil water holding

capacity, water infiltration and water use efficiency (Verhulst et al., 2010; FAO, 2011). Soil mulching is a well-established technique for increasing the profitability of crops, and the effectiveness of inorganic and organic mulches for soil evaporation control has been familiar for numerous annual crops (Zribi et al., 2015). The effects of crop residue management are most beneficial under rain fed conditions as rainfall distribution is often erratic and seasonal dry spells common (Thierfelder and Wall, 2010).

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Adoption is defined as the decision to use a new technology or practice by economic unit on a regular basis. In defining the criteria for adoption, it is also important to remember that although recommendations may be presented to farmers as a package of several practices, some components of the package may be adopted first, others may be adopted later, and some may never find widespread acceptance. The adoption study should therefore ask specifically about each component of the package, bearing in mind that individual components may be adopted at different times or under different conditions.

2.6 Impact of conservation agriculture on farmers' livelihoods

When practiced correctly, CA stabilizes crop yields, thereby increasing household food security, and economic and social wellbeing. Haggblade et al. (2003) reported that early CA adopters increased crop productivity by 30 to 70%. These findings were also noted by Pretty (1998, 2000) in the Butha Buthe and Tebellong districts of Lesotho. Conservation agriculture has been extensively adopted in South America. Research in Brazil and Paraguay compared yields from conventionally tilled and CA managed fields, finding that yields declined 5 to 15% after 10 years

under conventional tillage, while fields managed under CA increased 5 to 15% during the same period (Derpsch, 2008a). The same study in Brazil found that over a 17-year period, maize yields under a CA system increased by 86%, soybean yields under a CA system increased by 56%, while fertilizer and herbicides use declined by 30% and 50% for maize and soybeans, respectively. There were also considerable differences in soil erosion for fields managed under CA compared with fields managed using conventional tillage methods (Derpsch, 2008a).

The effects of CA described above such as higher and more stable yields with lower input costs and a better adaptation to dangers of climate change clearly have positive impacts on farmers' livelihoods. But there are also more direct impacts which have potential to turn around the daily and seasonal calendar and on the long term change the rhythm of farmers' family because of the reduced labour requirements for tillage, land preparation and weeding likely to occur. Especially women may be released from weeding tasks that traditionally were a women's task. More time availability offers real opportunities for diversification options such as for example poultry farming or on-farm sales of produce or other off-farm small enterprise developments that now (with time available) are a real opportunity. An International Food and Agriculture Development (IFAD) and FAO joint study that explored the potential of CA as a labour saving practice found out that the labour inputs in the CA system could be reduced by 75% (in the hand labour/hoe system) when a jab planter was used compared to hand hoe. In the draught animal powers category the CA system (with knife roller and direct seed drill) the labour reduction was 80% (IFAD/FAO, 2004).

Yield growths and sustainability of conservation agriculture (CA) systems largely depend on systematic crop rotations and in situ crop harvest residue management coupled with adequate crop nutrition (Thierfelder and Wall. 2010). It used to avoid risks of total crop failure rather than maximizing yields of one particular crop by using different crop varieties in the same season could be associated with lower expenses and ease of access by farmers (Belaineh Legesse et al., 2013).

2.7 Crops grown by Conservation Agriculture

In diverse agro-ecological conditions, Ethiopia to cultivate a large variety of crops such as cereals like teff, wheat, sourgum, maize and barley; pulses like horse bean, field peas, lentils, chickpeas and haricot beans; oil seeds like sesame, linseed, Niger seed and rapeseed; and different types of fruits and vegetables. The previous studies have shown positive impact of conservation agriculture practices on crop yields, mainly maize, soyabean, sorguem and rice rotation with other legmues crops are commun in many SSA countiries (Giller et al., 2011, Hailemariam Teklewold et al., Makate, et al., 2019). No-till in the context of CA can also lead to increases in soil quality by improving soil structure and enhancing soil bio-logical activity, nutrient cycling, soil water holding capacity, water infiltration and water use efficiency (Verhulst et al., 2010; FAO, 2011). Soil mulching is a well-established technique for increasing the profitability of crops, and the effectiveness of inorganic and organic mulches for soil evaporation control has been familiar for numerous annual crops (Zribi et al., 2015). The effects of crop residue management are most beneficial under rain fed conditions as rainfall distribution is often erratic and seasonal dry spells common (Thierfelder and Wall, 2010).

2.8 Conceptual framework of the study

Combination of the three principles of CA is important for the profitability of sustainable crop production and soil productivity in enhancing food security. Otherwise, there are the factors that influence adoption these technologies in decision-making process of smallholder farmers indicated in (Figure1).

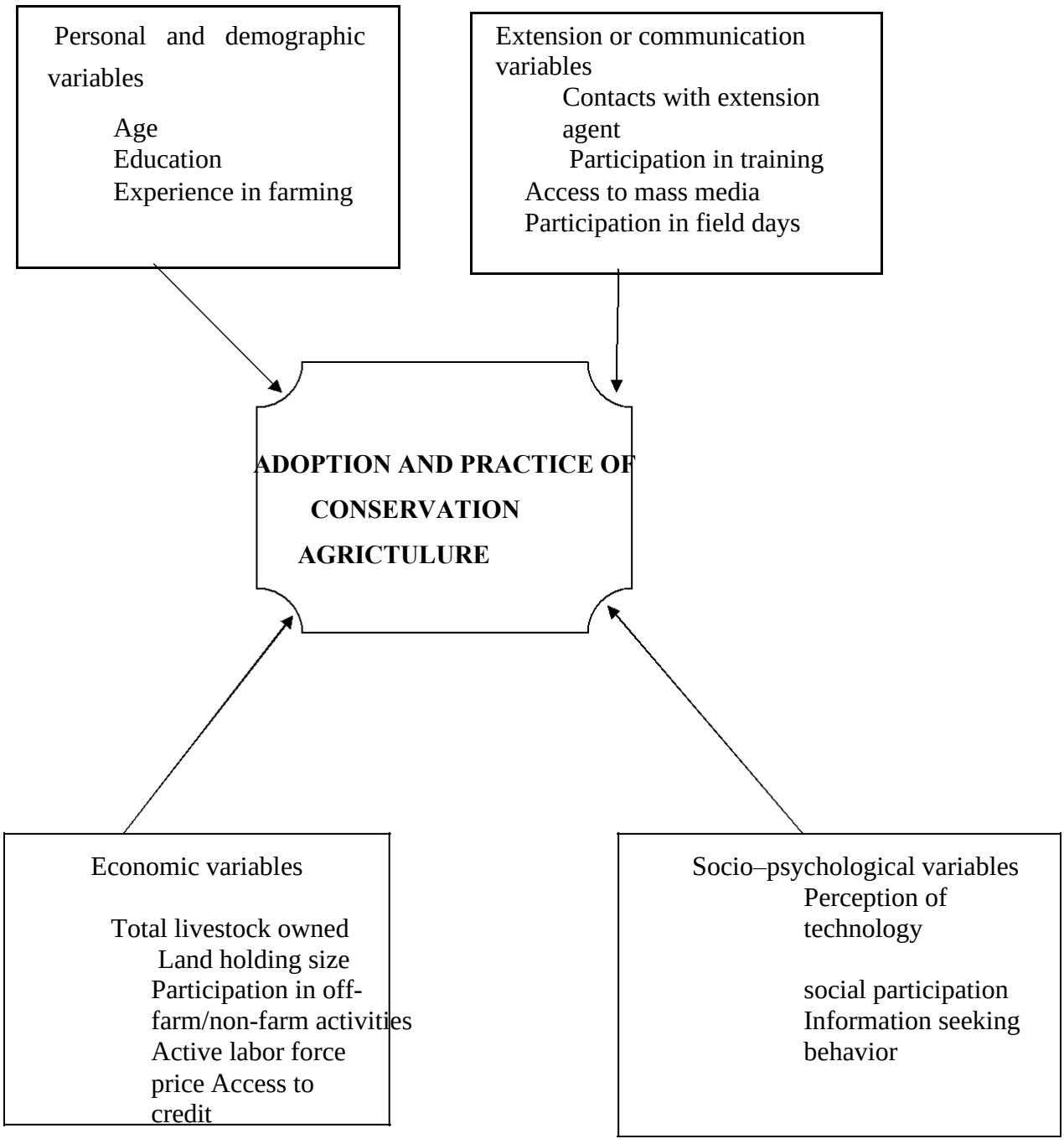


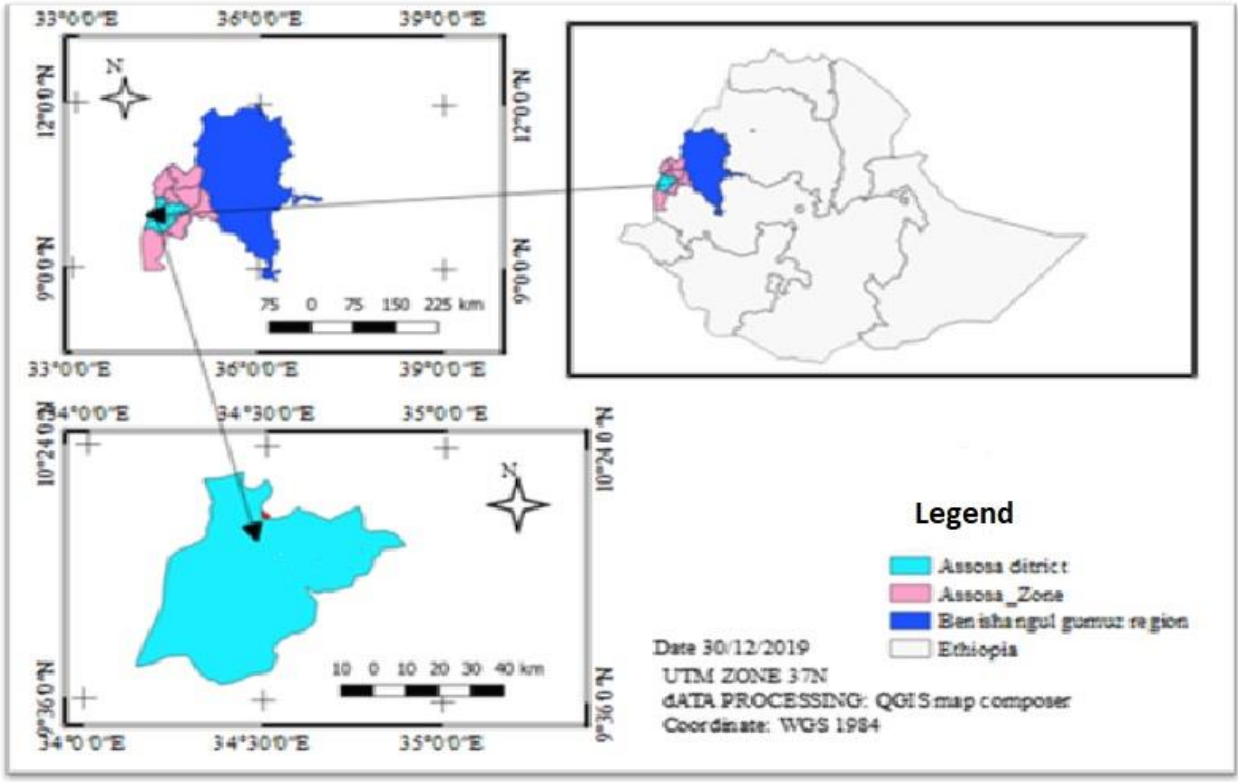
Figure 1. Conceptual Framework of the Study (Adapted from Shiferaw and Holden, 1998).

3. RESEARCH METHODS

3.1. A brief description of the study area

Geographical Location

Asossa district is one of the distric of Asossa Zone in Benishangul Zumuz Region of Ethiopia. Geographically, it is located beteween 10° 4' 0" North, 34° 32' 0" East ', with a total area of about 1,991.41km2 and altitude range of 1300-1570 meter above sea level. The district is located 680 km west from Addis Ababa the capital city of Ethiopia, and it is bordered by Kormuk and Komesha in the north, Menge in northeast, Oda Buldigilu in the east, Bambasi in the southeast, Mao-Komo special woreda in the south and Sudan in the west.



Population

The 2007 national census reported a total population for this woreda of 104,147, of whom 52,968 were men and 51,179 were women; 24,214 or 23.25% of its population were urban dwellers. The majority of the inhabitants said they were Moslem, with 63.27% of the population reporting they observed this belief, while 31.18% of the population practised Ethiopian Orthodox Christianity, and 5.23% were Protestant (CSA, 2007). According to the agriculture office in 2018 the total population of the woreda was 153,827 of which 76,497 men and 77,330 were woemen.

Climate and Agroecology

Assosa district is mostly classified as lowland (kola) with an average rainfall of 1275 mm per annum and an altitude range of 1300-1570 meter above sea level. The rainy season of Assosa district, is model type being distributed from end of April to early October and receives from 219.7 to 1858.3 mm of rainfall per annum for the years 2000-2018. The mean minimum and maximum annual temperature ranges of the distric from 14.7°C to16.3°C and 26.5° C to 30.1°C, respectively. Generally the two seasons are classified according to the amount and timing of rainfall (i.e. Kiremt and Bega). These seasons determine the seasonal agricultural activities.

Land Use Climate and Agroecology

Land use and land cover type of the study area mostly dominated by forest land, shrub/grassland, cultivated land and settlements and countian above 90% (Teshome Betru et al., 2019). Currently, above 40% forests converted to farm land and grass land. This indicated that forest was first changed to shrub/grasslands and finally end up in agriculture showing that degradation is leading

to deforestation (Teshome Betru et al., 2019). In the district both small-scale subsistence agriculture and largescale commercial agriculture are the major drivers of deforestation.

Majorty of forest land includes shrubs, woodland forests and lowland bamboo *(Oxythenantherae Abyssinia*) in the study area (BDI., 2019). Savanna and elephant grases were dominate in gras land of Asossa distirict. The increasing of food demand resulted in an expansion of croplands, it affects forests (shrub and wood land), and water bodies. The expansion of large farm investment and convantional cropland towards other natural resources, has resulted in deforestation and soil degradation. In Other way, increasing of fuel wood demandes in the shortage of alternative sources of energy have led to the damage of forests and farm land crop residues in the study area.

The dominant type of soil color in Asossa distirict is redish and dark clay, composed of vertisols, they have medium to high potential for agriculture. But it poses by tillage problems because they harden when dry and become sticky when wet. Both in the cultivated and uncultivated land of the district, there are different soil types. The dominant types of soil are nitosols and filvisols, have a good top soil structure, shallow depth and un compacted layer. The general physical characteristics of the soil are 60% sandy, 30% clay soil and 10% others (BoARD., 2019). Dominantly reddish and dark color soils are observed in the area. In addition, Asossa district, there are many known rivers and streams found in the district, those are used to irrigation purpuses. . Rivers include the Dabus and its tributary the Buldidine.

Agricultural and Socio economic activities

Agricultural farm land, forest and livestock are the main resources in the region incluiding Asossa district. Livestock mixed farming (crop production and livestock farming) is the predominant sources of smallholders' livelihood in the study area. The two types of farming systems used in

the study area namely shifting cultivation and permanent farming systems. The majority of the indigenous communities, Berta people in Assosa district practice shifting cultivation while settlers practice permanent farming. The crop production is dominated by rain fed agriculture. The district is located within the maize and sorguem production belt of Ethiopia. The major crops produced in Assosa district are: sorghum, maize and teff among food crops, haricot bean and soya bean among pulse crops,, sesame, groundnuts and nug, among oil seeds, and vigetables are tomato, onion, green pepper, cabbage, carrot, potatoes, and sweet potato and major fruits are mango, banana, papaya, avocado and cazamiro. The district has irrigation potential about ( ). It is practiced on small scale level using traditional stream diversion systems. Moreover, livestock production is an other important means of livelihood in the district next to crop production. The major livestock reared in the district are cattle, goats, sheep and poultry (BoBGARD, 2019). In addition modern and traditional bee keeping is an other source of local communities income.

In general the economic activities in Assosa district are predominantly crop production with livestock farming. Some of rural households in the district use lowland bamboo forest resources as additional source of food and income for their livelihoods. Besides agriculture, other means of livelihood are petty trade, daily labour and traditional gold, rock and sand minings, smallholder farmers use as alternative income sources. However, poor educational level, poverty, lack of infrastructure and alternative technology characterize the rural households (Said Sani *et al*., 2016). Chronic food insecurity has continued a critical development challenge for the district for many decades eported by Disaster prevention and Preparedness Agency (DPPA., 2019).

3.2 Research Design

Model specification

Mixed methods were used in collection of data. Mixed methods approach offered an opportunity to draw from the strengths of both quantitative and qualitative research. Quantitative data was collected using a questionnaire and interview conducted on 378 smallholder farmers that were randomly sampled from the list of farmers who considered as CA practitioners.

Farmer who have an area under minimum tillage was considered as adoptor of CA because minimum tillage is the most founder mental difference from conventional agriculture. Crop rotation was already a common practice among farmers among sampled farmers. Crop residue retention was a major challenge because fields soon after harvest were open for communal grazing thus making it hard to have permanent soil cover with organic matter. Hence, a household that is practicing minimum tillage only or minimum tillage plus other principles in 2018/2019 was considered as a a farmer who is adopting CA.

After setting a criteria for the farmers selecting the target of the research the next step was to determine the model that the analysis will be computed. In most of the studies on adoption behavior, the dependent variable can be effectively captured using binary choice models. Binary choice models are appropriate when the decision-making choice between two alternatives depends on the characteristics of the problem. Three types of models have been proposed in the econometric literature for estimating binary choice models: the linear probability, logit, and probit models represented by linear probability function, logistic distribution function, and normal distribution function, respectively (Gujarati,1995). Based on the nature of the variables a binary logistic regression was used in CA adoption model to determine factors influencing adoption of CA. According to diffusion of innovation theoretical perspective a farmer's response towards an innovation is binary, either adopts or rejects. Hence the model for CA adoption was specified as Logit $(P(y=1)) = \log (P/(1-P)) = \alpha+\beta_1X_1+\beta_2X_2+... + \beta_KX_K$ where Y is a categorical response variable with 1=adopters and 2=otherwise; α is the intercept; $\beta_1, \beta_2 .... \beta_k$ are coefficients of independent variables $X1X2\ldots X_k$: P is the probability of adopting CA and (1-P) is the probability that a farmer does not adopt CA. Since a farmer are either be CA adaptors or non-adoptors it was

most appropriate to use a binary logistic regression model (Agrestic, 2007) for the purposes of understanding factors explaining the likelihood of CA adoption. This was important because it provides additional information in identifying factors influencing the extent of CA adoption in terms of area. The CA adoption is influenced by a set of variables, in the model and specified as $Y= \alpha+ \beta1X1i+ \beta2X2i+... +\beta kXki +\varepsilon i$ where Y is a catagorcal response variable (1 adoptor or 2 Non-adoptor); α is the intercept; β1, β2.... βk are coefficients of independent variables X1 X2... Xk; εi=error term and i= i^{th} observation in the sample.

3.3 Sample and sampling technique

The study used multistage sampling techniques to identify the study site and target households. First, Assosa woreda purposively selected for there is CA use promotion by the organization called FH-Ethiopia and availability of CA practiticing farmers. In this study the farming household is actually responsible for making day to day decisions on farm activities and investment on land. Thus, a household will be the basic sample unit. The 16 kebeles of the woreda are stratified as Indigenous (Berta kebeles) (8) and Settlers (other than Berta) (8). Eight Kebeles (4 kebeles from each catagory) selected from each stratum because of time, financial and other resource limitation.

Table 2. Sampled kebeles for the survey

		Frequency	Percent	Valid Percent	Cumulative Percent
Name of Kebeles	Abramo	57	15.1	15.1	15.1
	Afafir Benare	45	11.9	11.9	27.0
	Jematsa	50	13.2	13.2	40.2
	Komoshiga 26	56	14.8	14.8	55.0
	Megele 37	41	10.8	10.8	65.9

	Mutsa	29	7.7	7.7	73.5
	Nebar Komoshiga	53	14.0	14.0	87.6
	Selga 24	47	12.4	12.4	100.0
	Total	378	100.0	100.0	

Sample size determination

The total household number who are practicing CA in Assosa woreda is 6000

The sample size can be determined using the formula

$$n = \frac{N}{1 + N(e)^2}$$ ……*(Yamane,. 1967)*

Where n- is the sample size, N - the population size (total members), and e - is the level of precision.

Thus N=6000, e=0.05, n= 375 but the survey was done on 378 farmers

3.4 Data Collection Instruments and Methods

The survey was conducted in April 2020 and additional field observation was done between July and August 2020 since CA is a sesonal activity. Both primary and secondary data was used to investigate this research. The primary data were obtained from primary sources including household survey, key informant interviews, focus group discussions and field observation. The secondary data collection was done through puplished documents such as journals, articles and books, and unpuplish docments such as reports were used.

Quantitative Data collection

Household survey

The household survey was carried out by using sample households drawn from the population in each kebele by using structured questionnairie. To carry out this household survey, close and open ended questionnairie was prepared. Prior to the actual interviews, the questionnaire was pretested to control validity, and modifications were made where necessary to enhance its utility in addressing the relevant issues and then distributed to respondents.

Qualitative Data collection

Key informant interview (KI)

The key informant interview was conducted from local people who have a good knowledge about the biophysical and socioeconomic conditions of the area and hence elders, development agents, local leaders, model farmers, office experts were used as key informants. KIs were important to get an overview of the trend of adoption level, crop production and other management sytems applied to conservation agriculture in the study area. To guide this interview, a checklist of the relevant quetions were used to get dep information and cross check the collected data. The main important issues included in this interview were focus on the adoption of conservation agriculture practices , factor affecting adoption of conservation agriculture practices and the adaptation strategies practiced by the smallholder farmers.

Focus Group Discussion (FGD)

By using FGD data collecting mathod, is essencial in allowing for deep information at rational cost and obtaining more people with in a shart paired of time compared to other metheds. In this study respondents in FGD were representatives of their local community including elders, women, and youth groups. The participants for the FGD were selected based on experience and having a better knowledge on the present and past environmental, social and economic status of the study

area and the benefits of conservation agriculture in their economy and enviroment. Participants of the FGD were individuals not included in the household and KII data collection methods. At each Kebele, one separate focus group discussion was carried with participation of men and women of (elders, model famers, and youth groups). Each group was contains 10 participants. The main purpose of the FGDs was uesd to check the information from other methods is consistent. The major discussion topics were community understanding on the benefit of CA to improve productivity and to inhance adaptive capacity to climate variability, major risks and their impacts, adoption options by small holder-farmers and obstacles and opportunities to employ them effectively.

Field observations

It was made as supportive or supplementary technique to collect data that could balance or set in perspectives of the data obtained by other means. During the field observation, I observed the physical characteristics of CA practices in the feild and under implementation by local farmers, how they were being practiced, their visible effects on the production, environmental protection, defferent challenges, etc. Direct field observation was conducted to observe CA technology practices mainly included suplmentary management practices and other adaptation practices of small holder farmers. This information was used to counter-check the collected data from household respondents, focus group participants and key informants.

3.5 Methods of data analysis

After collecting information from the selected samples, the next step was to analyze and present the data in meaningful manner. Accordingly, the data obtained from the respondents by using data collection instruments analyzed in the form of tables and numbers by using statistical tools to present the information simply and clearly with descriptive statistics.

The quantitative data analysis was be undertaken using SPSS version 25. Qualitative data gathered through Key informant interview, field observation and FGDs used to substantiate the quantitative data gathered through the structured questionnaires.

Qualitative data analysis

Qualitative data was analyzed by narrating the results and summarizing the findings just to substanciate the quantitave data. Descriptive tools was supplemented by qualitative analytical methods (mainly for those data that acquired through the participatory/ qualitative methods) like interpretation and explanation of various opinions, views and concepts; and summarizing, categorizing, and presentation of these in convenient forms.

Qualitative information used in this study is based on 16 focus group discussions: Five with women only, Five with men only and Six with both women and men. Key informants (30) were also interviewed. Key informants included agricultural extension staff, village headmen, lead farmers, and leaders of local farmer organisations and women clubs. Purposive sampling was used in the selection of key informants and focus group disccussions so as to have participants who are known to have opinions and experiences on the topics for discussion. Information was also collected through informal discussions with farmers and key informants. Review of literature such as extension manuals, monitoring and evaluation reports, were also used in data collection.

Measuring food security

Food security can be measured at various scales: regional, national, household and individual levels. In this case, the study focuses at the household level. A number of indicators are used to measure food security at household level, and these commonly include: The Household Dietary Diversity Score (HHDS); Copying Strategy Index (CSI) and the Food Consumption Score (FCS). The HHDS indicates the diversity of the dietary intake of a household; the CSI captures the severity of the strategy a household resorts to in copying with periods on food shortages; the FCS shows the quantity and quality of food consumed by a household. The suitability of each of these indicators depends on the given food shortage situation and intend use of the information.

For example, for the purpose of a quick assessment under an emergency relief situation, the CSI may be more appropriate. In this research I am concerned about both the quality and quantity

consumed by households; hence, the FCS is more suitable indicator of food security. The FCS computed in accordance with guidelines provided by Emergency Food Security Assessment Handbook. The FCS is designed to reflect the quantity and quality of people's diet at household level. A composite score derived from a weighted sum based on the food type and frequency of consumption during a 7-day period.

Quantitative data analysis

Descriptive statistical tools used to analyze the quantitative data. The important statistical measures that was used to summarize and categorize the research data are percentages and frequencies tables. Chi-square and regression applied to see the degree of association and significance between the dependant variable (adoption in this case) and the independent variables

3.6 Definition of variables and working hypothesis

Dependent variable

Adoption of conservation agriculture is dependent variable. Those faremrers who has been practicing CA for the last 4 years be targeted for the study.

Independent Variables

Age of the household head. This variable refers to the chronological age of household head at the time of the survey, measured in years. As the age of the household head increases, the probability of using CA is likely to decrease. Because, with age, a farmer can become more risk averse and then tend to be reluctant to new technologies. Therefore, it is hypothesized that age of household head are more likely to affect conservation tillage technology negatively (Kidane, 2001).

Education. It measures formal education of household head in the family. Education was categorized as Collage, Secondary complete, Secondary incomplete, primary complete , primary incomplete and illiterate. This kind of category is needed since each stage of the education level has impact on individuals on their thinking and level of understanding the technology. Education increases farmers' capacity to create or innovate. Farmers having a good education level are more

open to new technology. The study hypothesized that educational level would be positively related to technology adoption (Million and Belay, 2004).

Farming experience with CA. is to be measured in number of years of experience in CA farming. Farmers with higher experience appear to have often-full information and better knowledge and might be able to evaluate the advantage of the technology (Chilot *et al.,* 1996). Hence, farming experience is hypothesized to affect adoption of CA positively.

Participation on training. Training is one of the means by which farmers acquire new knowledge and skill. It is measured as the number of times the farmer has received CA training in the last four years. Hence, participation in training is expected to positively influence farmers' adoption behaviour. (Tesfaye and Alemu, 2001).

Participation on field days. It is measured as the number of times the farmer has participated in CA field days in the last four years. Participation in field days is expected to have positively influence farmer's adoption level of the CA technology. The term field day was understood in this research that when farmers go and learn from their fellow nebouring farmers within the same kebele. This is a dummy variable by which those who participated on the farmers field day event gets 1 while the others 0.

Participation on experience sharing. It is measured as the number of times the farmer has participated in CA experaince sharing by traveling cross kebele with in the last four years. Participation in experaince sharing is expected to have positively influence on farmer's adoption level of the CA technology. This is a dummy variable by which those who participated on the experience sharing event gets 1 while the others 0.

Access to CA radio programing. The regional government has radio program for the promotion of CA. As a result the this variable is a dummy variable and check if the respondent has access to radio or not. 1 for this who have access and 0 for those who have not access. It is expected that access to the CA radio programing will have positive association with the adoption of conservation agriculture (Yishak, 2005; Ebrahim, 2006).

Type of crop : from my expeirance of working in the study area for more than 10 years, the decision of the farmers to adopt technologies can be affected by the type of crop they are producing. Therefore, this variable is also considered as one of the important variable**.**

Access to credit. This variable is measured in terms of whether respondents have access to credit, in-terms of availability of credit sources and possibility of getting credit. It is a dummy variable, which takes a value 1 if the farm households have used credit or 0, otherwise. Farmers who have access to credit may overcome their financial constraints and therefore be able to buy inputs. Farmers without cash and do not have access to credit may find it very difficult to attain and adopt new technologies (Mekonnen, 2007; Minyahel, 2007 and Taha, 2007). Hence, access to credit is expected to increase the probability of adopting CA technology.

Member of farmers' group. A person's affiliation and involvement in farmers group likely to expose the individual to different knowledge. Individuals actively involving in various group membership are likely to have a better awareness and utilize for the knowledge than those who did not involve in social activities (Chilot et al, 1996; Asfew et al, 1997; Habtemariam, 2004). The variable will be measured by if the farmers are participating on CA farmers group or not.

Type of farm tools. From my experience in that specific area, type of farmtools used by the farmer will limit them to adopt new farming system. The assumption is those farmers who use improved farmtools will be positively affect to adopt new farming system such as CA.

Land Size. The land size is also expected to determine the adoption of CA. Those farmers who have larger land area will have a confidence than those who have small land area.

Table 3. Definition and units of measurement of the variables

Variable	**Description and measurement**
Age	Age of household (years)
Education	Catagorized as Illiterate, College, Primary complete, Primary incomplete, Secondary complete and Secondary incomplete
Experience in practicing CA	Farm experience of household (years) in practicing CA
Participation on CA training	Participation in training event (Yes or No)
Participating on CA field day	Participation in field day event (Yes or No)
Participation on CA farmer to farmer exchange visit	Participation in farmers to farmers experianse sharin event (Yes or No)
Membership on farmers' group	Participation on farmers' group
Farm tools	The kind of farm tools used by the farmer

Access to credit	Access to credit in which the farmer gets
Land holding size	In Hactar

Multi collinearity test: The Variance Inflation Factor (VIF)

Multicollinearity is a correlation or multiple correlations of sufficient magnitude to have the potential to adversely affect regression estimates. It was important to cheack before taking the selected variables in to regression. Based on the test the variables had no multicolinarity problem as it is indicated in the analysis table bellow. As it is shown all the VIF are less than 10 and the tolerance is also less than 1. This shows that the variables used in this study don't have any problem of mulicolinarity. This was my initial to use all the listed variable for further analysis.

Table 4. Multicolinarity test

Model		Collinearity Statistics	
		Tolerance	VIF
1	AGE	.901	1.110
	EDUCATION	.930	1.075
	LANDSZ	.881	1.135
	FARMTOOLS	.934	1.071
	TRIANING	.918	1.089
	FIELD DAY	.926	1.080
	EXPERIANCE SHARING	.894	1.118
	LISTINING CA RADIO PROGRAM	.866	1.154
	TYPES OF CROP BY CA	.836	1.196
	CREDIT ACCESS	.833	1.201
	MEMBER OF FARMER GROUP	.957	1.045
	SEX	.787	1.271

a. Dependent Variable: CA_Adoption

4. RESULT AND DISCUSION

This chapter discusses the descriptive results of the study. The descriptive statistics results section includes discussions about demographic and socioeconomic characteristics of sample farmers; landholding and farm characteristics of sample households; Type of conservation agricultural principles used by farmers, Impact of conservation agriculture on food security productivity are discussed.

4.1 Adoption of conservation agriculture in Assosa woreda

An area under minimum tillage was used as an indicator of adoption of CA because minim tillage is the most founder mental difference from conventional agriculture. Crop rotation was already a common practice among farmers among sampled farmers. Soil cover retention was a major challenge because fields soon after harvest were open for communal grazing thus making it hard to have permanent soil cover with organic matter. Hence, a household that had area under minimum tillage was considered as practicing CA in 2018/2019 farming season. Farmers who are practicing minimum tillage or minimum tillage in combination with other principles such as soil cover and crop rotation/association are considered as CA Adoptiors. Whereas those who are practicing only crop rotation/association are considered as non-adoptors of CA. Based on the above definition of CA Adoption about 91.5% of the respondants adopts CA while 9.1% of the respondants are not adopting.

Table 5. Rate of adoption of conservation tillage

CA Adoption					
		Frequency	Percent	Valid Percent	Cumulative Percent
Rate of adoption	CA_Adoptors	346	91.5	91.5	91.5
	Non-Adopters	32	8.5	8.5	100.0
	Total	378	100.0	100.0	

Source: Own survey, 2020

4.2 Demographic Characteristics of the Respondants

Marital status of the respondants

Based on the collected data about 74.3% of the respondants are married monogamous where as 6.9% fo the farmers are widowed women. During my focus group intereviw I noticed that CA is appropriate technology for the widowed since the technology is not labour intensive.

Table 7. Marital status of the respondants

			CA_Adoption		
			CA_Adoptors	Non-Adoptors	Total
What is your marital status?	Divorced	Count	15	1	16
		% of Total	4.0%	0.3%	4.2%
	Married monogamous	Count	281	24	305
		% of Total	74.3%	6.3%	80.7%
	Married polygamous	Count	9	1	10
		% of Total	2.4%	0.3%	2.6%
	Separated	Count	5	3	8
		% of Total	1.3%	0.8%	2.1%
	Single	Count	10	0	10
		% of Total	2.6%	0.0%	2.6%
	Widowed	Count	26	3	29
		% of Total	6.9%	0.8%	7.7%
Total		Count	346	32	378
		% of Total	91.5%	8.5%	100.0%

Age of the respondants

Age is difficult factors to link to CA adoption, given that studies have shown both negative and positive relationships. The age of respondents was accounted as an important factor during the choice of new agricultural practices at household levels. From the analysis we can understand that CA is a prefered technology by old farmers too though based on the chi-square result age is not significantly affecting the adoption. When we compute the chi-square (0.251) to see the association between the CA adoption and age, it shows that there is no association between CA

adoption and age. The P-value (0.264) obtained from the regression analysis also shows that age is not significantly affecting the adoption of the CA adoption. In contrast when we see the the frequency table bellow, to adopt CA there is no age limitation and the farming system can be done by any person regardless of age restriction. Literature illustrats that age is quit impossible to link age with CA adoption, given that studies have shown both negative and positive reationships (FAO, 2001; Knowler and Badshaw, 2007). The results in studied area shows that the older people are more likely than their younger colleagues to understand soil problems and yet likely to address the problems. CA involves a relatively new concept of farming so that farmers with long experaince in traditional farming may not be interested to adopt CA.

Table 8. Age category of the respondants

			CA_Adoption			Pearson Chi-square value	P-Value
			CA_Adoptors	Non-Adoptors	Total		
AGE	18- 25	Count	6	1	7	0.251	0.264
		% of Total	1.6%	0.3%	1.9%		
	26 - 30	Count	31	2	33		
		% of Total	8.2%	0.5%	8.7%		
	31 - 35	Count	65	1	66		
		% of Total	17.2%	0.3%	17.5%		
	36 - 40	Count	70	6	76		
		% of Total	18.5%	1.6%	20.1%		
	41 - 45	Count	49	4	53		
		% of Total	13.0%	1.1%	14.0%		
	46 -50	Count	54	7	61		
		% of Total	14.3%	1.9%	16.1%		
	51 -55	Count	29	3	32		
		% of Total	7.7%	0.8%	8.5%		
	56- 60	Count	22	3	25		
		% of Total	5.8%	0.8%	6.6%		
	61 and above	Count	20	5	25		
		% of Total	5.3%	1.3%	6.6%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

Sex of the respondants

The analysis shows that 91.5% of the respondants are CA adoptors out of the 378 farmers 44.7% are female and 46.8% are male. From this one can observe that CA is the kind of farm practice impmentened both by the male and female regardless of sex. During my observation and focus group discussion, I learned that since CA is not labour intensive female have high involvement. As per my interview with some of them during the KII, they said if the land size is small female can practice CA but when the land become bigger and bigger they couldn't practice CA due to reproductive and social role of the female farmers. The chi-square compted to see the association between sex and CA adoption shows that there is not significant association between the two variables.

Table 6. Sex of the respondants

			CA_Adoption			Pearson Chi-square value
			CA_Adoptors	Non-Adoptors	Total	
SEX	Female	Count	169	14	183	0.581
		% of Total	44.7%	3.7%	48.4%	
	Male	Count	177	18	195	
		% of Total	46.8%	4.8%	51.6%	
Total		Count	346	32	378	
		% of Total	91.5%	8.5%	100.0%	

Education level of the respondants

Before the survey was conducted education was classified into four categories; College, Secondary complete Secondary incomplete Primary complete, Primary incomplete and illiterate. Based on the analysis about out of the 23.3% are secondary incomplete and 13.5% are are illiterate, and 22.5 % are primary incomplete and 0.3 % are college complete. As we can see the chi-square test done to see if there is association between CA adoption and education, shows that there is association between adoption of CA and education level.

Therefore, this finding is in line with studies done by many of the previously conducted studies. For example, Tesfaye et al., (2001) reported a positive and significant relationship of education

with adoption. In the other way there are findings which shows negative influences of education on adoption, for instance, in Deginet et al., (1999). The finding of this study is in agreement with Tesfaye et al., (2001) reported a positive and significant relationship of education with adoption. But inconsistent with many of the previously conducted studies (e.g., Rahmeto (2007).

Table 9. Education status of the respondants

			CA Adoption			Pearson Chi-square value	P-Value
			CA_Adoptors	Non-Adoptors	Total		
Educational Status	College	Count	1	0	1	0.044	0.003
		% of Total	0.3%	0.0%	0.3%		
	Secondary Complete	Count	58	9	67		
		% of Total	15.3%	2.4%	17.7%		
	Secondary incomplete	Count	77	11	88		
		% of Total	20.4%	2.9%	23.3%		
	Primary complete	Count	77	9	86		
		% of Total	20.4%	2.4%	22.8%		
	Primary incomplete	Count	83	2	85		
		% of Total	22.0%	0.5%	22.5%		
	Illitrate	Count	50	1	51		
		% of Total	13.2%	0.3%	13.5%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

Experience in practicing CA. CA practicing experience experience is one of the household characteristics, which farmers acquired in their life by undertaking farming activities. Farmers can observe success and failure in crop production or otherwise. Therefore, this could help them to weight between the performance of a modern and a traditional technology, and to develop more confidence to take risks related to farming. It is also an important factor for success in farming. As it is indicated in the table below about 40.5% of the adoptor farmers are practicing CA for the 3 years and 36.1% of the adoptor farmers are practicing CA for four years. Others have experienced practicing CA at least once in the last 4 years. Therefore, as we see from the analysis about 89.6 % of farmers are practicing CA for the last three and more years. When we compute the Chi-square (0.111) to see the association between CA adoption and experience practicing CA, unfortunately there is no association between the two variables as indicate in the table bellow. Running the regression (0.571) to see significance level it shows practicing CA is not significant to influence the adoption of CA.

Experience in practicing CA imply farming knowledge gained over time and are important in evaluating technology information and adoption (Feder et al., 2008). In the contrary some studies reported (e.g. Traore , 1998) that CA practicing experience is becoming insignificant, which was never found to be negatively correlated with adoption practices.

Table 10. Respondants' experience in practicing CA

			CA_Adoptors	Pearson Chi-Square	P-Value
YEARCAPRACTICE	More than four years	Count	45	0.111	0.571
		% of Total	13.0%		
	Four years	Count	125		
		% of Total	36.1%		
	Three years	Count	140		
		% of Total	40.5%		
	Two years	Count	35		
		% of Total	10.1%		
	One year	Count	1		
		% of Total	0.3%		
Total		Count	346		
		% of Total	91.5%		

4.3 Economic variables of the respondants

Access to credit

Credit service is also another important variables that influences adoption of agricultural technologies, especially for poor farmers to relax the limited finance for purchasing agricultural inputs. Based on the frequency table below 44.2 % of the total and those who adopt CA are a member of saving and credit group while 47.4% of the total farmers who adopt CA are not a member of any credit association groups. Out of the total members 25.4 (23.8% adopters & 1.6% non adoptors) took a credit from their credit association. From the overall observation adoption of CA don't have association with access to credit based on the chi square test (0.851). The computed regression (0.441) access to credit will not significantly affect the adoption of CA.

This study is in contrary with Tura et al. (2009) which indicated that dis-adoption is largely determined by the asset portifolio of famers and by the structure of marked for credit , labour and seeds.

Table 11. Access to credit

			CA_Adoption			Pearson Chi-Square	P-Value
			CA_Adoptors	Non-Adoptors	Total		
CREDIT ACCESS	No	Count	179	16	195	0.851	0.441
		% of Total	47.4%	4.2%	51.6%		
	Yes	Count	167	16	183		
		% of Total	44.2%	4.2%	48.4%		
Are you used your savings from your group	No	Count	77	10	87	0.437	
		% of Total	20.4%	2.6%	23.0%		
	Yes	Count	90	6	96		
		% of Total	23.8%	1.6%	25.4%		
	Not member	Count	179	16	195		
		% of Total	47.4%	4.2%	51.6%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

Land holding size

According to the sample survey data, 38.9 % (of which 35.2 are CA adoptors & 3.7 % are non) of the total respondants has land size between 1.1-2 hactar. While 29.4 (26.7% are CA Adoptors &.2.6% non) of the total respondants has land size of 0.6-1 hactar. Computing the chi-square (0.838) to check if there is association between CA adoption and land size, shows that there is no significant association between the two variables. The regression analysis (0.587) also shows that land size is not siginficanly affecting the CA adoption.

Ndlovu et al. (2013), assert that CA is practiced on smaller plot compared to converionally tilled plots, thus land is not a binding constraint to CA adoption. shows that practicing CA is not decisive factor to adopt CA. Given the characteristics of the CA technology, it is expected that continued use will be prevalent among poor, who face constraient sucha as limited land.

Table 12. Land size of the respondants

			CA_Adoption			Pearson Chi-Square	P-Value
			CA_Adoptors	Non-Adoptors	Total		
LANDSZ	0 – 0.25	Count	9	0	9	0.838	0.587
		% of Total	2.4%	0.0%	2.4%		
	0.26 – 0.5	Count	36	3	39		
		% of Total	9.5%	0.8%	10.3%		
	0.6 – 1	Count	101	10	111		
		% of Total	26.7%	2.6%	29.4%		
	1.1 – 2	Count	133	14	147		
		% of Total	35.2%	3.7%	38.9%		
	2.1 – 4	Count	44	4	48		
		% of Total	11.6%	1.1%	12.7%		
	4.1 – 5	Count	7	1	8		
		% of Total	1.9%	0.3%	2.1%		
	5.1 or more	Count	16	0	16		
		% of Total	4.2%	0.0%	4.2%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

CA farmtools under utilization

As it is known different agricultural practices require different farm tools. In the study area out of the 378 the respondants 48.7% CA adopting farmers use combination of Hand hoe and Ox drawn plough. Where as 34.7 % of CA adopting farmers are using only Hand Hoe. So, from the analysis result, CA has been in practice in the study area with the existing traditional farm tools that are well known by the majority of the farmers of the country. From the observation , key informant interview and focus group discussion , I observed that Hand hoe has been used for a relatively smaller area where as the combination of both hand hoe and Ox drawn plough has been used jointly in relatively larger area. The chi-square computed to see the assoiction between the CA adoption and the types of farm tools utilized to implement CA shows insignificance.

Table 13. Farm tools used by the farmers

			CA_Adoption			Pearson Chi-Square
			CA_Adoptors	Non-Adoptors	Total	
FARMTOOLS	Hand hoe	Count	131	9	140	0.550
		% of Total	34.7%	2.4%	37.0%	
	Hand hoe Ox drawn plough	Count	184	21	205	
		% of Total	48.7%	5.6%	54.2%	
	Hand hoe Two wheel tractor	Count	5	0	5	
		% of Total	1.3%	0.0%	1.3%	
	Ox drawn plough	Count	26	2	28	
		% of Total	6.9%	0.5%	7.4%	
Total		Count	346	32	378	
		% of Total	91.5%	8.5%	100.0%	

4.4 Extension communication variables of the respondants

Farmers Trianing on CA

Among the factors which influence the farmers to adopt CA practice is the attendance of farmers on various CA trainings. Based on the focus group discussion and KII the training of CA focused on from land preparation to post harvest management of the harvest. According to

the analysis result bellow out of the total respondent 82.5% (74.3% adoptors and 8.2% non adoptors) attended CA related trainings while 65 farmers (17.2%) of the adoptors didn't attend those trainigs at all. The quation that one can raise here is ; how can those who didn't take part on the training adopt CA? To answere this I have tried to talk to them during my field observation and they mentioned that eventhough they didn't attend CA training they have been participating on experaince sharing, farmers field day, listening to the radio program. In addition to that the key informant interview explained that in each of the Farmers Training Center (FTC) there are demonstratin sites which illustrate how CA is practiced. Those trainings were organized by both governmental organization and non-governmental organizations. Surprisingly out of the non-adoptor farmers which accounts 8.2% of the total attended CA training but they didn't adopt CA. Based on the definition of CA adoption above the non adoptors of CA are those who only practicing crop rotation/association. During my field observation I tried to talk with those who are considered to be non-adoptors and they replied that since eventhough they attended on various CA trainings, they don't have ample land to practice different technologies. Some of them said they are scared of the technology since they can't think of crop production without tilling the land frequently which contradicts with the main CA principle i.e minimum tillage. The chi-square (0.026) result computed to see the association between the CA adoption and CA training shows that there is strong and significant association between the two variables. The binary logistic regression (0.047) also shows that training will significantly affects the adoption of CA.

The analysis result is consistent with that of Tesfaye et al., (2001) which confirms that participation in training is posetively influences farmers' adoption behaviour. As a result the farmers who are participating on the training will be influenced and get ecoruaged to participate on adopting CA.

Table 14. Participation on CA training

			CA_Adoption			Pearson Chi-Square	P-Value
			CA_Adoptors	Non-Adoptors	Total		
TRIANING	No	Count	65	1	66		
		% of Total	17.2%	0.3%	17.5%		
	Yes	Count	281	31	312	0.026	0.047

		% of Total	74.3%	8.2%	82.5%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

Farmers' field day on CA

Farmers field day is one of the practical larining opportunity by which farmers go to their noughbours and learn from them. Thos farmers' field day has been organized within the kebeles. Based on the result of the analysis sampled household about 92.1 % (85.2% CA adoptors and 6.9% non adoptors) responded that they attended on the farmers field day organized at their local areas. When we compute the chi-square (0.018) it shows that there is significant association between the farmers field day and CA adoption as we see in the table below. The regression result to see the significant level of farmers field day and adoption shows that participation on farmers field day will significantly affects the CA adoption.

This study is consistent with Taha, (2007) which confirmed that participation on farmers field day will have positive impact on CA adoption. According to the qualitative data farmers field day will help the farmers to learn from each other. On the event farmers will share their experience, challengs and success.

Table 15. Participation of farmers field day

			CA_Adoption			Pearson Chi-Square	P-Value
			CA_Adoptors	Non-Adoptors	Total		
FIELD DAY	No	Count	24	6	30	0.018	0.004
		% of Total	6.3%	1.6%	7.9%		
	Yes	Count	322	26	348		
		% of Total	85.2%	6.9%	92.1%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

Experaince sharing on CA

Based on the definition I found from the farmers to differentiate between experience sharing and faremrs field day they defined it as experience sharing of CA is when farmers taken to another kebele so that they can learnd from other farmers who are practicing the technology in a better way. Accordingly, out of the total sample 72.2% (64.8% adoptors and 7.4% non adoptors) participated on experience sharing event. Eventhoug 28 farmers out of the 32 non adoptors parcticipated on the on CA focused experience sharing but they are didn't adopt CA. After computing the chi-square (0.044) to see the association between the experience sharing and CA adoption, the test shows that there is strong and significant association between the two variabels. The P-Value (0.035) after computing regression shows that participation on experience sharing will significanly affects the adoption of CA.

Study done by Tesfaye et al., (2001) shows that participation in training is posetively influences farmers' adoption behaviour. As a result the farmers who are participating in experience visit tend to adopt CA.

Table 16. Participation on experience sharing

			CA_Adoption			Pearson Chi-Square	P-Value
			CA_Adoptors	Non-Adoptors	Total		
EXPERIANCE SHARING	No	Count	101	4	105	0.044	.035
		% of Total	26.7%	1.1%	27.8%		
	Yes	Count	245	28	273		
		% of Total	64.8%	7.4%	72.2%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

Mass media exposure

The adoption process of agricultural technologies depends primarily on access to information and on the willingness and ability of farmers to use information channels available to them. Mass media exposure was also hypothesized to be one of the determinant variables to affect adoption of conservation tillage technologies. Accordingly, the survey tried to check of the common massmidia that the farmers are using to to learn about CA. Based on the finding the Benshangul Gumuz regional government has FM radio which has a broadcast about conservation agriculture

twice a week. Based on the analisis of the survery, about 71.7% of the total (66.9% adoptors & 4.8% non adoptors) were attentively listenting to the CA radio program broadcasted by the regional agriculture office while 93 farmers who adopts CA were not lsitining the CA programing broadcasted through regional FM radio at all. The chi-square computed to see the association between the varabiles show that there is significant association between listening to CA radio program and CA adoption. The regression computed also shows that listing to the radio will significantly affects CA.

This study is consistent with similar studies by Ebrahim, (2006) and Yishak, (2005). The two studies confirmed that access to mass media to have positive association and significantly affecting the adoption of conservation tillage (Yishak, 2005;).

Table 17. Access to listening CA radio programing

			CA_Adoption			Pearson Chi-Square	P-Value
			CA_Adoptors	Non-Adoptors	Total		
LISTINING CA RADIO PROGRAM	No	Count	93	14	107	0.043	0.023
		% of Total	24.6%	3.7%	28.3%		
	Yes	Count	253	18	271		
		% of Total	66.9%	4.8%	71.7%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

Crop type applied for CA practice

As we can see from the table below out of the total adoptors 346, about 228 farmrs are producing maize are producing maize while 70 are producing maize , shorghum and beans. This might depends on the agro ecology the study area and the type of technology they are using. In the study area staple food is maize and sorghum. They are using beans for interctoping and crop rotation. In addition to that the majority of the respondent produce maize by applying minimum tillage since maize don't neccesarly need repeatedly ploughed land. But for small sized grain the farmers need to plough their land frequantly. The chi-square test shows there is no significant association between the type of crop applied and CA adoption. The logstic regression also shows that there is no signficcance between the two variables.

Table 18. Types of crop produced by CA

			CA_Adoption			Pearson Chi-Square	P-Value
			CA_Adoptors	Non-Adoptors	Total		
TYPES OF CROP BY CA	Maize	Count	228	19	247	0.614	0.164
		% of Total	60.3%	5.0%	65.3%		
	Maize Beans	Count	23	1	24		
		% of Total	6.1%	0.3%	6.3%		
	Maize Beans Sorghum	Count	70	8	78		
		% of Total	18.5%	2.1%	20.6%		
	Maize Sorghum	Count	23	4	27		
		% of Total	6.1%	1.1%	7.1%		
	Sorghum	Count	2	0	2		
		% of Total	0.5%	0.0%	0.5%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

4.5 Socio–psychological variables of the respondants

Member of CA farmer group

Membership and frequency of participation in different social organizations is the other important variable expected to have relation with adoption of conservation agricutlure practices. As it is indicated in the table below 57.1% of the CA adoptor farmers are a member of CA farmer groups. Based on the observation, FGD and KII the I confirmed that these groups are the ideal place where farmers share their experience, challenges and success. As we see the chi-square result there is strong association between being am member of farmers group and CA adoption.

The analysis result of this research shows that as farmers participated on different farmers' membership the probability to adopt CA will increase. This will be consistent with by Habtemariam ,(2004) which illustrates that individuals actively involving in various social activities are likely to have a better awareness and utilize for the knowledge than those who did not involve in social activities .

Table 19. Farmer's engagement in farmer's group

			CA_Adoption			Pearson Chi-Square	P- value
			CA_Adoptors	Non-Adoptors	Total		
MEMBER OF FARMER GROUP	No	Count	130	5	135	0.013	.016
		% of Total	34.4%	1.3%	35.7%		
	Yes	Count	216	27	243		
		% of Total	57.1%	7.1%	64.3%		
Total		Count	346	32	378		
		% of Total	91.5%	8.5%	100.0%		

4.6 Perception of farmers to practice CA

Knowing the percieption of the farmers to practice CA or not will help us if farmers are realy interested in CA or not. Based on the survey result, out of the total 378 respondants 35 farmers (9.3%) of them are not sure to practice CA or not, 8 (2.1%) said no and 335 (88.6%) confirmed that they will practice CA in the coming year. To answer the question why farmers are 'Not sure' to practice in the coming season, I included the the question on FGD and KII. Then I found those farmers who are practicing CA in the rented land they are not sure to practice or not to practice CA. In other way farmer are practicing CA and responded no to practice CA in the coming year, came to this decision since they are not satisfied with the result of adopting.

Table 20. Decision of the farmrs to practice CA in the coming season

			CA_Adoption		
			CA_Adoptors	Non-Adoptors	Total
Will you continue practicing CA in the coming year (2020/2021)	Not sure	Count	33	2	35
		% of Total	8.7%	0.5%	9.3%
	No	Count	8	0	8
		% of Total	2.1%	0.0%	2.1%
	Yes	Count	305	30	335
		% of Total	80.7%	7.9%	88.6%
Total		Count	346	32	378
		% of Total	91.5%	8.5%	100.0%

4.7 Implication of CA practice on food security

Increases in Crop Yields

Since this research was not focused on yield assessment due to the season , the researcher relied on the secondary data of the project. Therefore, according to the data tracked on yield starting from harvesting period of first year of the project, an increase in yield of crops using conservation agriculture have been recorded for the past four years of the project. Farmers have also noted and stated that conservation agriculture improved not only yield but also the quality of grain which is highly attributed to soil fertility improvement in practicing the principles of conservation agriculture like using mulch/ leaving stubble stands on farm fields, green manure/cover crop, reducing number of tillage as well as application of lime and composts. Moreover, the yield difference between plots under conservation agriculture practice and conventional farming showed significant difference where higher yield recorded on CA plots as compared to the conventional one.

Based on the post-harvest yield assessment, the average yield is indicated in the following table

Table 20 : Year (2019/20) Yield of Conservation Agriculture Vs the first year-Year I (2016/17)

No	Crop type	Yield(2016/17) Kg per ha	Yield(2019/20) Kg per ha	Difference in Kg per ha	Difference in Percentage
1	Maize	4812	7000	2188	45.5%
2	Wheat	3086	5900	2814	91.2%
3	Teff	1271	1900	629	49.5%
4	Faba bean	925	2050	1125	121.6%

Months of Adequate Household Food Provision

This parameter is one of the important ones to know the food security status of the household. This will measure if the household has enough food in the last 12 months that is from March 2019- March 2020. The months of adequate household food provision was computed for farmers who are adopting CA and for the non adopters. The result of the analysis shows that 320 of the CA adopters (out of 346 CA adopters) i.e about 92% of them had adequate food for their household. Whereas out of 32 non CA adopters only 4 of them (12.5%) of them had enough food for the last 12 months.

Table-21 Showing Months of Adequate Food Provision by household

Description	**# Respondents**	**%age**	**Remark**
Monthly adequate food provision (CA adopters)	320	92% of the adopters	HHs who accessed adequate food for 12 straight months
Monthly adequate food provision (non-adopters)	4	12.5% of the non adopters	HHs who accessed adequate food for 12 straight months

As above table illustrates, it is 85.7% of the 378 respondents who are reported to have been experiencing adequate food provision at household level throughout the year. Comparing the majority of the respondent based on the set division (Adopter and non adopter) the majority of CA adopters has sufficient food for 12 straight months. The CA adopters were confirming that CA is very important to boost production and productivity.

In addition to the above tabulated quantitative analysis , the FGD, KII and observation helped the researcher to dig more about this food security measurement. As a result the respondents confirmed that each member of the household has the access to better quantity and quality of food regardless of their sex and age. Among the household members, no one

left behind while serving food. But rather, everybody in the household come together and eat what is served.

Availability of food for household consumption throughout the year has profoundly improved the ability of everyone in the household to access better quantity and quality food. It is mentioned that farmers have been selling crops to purchase other food items from the local markets. They were doing this (selling of crops) for their children to have nutritious food.

Food Consumption Score

The table below shows that the food consumption status of interviewed households under three categories-poor, borderline and acceptable. Households who have achieved the acceptable class of food consumption score constitute 94% of the total sampled households. While, 5% of the respondents are categorized under borderline. The table further indicates that only 1% of the total sample population is found in the poor food consumption bracket. Based on the detail analysis of the food consumption score the result shows that about all the CA adoptiong farmers 346 and 9 which (out of 32 non adopting) are acceptable range while 19 (5%) of non adopting farmers are in borderline and the rest 7 non adopting farmers are in poor level clasification.

Table 22 - FCS Threshold profile by gender

FCS Classification	Survey Result		
Profile	FHH/FMHH	MHH	All HH
	%	%	%
Poor [0-20]	0	1	1
Borderline [21-35]	2	3	5
Acceptable >35	46.4	47.6	94
Total	48.4	51.6	100

FGD summary CA Practices and Food Security

To see the how CA is helping the famers on food security I did focus group discussion. Based on the response from the respondents' words, CA is 'life-changer of their household'. They responded that CA practice is has strengthen social value of the local communities. It is noted that CA farmers were supporting each other during which they collect savanna grasses from remote areas. It further solidified the existing social interaction than ever before, as the respondents said.

Before practicing CA in those targeted kebeles, the farmers did not feel that CA could increase their production and take them out of food insecurity. There was fear of adopting CA as it was new agricultural extension system. The participants also mentioned that it was completely tough for all households to switch from conventional extension system to conservation agriculture. A man from Afafer-Benare village of Assosa district said that:

> *It used to be said that CA is a foolish people work but now it is being said it is a wise people work. Because the CA farmers are becoming a role model among the communities, we live in.*

In the beginning, the farmers doubt that conservation agriculture increases production and productivity. Due to this reason, they had to practice CA on a very small plot of land and see what happens. It was after they had seen it the outcome of CA in action that they decided to expand their farmland. The significant change that conservation agriculture brought is the stagnation of burning the crop residuals while still on the farm field, the participants said.

According to the respondents, all farmers were used to burn the crop residue before the onset of the next production season. It is discovered that the CA practice shaped the way farmers do things [of farming activities] which pertained to behavioral change. One of the respondents stated that:

It was gloomy for us to involve in CA practice at the beginning as unknown country does not miss. No one was trusting CA let us produce a surplus production and improve our living standard.

Following the introduction of CA in the communities, it is stated that the farmers particularly CA adopters are able to visit their farmland [both CA and non-CA] as frequently as possible. This change which brought about by CA practice, as to them, has paramount impact in improving the productivity of the soil which, in turn, increases the yield.

Regeresssion table for CA Adoption

Regression has been computed to analyze the statistical significant level of the variance. Accordingly, age, education, training, field day, experaince sharing , listening to CA radio programing and being a membership of farmers group are the variables that significantly finluence the adoption of CA. During my observation, focus group discussion and KII I have understood that for smaller sized grains the farmers need to plough their land frequently compared to that of the larger sized crop. On other way ploughing land frequently will contradict with the first principle of CA which is minimum tillage. Therefore, farmers lean to prefere to produce larger sized grain using CA. The last significant variable for the adoption of CA is involvement of farmers in different farmers' group. This will help farmers to learn from each other while they involved in some groups.

Table 23. Regression table

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Step 1[a]	SEX	.820	.475	2.973	1	.085	2.270	.894	5.764
	AGE	.119	.106	1.248	1	.264	1.126	.914	1.386
	EDUCATION	-.535	.178	9.028	1	.003	.585	.413	.830
	LANDSZ	-.106	.195	.295	1	.587	.899	.614	1.318
	YEARCAPRACTICE	.085	.150	.321	1	.571	1.088	.812	1.459
	FARMTOOLS	-.026	.241	.012	1	.914	.974	.607	1.564
	TRIANING	2.115	1.064	3.953	1	.047	8.286	1.030	66.627
	FIELD DAY	-1.847	.643	8.259	1	.004	.158	.045	.556
	EXPERIANCE SHARING	1.182	.633	4.067	1	.035	3.259	.943	11.261
	LISTINING CA RADIO PROGRAM	-.358	.438	4.108	1	.023	.699	.296	1.651
	TYPES OF CROP BY CA	.281	.201	1.938	1	.164	1.324	.892	1.965
	CREDIT ACCESS	.339	.440	.594	1	.441	1.403	.593	3.322
	MEMBER OF FARMER GROUP	1.333	.555	5.772	1	.016	3.793	1.278	11.252
	Constant	-7.634	3.060	6.223	1	.013	.000		

a. Variable(s) entered on step 1: SEX, AGE, EDUCATION, LANDSZ, YEARCAPRACTICE, FARMTOOLS, TRIANING , FIELD DAY, EXPERIANCE SHARING, LISTINING CA RADIO PROGRAM, TYPES OF CROP BY CA, CREDIT ACCESS, MEMBER OF FARMER GROUP.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Even though, agriculture is the most important sector in the Ethiopian economy, which is characterized by low productivity and highly vernerable to climate variability. Many reseachers reported the problem with population explosion, massive environmental degradation, limited accessibility and use of technology, insufficient infrastructure, poor traditional practices and lack of information dissemination. To tackle the abover problems it is mandatory to apply different improved farming system such as CA. As indicated in the finding among the responents 91.5% adopted CA which will help them to boost the crop production and productivity and be food secured. Training, age, education ,farmers field day, listening CA radio program, experience sharing and farmers engagement in different are the major determinnats of CA adoption.

Whith regard to food security about 94 % of surveyed farmers are food secured. This shows that CA will help the farmers to be food secured and be self sufficient. In addiotion to that since there is attention for the soil fertitlity while implementing CA, the land will be regenerated since there is minimum tillage, soil cover and crop roation/association applied in CA. 92% of the CA adoptors didn't face any food shortage for 12 continous months. This also confirms that CA is very helpful in assising farmers to be food secured.

Based on the survey result, out of the total 378 respondants 35 farmers (9.3%) of them are not sure to practice CA or not, 8 (2.1%) said no and 335 (88.6%) confirmed that they will practice CA in the coming year. Therefore, this shows that the majority of the farmers are well aware of the benefit and importance of CA and they will implement CA with out the support of external agent such as NGOs.

5.2 Recommendations

Based on these findings, this study makes the following recommendations in order to increase the adoption of CA

- The regional government need to encouraging farmers to be involved in different farmers group as this will help them to learn new technologies and facilitate CA adoption.
- The regional government need to organize organizing different farmer to farmer training and experience sharing cross village/woreda are also very important in adopting CA.
- The regional government need to introduce convinuent and applicable farm tools since the adoption of technology significantly depends on the farm tools.
- As per the findings of this research maize, beans and sorghum are appropriate crops for CA be it in combination or separtaly. So, whenever the regional government want to introduce and cascade CA it is better to start with those crops.
- it is better to focus on the invovment of the farmers on different social events so that farmers can learn from each other.
- Since CA is a kind of technology that will be implemented by any age level, the regional government have to give emphasis on its implementation and consider CA as its part of other extension packages.
- Radio broadcasting about CA through the regional FM radio should also be the attention of the regional government to scalup CA.

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Annex

Sex of the respondants

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.304[a]	1	.581		
Continuity Correction[b]	.135	1	.714		
Likelihood Ratio	.305	1	.581		
Fisher's Exact Test				.712	.358
Linear-by-Linear Association	.304	1	.582		
N of Valid Cases	378				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.49.

b. Computed only for a 2x2 table

Education level of the respondants Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.401[a]	5	.044
Likelihood Ratio	13.612	5	.018
Linear-by-Linear Association	9.393	1	.002
N of Valid Cases	378		

a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is .08.

Age of the respondent-Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.199[a]	8	.251
Likelihood Ratio	10.946	8	.205
Linear-by-Linear Association	5.999	1	.014

N of Valid Cases	378		

a. 6 cells (33.3%) have expected count less than 5. The minimum expected count is .59.

Farm experience

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.514[a]	4	.111
Likelihood Ratio	6.540	4	.162
Linear-by-Linear Association	.742	1	.389
N of Valid Cases	378		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is .08.

Chi-Square Tests

Credit Access

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.035[a]	1	.851		
Continuity Correction[b]	.000	1	.998		
Likelihood Ratio	.035	1	.851		
Fisher's Exact Test				.856	.498
Linear-by-Linear Association	.035	1	.851		
N of Valid Cases	378				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.49.

b. Computed only for a 2x2 table

Have you used Credit

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.655[a]	2	.437
Likelihood Ratio	1.616	2	.446
N of Valid Cases	378		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.37.

Chi-Square Tests for training

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.985[a]	1	.026		
Continuity Correction[b]	3.958	1	.047		
Likelihood Ratio	6.902	1	.009		
Fisher's Exact Test				.026	.014
Linear-by-Linear Association	4.972	1	.026		
N of Valid Cases	378				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.59.

b. Computed only for a 2x2 table

Chi-Square Tests

Farmers field day	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.595[a]	1	.018		
Continuity Correction[b]	4.095	1	.043		
Likelihood Ratio	4.312	1	.038		
Fisher's Exact Test				.031	.031
Linear-by-Linear Association	5.580	1	.018		
N of Valid Cases	378				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.54.

b. Computed only for a 2x2 table

Experaince sharing

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.067[a]	1	.044		
Continuity Correction[b]	3.278	1	.070		
Likelihood Ratio	4.699	1	.030		
Fisher's Exact Test				.061	.029
Linear-by-Linear Association	4.057	1	.044		
N of Valid Cases	378				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.89.

b. Computed only for a 2x2 table

Chi-Square Tests

Land size	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.766[a]	6	.838
Likelihood Ratio	4.850	6	.563
Linear-by-Linear Association	.034	1	.854
N of Valid Cases	378		

a. 5 cells (35.7%) have expected count less than 5. The minimum expected count is .68.

Chi-Square Tests

Mass media	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.108[a]	1	.043		
Continuity Correction[b]	3.319	1	.068		

Likelihood Ratio	3.809	1	.051		
Fisher's Exact Test				.063	.038
Linear-by-Linear Association	4.097	1	.043		
N of Valid Cases	378				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.06.

b. Computed only for a 2x2 table

Chi-Square Tests

Farm tools	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.112[a]	3	.550
Likelihood Ratio	2.552	3	.466
Linear-by-Linear Association	.152	1	.696
N of Valid Cases	378		

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is .42.

Crop type- Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.675[a]	4	.614
Likelihood Ratio	2.718	4	.606
Linear-by-Linear Association	1.190	1	.275
N of Valid Cases	378		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is .17.

Chi-Square Tests

Membership in farmers group	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.145[a]	1	.013		
Continuity Correction[b]	5.226	1	.022		
Likelihood Ratio	6.934	1	.008		
Fisher's Exact Test				.012	.008
Linear-by-Linear Association	6.129	1	.013		
N of Valid Cases	378				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.43.

b. Computed only for a 2x2 table

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	AGE	.932	1.073
	EDUCATION	.951	1.052
	LANDSZ	.877	1.140
	FARMTOOLS	.934	1.071
	TRIANING	.918	1.089
	FIELD DAY	.959	1.042
	EXPERIANCE SHARING	.893	1.120
	LISTINING CA RADIO PROGRAM	.886	1.129
	TYPES OF CROP BY CA	.832	1.201
	CREDIT ACCESS	.913	1.095
	MEMBER OF FARMER GROUP	.956	1.046
	MEMBER OF AGGREGATION GROUP	.907	1.103

a. Dependent Variable: SEX

1. Household Interview

Interview the CA farmer in the household at the time of the visit. Use one questionnaire per household. In case of a child headed household, interview the senior CA farmer of the household.

Questionnaire No:…….

Hello, my name is _____. I am an enumerator to collected data for the Master of Science (M.Sc.) thesis titled as "Adoption and practice of conservation agriculture and its implication on food security in Assosa woreda, Benshangul Gumuz region". To see how CA is helping you, we would like to hear about your experience with CA over the past two years and your perspectives on some different aspects of the practices. I want to thank you for your time today and would like to reassure you that your responses on these matters will remain confidential. But the information gathered from all the interviewee will be analysed and shared for the public. Your responses will contribute for the entire assessment and it is not taken as individual response. You are free to refuse to answer any question and you may end your participation in this interview at any point without any negative consequences. However, I would greatly appreciate if you could share your experiences and opinions, and show us your CA farm after the interview, which will contribute to better understanding the current situation in your community with regards to sustainable farming and food security.

SECTION A. IDENTIFICATION

Interview date……..…/……..……/2020 County……..……..Location ……

Sub location ……..Village…….

Name of Interviewer ……..……..……

Starting time …… Ending time …….

INTRODUCTION and purpose of the questions and observations: To study the adoption and practice of conservation agriculture and its implication on food security.

SECTION B: DEMOGRAPHIC INFORMATION

NO.	QUESTION	ANSWER CATEGORY
1	Code for the CA farmer respondent	Code:
2	This farmer is a CA farmer?	Yes / No
3	This CA farmer is the head of the household?	Yes /No. If no, who is the head of the household? Circle: M / F
4	Gender of the respondent	1. Male 2. Female
5	Age of the respondent	Age:

6	Which role do you play in this CA project? (Tick one)	__ CA Farmer __ ToT ___ Lead Farmer ___ Contact Farmer __ Model Farmer __ Champion Farmer ___ Animator ___ Mentor Farmer
7	Is this farmer a member of a CA farmer group?	____ Yes ____ No. If yes, what is the name of the CA Farmer Group?

Objective 1: To identify the relevant conservation agriculture practicing method

Section C: Let's talk about your CA farm and let's go see it after we finish talking here.

1. Which CA principles do you practice? List all here:

Table C-1: How many seasons and for which main crops have you practiced each of the CA principles since the last five years?

CA practices embraced	Category of CA principle	No. of seasons	Main crop for each principle
Minimum tillage	Minimum Soil Disturbance		

Cover crops	Permanent Soil Cover		
Mulching	Permanent Soil Cover		
Intercropping	Crop rotation & association		
Crop rotation	Crop rotation & association		

Table C-: Which CA learning events did you attend over the past two years?

Topic *(edit as per country/partner*)	**Mark (Tick)**	**Relevance/Usefulness (1-5) where 1 is lowest, 5 is highest**	**If rated 4 or 5, why was it relevant?**	**If didn't attend Why not?**
Group dynamics				
Situational analysis (Why CA?)				
Contour farming				
Minimum tillage & CA tools for planting				
Minimum Tillage Ripping				
Minimum Tillage Planting basin				
Importance of soil cover/mulching				
Planting with precision				
Cover crops				
Record keeping				
Weed Management in CA				
Crop residue Management				
Post-harvest Management				
Village Savings and Loans (VSLA)				

Self Help Groups				
Agroforestry				
Pest and Disease prevention				
Soil Fertility				
Nutrition / Food Habits				
Advocacy for and by farmers				
Marketing and value chain development				
Gender roles				
Other:				

2. Was the training offered at a time (YES / NO / DON'T KNOW), on a day (YES / NO / DON'T KNOW), and at a venue (YES / NO / DON'T KNOW) which made it possible for women to attend? Answer appropriately for each one. If no, why not?

3. Was childcare offered for women CA farmers with nursing babies / small children so that women could attend the CA training without "disruption"? Yes / No. Did women CA farmers with nursing babies / small children attend the trainings? YES / NO / Don't know. Was the environment welcoming for women with nursing babies and small children to attend the training? YES / NO / DON'T KNOW.

4. Have you participated in:
   a) CA field day/Exhibitions – yes or no?
      If yes, on a scale of 1-5, how useful was this experience for learning more about how to practice CA on your farm?
      1 = not useful at all; 2 = not very useful; 3 = neither useful or not useful; 4 = useful; 5 = very useful
      Please explain your reason for choosing your response:

   b) CA farmer exchange visit – yes or no?
      If yes, on a scale of 1-5, how useful was this experience for learning more about how to practice CA on your farm?
      1 = not useful at all; 2 = not very useful; 3 = neither useful or not useful; 4 = useful; 5 = very useful
      Please explain your reason for choosing your response:

Objective 2: To assess farmers' perception on CA and level of adoption

Section H: Perception of farmers:

1. As a result of practicing CA, has your household's ability to pay for household needs changed over the past year?

1 – No change (CA has made no difference)
2 – Little change
3 – Great change
4 – Very much change

1b. Why has your household's ability to pay for household needs changed (*or not changed*) over the past year?

1c. How has the CA harvest affected your household's ability to pay for household needs:

1. Very able
2. Able
3. Somewhat able
4. Not able

2. In which three ways has CA been most useful to you?

1.

2.

3.

3. Please share with us three ways in which CA can be improved to be more helpful to you?

1.

2.

3.

4. What is the most important thing that keeps you implementing CA? Please rank each important thing on a scale of 0-5, with 0 being not applicable, 1 being not important and 5 being extremely important.

___ Free seeds

___ Free tools

___ Free herbicides

___ Free fertilizer

___ Free pesticides

___ Increased knowledge

___ Increased yields

___ Reduced labour

___ Linkages to markets

___ Linkages to suppliers

___ Improved soils

___ Reduced weeding time required

___ Reduced artificial fertilizer input required

___ Other: specifiy

5. Please rank each important thing on a scale of 0-5, with 0 being not applicable, 1 being not important and 5 being extremely important.

Do you intend to practice CA again next year? Yes / No Why or why not? Please explain:

6. If yes, will you practice CA on the same plot(s)? Yes / No Why or why not? Please explain:

7. If yes, will you practice CA on the same size of plot(s)? (Same size, smaller or bigger). Tick one. Please explain:

9. Have any of your neighbors copied from you and started CA? Yes / No If yes, how many?_____

Objective 3: Identify the Factors that determine the adoption of conservation agriculture practices

5. For the season that has just ended, or if you are in season now, how many plots do you practice CA on? _____ What is the size of each CA plot and what are all the crops on each CA plot (list in table below)?

Table C-3

CA Plot:	**Size of CA Plot (in mxm or acres or hectares). Indicate unit used.**	**List ALL crops and plants and vegetation on each CA Plot (grains, legumes, green manure, vegetables, fruits, flowers, pest control plants, trees, etc.)**
CA Plot 1		
CA Plot 2		
CA Plot 3		
CA Plot 4		
CA Plot 5		

Table C-4: For the growing season that has just ended, please answer the following questions for **each of your CA plots as listed in Table C-3**. Which crops did you grow using CA principles on each plot? (To the Enumerator: List these crops in row 1 in the table below, for each plot. Ask each question across the rows for each plot listed and not down the columns per crop.)

Last Season:	**CA Plot 1**	**CA Plot 2**	**CA Plot 3**	**CA Plot 4**
1. Which main crop was grown using CA principles during the growing season that has just ended? (list main crop per plot).				

2. Which inputs did you use in the CA plot? (read each one and tick each one used).	___herbicide ___hybrid seed ___artificial fertilizer ___animal manure ___compost manure ___pesticides ___ other:_____	___herbicide ___hybrid seed ___artificial fertilizer ___animal manure ___compost manure ___pesticides ___other:_____	___herbicide ___hybrid seed ___artificial fertilizer ___animal manure ___compost manure ___pesticides ___other:_____	___herbicide ___hybrid seed ___artificial fertilizer ___animal manure ___compost manure ___pesticides ___ other:_____
3. Was the main crop intercropped with another crop? 3a. If yes, with which one(s)?	___ Yes ___ No If yes, Plot 1 crop was intercropped with:	___ Yes ___ No If yes, Plot 2 crop was intercropped with:	___ Yes ___ No If yes, Plot 3 crop was intercropped with:	___ Yes ___ No If yes, Plot 4 crop was intercropped with:
3b. In case the main crop was intercropped, estimate the proportion of the main crop in the plot.	Proportion of crop in plot: ___ 100% ___ 50% ___ 75% ___ 25%	Proportion of crop in plot: ___ 100% ___ 50% ___ 75% ___ 25%	Proportion of crop in plot: ___ 100% ___ 50% ___ 75% ___ 25%	Proportion of crop in plot: ___ 100% ___ 50% ___ 75% ___ 25%
4. Was the main crop rotated with another crop? If yes, with which one(s)?	___ Yes ___ No If yes, Plot 1 crop was rotated with:	___ Yes ___ No If yes, Plot 2 crop was rotated with:	___ Yes ___ No If yes, Plot 3 crop was rotated with:	___ Yes ___ No If yes, Plot 4 crop was rotated with:
5. Did you collect and add additional mulch to your CA field? Yes or No. If yes, what was used as mulch? Did you achieve 30% cover?	___ Yes ___ No Mulch Type: Source: 30% ___ Yes ___ No	___ Yes ___ No Mulch Type: Source: 30% ___ Yes ___ No	___ Yes ___ No Mulch Type: Source: 30% ___ Yes ___ No	___ Yes ___ No Mulch Type: Source: 30% ___ Yes ___ No
6. Did the main crop have a soil cover crop? If yes, which crop was the soil cover crop?	___ Yes ___ No If yes, soil cover crop:	___ Yes ___ No If yes, soil cover crop:	___ Yes ___ No If yes, soil cover crop:	___ Yes ___ No If yes, soil cover crop:
7. Did the main crop experience any pests? If so, are the pests for crops under CA less, more or the same as the same crop not grown under CA?	___ Yes ___ No If yes, pests are: ___ Less ___ Worse ___ Same ___ Don't know	___ Yes ___ No If yes, pests are: ___ Less ___ Worse ___ Same ___ Don't know	___ Yes ___ No If yes, pests are: ___ Less ___ Worse ___ Same ___ Don't know	___ Yes ___ No If yes, pests are: ___ Less ___ Worse ___ Same ___ Don't know

8. Which tools were used to prepare your land for planting? Select all that are applicable.	___ handhoe ___ conventional plough ___ modified plough ___ ripper ___ jab planter ___ machete ___ subsoiler ___ chisel plough ___ none ___ other: _____	___ handhoe ___ conventional plough ___ modified plough ___ ripper ___ jab planter ___ machete ___ subsoiler ___ chisel plough ___ none ___ other: _____	___ handhoe ___ conventional plough ___ modified plough ___ ripper ___ jab planter ___ machete ___ subsoiler ___ chisel plough ___none ___other: _____	___ handhoe ___conventional plough ___ modified plough ___ripper ___ jab planter ___ machete ___ subsoilers ___ chisel plough ___ none ___ other: _____
9. Is more time required to prepare the land for the crop under CA compared to the same crop not under CA?	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No
10. Who performed the land preparation? (Tick all that apply and record number of people of each category who worked per plot)	___Adult male farmer ___Adult female farmer ___ Boy under 18 ___ Girl under 18 ___ Hired adult male ___ Hired adult female	___Adult male farmer ___Adult female farmer ___Boy under 18 ___Girl under 18 ___ Hired adult male ___ Hired adult female	___Adult male farmer ___Adult female farmer ___Boy under 18 ___ Girl under 18 ___ Hired adult male ___ Hired adult female	___Adult male farmer ___Adult female farmer ___Boy under 18 ___ Girl under 18 ___ Hired adult male ___ Hired adult female
11. Which methods and tools were used for weeding? Tick all that apply for each plot.	___ handhoe ___ machete ___ herbicide ___ hand pulling ___ scraper ___ plough ___ mulch ___ none ___ other: _____	___ handhoe ___ machete ___ herbicide ___ hand pulling ___ scraper ___ plough ___ mulch ___ none ___ other: _____	___ handhoe ___ machete ___ herbicide ___ hand pulling ___ scraper ___ plough ___ mulch ___ none ___ other: _____	___ handhoe ___ machete ___ herbicide ___ hand pulling ___ scraper ___ plough ___ mulch ___ none ___ other: _____
12. Is more time required to weed each main crop compared to the same crop not under CA?	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No
13. Who performed the weeding? (Tick all the apply and record number of people of each category who worked per plot).	___Adult male farmer ___Adult female farmer ___Boy under 18 ___ Girl under 18	___Adult male farmer ___Adult female farmer ___Boy under 18 ___ Girl under 18	___Adult male farmer ___Adult female farmer ___Boy under 18 ___ Girl under 18	___Adult male farmer ___Adult female farmer ___Boy under 18 ___ Girl under 18

	___ Hired adult male ___ Hired adult female	___ Hired adult male ___ Hired adult female	___ Hired adult male ___ Hired adult female	___ Hired adult male ___ Hired adult female
14. What was the yield of your CA main crop (in kg) for the most recent harvest? (If there was no CA harvest, indicate the reason(s) why there was no CA harvest, and go to question 24). Did the household remove any of the main crop from the field before it was dried?	_____ Kgs Reason(s) for no yield: Did the household eat some of the crop before it matured? Yes/No. **If yes, how much (in kg)?**	_____ Kgs Reason(s) for no yield: Did the household eat some of the crop before it matured? Yes/No. **If yes, how much (in kg)?**	_____ Kgs Reason(s) for no yield: Did the household eat some of the crop before it matured? Yes/No. **If yes, how much (in kg)?**	_____ Kgs Reason(s) for no yield: Did the household eat some of the crop before it matured? Yes/No. **If yes, how much (in kg)?**
15. Have you experienced any benefits to your household from the CA crop harvest? How did the CA crop harvest help you?	Yes / No. If yes: a) I saved money by not buying food b) I sold the CA crop harvest and earned money c) Both	Yes / No. If yes: a) I saved money by not buying food b) I sold the CA crop harvest and earned money c) Both	Yes / No. If yes: a) I saved money by not buying food b) I sold the CA crop harvest and earned money c) Both	Yes / No. If yes: a) I saved money by not buying food b) I sold the CA crop harvest and earned money c) Both
16. What proportion of the CA main crop harvest was sold? Are you storing the main crop to sell for a better price in the future?	___ None ___Half ___ All ____ 3/4 _____1/4 Yes / No	___ None ___Half ___ All ____ 3/4 _____1/4 Yes / No	___ None ___Half ___ All ____ 3/4 _____1/4 Yes / No	___ None ___Half ___ All ____ 3/4 _____1/4 Yes / No
Continue with the next questions only if all or some of the CA harvest was sold; otherwise go to question 23.				
17. Who made the decision about how to spend the money earned from the CA harvest? (Tick only one).	___ Husband ___ Wife ___ Together ___ Other: _____	___ Husband ___ Wife ___ Together ___ Other: _____	___ Husband ___ Wife ___ Together ___ Other: _____	___ Husband ___ Wife ___ Together ___ Other: _____
18. For what price did you sell the main CA crop? (in local currency per Kg)				
19. Do you consider this a fair market price?	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No
20. Is this a better price than last season?	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No

21. Did you sell at farm gate? (Did someone come to the farm to buy?)	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No
22. Did you aggregate your main CA crop with other farmers' produce for a higher price?	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No
23. What is the major challenge you face in farming each of the CA plots? (Be specific for each plot).				
24. Do you keep written records on this plot? *(If yes, enumerator to take a photo of the records).*	___ Yes ___ No ___ Photo Taken	___ Yes ___ No ___ Photo Taken	___ Yes ___ No ___ Photo Taken	___ Yes ___ No ___ Photo Taken

6. Are you a member of any Savings and Credit group? Yes No (if No why not?)
If yes, when was this Savings and Credit group formed?
If yes, is your Savings and Credit Group local or other?
If local, which type? ____VSLA _If other, which type? ___ microfinance bank
___table banking ___ commercial bank
___ merry go round ___ cooperative society
___ other ___ mobile banking
___ other

If yes, does your savings and credit group support CA Farming *(for example, through loans, inputs, training, other ways)?*

Yes (If Yes, how?) No. (Why not?)

7. Have you taken credit in order the practice CA farming over the past 2 years? Explain why or why not.

8. Did you purchase any agricultural inputs for your CA plot? (seed, fertilizer, pesticide or tools) this past season? Yes / No.

If no, why did you not buy inputs for the CA plot? ____I have them already ____I was given for free _____Other:_____

If yes, did you buy them at the same supplier as before you began practicing CA or at a different supplier? (Same / Different)

If you purchased from a different supplier, why did you change suppliers?

What would you say about CA to a non-CA farmer from your experience so far?

Objective 4: To assess the implication of Conservation Agriculture on food security

Section D: Please tell us about the foods you have eaten over the past 7 days.

This past week, for each day, during the day and at night, think back to what you (you as an individual, not as a household) ate and drank for breakfast, for lunch and for supper as well as in between meals, at night or any other time.

Record answers in the table below. (In case the amount consumed is less than one tablespoon, do not count as a yes).

ENUMERATOR: Start with the day of yesterday and work backwards.

Food groups	**Food categories**	**Examples**	**Consumed, yes or no**

			Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
1. Grains, white roots and tubers, and plantains	Any food made from grains; cereals	Porridge, rice, noodles, injera, dried maize, bread	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
	White roots, tubers or plantains	White potatoes, white yams, cassava, cocoyam, green bananas, white sweet potatoes	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
2. Other vitamin A-rich fruits and vegetables	Orange coloured vegetables or roots	Pumpkins, carrots, butternut squash, orange fleshed gourds, orange-fleshed or dark yellow sweet potatoes, sweet red peppers, etc.	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
	Any fruits that are dark yellow or orange inside	Ripe mango, ripe papaya, pink guavas, ripe passion fruits, loquats, cantaloupe, peaches, tree tomato, etc.	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|

3. Dark green leafy vegetables	Any dark green leafy vegetables	Kales, spinach, manangu, wild vegetables, broccoli, okra, etc.	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|___| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|
4. Other fruits	Any other fruits	Banana, Avocado, baobab, orange, lemon, watermelon, pineapple, tamarind, white guava, various berries, grapes, wild fruits, etc.	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|___| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|
5. Other vegetables	Any other vegetables	Cabbages, onions, corgettes (zucchini), French beans, other bean pods, pea pods, cucumbers, green peppers (capsicum), green maize, sweet corn, tomato, light coloured squash, Beet	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|___| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|

		roots, etc.							
6. Meat, poultry, and fish	Any meat made from animal organs	Kidney, liver, heart, or other organ meat or blood based foods	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
	Any other types of meat or poultry	Beef, lamb, goat, rabbit, chicken, duck, other birds	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
	Fresh or dried sea food.	Fish, seafood, etc.	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
7. Eggs	Any eggs	From poultry or any other birds	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
8. Pulses (beans, peas, and lentils)	Any mature beans or peas or nuts	Mature beans or peas (fresh or dried), lentils, peas, groundnuts, cashew nuts, other nuts	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
9. Nuts and seeds	Any nuts or seeds	Ground nuts / peanuts, any tree nut/seed, any nut "butters"	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|
10. Dairy	Any milk or milk products	Milk, cheese, yoghurt, fermented milk /	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|	Yes|___| No |___|

		mala, but NOT butter, ice cream, cream or sour cream							
11. Sugar	Sugar and sugar products	Sugar, honey	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|___| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|
12. Fats	Fats and oils	Butter, cooking oil, cooking fat	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|___| No |___|	Yes|__| No |___|	Yes|__| No |___|	Yes|__| No |___|

Section E: Coping Strategies

SIMPLE FOOD CONSUMPTION COPING STRATEGIES	
During the last 7 days, were there days (and, if so how many) when your household had to employ one of the following strategies (to cope with a lack of food or lack of money to buy food)? **READ OUT STRATEGIES**	Frequency (number of days from 0 to 7)
1 Relied on less preferred, less expensive food?	
2 Borrowed food or relied on help from friends or relatives?	
3 Reduced the amount of food (quantity) consumed daily by mothers in order for young children to eat?	
4 Sent household members to eat elsewhere?	
5 Went an entire day without eating?	

LIVELIHOOD COPING STRATEGIES	
During the past *30 days*, did anyone in your household have to engage in any of the following behaviours *due to a lack of food or a lack of money to buy food?*	1 = Yes 2 = No, because I did not face a shortage of food

(Tick the correct answer under 1, 2, 3, or 4).	3 = No, because I engaged in this activity within the last 12 months and cannot continue to do it 4 =Not applicable			
STRESS CATEGORIES:	1	2	3	4
1 Purchased food on credit?				
2 Sold household non-productive assets / goods (radio, furniture, television, etc.)?				
3 Spent savings?				
4 Sold more male and non-productive female animals than usual?				
5 Moved children to a less expensive school?				
CRISIS CATEGORIES:				
1 Sold productive assets (ox, donkey, wheelbarrow, bicycle, cart, farm tool, etc.)?				
2 Withdrew children from school?				
3 Harvested immature crops (for example, green maize)?				
4 Consumed seed stocks that were to be saved for the next planting season?				
EMERGENCY CATEGORIES:				
1 Sold land?				
2 Sent children or other household members to beg?				
3 Sold last female animal?				
4 Entire household migrated?				

Indicate here any other coping strategies that the household used:

Section F: Food Supply

Now I would like to ask you about your household's food supply during different months of the year. (Think back over the last 12 months, from this month going backwards). **Please note: This includes any kind of food from any source, whether from one's own farm, purchased or exchanged, borrowed, given for free, or taken on credit.** 1. Were there months, in the past 12 months, in which **you did not have enough food** to eat for the full month? 2. If yes, tick the situation of the food adequacy per month below. If No, go to Section F.		Yes |___| No |___|
Month	**Enough Food**	**Not enough food**
March 2020	|___|	|___|
February 2020	|___|	|___|
January 2020	|___|	|___|
December 2019	|___|	|___|
November 2019	|___|	|___|
October 2019	|___|	|___|
September 2019	|___|	|___|
August 2019	|___|	|___|
July 2019	|___|	|___|
June 2019	|___|	|___|
May 2019	|___|	|___|
April 2019	|___|	|___|

If you had no months in which you did not have inadequate food, how was your household able to have enough food?

Section G: Food and Household Expenses

Household Expenditures – Past 30 days			
In the last 30 days approximately how much did your household spend on the following? (in local currency)			
Categories can be added or removed based according to what is appropriate to the local context (maximum change of categories of 4-6)			
1 Soap and other household toiletries		12 Phone Airtime	
2 Transport (minibus, bikes, carts, etc.)		13 Electricity / Lighting	
3 Fuel (wood, charcoal, cooking gas etc.)		14 Alcohol / tobacco / khat	
4 Water		15 Renting land	
5 Medical expenses, health care		16 Tithe / Gifts	
6 Clothing / shoes		17 Savings / Chamas / Table Banking Groups	
7 Education / school fees, uniform etc.		18 Animal feed & health (e.g. veterinary)	
8 Debt repayment		19 Insurance	
9 Celebrations / social events / funerals		20 Construction / house repairs	
10 Water tank		21 Farming equipment	
11 Seeds		22 Fertilizer / Herbicides / Pesticides	

FOOD EXPENDITURES				
		G1 – Did you purchase any of the following items during the *last 30 days* for household consumption? If "NO", enter '0' in first column and proceed to the next food item. If "yes", ask the respondent to estimate the total cash and credit expenditure on the item for the *last 30 days.* (register the expenses in local currency)		G2 – During the *last 30 days* did your household consume the following foods without purchasing them? (e.g., consumed from own production). If "Yes", estimate the amount and value of the non-purchased food items consumed during the *last 30 days*
	Food Item			
		Cash, in local currency	***Credit, in local currency***	***Value, in local currency***
1.	Cereals (maize, rice, sorghum, wheat, teff, millet, bread, etc.)			
2.	Tubers (potatoes, arrow roots, yams, cassava, enset, etc.)			
3.	Pulses (beans, peas, groundnuts, baghia, etc.)			
4.	Fruits & vegetables			
5.	Fish/Meat/Poultry/Eggs			
6.	Milk/cheese/yoghurt			
7.	Oil, fat, butter			
8.	Sugar/salt			

9.	Tea/coffee			
10.	Other meals/snacks consumed outside the home			

Summary:

How would you rate your household's current state of food security?

2) Food secure
3) Slightly food insecure
4) Moderately food insecure
5) Very food insecure
6) Extremely food insecure

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