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The case of three districts of Tigray, Northern Ethiopia

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Indra Gandhi National Open University

Masters of Art in Rural Development

Thesis Proposal

Opportunities and Challenges for Adopting Conservation Agriculture At Smallholder Farmer's Level
The case of Embalage, Tigray, Northern Ethiopia

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INTRODUCTION

BACKGROUND

Declining soil fertility is a major constraint on crop production in the semi-arid highlands of Tigray, Northern Ethiopia. In many parts of Ethiopia, land degradation in the form of soil erosion, nutrient depletion, soil compaction, and increased salinization and acidity pose a serious threat to sustainable intensification and diversification of agricultural production systems. Moreover, prevailing soil management practices including over tillage and blanket fertilization are key factors in Ethiopian agriculture's contribution to climate change. It is estimated by the World Bank that annually, 30,000 ha of agricultural land is lost due to topsoil erosion, and that the annual cost of land degradation is about 2-3% of agricultural GDP. Furthermore, the rate of soil loss due to water erosion is among the highest globally, averaging 30 to 42 tons/ha/year,(Mitiku et al, 2006). In addition, Ethiopia has the highest level of salt affected soils in Africa (FAO, 1988),while the occurrence of highly weathered acid soils is two to three times higher than that of other East African countries (Sumner and Nobel, 2003) .[3]

One of the major constraints to crop production faced by smallholder subsistence farmers is the inadequate supply of nutrients (Quinones et al., 1998; Shapiro and Sanders, 1998). Farmers are either entirely abandoning the traditional practice of using natural fallow to restore soil fertility, or are unable to leave land fallow for long enough for it to be effective. The use of mineral fertilisers is declining as they are increasingly beyond the means of most small-scale farmers (Larson and Frisvold, 1996). Erosion and severe run-off are further depleting existing soil nutrient reserves, while levels of soil organic matter are declining as land is subject to over-use.

The majority of the soils of Tigray are reported to be shallow, have low soil fertility, high run-off, and low infiltration capacity (Mitiku, 1996). Declining soil fertility is particularly severe in Tigray because of high nutrient losses through soil erosion, and extremely low use of external nutrient inputs (Virgo and Munro, 1978).

Declining soil fertility has continued to be a major constraint to food production in many parts of the tropical region. The low soil fertility in the tropics has been attributed to the low inherent soil fertility, loss of nutrients through erosion and crop

harvests and little or no addition of external inputs in the form of organic or inorganic fertilizers. This is particularly evident in the intensively cultivated areas, traditionally called high potential areas that are mainly concentrated in the highlands of Ethiopia.

These imply that the outflow of nutrients in most smallholder farms far exceeds inflows. To address the problems of soil fertility, several technological interventions, especially those geared towards nutrient management and soil moisture conservation, have been suggested. Besides, the productivity of some soils is constrained by some other limiting factors even though they have high potential productivity or are naturally fertile.

In many parts of Ethiopia, including Tigray, the shortage of firewood leads to the utilization of straw and leaves for fuel. Animal manure is also commonly dried and burned. Very little organic residues are therefore returned to the soil apart from the roots of annual crops. As a consequence, soils become low in organic matter after sometime of continuous cultivation. Depletion of organic matter and destruction of soil aggregates lead to increased rates of soil losses in cultivated areas.

However, they can be reversed in part by promoting increased adoption of appropriate soil management techniques and soil amendments by smallholder farmers as well as by restoring soil fertility through enhanced agronomic practices, improving the adoption of appropriate fertilizer use and other soil fertility augmenting technologies, such as conservation agriculture. Many countries that have successfully transformed their agriculture sector, and done so in a sustainable manner, have focused on the adoption of improved soil management techniques and other soil fertility enhancing technologies, with significant gains.

This research aims at understanding and documenting the opportunities and challenges for adopting conservation agriculture at smallholder farmer level in different livelihood zones of Tigray and suggests policies and strategic approaches for increased adoption of the technology by smallholder farmers.

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STATEMENT OF THE PROBLEM

Conservation actions to halt and reverse degradation as well as boost agricultural productivity have gained increasing interest in Africa and the world at large. Conservation approaches, particularly through Conservation Agriculture (CA), could contribute significantly to reducing land degradation and increasing food security.

Conservation agriculture (CA) has been proposed as an alternative to conventional tillage to sustainably intensify crop production. Conservation Agriculture (CA) is a combination of tested scientific technologies and/or principles in agricultural production. The key-elements of conservation agriculture are minimal soil disturbance (minimum or no-tillage), stubble retention, and the implementation of viable crop rotations. Compared to tillage-based agriculture, CA has the potential to decrease soil loss, enhance levels of soil organic matter, increase plant available soil water, and save costs due to fewer or no tillage operations. CA is an approach that advocates the concept of sustainable intensification of production by picking the best possible options that farmers can apply at their own conditions.

The practice of CA in Africa is now maturing with increasing demand for more sustainable agricultural practices and better natural resources management and conservation. Conservation Agriculture, as a concept for natural resource-saving, strives to achieve acceptable profits with high and sustained production levels while concurrently conserving the environment. It appears to be a promising way of attaining sustainable agricultural production.

Conservation Agriculture is being practiced in a number of countries as traditional soil and water conservation practices by specific communities or at pilot project scale throughout the continent. Despite the difficulties faced in the first years of implementation, benefits from this practice have shown great potential in boosting agricultural production and diversifying livelihood incomes.

But its level of adoption is still very low and the total area of coverage could be estimated to be less than 1 percent of the continent’s land. Therefore, there is need to move from project based and site based approaches to programme large scale approaches through upscaling of this technology.

The vulnerability to climate-related hazards and food insecurity is closely linked to land degradation. About 85% of the land surface in Ethiopia is considered susceptible to moderate or severe soil degradation and erosion. In the Highlands, those problems are reducing the sustainability of agricultural production, thereby making it difficult for rural populations to meet their basic needs. Repeated ploughing to achieve fine seedbeds using maresha, the almost complete removal of crop residues after the harvest and insufficient application of manure are major contributors for soil degradation in Ethiopia. Tillage has long been used by farmers to loosen the soil, make a seedbed, and control weeds. However, not all outcomes of this practice are positive; it has been discovered that tillage operations, over time, cause a decline in soil fertility and overall productivity resulting from deterioration of soils' physical, chemical, and biological properties.

Among the solutions being floated to mitigate the impact of climate change is adapting to droughts through sustainable farming methods. Conservation farming (CF) practices hold the promise of providing both a strategy for mitigating climate change and also working as an adaptive mechanism to cope with climate change. CF is being promoted as a panacea to the production challenges, confronting rural smallholder families particularly in Sub-Saharan Africa.

While soil conservation practices, including minimum or no tillage have long been practiced by farmers in Ethiopia, conservation agriculture and its associated package of best practices were introduced in 1998 by Sasakawa Global 2000 (SG 2000) on 77 maize plots (Matsumoto et al., 2004).

Despite the decade old national effort to systematically disseminate conservation agriculture, no empirical evidence has been presented as to what extent the technology package is being adopted, or the extent to which farm yields are being influenced. Only a few studies (Kassie et al., 2009; Rockstrom et al., 2009; Wellelo et al., 2009; and Shames, 2006) have reported on the status and effects of conservation agriculture in the country.

The adoption of CF in Ethiopia would enable farmers to benefit from improved crop yields and other associated economic gains and also contribute to the sustainable management of land resources in the country. Besides, the policy environment in the country is favourable for promoting CF as the government has recently developed a

national strategy for Sustainable Land Management practices in which the CF is an important component. Despite such a sound policy framework, the practical implementation of the CF on the ground has not yet materialized.

Therefore, the adoption of CF, which aims to conserve soil and water by using surface cover (mulch) to minimize runoff and erosion and improve the conditions for plant establishment and growth could minimize the impact of climate change and land degradation in Ethiopia.

Looking in to the opportunities and challenges for adapting the conservation could enable to identify feasible strategies to promote and scale up conservation agriculture at a wider scale in smallholder farmers.

RESEARCH OBJECTIVE

General objective

The overall objective of this research is to identify the feasible strategies for the promotion and scaling up of conservation agriculture by smallholder farmers by studying the opportunities and challenges for adopting the tested technology.

Specific objective

The research is specifically aiming:

- To understand and analyse farmer's perception on conservation agriculture;
- To document existing practices implemented by the farmers from components of conservation agriculture;
- To assess the opportunities and challenges for adapting the technology in the context of the existing farming system.

HYPOTHESIS

The hypotheses framed for this study are as follows:

- Farmers have general knowledge on conservation agriculture practices;
- The adoption rate of the farmers for conservation agriculture is affected by the socio-economic and bio-physical conditions in the local area;
- The smallholder farmers have experience in practicing one or more of the conservation agriculture components.

LITERATURE REVIEW

Ethiopian agriculture is characterized by low productivity attributed mainly to soil degradation and inefficient use of water resources. Soil and water resource use inefficiency is so significant that the country is unable to produce enough grains to feed its population even in years of good rainfall (Kassa, 2003). The domestic grain production is estimated to supply only about 70% of the total food requirement, and each year, 4 to 6 million people need food assistance despite the existence of potentially productive resources for food self-sufficiency and even surplus production (EEA, 2006). Virtually all of the country's crop farming is operated by smallholder farmers, practicing traditional plough-based activities. It is well documented that conventional farming with frequent ploughing gradually degrades the physical structure and chemical quality of tropical soils (Brady and Weil, 2001). The dire situation Ethiopia is facing has prompted the government and other actors in agriculture to identify and implement alternative farm-level practices that increase productivity without undermining the natural resources.

Conservation agriculture, a package of activities initially promoted by FAO, was among one of the initiatives introduced in Ethiopian agricultural system to abate deterioration of soil and water resources. According to FAO (2001), conservation agriculture aims at making better use of agricultural resources through the integrated management of available soil, water and biological resources, combined with limited external inputs. The concept of conservation agriculture aggregates a number of soil and water management and conservation practices under a single banner for delivery to farmers (Garcia-Torres et al., 2003; Knowler and Bradshaw, 2007).

Conservation agriculture promotes different conservation practices, with permanent soil cover, minimal soil disturbance, and crop rotations always emphasized (FAO, 2001). Different conservation agriculture practices have included, among others, integrated pest management (Leake, 2003), planting of perennial legume trees (Mowo and Kiwia, 2009), construction of runoff harvesting furrows (Wellelo et al, 2009), manure and inorganic fertilizer applications (Mazvimavi and Twomlow, 2009).

While soil conservation practices, including minimum or no tillage have long been practiced by farmers in Ethiopia, conservation agriculture and its associated package of best practices were introduced in 1998 by Sasakawa Global 2000 (SG 2000) on 77 maize plots (Matsumoto et al., 2004).

Land degradation in northern Ethiopia is a great problem mainly aggravated by overpopulation in the highlands, over cultivation, soil erosion, and an unbalanced crop and livestock production system (Girma 2001). As a consequence of loss of the top fertile soil by erosion, there is severe decline in soil quality. The poor infiltration and water holding characteristics of the soil makes water a key limiting factor for crop yield in this area. The livelihood of 85 % of the population of Tigray depends on agriculture, mainly on crop production, and small units of land have been extensively cultivated by subsistence farmers for centuries.

The rain fed farming agriculture is dominant and has low productivity. The rainfall in the region is erratic and insufficient during the growing season (Ermias et al.2005). It is common to observe both water logging and drought in one cropping season (personal observation). Soil oisture in the Vertisols is insufficient due to periodic drought, low moisture holding capacity of the soils, high tillage frequency, and high runoff rates from sloping lands in case of periodic excess of rain water (Mati 2006). Tillage is done with a breaking plough locally known as mahresha with frequent ploughing before sowing which may result in compaction, poor drainage and crusting in Vertisols. Also, farmers harvest the straw of crops in order to feed their animals leaving no residues as soil cover. There is also free grazing of animals on the stubble residue after harvest. These operations have led to the long term reduction in soil organic matter content which consequentially increased soil erosion. Recent policy in Tigray region favours in situ water conservation, stubble management and the abandonment of free grazing. Vertisols are hard when dry, very sticky when wet and susceptible to erosion depending on how the y are managed and on their top soil structure and texture (Deckers et al. 2001). McHugh et al.(2007) reported that ridges significantly increased soil moisture and grain yield and reduced soil loss in north Wollo, Ethiopia. Experiments conducted in Mexico by Govaerts et al.(2005) on a fine, mixed, thermic, Cumulic Haplusto ll with zero tillage treatment combined with rotation and residue retention showed improvements in yield as compared to heavy tillage before seeding, mono cropping and crop residue removal. They report ed that

permanent bed with crop rotation and residue yielded the same as zero tillage. Various studies on CA outlined many benefits as it allows early sowing, growing long maturing crops/varieties, reduces runoff and evaporation, reduces soil loss, conserves soil moisture, increases labour efficiency, reduces oxen and straw demand, and enhances soil fertility (Nyssen et al. 2006). In contrast to traditional agriculture, conservation agriculture leaves residues from the previous crop on the surface. It may store a considerable amount of water and increases roughness, slowing down the runoff flow velocity (Findeling et al.2003). However, comparison of conservation agriculture and traditional agriculture practices over different time periods have not been consistent across soils, climate, and experiments in different parts of the world (Ahuja et al.2006). Conservation agriculture and other CA based resource conserving technologies practices like permanent bed and modified terwah tillage systems were introduced in Adigudom, Tigray, Ethiopia for the last three years since 2005 with the aim to conserve moisture, reduce runoff and soil loss on farmers' fields, hence increasing crop yields on Vertisols. In Tigray, farmers use to make contour furrows at 2-4 m interval, locally called terwah, usually on teff to trap water for later crop use instead of being lost as runoff. Therefore, the objective of this study was to evaluate runoff and soil loss, and crop yield under conservation and conventional agriculture in Tigray, northern Ethiopia. Short-term effects on physical soil quality are reported elsewhere (Oicha et al.2010a,b)

RESEARCH METHODOLOGY

COVERAGE OF THE STUDY

The research will be conducted in the Tigray regional state, the northern part of Ethiopia. The Woreda selected for the study is located in southern zone of Tigray region. The district is named as EmbaAlaje located in Alaje –Ofla, livelihood zone.

EmbaAlaje

Alaje is one of the woredas in the Tigray Region of Ethiopia located 21km from Mekelle. Part of the Debubawi Zone, Alaje is bordered on the south by Endamehoni, on the southwest by the Amhara Region, on the north by Debub Misraqawi Zone, and on the southeast by Raya Azebo. The administrative center of this woreda is AdiShehu.

SAMPLING

To achieve the objective of the study a multi-stage stratified random sampling method is selected. Important information shall be collected from village community with complementing data collected from groups of respondents at different level.

First the Woreda is selected at random. One village from the woreda where the Global Climate Change Alliance project is actively working shall be selected on random basis. From the village 30 households shall be chosen at random.. Both male and female, poor and better off and illiterate and literate shall be addressed during the study.

Moreover, one village leader and three development agents in each village shall be interviewed. Focus group discussion and key informat interview will also be done.

Opinions of district level office of agriculture staff shall also be collected by interviewing three office staff (one agronomist, one livestock expert and one socio-economist) from each district. Thus, a total of nine Woreda offices of agriculture staff will be interviewed.

DATA COLLECTION: TOOLS AND PROCEDURES

Data collection

Survey method will be the main methodological approach for this research. Using this method relevant primary data that helps to address the objectives of the study will be collected through structured and semi-structured interview techniques. An inventory of relevant experiences and literature reviews relevant to this study will be performed. Both qualitative and quantitative data will be collected with the help of the questionnaires from individual households. In addition, discussions will be held with elders and key informants to access additional information in the study sites.

Furthermore, to make necessary modification on the questioner and to check its appropriateness sample pre-test will be conducted and based on it corrections and modification will be made in order to capture the necessary information for the analysis. In addition, secondary data and other relevant information related to the research topic and objectives will be collected from respective offices to substantiate the primary data.

Method of data analysis

Descriptive statistics will be employed to describe, compare and contrast the different categories of data with respect to the desired characteristics. Mean, standard deviation, percentages, average, ratio, chart etc. will be used to analyse the collected data. Qualitative data from various sources will be examined and presented in different forms.

Quantitative data will be edited, coded and entered in a computer and the Statistical Package SPSS software version 12 will be used for the analysis. Multiple response questions will be analysed so as to give frequencies and percentages. Tables and graphs will be used to present different variables.

CHAPTERIZATION

Chapterization of the thesis will be made in a way it address the objectives and hypothesis of the study. The research document shall accordingly be classified in to five main chapters.

The first chapter will deal with introduction to the current status of conservation agriculture adoption efforts in the world, in Ethiopia and in Tigray region. Moreover, an attempt will be made to describe the concepts of conservation agriculture and brief discussion on the so far efforts made to introduce the conservation agriculture in the region.

The second chapter shall deal with the review of relevant literatures throughout the world in the country and in the region.

The third chapter shall elaborate the research methodology which comprises the sampling procedures, socio-economic and biophysical description of the study areas, data collection and data processing methods employed by the study.

The fourth chapter shall focus on the finding of the study. Brief discussion of the major findings of the study in comparison with other relevant studies shall be made under this chapter

The fifth and last chapter shall deal with the concluding remarks of the study and recommendations to promote and scale up conservation agriculture at smallholder farmers level.

TIME SCHEDULE

No.	**Activities**	**Month**							
		Oct	**Nov**	**Dec**	**Jan**	**Feb**	**March**	**April**	**May**
1	Review of literatures								
2	Data collection								
3	Data entry and analysis								
4	Thesis write up								
5	First draft submission								
6	Final draft submission								

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