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CLIMATE CHANGE ADAPTATION, SOCIAL NETWORKS, AND AGRICULTURAL EXTENSION REFORMS IN ETHIOPIA

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List of Abbreviation

ADLI	Agricultural Development Lead Industrialization
ADPLACs	Agricultural Development Partners' Linkage Advisory Councils
AGP	Agricultural Growth Program
ANRS	Amhara National Regional State
ATA	Agricultural Transformation Agency
ATVET	Agricultural Technical and Vocational Education and Training
CVCA	Climate Vulnerability and Capacity Analysis
DA	Development Agent
DIG	Development Innovation Grant
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FGDs	Focus Group Discussions
FREGs	Farmers Research and Extension Groups
FTC	Farmers' Training Center
FTC-MCs	Farmers' Training Center Management Committee
FIF	Farmers' Innovation Fund
HABP	Household Asset Building Program
HLIs	Higher Learning Institutes
KII	Key-Informant Interview
ICT	Information Communication Technologies
IPCC	Intergovernmental Panel on Climate Change
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
MIS	Management Information System
MoARD	Ministry of Agriculture of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
NAPA	National Adaptation Plan and Action
OLS	Ordinary Least Squares
NGOs	Non-Governmental Organizations
PADETS	Participatory Demonstration and Training Services
PME	Planning, monitoring and evaluation

PSNP	Productive Safety Net Program
RCBP	Rural Capacity Building Program
SLM	Sustainable Land Management
SMS	Subject Matter Specialists
TLU	Tropical Livestock Unit
WFP	World Food Programme
WoARD	Woreda office of Agriculture and Rural Development

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EXECUTIVE SUMMARY

Research on the impact of climate change in sub-Saharan Africa shows that climate change is expected to cause an increased frequency of extreme events such as high temperature and rainfall intensity, droughts and floods, desertification, and spread of animal and human diseases. These extreme events are likely to have a negative impact on food security. Using the case of Ethiopia, this thesis analyses the role that social network and agricultural extension can play in enhancing farmers' ability to adapt to climate change.

The thesis builds on recent research, which has highlighted the role of social networks and extension in promoting adaptation to the negative impacts of climate change. Social networks between farmers can build community resilience and increase adaptation to climate change. They also affect technology adoption and climate change adaptation through social learning, joint evaluation of new technologies and collective action. Current research on social networks in Ethiopia has mainly focused on the effects of network size on technology adoption and there is no empirical study on which types of social networks matter the most, and how do such types of social networks matter for climate change adaptation.

Agricultural extension is expected to facilitate climate change adaptation through training and education of farmers, enabling them to anticipate climate change and to update their knowledge, attitudes and adaptive capabilities in response to climate change. In addition to their well-established function of promoting technologies and natural resource management practices, agricultural extension services are expected to play new roles in building farmers' social networks and supporting climate change adaptation strategies.

There are various studies on agricultural extension reforms in Ethiopia, but there are still gaps in this literature, especially regarding the capacity of the extension service to promote adaptation to climate change and to promote social networks.

The purpose of this thesis is, therefore, to fill these knowledge gaps and to contribute to the current debate on the dynamic links between climate change, social networks and extension reforms. The thesis combines quantitative and qualitative methods for analysis of three inter-related research topics. First, the thesis examines farmers' vulnerabilities to climate change and the role of adaptation in increasing productivity at the household level. Second, it assesses how the different types of social networks are related with the adoption of sustainable land management practices for climate change adaptation. Third, by examining what works and what does not work well in the agricultural extension reforms in Ethiopia, the thesis

investigates the interactions between climate change, social networks and extension reforms in Amhara region of Ethiopia.

The thesis is based on a mixed methods approach. It combines a quantitative analysis, using World Bank data from a survey conducted in 2011 covering 1338 farmers. The analytical methods include a probit model, an OLS analysis and an endogenous switching regression model. Qualitative research methods included Focus Group Discussions (FGDs) combined with an individual scoring technique, and a Climate Vulnerability and Capacity Analysis.

The study on climate change adaptation found that the effects of climate change and adaptation practices differ across agro-ecological zones and adopter groups. In the kolla agro-ecologies, the major hazards were drought, floods, and migration. In contrast, snowfall, landslides and crop diseases were the main hazards in the dega and woyna-dega agro-ecologies. Erratic rainfall, soil erosion and livestock diseases were common hazards to all agro-ecologies. Households' responses to the hazards were differed across the different agro-ecologies. In the kolla agro-ecologies, the most common coping strategies were reducing the number of daily meals, migration, livestock selling and utilization of irrigation. In the dega and woyna-dega agro-ecologies common coping strategies included: changing consumption patterns; adopting drought resistant crops (sorghum and millet); sale of chickens, eggs, sheep, goats, eucalyptus trees; soil conservation and tree planting; zero grazing and water harvesting. In all agro-ecologies, local institutions support communal adaptation strategies such as communal water harvesting and irrigation schemes, reforestation, rangeland enclosure and prevention of soil erosion. The empirical results also revealed that farmers who implemented climate change adaptation strategies have significantly increased their food productivity and food security, compared to farmers who did not implement such strategies.

The findings regarding the relationship between social networks and sustainable land management revealed that networks with relatives have a positive impact on planting trees, but the impact of such networks on soil conservation was found to be negative. This finding can be interpreted as an incidence of self-interested behavior, since farmers may plant trees as a means of securing land holdings. When farmers are faced with the risk of losing their land to relatives, due to common heritage, they prefer planting trees to soil conservation. Farmers can reclaim all their investment costs by cutting trees, should they lose their land holding rights to relatives. In contrast, it would be difficult to regain soil conservation investment costs in this case. Friendship networks were found to be insignificant in both planting trees and soil conservation, while neighborhood ties only had a significant association with tree

planting. This suggests the potential contributions of friendship and neighborhood networks, which can significantly affect sustainable land management practices, but may remain untapped.

The analysis of extension conducted as part of this thesis suggests that a uniform reform approach, as pursued in Ethiopia, does not fit well with the diverse agro-ecologies and extension challenges in the country. While the number of service providers increased substantially, they still lack skills, incentives and resources, which affect their work motivation and job performance. Moreover, the planning, monitoring and evaluation system was found not to be very effective in regularly assessing what has been achieved at the farmers' training centers and what remains to be done in the future. Similarly, there is room to improve partnerships and linkages of actors, especially by including key actors that are currently missing.

Based on the above findings, this thesis derived the following policy implications:

1. The potential capacity of schools and religious organizations in supporting climate change adaptation should be tapped. The case study identified agricultural extension, health extension, NGOs, cooperatives, indigenous institutions (Iddir, Kirre, Jiggie, Debo, Iquib), microfinance institutions, schools, local governments, youth and women groups as key institutions providing rural services. However, extension organizations, cooperatives/unions, local governments and NGOs were the only institutions providing services relevant for climate change adaptation. Surprisingly, important local institutions (schools and religious organizations) did not have any short or long term plans to support climate change adaptation efforts despite the fact that they have the social capital to plan and implement some communal strategies such as terracing and planting trees on communal lands.

2. The regional and national policies should support local climate change adaptation strategies. The study showed that adaptation efforts should not be left to only farmers and local governments. Regional and national policies should support the local adaptation strategies. It was found that the absence of communal land and natural resource use policies was encouraging farmers to over utilize natural resources, and the long delay in land use rights (certification) was discouraging farmers from making long term investments on their land (e.g., tree planting and soil conservation). Therefore, the findings suggest that it would be useful to promote the introduction of communal land and natural resource use policy and a speedy land certification process.

3. The potential contributions of social networks as alternative channels of extension services should be tapped. The findings revealed that funds for agricultural extension are declining and extension managers should look for alternative source of funding and move away from a "one-size-fits-all" thinking to a "best fit" approach. It needs to become a priority for the current extension system to better understand what types of social networks matter most for technology adoption.

4. The findings also indicate that extension reforms should consider current agricultural challenges, especially climate change. In dega and woyna-daga agro-ecologies, the main challenges were getting information on climate change related hazards (rainfall and temperature), commercial marketing (cooperative development, price and new markets), post-harvest handling (drying and storage technique). In the kolla agro-ecologies, the major problems were lack of dry land farming methods (contour plowing, mulching, strip farming, summer fallow, seedbed preparation and planning in rows). So far, the extension system is not geared towards addressing these different challenges, which calls for aligning the extension reforms to the different local farming systems.

5. It can also be derived from the findings of this study that the regional government should design a new incentive system for the extension service. The case study showed that current incentives are inconsistent with the regional goal of promoting commercially oriented agriculture. Service providers in the region were found to lack the soft skills, incentives and resources to provide commercially oriented services. This finding calls for designing a new incentive system, which may include better salary, improved career prospects, and recognition as well as incentives for extra work. Such provisions will motivate and enable frontline service providers.

6. The governance and management structures of the Agricultural Development Partners' Linkage Advisory Councils (ADPLACs) should be redesigned. The case study revealed that when measured against indicators such as information sharing and feedback, joint planning, monitoring, evaluation and implementation, the linkages between farmers, NGOs and research institutes were very weak. This calls for redesigning the governance and management structures of the Agricultural Development Partners' Linkage Advisory Councils (ADPLACs), which was responsible for facilitating the partnership and linkages of extension actors in the region.

7. The findings of this thesis also suggest that the roles of NGOs and the private sector in the provision of extension service should be enhanced. The case study found that key actors such as the private sector and NGOs were missing from effective provision of extension services. The private sector and NGOs may have a comparative advantage in activities such as provision of improved seeds, fertilizers, pesticides, vaccination, deworming and artificial inseminations. NGO and private sector engagement in these areas will allow the regional government to free up and reallocate funds to its broader extension strategies such as development of new incentive schemes, education and training, technical advisory services, sustainable natural resource management practices and organizing farmers to link them with new markets.

ZUSSAMMENFASSUNG

Die Forschung über den Wirkung des Klimawandels in Sub-Sahara-Afrika zeigt, dass der Klimawandel extreme Ereignisse wie hohe Temperaturen und Regenfälle, Dürren und Überflutung, Desertifizierung, die Verbreitung von tierischen und menschlichen Krankheiten auslösen wird. Diese extremen Ereignisse lassen eine negative Wirkung auf die Nahrungssicherheit erwarten.

Neuerdings erkennt die Wissenschaft die Bedeutung von sozialen Netzwerken und Beratungsdiensten, um die negativen Auswirkungen des Klimawandels zu mildern. Soziale Netzwerke zwischen Landwirten können gemeinschaftliche Resilienzen bilden und die Adoption von Anpassungsmaßnahmen verbessern. Modelle von sozialem Lernen und Technologieadaption führen zu der Hypothese, dass soziale Netzwerke die Technologieadaption und Klimawandelanpassungen durch soziales Lernen, gemeinsame Evaluierung, soziale Einflussnahme und kollektiven Handeln fördern können.

Von landwirtschaftlichen Beratungsdiensten wird erwartet, dass sie die Anpassungen an den Klimawandel durch Training und Bildung von Landwirten (zu Themen wie Vorhersagefähigkeit, das Verbesserung von Wissen, Attituden und adaptive Fähigkeiten) erleichtern. Es gibt eine Vielzahl von Arrangements durch die Mitarbeiter von Beratungsdiensten, wenn sie gut passen (“best-fit“), Anpassungen an den Klimawandel erleichtern und die Einkommens- und Nahrungssicherheitssituation von Landwirten verbessern können. Zusätzlich zu ihrer traditionellen Funktion als Verbreiter von Technologien und Praktiken des natürlichen Ressourcenmanagements wird von landwirtschaftlichen Beratungsdiensten erwartet, dass sie ein Rolle im Aufbau von sozialen Netzwerken von Landwirten spielen und Anpassungsstrategien an den Klimawandel unterstützen.

Es wird auch argumentiert, dass sich Anpassungen an den Klimawandel und Bewältigungsstrategien von Landwirten je nach Zeit und Ort unterscheiden und dass lokal-spezifische Studien nötig sind, um effektive Anpassungspläne und –politiken umzusetzen. Allerdings beschränkt sich die bisherige Forschung zu sozialen Netzwerken in Äthiopien weitestgehend auf den Effekt von Netzwerkgrößen auf die Technologieannahme.Außerdem gibt es keine empirischen Studien darüber, welche Netzwerktypen am wichtigsten sind und wie solche Netzwerktypen das Management von natürlichen Ressourcen und Anpassungen an den Klimawandel beeinflussen. Zudem sind die bisherigen Studien zu den Reformen der

landwirtschaftlichen Beratungsdienste in Äthiopien oftmals mit Problemen in Methodik, Reichweite und Identifikation von Indikatoren behaftet.

Das Ziel dieser Dissertationist es demnach, mit einer Kombination aus qualitativen und quantitativen Methoden diese Wissenslücken zu schließen und zu der Debatte zu den dynamischen Verbindungen zwischen Klimawandel, landwirtschaftlichen Beratungsdiensten und sozialen Netzwerken beizutragen. Dazu untersucht die Dissertation die Vulnerabilität von Landwirten mit Blick auf den Klimawandel sowie die Auswirkungen von Anpassungen auf Produktivitätssteigerungen auf Haushaltsebene. Sie liefert damit Erkenntnisse zu dem Zusammenhang zwischen Klimawandel, Anpassungen und Nahrungsproduktivität in der Amhara-Region von Äthiopien.Danach analysiert dieDissertation den Zusammenhang von verschiedenen Typen von sozialen Netzwerken und der Übernahme von nachhaltigen Landmanagementpraktiken zur Anpassung an den Klimawandel. Mit Hilfe von innovativen analytischen Methoden werden daraufhin die Reformen des landwirtschaftlichen Beratungsdienstes in Äthiopien analysiert.

Die Forschungsmethode dieser Dissertation basiert auf zwei Ansätzen (*mixed methods*). Der erste Ansatz beinhaltet partizipative und qualitative Forschungsmethoden wie Fokusgruppendiskussionen (FDGs) mit individuellem Scoring und *Climate Vulnerability and Capacity Analysis* (CVCA). Der zweite Ansatz nutzt quantitative Methoden (*plot-level probit*und *endogenous switching*Regressionsmodelle) basierend auf Daten einer Weltbank-Umfrage mit 1338 Landwirten im Jahr 2011.

Die Studie zu Anpassungen an den Klimawandel zeigte, dass die Effekte von Klimawandel und Adoptionspraktiken je agro-ökologische Zone und je Anwendergruppe verschieden sind. In pastoralen und tiefen Ebenen waren die größten Risiken Dürre, Fluten und Migration. Im Gegensatz dazu waren Schneefälle, Landrutsche und Pflanzenkrankheiten die wesentlichen Risiken im Hochland. Unberechenbare Regenfälle, Bodenerosionen, Nutztierkrankheiten waren hauptsächliche Risiken in sowohl Hoch- als auch Tiefland. Die Antworten der Haushalte zu diesen Risiken variierten je nach agro-ökologischer Zone. In den pastoralen und tiefen Ebenen waren die üblichsten Anpassungsstrategien die Verringerung der Anzahl der täglichen Mahlzeiten, Migration, das Verkaufen von Nutztieren und die Nutzung von Bewässerung. Im Hochland waren die üblichsten Anpassungsstrategien das Ändern von Konsumverhalten; die Übernahme von dürre-resistenten Pflanzen (Sorghum und Hirse); das Verkaufen von Hühnchen, Eiern, Schafen, Ziegen und Eukalyptusbäumen; Bodenkonservierung und Baumpflanzen; Verzicht auf Weidehaltung und

Regenwassersammeln). In sowohl Hoch- als auch Tiefland, fördern lokale Institutionen kommunale Anpassungsstrategien wie kommunales Regenwassersammeln, Bewässerungssysteme, Wiederaufforstung, das Eingrenzen von Weideland und die Vermeidung von Bodenerosionen. Die empirischen Ergebnisse zeigten auch, dass Landwirte, welche auf ihren Feldern Bäume gepflanzt und Bodenkonservierungsmaßnahmen umgesetzt haben, ihre Nahrungsproduktivität und Ernährungssituation im Vergleich zu Landwirten, welche diese Maßnahmen zur Anpassungen nicht umgesetzt haben, signifikant erhöhen konnten.

Die Ergebnisse zu den Zusammenhängen zwischen sozialen Netzwerken und nachhaltigem Landmanagement zeigten, dass Netzwerke mit Verwandten einen positiven Einfluss auf das Pflanzen von Bäumen, aber einen negativen Einfluss auf Bodenkonservierung haben. Das deutet darauf hin, dass egoistisches Verhalten und Trittbrettfahren *(Free Riding)* selbst in engen Beziehungen wie etwa zwischen Verwandten existiert. Unsere Erklärung ist, dass Landwirte Bäume pflanzen, um ihre Landrechte zu sichern. Diese privaten Vorteile können allerdings verschwinden, wenn es um Bodenkonservierung geht, was ein eher sozialer Vorteil ist. Im Gegensatz zu verwandtschaftlichen Beziehungen, waren die Auswirkungen von Freundschaftsnetzwerken auf sowohl Baumpflanzen und Bodenkonservierung insignifikant. Das deutet darauf hin, dass die potenziellen Beiträge von freundschaftlichen und nachbarschaftlichen Netzwerken, welche nachhaltige Landmanagementpraktiken beeinflussen können, bislang nicht genutzt werden.

Die Beurteilung der landwirtschaftlichen Beratungsdienste deutet darauf hin, dass gleichförmige Reformanstrengungen nicht zu den vielfältigen Situationen und Beratungsherausforderungen des Landes passen. Die Zahl der Serviceanbieter ist zwar deutlich gestiegen, diesen fehlen allerdings Fähigkeiten, Anreize und Ressourcen, was ihre Arbeitsmoral und –leistung beeinträchtigt. Zudem sind Planungs-, Überwachungs- und Evaluierungssysteme nicht effektiv darin, regelmäßig zu zeigen, was in den landwirtschaftlichen Trainingszentren erreicht wurde und was noch getan werden muss. Gleichermaßen, gibt es Möglichkeiten um Partnerschaften und Verbindungen zwischen Akteuren zu verbessern – insbesondere durch die Inklusion von zurzeit fehlenden Schlüsselakteuren.

Basierend auf den obigen Ergebnissen, hat diese Dissertation folgende Implikationen für die Politik abgeleitet:

1. Manche der Rollen von lokalen Institutionen, welche ländliche Dienstleistungen anbieten, sollten gestärkt werden. Die Fallstudie identifizierte landwirtschaftliche Beratungsdienste, gesundheitliche Beratungsdienste, NROs, Kooperativen, indigene Institutionen (Iddir, Kirre, Jiggie, Debo, Iquib), Mikrofinanzinstitute, Schulen, lokale Regierungen und Jugend- und Frauengruppen als zentrale Institutionen, welche ländliche Dienstleistungen anbieten. Allerdings waren Beratungsorganisationen, Kooperativen/Gewerkschaften, lokale Regierungen und NROs die einzigen Institutionen, welche Dienstleistungen zur Anpassung an den Klimawandel anbieten. Überraschenderweise hatte wichtige lokale Institutionen (Schulen und religiöse Organisationen) keine kurz- und langfristigen Pläne, Anstrengungen zur Anpassung an den Klimawandel zu unterstützen, obwohl sie das soziale Kapital hätten, kommunale Strategien wie Terrassierung und Baumpflanzaktionen auf kommunalen Land zu planen und umzusetzen. Beratungsrganisationen sollten kooperative Praktiken des Managements von natürlichen Ressourcen in ihre Entwicklungsagenden einbauen und damit ihre jetzige Rolle als Verteiler von landwirtschaftlichen Betriebsmitteln erweitern.

2. Die regionalen und nationalen Politiken sollten lokalen Strategien zur Anpassung an den Klimawandel unterstützen. Die Studie verdeutliche, dass, obwohl sich Implikationen bezüglich der Nahrungssicherheit von Maßnahmen zur Anpassung an den Klimawandel eher auf der lokalen und individuellen Landwirt-Ebene abbilden. Die Anpassungsanstrengungen sollten aber nicht allein den Landwirten und lokalen Regierungen überlassen werden. In dieser Hinsicht schafft die Abwesenheit von kommunalen Land- und Ressourcennutzungsrichtlinien Anreize für Landwirte, ihre natürlichen Ressourcen zu übernutzen. Genauso entmutigen die Verzögerungen der Landrechtezuteilung (Zertifizierung) Landwirte, langfristige Investitionen in Land zu tätigen (z.B. Baumpflanzungen und Bodenkonservierung). Dementsprechend empfiehlt diese Dissertation die Einführung von kommunalen Land- und Ressourcennutzungsrichtlinien und einen schnellen Landregistrierungsprozess.

3. Die potenziellen Beiträge von sozialen Netzwerken als alternative Kanäle von landwirtschaftlichen Beratungsdiensten sollten genutzt werden. Die Fallstudie und empirische Ergebnisse offenbarten, dass Geldmittel für landwirtschaftliche Beratungsdienste abnehmen und das Beratungsdienstmanager nach alternativen Geldquellen suchen müssen. Gleichzeitig müssen sie von einem *„one-size-fits-all“*-Denken zu einen *„best-fit“*-Denken gelangen.

Entsprechend muss es eine Priorität des heutigen Beratungsdienstsystems sein, zu verstehen, warum ländliche, soziale Netzwerke entscheidend sind und welche Typen von sozialen Netzwerken am wichtigsten für die Adaption von Technologien sind.

4. Reformanstrengungen sollten die heutigen Herausforderungen von landwirtschaftlichen Beratungsdiensten berücksichtigen. Die Ergebnisse offenbarten, dass das Beratungssystem in der Amhara-Region nicht angemessen an die heutigen Herausforderungen angepasst ist. In den getreidebasierten Farmsystemen des Hochlands gibt es folgende Herausforderungen: Informationsbeschaffung zu Risiken des Klimawandels (Regenfälle und Temperaturen), kommerzielle Vermarktung (Entwicklung von Kooperativen, Preise und neue Märkte) und Nacherntetechnologien (Trocknen und Lagerungstechniken). In den halb-pastoralen Farmsystemen des Tieflandes ist das wesentliche Problem ein Mangel and Methoden des Trockenfeldbaus (Konturpflügen, Mulchen, Streifenanbau, sommerliche Brachflächen, Saatflächenvorbereitung und Reihenpflanzung). Entsprechend sollten die Beratungsreformen an die lokalen Farmsysteme angepasst werden.

5. Die Regierung sollte ein neues Anreizsystem gestalten. Die Fallstudie zeigte, dass es Serviceanbietern in der Region an Sozialkompetenzen, Anreizen und Ressourcen mangelt, um kommerziell orientierte Dienstleistungen anzubieten. Das ist inkonsistent mit dem regionalen Ziel, eine kommerziell orientierte Landwirtschaft zu fördern.Entsprechend sollte ein neues Anreizsystem (z.B., bessere Bezahlung, Aufwandentschädigungen, Karriereplanung, Anerkennung und Anreize für zusätzliche Arbeit) gestaltet werden, welches Serviceanbieter an vorderster Front motiviert und ermöglicht.

6. Die Führungs- und Managementstrukturen des *"Agricultural Development Partners' Linkage Advisory Councils" (ADPLACs)* sollten neu gestaltet werden. Die Fallstudie zeigte, dass die Verbindungen zwischen Landwirten, Nichtregierungsorganisationen (NROs) und Forschungsinstituten sehr schwach sind (gemessen an Indikatoren wie Informationsteilen, Feedbacks, gemeinsame Planungen, Überwachung, Evaluierung und Umsetzung). Dies ruft nach einer Neugestaltung der Führungs- und managementstrukturen des *"Agricultural Development Partners' Linkage Advisory Councils" (ADPLACs),* welches für die Erleichterung vonPartnerschaften und Verbindungen von Beratungsakteuren verantwortlich ist.

7. Die Rolle von NGOs und dem privaten Sektor in der Bereitstellung von landwirtschaftlichen Beratungsdienstleistungen sollte gestärkt werden. Die Fallstudie zeigte,

dass Schlüsselakteure wie der private Bereich und NROs als landwirtschaftlichen Serviceanbieter fehlen. Das ruft nach einer Beteiligung von privatem Akteuren und NROs in landwirtsachlichen Servicedienstleistungen mitprivaten Naturen, wie beispielsweise die Bereitstellung von verbesserten Saatgut, Düngemitteln, Pestiziden, Impfungen, Entwurmung und künstliche Besamung. Dadurch kann die regionale Regierung Geldmittel freisetzen und an seine übergeordnete landwirtschaftliche Beratungsstrategie umverteilen. Dazu zählen die Entwicklung von neuen Anreizsystem, Bildung und Training, technische Beratungsdienste, Praktiken des nachhaltigen Managements von natürlichen Ressourcen, die Organisation von Landwirten und deren Verlinkung mit neuen Märkten.

1 Introduction

According to the Intergovernmental Panel on Climate Change (IPCC, 2007), the Horn of Africa is the most vulnerable region in terms of the impacts of climate change and variability. Climate change in IPCC usage refers to "a change in the state of the climate that can be identified (e.g. using statistical test) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity". In Sub-Saharan Africa, climate change is manifested in various forms such as increased rainfall intensity; short rainfall duration; and high temperatures leading to increased evaporation and reduction in soil water moisture. Amongst the major effects of climate change are land degradation problems such as accelerated erosion and depletion in soil fertility. These land degradation problems in turn lead to significant reduction in agricultural productivity and worsening food security (Bekele, 2005; Byiringiro et al., 1996; Shiferaw et al.,2009; Niang et al. 2014; Thornton et al. 2011). Apart from reduction in agricultural productivity, other impacts of climate change in SSA include, extreme events like floods and drought, desertification, and spread of diseases (Niang et al. 2014; Tschakert et al. 2010, Chen et al. 2006; Reich et al. 2001).

1.1. General Background

The role of social networks and extension in climate change adaptation

Social networks and agricultural extension play key roles in linking farmers to new information and technologies that are essential for climate change adaptation. Social networks between farmers can build community resilience and increase adaptation to climate change. A social network as defined by (Maertens et al., 2013) is "individual members (nodes) and the links among them through which information, money, goods or services flow" and climate change adaptation refers to "the process of adjustment to actual or expected climate and its effects"(IPCC, 2014: 5). Bandiera et al. (2006) and Monge et al. (2008) indicated that social networks affect technology adoption and climate change adaptation through social learning, joint evaluation, social influence, and collective action. Models of social learning and technology adoption hypothesize that, farmers learn about the existence and characteristics of new technology from their friends, neighbors or relatives and take advantage of their networks' experiences during adoption decision (Monge et al., 2008). Similarly, Maertens et

al. (2013)reported that models of social learning and adoption try to answer questions such as what do farmers value and over what time period? What type of information does the farmer absorb and from whom? How do farmers learn or how do they update their beliefs? How do beliefs translate into actions? And do farmers interact strategically?

Agricultural extension is also expected to facilitate adaptation through training and educating farmers to anticipate and change their knowledge, attitudes and adaptive capabilities in response to climate change. According to Swanson et al. (2010: 176), agricultural extension refers to "the application of scientific research, knowledge, and technologies to improve agricultural practices through farmer education". Different models of extension suggest that extension services should be farmer-oriented. In all of these models, agricultural extension reforms occupy a central stage (Davis 2010). However, most of the extension systems in Sub-Saharan Africa are not responsive to farmers' technology and information needs (Simpson et al., 2014).

In the case of Ethiopia, farmers have two technology and information sources for climate change adaptation: formal networks (extension system) and informal networks (relatives, friends and neighbors) (Dercon et al., 2006; Di Falco et al., 2013). Informal social networks are more complex than the conventional extension approaches and do significantly influences the adoption of technologies(Di Falco et al., 2013; Spielman et al., 2010). The informal social networks are especially important for smallholder and resource-poor farmers whose technology needs are not often addressed by formal extension services (Matuschke, 2008). Compared to the formal extension approach, farmers' informal social networks are also both time efficient and cost effective, since these social networks are durable and would not have to be constructed by government agencies (Matuschke, 2008).

Apart from the extension system, the introduction of social networks into climate change studies, therefore, allows for a range of policy alternatives. For example, funds for agricultural extension are declining and hence looking for alternative sources of funding and moving away from *a "one-size-fits-all" thinking to a "best fit" extension approach*es indispensable for climate change adaptation (Regina Birner et al., 2009). Hence, in addition to assessing what works and what does not work well in the public agricultural extension system, understanding whether rural social networks matter and which types of social networks matter most for climate change adaptation needs to be a priority of the current extension system (Maertens et al., 2013; Matuschke et al., 2009). Further, investigating how climate change is affecting various agro-ecologies differently and how farmers' adaptation practices in response to

climate hazards are enhancing their food productivity and food security needs to be the priority of current research (Di Falco et al., 2011; IPPC, 2014).

1.2. Problem statement

Extreme events, such as droughts and floods, associated with climate change are common hazards to farmers in Sub-Saharan Africa (Connolly-Boutin et al., 2015). These climate shocks put additional pressure to farmers in Africa whose vulnerability is already affected by weak social networks and poor extension support. Climate change and weak social and institutional support are believed to have overwhelming consequences for food security in sub-Saharan Africa (Codjoe et al., 2011; Thompson et al., 2010).

Although there are many studies on the impacts of climate change in Ethiopia (e.g., Hadgu et al., 2015; World Bank, 2010), these studies overlooked the role of adaptation on food productivity and food security. It is also argued that adaptation and copying strategies by farmers varies in time and space and therefore local-level studies are important for implementing effective adaptation plans and policies (IPPC, 2014). Moreover, current research on social networks in Ethiopia focuses mainly on the effects of network size on technology adoption (Di Falco et al., 2013; Wossen et al., 2013) and there is no empirical study on which types of social networks matter the most, and how do such types of social networks matter for climate change adaptation. Similarly, the various studies on agricultural extension reforms in Ethiopia (see Belay, 2003; Davis et al., 2010; Gebremedhin et al., 2006), are subject to a range of problems including, methodological, scope and identification of indicators.

Based on qualitative and quantitative approaches, this thesis seeks to contribute to the current debate on the dynamic links between climate change, extension and social networks through empirical analysis of three inter-related research topics. First, it examines farmers' vulnerabilities to climate change and the role of adaptation on food productivity and food security at the household level. Second, it assesses how the different types of social networks are related with the adoption of sustainable land management practices for climate change adaptation. Third, by investigating what works and what does not work well in the agricultural extension reforms in Ethiopia, the thesis identifies the reform options that will fit well under different agro-ecologies.

1.3. Motivation of the thesis

The thesis is motivated by the desire to investigate the roles of social networks and agricultural extension reforms on natural resource management and climate change adaptation

in Ethiopia. The investigation is important as climate change poses new challenges to the existing farmers' social networks and agricultural extension systems. Understanding the relationship between climate change, social networks and agricultural extension reforms will help to design effective policies and programs, such as climate change adaptation, that are important for improving the food security of farmers in Ethiopia or other sub-Saharan Africa countries. For instance, the climate change and food security framework developed by Boutin et al. (2015) indicate that climate change adaptation programs will fail unless their intervention considers farmers' social networks and their asset bases (natural, human, financial and physical capital). Similarly, Birner et al. (2009) demonstrate how agricultural advisory services that failed to fit with contextual factors are unlikely to succeed in meeting their objectives. This thesis is motivated by the desire to empirically apply these frameworks in the context of Ethiopia.

1.4. Objectives of the thesis

The main objective of this thesis is to contribute to the current debate on the dynamic links between climate change, social networks and extension reforms in Ethiopia. Specifically, the thesis has the following three broad objectives.

Objective one: to investigate how climate change affects livelihood resources, agriculture and food security and how adaptation practices, social networks and institutions in response to climate change affects crop productivity and food security.

Objective two: to assess how the different types of social networks (relatives, friendship and neighborhood) are related with the adoption of SLM practices (tree-planting and soil conservation) for climate change adaptation.

Objective three: to examine what works and what does not work well in the agricultural extension reforms in Ethiopia.

The above three objectives are addressed in separate chapters of this thesis.

1.5. Research questions

In order to address the objectives described in section 1.4, the thesis has developed the following research questions related to each of the three objectives.

The research questions for objective one are:

a) What are the major climate hazards and their effects on agriculture and natural resources?

b) What adaptation or copying strategies are used to address the hazards?

c) What is the role of adaptation on food productivity and food security?

The research questions for objective two are:

a) Which types of social network matter most for Sustainable Land Management (SLM) practices?

b) How do specific network types matter?

The research questions for objective three are:

a) Does the agricultural extension reform in Amhara region of Ethiopia enable farmers to voice their demands and hold service providers accountable?

b) Does the reform strengthen the capacity of service providers to respond to the needs of farmers?

c) Does the reform created market-lead and farmer-driven extension system?

1.6. Overview of the literature

The research on the impact of climate change in sub-Saharan Africa show that climate change is expected to cause high temperature and rainfall intensity (Thomas et al., 2007), droughts and floods (Niang et al., 2014; Tschakert et al., 2010), desertification (Reich et al., 2001), spread of animal and human diseases (Chen et al., 2006). These extreme events are likely to have negative impacts on production and food security (Niang et al., 2014; Porter et al., 2014).

Recently, scholars have given due consideration to the role of adaptation in mitigating climate change and enhancing agricultural productivity (Di Falco, Veronesi, & Yesuf, 2011b; IPPC, 2014). Climate change in IPCC usage refers to "a change in the state of the climate that can be identified (e.g. using statistical test) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer". Aadaptation is then *"the process of adjustment to actual or expected climate and its effects"* (IPCC, 2014:

5). According to Adger (2003) the capacity of farming households to cope with climate change (adaptive capacity) depends on the household's and local resources[1] (asset base), social networks and institutional support (land tenure, safety net programs and extension services). Vulnerability is then the lack of capacity to adapt to climate change that may arise due to environmental changes and lack of institutional support (Adger, 2006; Gentle et al., 2012; Thornton et al., 2007). Adaptive capacity is local specific that varies over time, space and communities depending on human and social capital levels (social networks) and institutional services such as agricultural extension(Gentle et al., 2012; Smit et al., 2006; World Bank, 2010).

Most of the research on climate change in sub-Saharan Africa, as evidenced in IPCC assessments, focuses on the role of social capital (social networks) in climate change adaptation. A social network as defined by (Maertens et al., 2013) is "individual members (nodes) and the links among them through which information, money, goods or services flow". Research has shown that social networks (relative, friendship and neighborhood) offer farmers access to diverse pools of information and resources (Bandiera et al., 2006; Bodin et al., 2006). Within the context of resource management, friendship and neighborhood ties can make a network more resilient and adaptive to climate change.

According to several authors (Bandiera et al., 2006; Monge et al., 2008), social networks affect technology adoption and climate change adaptation through social learning, joint evaluation, social influence, and collective action. Models of social learning hypothesize that, farmers learn about the existence and characteristics of new technologies from their friends, neighbors or relatives and take advantage of their networks' experiences during adoption decision (Monge et al., 2008).

The literature on social network and resource management also extensively discusses how networks influence individual actors and groups. Social influence refers to "the enforcement of social norms, opinions and attitudes on individual's preferences and behaviors" (Monge et al., 2008:9). According to the social influence theory, the outcomes of the network are different for different types of networks, for example, strong networks (comprising relatives)[2] versus weak networks (based on friendship and neighborhoods) (Bodin et al. 2006). Similarly, Prell et al. (2009) notes that actors with strong networks have the tendency to: influence one another more than weak networks; share similar ideas; offer one another emotional support

[1]Natural, human, physical, social and financial resources.

[2]In this study, a strong network is defined by bloodline and marriage networks.

and help during crises; communicate effectively regarding complex issues such as climate change.

Social networks are often more complex than conventional "extension" approaches and do significantly influence climate change adaptation (Di Falco et al., 2013; Spielman et al., 2010). The informal social networks are especially important for smallholder and resource-poor farmers whose technology needs are not often addressed by formal extension services (Matuschke, 2008). Compared to the formal extension approach, farmers' informal social networks are also both time efficient and cost effective, since these social networks are durable and would not have to be constructed by government agencies (Matuschke, 2008).

While social networks are crucial for climate change adaptation, extension services are equally important. The literature on extension and climate change demonstrates that agricultural extension is also expected to facilitate adaptation through training and educating farmers to anticipate and change their knowledge, attitudes and adaptive capabilities in response to climate change. According to Swanson et al. (2010: 176), agricultural extension refers to "the application of scientific research, knowledge, and technologies to improve agricultural practices through farmer education".

There is broad agreement among extension professionals that agricultural extension services, if "best-fit", improves the income and food security of farmers (Ashworth, 2005; Birkhauerser et al., 1991; Birner et al., 2009; Davis et al., 2010; Egziabher et al., 2013; Evenson et al., 2001). In addition to their traditional function of promoting production technologies and natural resource management practices, agricultural extension services are expected to play new roles in building farmers' social networks and supporting climate change adaptation strategies (Swanson et al., 2010).

Among the new extension approaches widely discussed are best-fit , decentralization, new information and communication technologies, farmer field schools, cost-recovery schemes for public services and privatized extension (e.g., Anderson, 2007; Rivera et al., 2004; Swanson et al., 2010). These approaches (both public and market-based extension) are being implemented in different countries, and their impacts on natural resource management, climate change adaptation and productivity are currently being evaluated by different scholars (e.g., Alex et al., 2002; Benin, 2006). The conceptual framework on agricultural advisory services so far suggest that the successes of extension services depend on their best-fit with the contextual factors and that more empirical studies and rigorous evaluation tools are required (Birner et al., 2009).

Review of climate change studies in Ethiopia

There have been several studies on climate change and adaptation in Ethiopia (Oxfam 2013, Gebre egziabher et al. 2011, Di Falco et al. 2011, World Bank 2010, Yuo You et al. 2010, Deressa et al 2009, Deressa 2007, NMA 2007). Oxfam (2013), World Bank (2010) and NMA (2007) identified a wide range of climate change adaptation strategies implemented by farmers and pastoralists in Ethiopia. However, these studies did not use any models (econometrics, agronomic or multi-market) to investigate the determinants of climate change adaptation strategies.

Using econometric analysis, Deressa (2007) applied a Ricardian approach to estimate the effects of climate change on farm income and land value, after controlling for other relevant explanatory variables (e.g., factor endowment, proximity to markets). The author regressed net revenue per hectare on climatic variables (temperature, precipitation) and other control variables such as household attributes and soil types. Additionally, the study analyzed the expected impact of climate change on net revenue using three Special Report on Emission Scenario (SRES) climate change models (CGM2, HaDCM3 and PCM). All the models predicted that increasing temperature and decreasing precipitation are negatively affect Ethiopian agriculture.

A similar conclusion was reached by Gebre egziabher et al. (2011), using Ricardian approach of a countrywide computable general equilibrium model. They too projected that the overall economic impacts of climate change on Ethiopia's agriculture will worsen considerably after 2030. This in turn will lead to a significant reduction in agricultural productivity and at least a 30 percent reduction in average income, compared with the possible outcome in the absence of climate change. They recommended implementation of adaptation strategies and institutional support to mitigate the impact of climate change.

Using multi-market sector model, Yun and Ringler (2010), integrate climate change modules to explore; (i) water availability under higher temperatures and changing precipitation patterns, (ii) the impact of changing precipitation patterns on flooding, and (iii) the potential impact of the carbon dioxide (CO2) fertilization effect on crop production. Their analysis finds that the major impact of climate change on Ethiopia's economy results from more frequent occurrence of extreme hydrologic events, which cause losses in both the agricultural and nonagricultural sectors. To adapt to these long-term changes, therefore, they

recommended that Ethiopia should invest in enhanced water control to expand irrigation and improve flood protection.

Despite their importance, one of the shortcomings of the above Ricardian (Deressa 2007, Gebre egziabher et al. 2011) and agronomic (Yun and Ringler 2010) approach is that both methods focus on the impact of climate change rather than on the role of adaptation. However, the Ricardian approach implicitly incorporates adaptation and consequently estimate the marginal impacts on outputs of future temperature or rainfall changes by already assuming that farmers have been implementing the strategies through input utilization. However, in reality farmers input use might not necessary reflect adaptation to climate change. The input use could be for profit motive as well. These shows how the Ricardian and agronomic models fail to identify the key adaptation strategies and hence the implication of climate on food production (Di Falco et al., 2011; Deressa *et al*., 2009). Another weakness of the Ricardian approach is that it assumes land markets are working properly with the implication that land prices will reflect the present discounted value of land rents into the infinite future. However, land markets are not working properly in Ethiopia as land property rights are not perfectly assigned (Di Falco 2011). Additionally, adaptation to climate change is a two-step process: first, the farmer must perceive climate changes and then she/he should respond to the changes by implementing the different adaptation strategies (Deressa et al 2009).

Taking note of these shortcomings, Deressa et al. (2009) employed a multinomial logit (MNL) model to study the factors that affect households' choice of adaptation methods and perceptions of climate change in the Blue Nile basin of Ethiopia. Their study finds that farmer's choices of adaptation strategies are influenced by the level of education, gender, age, and wealth; access to extension and credit; information on climate, social capital, agro-ecological settings, and temperature. The study also finds that lack of information on the strategies and financial constraints are the main barriers to adaptation.

Though Deressa et al's (2009) study gave more focus on the determinants of adaptation; it did not disentangle the productivity and food security implication of adaptation to climate change. Climate change impacts the four key dimensions of food security- availability, access, stability and utilization (Edame, et al., 2011). More specifically, the model did not assess whether farm households that actually implement the adaptation strategies are indeed getting

benefits in terms of an increase in the productivity[3] of food crop. This is an important factor in farmer decision to adapt or not to adapt to climate changes (Di Falco et al. 2011).

This thesis fills this gap by investigating how farm households' decision to adapt, that is to implement a set of strategies (e.g., tree planting and soil conservation) in response to long run changes in key climatic variables such as rainfall, affects food crop productivity in Amhara region of Ethiopia.

Review of methodological approaches

Different methodological approaches have been implemented to examine the effect of climate variability and the role of adaptation strategies. Irrespective of the methods applies; reported results confirm that climate change will on average have an adverse effect. Methodological approaches for examining the effect of climate change and adaptation can be categorized into two groups: The first group consists of quantitative approaches while the second group relies on qualitative assessments. Quantitative approaches include statistical analysis; simulation modeling and process based bio-physical models such as crop growth models. Further, each modeling approach also consists of different modeling approaches and behavioral adjustments.

The majority of quantitative methods applied so far agree on the direction of climate change impact as well as the role of adaptation strategies which is negative and positive respectively. However, significant difference has been reported on the magnitude of estimated impacts as well on the roles of adaptation strategies (Nelson *et al*., 2014; Di Falco et al., 2014; Arndt et al., 2011; Lippert et al., 2008). Partial equilibrium and general equilibrium models are employed to examine the expected economic impacts of climate change as well as the costs of mitigation and adaptation. Both partial and general equilibrium models capture climate change as exogenous shocks and measure how these shocks transmit to the rest of the economy or to some specific sectors. In particular, general equilibrium models investigate how exogenous climate shocks may affect factor productivity, aggregate commodity price as well wages in the agricultural sector as well as in the rest of the economy.

In addition to the above mentioned simulation approaches, econometric models have also been applied in many case studies. This method uses ex-post cross sectional and panel data to estimate the effect of year to year weather variation as well as climate change on productivity and welfare outcomes. In particular, the Ricardian approach as well as other production

[3] Productivity is the main determinant of food availability.

function specifications capture temperature and rainfall realizations over time for a given country or region to estimate effects on productivity, food security and poverty. Since, these methods relay on exogenous variation of rainfall and temperature at a given time, they can provide a robust mechanism through which climate change may affect the whole economy. In addition, these methods are also suitable to examine the heterogeneous treatment effects across different types of agro-ecological zones as well as individuals. Finally, the nonlinear effects of temperature can also be captured to non-linear regression approaches as well as by introducing nonlinear terms in the estimation procedure (Dell et al., 2014).

Some of the econometric approaches used for estimating the effects of climate change are however not without problems. In particular, the Ricardian approach developed by Mendelsohn et al. (1994) is the most widely used but also criticized approach. This method relies of land values as indicator for climate change impacts as it regresses land values or revenues on climate variables (Mendelsohn *et al*., 1994; Di Falco, 2014). In doing so, the model assumes that the effects of climate change are reflected in the reduction in land values or sale revenues. In doing so, the model relies on the assumption of competitive land markets. However, the assumption of perfect land markets rarely works in Africa in general and in Ethiopia in particular as land markets do not exist and mostly are distorted. Modeling adaptation and climate change effects is considered as the main strength of the Ricardian model. However, this also introduces another bias in the models ability to provide robust results since adjustment costs for adaptation are not taken into account. This costs can be significant since poor farm households may need to switch their production and consumption behavior in response to climate change (Hertel et al., 2010; Di Falco, 2014).

The other perhaps most often used modeling approach outside main stream economics is the use of crop growth simulation models. These models are usually process-based and are more reliable in capturing effects of temperature and rainfall at different growth stages of crops (Lobell *et al.*, 2008). The main advantage of crop growth modeling is related to their process based underpinning. In addition, crop models can also estimate the effects of other management techniques such as the use of fertilizer, improved seed under climate change. However, crop-growth models do not capture the role of adaptation. Given the importance of modeling adaptation and effects within the same framework, their inability to model adaptation makes them a less preferred choice by economists.

However, examining food security and poverty outcomes under climate change requires evaluating a large number of complex and interrelated factors that can only be captured through mixed approaches. While quantitative approaches are important to estimate cause and

effect relationships, qualitative approaches can also be used to reinforce quantitative results. In addition, qualitative approaches on their own could also play a crucial role in understanding farmer's perception to climate change. Farmer elicitation techniques will in many cases generate adequate data to understand context specific problems of climate change.

Recently, the Climate Vulnerability and Capacity Analysis (CVCA) technique has been widely used as a tool to assess livelihoods and climate change vulnerabilities (Gentle, P. et al., 2012; Daze et al., 2009). The Climate Vulnerability and Capacity Analysis tool is designed to examine the implication of climate change on farmers' livelihoods and to analyze the role of institutions in supporting adaptation. The CVCA approach employed four participatory tools (hazard mapping, seasonal calendars, historical timeline and institutional mapping) in examining vulnerability and capacity of farmers. The CVCA tools have two advantages: First, the visual diagrams and maps can easily be understood by farmers and secondly, the tools can be used to triangulate quantitative survey data results.

1.7. Methodology

The research methodology in this thesis comprised of two approaches (mixed methods). The first approach uses quantitative methodology using the World Bank survey data conducted on 1338 farmers in 2011. The second approach employed participatory and qualitative research methods like Focus Group Discussions (FGDs) with scoring and Climate Vulnerability and Capacity Analysis (CVCA)[4].

For the first objective of investigating how climate change affects livelihood resources, agriculture and food security and how adaptation practices, social networks and institutions in response to climate change affects crop productivity and food security, the thesis employed qualitative and quantitative methods (mixed methods). The quantitative approach employed endogenous switching regression model using the World Bank survey data. The qualitative approach uses Climate Vulnerability and Capacity Analysis (CVCA) and Focus Group Discussions (FGDs).The aim of the CVCA method was to examine the implication of climate change on farmers' livelihoods and to analyze the role of social networks and institutions in supporting adaptation. The CVCA approach employed four participatory tools (hazard mapping, seasonal calendars, historical timeline and institutional mapping) in examining vulnerability and capacity.

[4]Recently, CVCA technique has been widely used as a tool to assess livelihoods and climate change vulnerabilities (Gentle, P. et al., 2012; Daze et al., 2009).

For the second objective of assessing how the different types of social networks (relatives, friendship and neighborhood) are related with the adoption of SLM practices (tree-planting and soil conservation) for climate change adaptation, quantitative approach using the Farmers' Innovation Fund (FIF) data of the World Bank gathered during 2011 was used. The survey was administered by the International Food Policy Research Institute (IFPRI) with the support from the Ministry of Agriculture and Rural Development of Ethiopia and the World Bank. A multi-stage stratified sampling procedure was followed, in which FIF project woredas (districts) were first randomly selected within each agro-ecological zone, followed by kebeles (sub-districts) and then, ultimately, households. Using this method, 19 kebeles and between 35 and 88 households in each kebele were randomly sampled. Two respondents were interviewed in each household, the main respondent (generally a male head), and a second respondent (a female spouse in male-headed households, or "other main farmer" otherwise).The dataset used in this study combines responses from both interviewees, for a total sample size of 1338 households. The dataset has detailed information on household characteristics, agro-climatic zones, production (crop, livestock and nonfarm activities), input use (fertilizer, chemicals and seed), and institutional services (credit, extension service, technology adoption, groups and networks). Such data set are rarely available in developing countries.

For the third objective of examining what works and what does not work well in the agricultural extension reforms in Ethiopia, semi-structured questionnaire, key-informant interviews, net-mapping and focus group discussions were used to generate data from respondents in three different sub-districts. At each administrative level, key informant interview were done with extension managers prior to the focus group discussions with all the experts along the extension system and with farmers. The focus group discussions were corresponding to the semi-structured questionnaires and respondents were asked to give individual scoring after intensive discussion on each of the discussion points in the questionnaire. Later, this quantified rating was used to aggregate the outcomes of the focus group discussions at different level.

Focus group discussions with farmers and FTC-MCs required individual scoring using seeds. First we arranged farmers to sit in a circle and gave five seeds to each participant to score each extension service out of five. When farmers were ready to score, we asked them to put the number of seeds in their right hand and put their hand behind their back. Then, the facilitator walked around the back of the circle and counted everyone's score. This way each farmer decided on their own score privately without showing anyone what score he/she gave.

Satisfaction scores were quantitative values ranging from one to five, where 1 refers to 'strongly disagree', 2 'disagree', 3 'somehow agree', 4 'agree' and 5 'strongly agree'.

The FGDs and CVCA[5]for the first and third objectives were conducted in three woredas selected from Farmers' Innovation Fund (FIF) project woredas of the World Bank. The samplings of the three woredas were done based on stratification of the traditional agro-ecological zones (*Dega, Woyna dega and Kolla*). Considering these agro-ecological differences, three kebeles (one from each woreda) were selected for the qualitative study. Random sampling was then used to select 10 FGDs participants from each kebele.

1.8. Description of the study area

The study was conducted in Amhara National Regional State (ANRS) of Ethiopia (Figure1.1). ANRS is located in the Northern western part of Ethiopia covering an area of 150,374 square kilometers and having a population size of over 17 million (Tesfahun et al., 2004). ANRS is chosen for the study because the region is a good representative of Ethiopia in terms of its diverse agro-ecology, topography and extension reform efforts. With regard to agro-ecological classification, the region is composed of 3% below 500 meters above sea level, 22% between 500 and 1500 meters above sea level, 44% between 1500-2300 meters above sea level, 27% between 2300 and 3000 meters above sea level, 4% above 3000 meters above sea level. The recorded annual mean temperature of the region ranges from 12.4 degree centigrade to 27.8 degree centigrade (Desta et al., 2000).

The pattern of land utilization in the region is as follows: 28.2 percent arable land, 30 percent pastoral land, 2.1 percent forest land, 12.6 percent bush land, 7.2 percent settlement, 3.8 percent water bodies and 16.2 percent unusable land (Lakew et al., 2000).

[5]The participatory tools had two advantages: First, the visual diagrams and maps were easily understood by FGDs participants and secondly, we used the tools to triangulate the world Bank survey data that we used in this study.

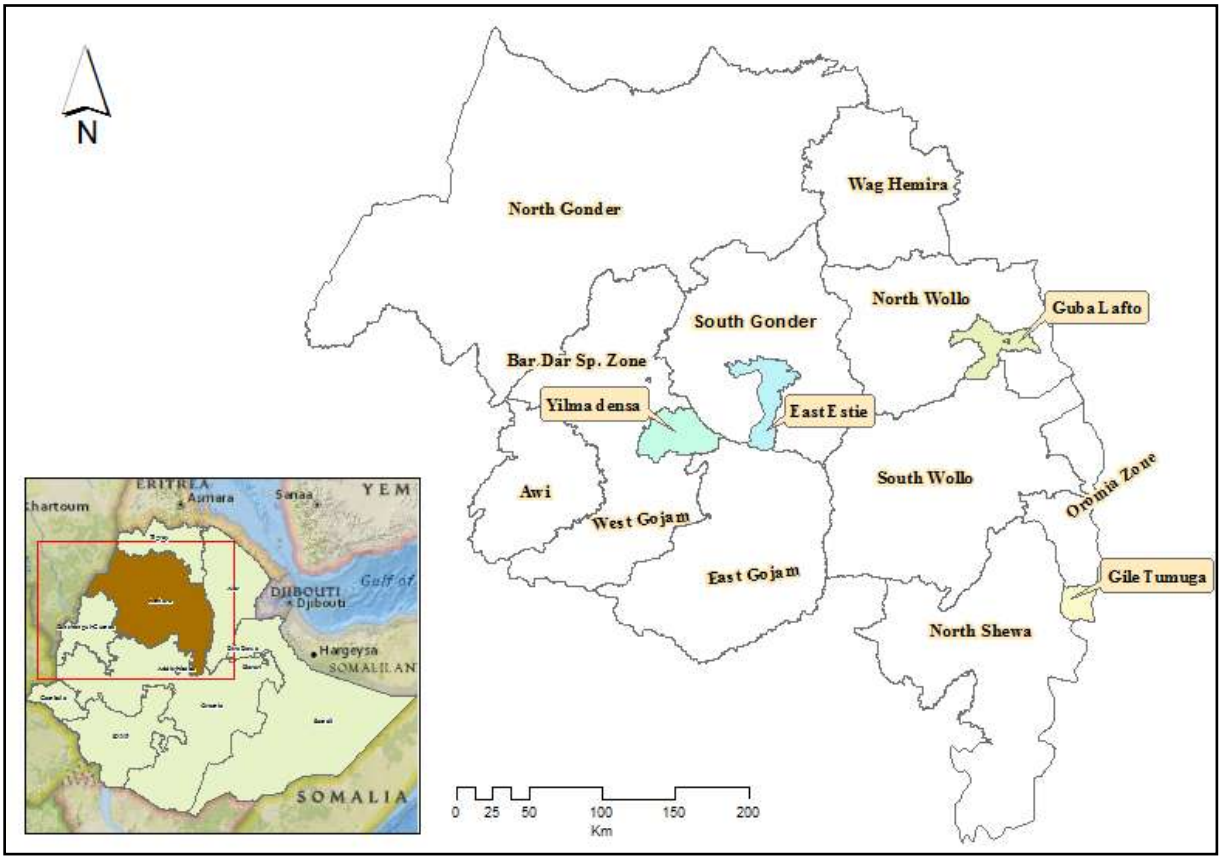

Figure 1.1: Map of the study area

Source: Author's GIS reading

The topography of the region is composed of diverse setups, including lowland, midland and highland plains, mountains, rugged lands, chains of plateaus. ANRS is one of the most vulnerable regions to climate change induced land degradation in Ethiopia. Over the last few years, the region has experienced intense rainfall, shorter rainy seasons and higher temperatures which are characteristics of climate change (Lakew et al., 2000; Yesuf et al., 2005).

To counter the effects of climate change induced land degradation, people in the region have adopted land management technologies such as terracing along mountain slopes, water harvesting and tree planting, which help in both preserving soil moisture and increase biodiversity (Lakew et al., 2000). Some of these activities are done collectively by community members through well-established community mobilization efforts. At the individual level, farmers in the region have adopted Sustainable Land Management (SLM) technologies on their plots, mainly soil conservation techniques (soil and stone walls) and agro-forestry (tree planting) (Benin, 2006; Mekonnen, 2009).

The regional government also introduced major agricultural extension reforms in 1995 to counter the negative effects of climate change through increasing agricultural productivity and natural resource management practices. Participatory Demonstration and Training Services (PADETS) was introduced in 1995 with the aim to introduce agricultural reforms and new extension packages for different farming systems (Spielman et al., 2011). PADETS also involved the use of extension management and training plots of the Farmers' Training Centers (FTCs) along with package approaches such as provision of training, credit, improved seeds and chemical fertilizers (Davis et al., 2010).

Under the auspices of the Federal government, the regional government has also introduced the Rural Capacity Building Program (RCBP) in 2007 aimed at improving PADETES through strengthening the capacity of government extension organizations (MoARD, 2012). The RCBP involved five broad components: (i) Agricultural Technical and Vocational Education and Training (ATVETs), (ii) Agricultural Extension Services, (iii) Agricultural Research, (iv) Improving Information and Communication Systems and (v) Development of Agricultural Marketing Institutions.

Apart from being a good representative of Ethiopia (in terms of agro-ecology and topography), it has been reported that climate change induced land degradation was more severe in Amhara region than any other region in Ethiopia. Since the introduction of the extension reforms in 1995, the efficiency and effectiveness of the extension service has been improved (Ashworth, 2005). It is these claims that make the region an ideal study area for the research questions of this thesis.

1.9. Significance of the study

The research questions and methodologies in this study are relevant for the following reasons. First, although there is sufficient research on the impacts of climate change and adaptation practices in Ethiopia, both at the national level and at the household level, very little is known how climate change is affecting various agro-ecologies differently and how farmers' adaptation practices are enhancing their food productivity (role of adaptation). This study empirically investigates the role of adaptation on food security by linking adaptation practices (tree planting and soil conservation) with climate variability (shock). Moreover, the study analyzes the roles of social networks and institutions in supporting climate change adaptation using CVCA tools (hazard mapping, seasonal calendars, historical timeline and institutional mapping). It is believed that the results from this study will help derive practical initiatives

(policies and programs on climate change adaptation) to improve the food security of farmers in Ethiopia or other countries in sub-Saharan Africa as the climate continues to change.

Second, current network research in Ethiopia focuses mainly on the effects of network size on technology adoption and there is no empirical study on which types of social networks matter the most, and how do such types of social networks matter for Sustainable Land Management practices. This study employed plot-level probit model using Mundlak approach to understand whether rural social networks matter and which types of social networks matter most for technology adoption and climate change adaptation.

Finally, although there are various studies on the agricultural extension reforms in Ethiopia, most of these studies are subject to a range of problems including, methodological, scope and identification of indicators. This study generates new insights on extension reforms in Ethiopia and the insights from the study can inform the extension reform efforts in Ethiopia as well as other countries. Moreover, a method was developed that combines qualitative focus group discussions with anonymous quantitative ratings by the participants .This method is particularly suitable to evaluate sensitive aspects of extension reforms.

1.10. Thesis Layout

The thesis has five chapters. Chapter 2 assesses the effect of climate change on livelihoods resources and agriculture and the roles social networks and institutions on climate change adaptation. Chapter 3 investigates the impact of social networks on adoption of land management practices. Chapter 4 presents an empirical case study of what works and what does not work well in the agricultural extension reforms in Amhara region of Ethiopia. Chapter 5 summarizes the overall results of the thesis and provides policy recommendations based on the findings.

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Chapter Two

2. Climate Change and Adaptation in Ethiopia

Abstract

This study employed mixed methods (qualitative and quantitative) to assess the effects of climate change and the role of adaptation in Ethiopia. Climate Vulnerability and Capacity Analysis (CVCA) and Focus Group Discussions (FGDs) were conducted in three districts of Amhara region in 2013. To complement the qualitative study, this study also employed ordinary least square (OLS) and endogenous switching regression models using the World Bank survey data conducted on 1338 farmers in 2011. The study found that the effects of climate change and adaptation practices differ across agro-ecological zones and adopter groups. In agro-pastoral agro-ecologies the major hazards were drought, floods, and migration. In contrast, snowfall, landslides and crop diseases were the main hazards in rugged central highlands and western plateau agro-ecologies. However, erratic rainfall, soil erosion and livestock diseases were common hazards to all agro-ecologies. Households' responses to the hazards were also different based on agro-ecology. In kolla agro-ecologies the most common coping strategies were reducing the number of daily meals, migration, livestock selling and utilization of irrigation. In dega and woyna-dega agro-ecologies the most common coping strategies were: changing consumption patterns; adopting drought resistant crops (sorghum and millet); sale of chickens, eggs, sheep, goats, eucalyptus trees; soil conservation and tree planting; zero grazing and water harvesting. In all study areas, local institutions also support communal adaptation strategies such as communal water harvesting and irrigation schemes, reforestation, rangeland enclosure and prevention of soil erosion.

The quantitative results also revealed that farmers who implemented climate change adaptation strategies (tree planting and soil conservation) on their plots have significantly increased their food productivity compared to farmers who did not implement these strategies. Based on the qualitative and quantitative results, our conclusion is that the absence of communal land and natural resource use policy was encouraging farmers to over utilize natural resources and the long delay in land use rights (certification) were also discouraging farmers from making long term investments on their land. Therefore, implementation of communal land and natural resource use policy and speedy land certification process are required to reduce farmers' vulnerability to climate change.

2.1. Introduction

The research on the impact of climate change in sub-Saharan Africa shows that climate change is expected to cause increased temperature and rainfall intensity (Thomas et al., 2007), droughts and floods (Niang et al., 2014; Tschakert et al., 2010), desertification (Reich et al., 2001), spread of animal and human diseases (Chen et al., 2006). These extreme events are likely to have negative impacts on production and food security (Niang et al., 2014; Porter et al., 2014)

Scientific evidence on the relationship between climate change and food productivity in developing countries shows that agricultural productivity will continue to decline due to climate change (Cline, 2007; Di Falco et al.,2011; Parry et al., 2005; Rosenzweig, 1994). It is projected that by 2020 crop yields from rain-fed agriculture in Africa may fall by up to 50% (IPCC, 2007). These events in turn affect all aspects of food security in the region including food availability, access, utilization and stability (IPPC, 2014).

The adverse effects of climate change on food productivity and food security in Ethiopia are also significant as small-scale and subsistence farmers depend on rain-fed agriculture with limited irrigation coverage. From 1951 to 2006, the average temperature in Ethiopia increased by about 0.37 ^{0}C every ten years and climate projections reveal that the mean annual temperature will increase in the range of 0.9 to 1.1 ^{0}C by 2030. In addition, average temperature is expected to increase in the range of 1.7 to 2.1 ^{0}C by 2050 and in the range of 2.7 to 3.4 ^{0}C by 2080 (NAPA, 2007). Climate change models have also predicted that the mean temperature for Amhara region, where the study area is located, is also high (Desta et al., 2000; World Bank, 2010). Changes in rainfall and temperature along with the associated hazards (droughts, higher temperatures and flooding) and vulnerability (high dependence on rain-fed agriculture and natural resources, rapid population growth and poverty) are dragging Amhara region into one of climate change hotspot regions in Ethiopia (Deressa et al., 2009; NAPA, 2007; World Bank, 2010). These changes have already been causing significant challenges to the region by putting additional pressure on scarce natural resources such as water and land that ultimately lead to crop failures and increased food insecurity (Bewket et al., 2007). Nearly 85% of the farmers in Amhara region are totally dependent on "*Meher*" rainfall and hazards caused by climate change are affecting production of major cereal crops (Tesfahun et al., 2004).

There is sufficient research on the impacts of climate change and adaptation practices in Ethiopia, both at the national level (e.g., NAPA, 2007) and at the household level (e.g., Deressa, 2007; Di Falco et al., 2011). However, very little is known how climate change is

affecting various agro-ecologies differently and how farmers' adaptation practices are enhancing their food productivity. The main objective of this paper is therefore, to investigate how adaptation practices (tree planting and soil conservation) in response to climate shocks (temperature and rainfall), affects food crop productivity and food security in Ethiopia. Using quantitative and qualitative approaches, the research will respond to the following research questions: (1) What are the major climate hazards and their effects on agriculture and natural resources in Amhara region? (2) What adaptation or copying strategies are used to address the hazards? (3) What is the role of adaptation in increasing food productivity and what are the roles of policies and institutions? By focusing on farmers' vulnerabilities to climate change and the role of adaptation in increasing productivity at the household level, this study aims to fill research gaps in understanding the interactions between climate change, adaptation and food productivity in Amhara region.

2.2. Definition of concepts and literature review

As has been pointed out above, the research on the impact of climate change in sub-Saharan Africa shows that climate change is expected to have negative impacts on production and food security (Niang et al., 2014; Porter et al., 2014).

Recently, scholars have given due consideration to the role of adaptation in mitigating climate change and enhancing agricultural productivity (Di Falco et al., 2011b; IPPC, 2014). Climate change in IPCC usage refers to "a change in the state of the climate that can be identified (e.g. using statistical test) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer". Adaptation is then "the process of adjustment to actual or expected climate and its effects" (IPCC, 2014: 5). According to Adger (2003) the capacity of farm households to cope with climate change (adaptive capacity) depends on the household's and local resources[6] (asset base) and local institutional support (land tenure, safety net programs and extension services). Vulnerability is then the lack of capacity to adapt to climate change that may arise due to environmental changes and lack of institutional support (Adger, 2006; Gentle et al., 2012; Thornton et al., 2007). Adaptive capacity is location specific and varies over time, space and communities depending on human and social capital levels, quality of governance and institutional services (Gentle et al., 2012; Smit et al., 2006; World Bank, 2010).

Reducing farm households and communities vulnerability to climate change is highly related to increasing food security. Food security is often defined as household's or communities' ability to access and utilize the available food items where food productivity is the main

[6]Natural, human, physical, social and financial resources.

aspect (Di Falco et al., 2011a; FAO, IFAD, & WFP, 2015; IPPC, 2014). According to Devereux (2000), low productivity and food insecurity in Ethiopian is associated with long term climatic changes related to scarce and erratic rainfall. Moreover, Di Falco et al. (2011)argue that adaptation enables farmers in Ethiopia to mitigate climate hazards and increase food productivity and food security even under high climate vulnerability. However, adaptation capacity depends on the existing policy and institutional arrangements like land tenure, social safety net programs and extension services (Abegaz et al., 2014; Devereux, 2000; Weldegebriel et al., 2013). Thus, adaptation to climate change is key for food productivity and food security in Ethiopia (Di Falco et al., 2011b).

Similar to other resource dependent developing countries (Adger, 2003; Agrawal, 2001), the livelihoods of farmers in Ethiopia are highly associated with the availability of natural resources such as livestock, agriculture and rain water (Tschopp et al., 2010). Historically, farmers in Ethiopia have been implementing a variety of adaptation practices (Hadgu et al., 2014; Bishaw et al., 2013). However, adaptation strategies of farmers are mainly short term reactive responses to climate shocks rather than planned long term strategic actions (Bryan et al., 2009). Documented examples of climate change adaptation strategies in Ethiopia include; crop diversification, change in crop type, soil and water conservation, change in planting dates and irrigation practices (Hadgu et al., 2015; World Bank, 2010). The negative impact of climate change is projected to be more severe in Ethiopia where farmers are dependent on rain-fed agriculture and natural resource. Current studies reported that adaptation and coping strategies by farmers vary in time and space and therefore local-level studies are important for implementing effective adaptation plans and policies(IPPC, 2014). Therefore, this study investigates the links between climate change, adaptation and food productivity in the Amhara region of Ethiopia.

2.3. Conceptual Framework

This study draws upon the conceptual framework developed by Connolly-Boutin et al (2015), which explains that the vulnerability of a farming community depends on two interrelated factors: The first is related to shocks such as climate change and socioeconomic factors and the second on the capacity to adapt to the shocks. Climate change/shocks include high temperature and rainfall intensity (Thomas et al., 2007), droughts and floods (Niang et al., 2014; Tschakert et al., 2010), desertification (Reich et al., 2001), spread of animal and human diseases (Chen et al., 2006). Socioeconomic factors such as population growth, policies and institutions are also important drivers of vulnerability (Adger et al., 2006; Scoones, 2009). Climate shocks and socioeconomic factors systematically interact (overlap) to affect the food

security of a community and are regarded as hazards (Gentle et al., 2012). Adaptive capacity then refers to the ability of a farmer or a community to use their assets or social networks in order to deal with the hazards.

Access to assets is determined by local institutions and polices as well as by the interaction between climate and socioeconomic conditions (sees Fig. 2.1). Assets are the livelihood resources that farmers use to devise adaptation strategies (Scoones1998). For instance, in order to make a long term investment on land, a farmer may seek advice from friends and neighbors (hence using their social capital).

Adaptation strategies are the actions that farmers individually or collectively undertake to respond to climate hazards (e.g., tree planting, soil conservation and migration). In other words, adaptation strategies are the realization of adaptive capacity, as farmers use their assets for adaptation (Adger 2006; Smit et al., 2006). However, before the decision to implement adaptation strategies, farmers have to perceive climate change and its effect on their livelihood resources.

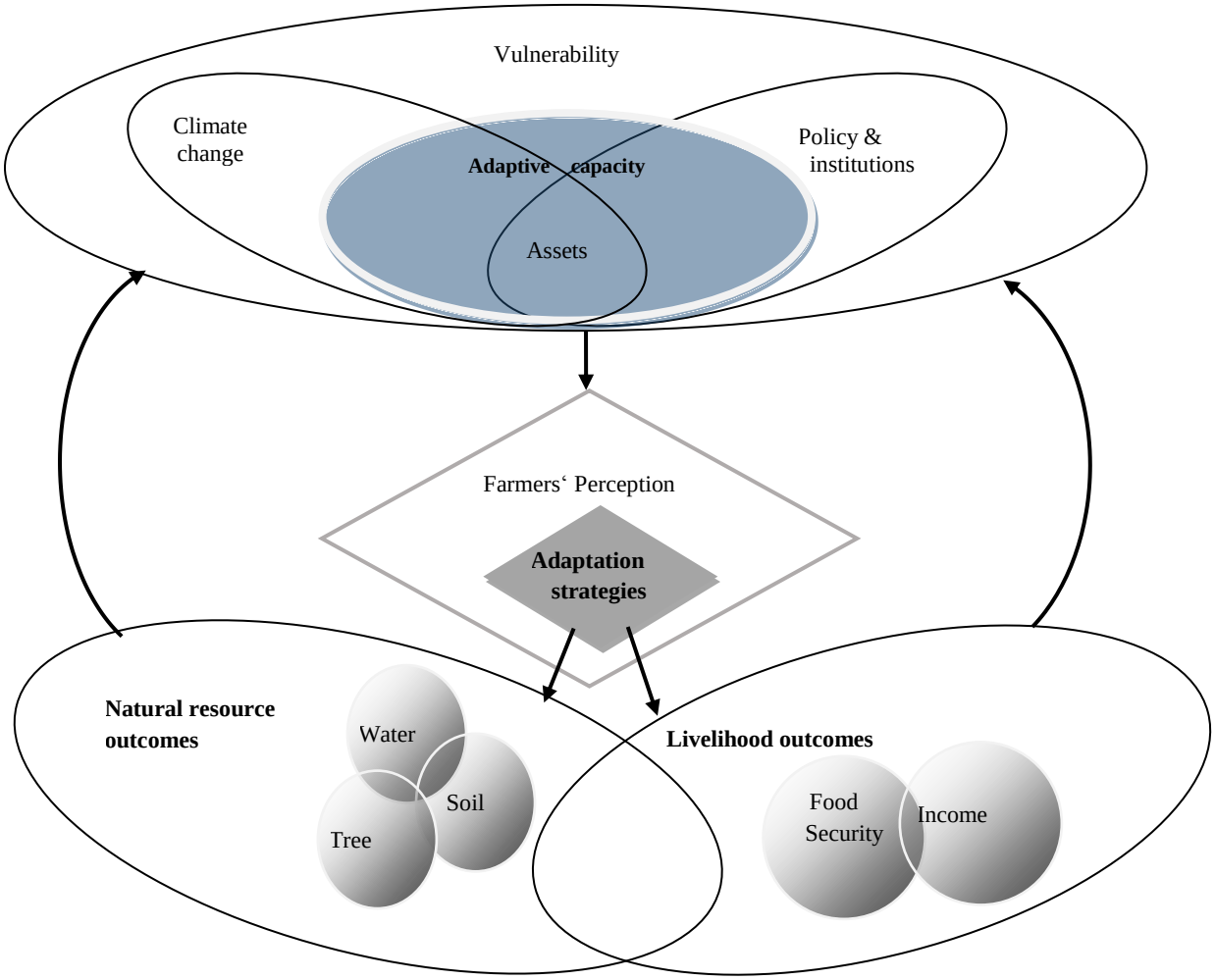

Figure 2.1: Climate change, food security and livelihoods framework

Source: Adapted from Connolly-Boutin et al (2015)

Farmers' joint climate change perceptions and adaptation decisions are reflected in outcomes. Livelihood outcomes include changes in income and food security (Gladwin et al. 2001). Natural resource outcomes include changes in soil quality, afforestation and water availability (Fisher et al.2013). As shown in the conceptual framework, the natural resource and livelihood outcomes overlap to show that they are interrelated. For example, sale of livestock (livelihood strategy) may help reduce overgrazing, but the loss of manure due to the sale may reduce soil fertility (natural resource). Finally, the livelihood and natural resource outcomes can change a community's vulnerability to climate change through feedbacks to its adaptive capacity (see the arrows in Fig 2.1). For example, a short term increase in income through cutting of trees may have negative effect in the long run by increasing soil erosion and reducing natural resources.

2.4. Study area, data and methodology

2.4.1. Study area

The study has been conducted in the Amhara regional of Ethiopia. Amhara region is located in the north western part of Ethiopia covering an area of 150,374 square kilometers and having a population size of over 17 million (Tesfahun et al. 2004). In terms of agro-ecological classification, the region is composed of 3% below 500 meters above sea level, 22% between 500 and 1500 meters above sea level, 44% between 1500-2300 meters above sea level, 27% between 2300 and 3000 meters above sea level, 4% above 3000 meters above sea level. The recorded annual mean temperature of the region ranges from 12.4 degree centigrade to 27.8 degree centigrade (Desta et al., 2000).

The pattern of land utilization in the region is as follows: 28.2 percent arable land, 30 percent pastoral land, 2.1 percent forest land, 12.6 percent bush land, 7.2 percent settlement, 3.8 percent water bodies and 16.2 percent unusable land (Desta et al. 2000). The topography of the region is composed of diverse setups, including lowland, midland and highland plains, mountains, rugged lands, chains of plateaus. ANRS is one of the most vulnerable regions to climate change induced land degradation in Ethiopia. Over the last few years, the region has experienced intense rainfall, shorter rainy seasons and higher temperatures which are characteristics of climate change (Yesuf and Pender 2005; Desta et al. 2000). Apart from being a good representative of Ethiopia (in terms of agro-ecology and topography), it has been reported that climate change induced land degradation was more severe in Amhara region than any other region in Ethiopia. It is these claims that make the region an ideal study area for the research questions of this thesis.

2.4.2. Data sources

For examining the effect of climate variability and the role of adaptation strategies on food productivity, this thesis used the data on the Farmer Innovation Fund (FIF) of the World Bank, which was collected in 2011. The survey was administered by the International Food Policy Research Institute (IFPRI) with the support from the Ministry of Agriculture and Rural Development of Ethiopia and the World Bank. A multi-stage stratified sampling procedure was followed, in which FIF project woredas (districts) were first randomly selected within each agro-ecological zone, followed by kebeles (sub-districts) and then, ultimately, households. Using this method, 19 kebeles and between 35 and 88 households in each kebele were randomly sampled. Two respondents were interviewed in each household, the main respondent (typically a male household head), and a second respondent (typically a female spouse in male-headed household, or "another main farmer" otherwise).

The dataset used in this study combines responses from both interviewees, resulting in a total sample size of 1338 households. The data set has detailed information on household characteristics, agro-climatic zones, production (crop, livestock and nonfarm activities), input use (fertilizer, chemicals and seed), and institutional services (credit, extension service, technology adoption, groups and networks). Such data set are rarely available in developing countries.

To complement the World Bank survey data with quantitative information, Climate Vulnerability and Capacity Analysis (CVCA)[7] and Focus Group Discussions (FGDs) were conducted in three of FIF project woredas. Furthermore, in order to estimate the effect of climate variability on food productivity, monthly rainfall and temperature data covering the period 1970-2011 were collected from the Amhara metrological service and included to the World Bank survey data for the analysis.

Fig. 2.2 shows observed historical mean rainfall data of 40 years in the region. The data clearly shows that the level of rainfall variability has increased over time. Moreover, the trend line shows that the magnitude of growing period rainfall, which is very critical for food production, has declines over time with a clear declining trend.

[7]The participatory tools had two advantages: First, the visual diagrams and maps were easily understood by FGDs participants and secondly, we used the tools to triangulate the world Bank survey data that we employed in this study.

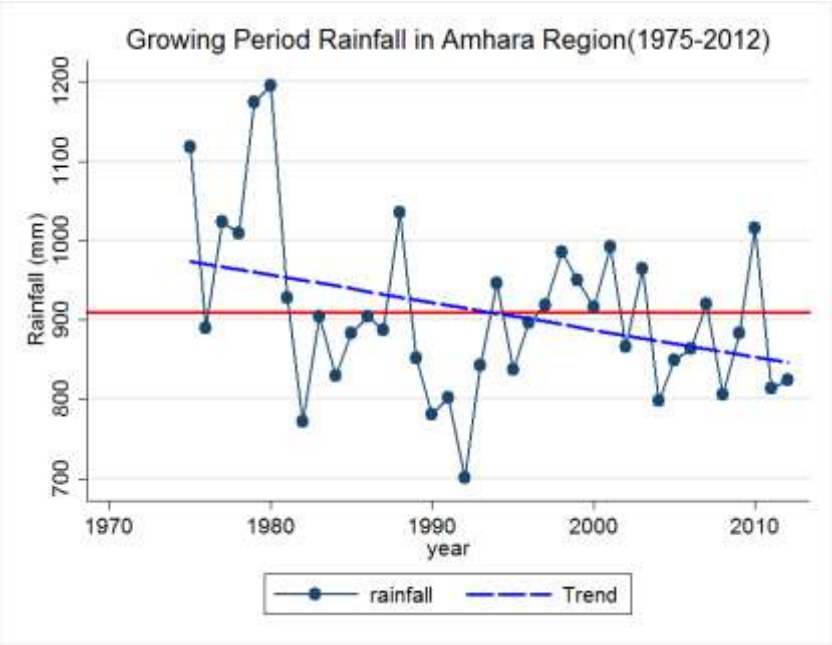

Figure 2.2: Rainfall trends in Amhara region

Source: Authors computation, based on official data

The combination of highly variable and declining trend rainfall makes examining the effect of climate variability challenging. More importantly, the historical temperature data also exhibits increasing trend (Fig. 2.3).

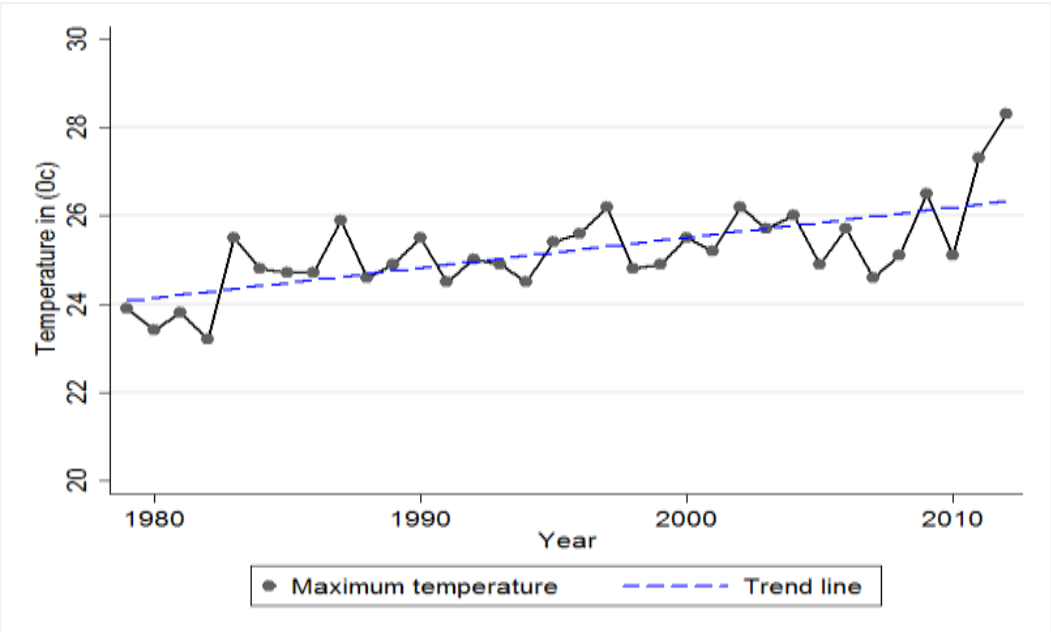

Figure 2.3: Maximum temperature trend in Amhara region

Source: Authors computation, based on official data

In this paper, we focus on rainfall shock since rain-fed agriculture forms the basis of livelihood for many smallholders in Ethiopia. In order to examine the effect of climate variability, we computed Standardized Anomaly Index (SAI) (see Kadi et al., 2011) for each study area (woreda) based on long term mean and standard deviation of observed rainfall.

$$SAI = \frac{R_{jt} - \bar{R}_j}{SD} \quad (1).$$

Where, SAI, measures Standardized Anomalies; R_{jt} refers to the level of rainfall at time t for village j, while $\bar{R}_j$ measures the corresponding long term rainfall mean of the village. SD measures the standard deviation of the historical rainfall distribution. Accordingly, a year with SAI value of <-1 is considered as a dry year[8]. Using the above index, we categorized the different observed rainfall years into different climate types.

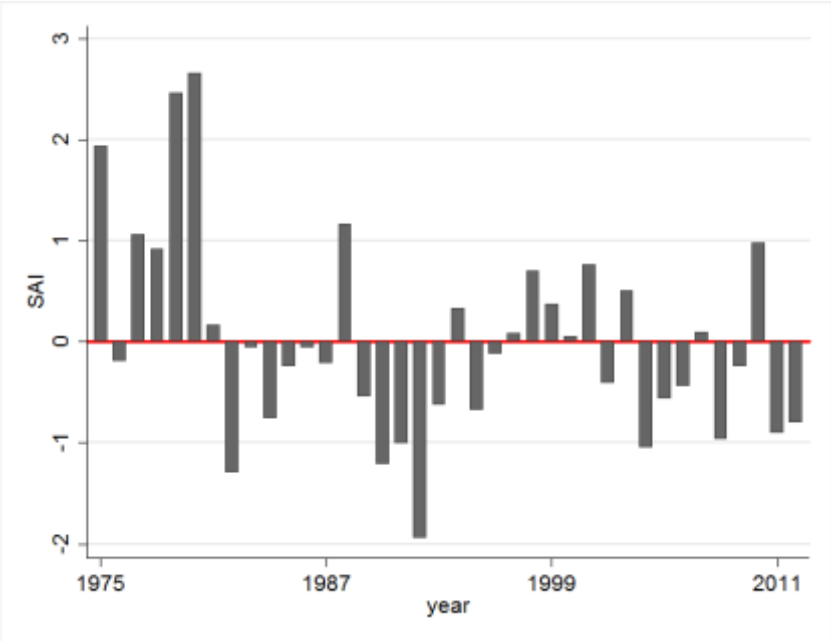

Figure 2.4: Historical rainfall shocks in the region

Source: Authors computation, based on official data

Fig. 2.4 shows, SAI values over time for the region. For this study we focus on negative rainfall shocks. We measure a negative rainfall shock by a dummy variable which takes a value of one if the rainfall levels in the village in the 12 months preceding the survey fall one standard deviation below the long-term mean (if the climate year is dry or very dry). Using this measure, we then estimate its effect on food productivity.

[8]Dry year -1<=SAI<0.5, Very dry year = -2<=SAI<-1, Wet year 0.5<=SAI<1, Very wet year= 1<=SAI<2, Normal year -0.5<=SAI<0.5

In addition, the survey contains information about long term investments made by households in response to climatic change. These include tree planting and adoption of soil and water conservation practices at plot level. We considered the implemented strategies as an "adaptation strategies," and assigned a dummy variable equal to one if a farm household implemented tree-planting and/or soil conservation, and zero otherwise. These strategies are mainly yield-related and account for more than 70% of the adaptation strategies. Furthermore, detailed production and inputs data were collected at the plot level and farmers grow five major crops (Teff, Maize, Wheat, Barley and Sorghum) on their plots. Since these are also the main staple crops in the region (Taffesse et al., 2012; Tesfahun et al., 2004), our plot level analysis considers these crops.

2.4.3. Methodology

As indicated above, the research methodology in this study comprised of two approaches (mixed method). The first approach employed quantitative methodology using OLS and endogenous switching regression model to estimate the effect of climate variability on food productivity and the role adaptation strategies may play at times of shocks respectively.The second approach uses participatory and qualitative research methods like Climate Vulnerability and Capacity Analysis (CVCA)[9] and Focus Group Discussions (FGDs). The aim of the CVCA method was to complement the results of our quantitative analysis and to examine the implication of climate change on farmers' livelihoods. Moreover, the CVCA is used to analyze the role of institutions in supporting adaptation. The CVCA approach employed four participatory tools (hazard mapping, seasonal calendars, historical timeline and institutional mapping) in examining vulnerability and capacity.

For estimating the effect of climate change and the role of adaptation, the study uses FIF (Farmers Innovation Fund) data set described above. Using this rich data set, we developed two econometric models: One for estimating the effect of climate change on food production and the second for estimating the role of adaptation strategies (tree planting and soil conservation) on food security.

An Ordinary Least Square (OLS) model was used to estimate the effect of climate change on crop value per hectare (our indicator of food productivity). Further in our regression, we controlled for different household characteristics (age, education), plot characteristics (slope, soil fertility, and land size), institutional factors (credit access), environmental variables (rainfall shock measures and agro-ecology dummies), and inputs (fertilizer, seed). The effect

[9]Recently, CVCA technique has been widely used as a tool to assess livelihoods and climate change vulnerabilities (Gentle, P. et al., 2012; Daze et al., 2009).

of climate variability on food production is modelled using the following parsimonious specification:

$$Y_i = \alpha_0 + \gamma S_{ij}^r + \vartheta X_i + \varepsilon_i \quad (2).$$

In the above specification, S_{it}^r measures rainfall anomalies faced by household i in village j; while $X_{i,}$captures other factors, such as household and farm characteristics.γ and ϑ are vectors of parameters to be estimated, Y_i refers crop revenue per hectare. If climate variability affects food productivity, we expect $\gamma$to be significant. $\varepsilon_i$is household specific idiosyncratic random shock.

Next, we introduce the role of adaptation strategies on food productivity in the above specification. This step is quite crucial since examining how the different strategies implemented by the farming households (e.g., soil conservation, tree-planting, crop selection, etc) in response to changes in climate (rainfall and temperature) affect their food productivity. In this study, we employed endogenous switching regression model to investigate whether farmers who implemented two important climate adaptation strategies (tree-planting and soil conservation) increased their productivity compared to non-adopters. Following Di Falco et al. (2011) and Kassie et al. (2014) the joint determination between climate change adaptation (through tree-planting and soil conservation) and the effects of adaptation on productivity (net revenue) can be modelled in two steeps. In the first step, the farmer will adopt tree-planting and/or soil conservation, if the expected benefits from adoption are larger than not adopting (equation 1).

$$\mathrm{I}_\mathrm{i}^* = \mathrm{Z}_\mathrm{i}^\alpha + \varepsilon_\mathrm{i} Where I_i = \begin{cases} 1 & \text{if } \mathrm{I}_\mathrm{i}^* > 0 \\ 0 & \text{Otherwise,} \end{cases} \quad (3).$$

Where, I_i^* is a latent variable that reflects farmer i decision and $\mathrm{I}_\mathrm{i} = 1$ if $\mathrm{I}_\mathrm{i}^* > 0$ (the farmer adopts tree planting and/or soil conservation), and 0 otherwise; Z is a vector characteristics that influence tree-planting and soil conservation (climate change adaptation). These include: plot characteristics (e.g., soil fertility, land slop); household characteristics (age, gender, education, household size); current climatic factors (rainfall, temperature); networks (formal and informal); institutional services (extension and land tenure); and ownership of assets (farming tools, animals).

In the second step, the endogenous switching regression model captures the effect of adaptation on food productivity by estimating two separate equations for the farm households that adapted and not adapted.

$$Regime1: y_{i1} = X_{i1}\beta_1 + U_{i1}\ if I_i = 1 \quad (4).$$

$$Regime2: y_{i2} = X_{i2}\beta_2 + U_{i2}\ if I_i = 0 \quad (5).$$

In the above specification, $Regime1$ estimates the effect of adaptation while $Regime2$ captures the counterfactual group (non-adopters). y_i denotes the per hectare productivity for the two groups, and $X_i$represents a vector of inputs (e.g., seeds, fertilizer), and household characteristics, plot characteristics, asset holdings, and the climate variables included in steep 1. The two β vectors capture, respectively, how adapters and non-adapters food productivity respond to the household and plot characteristics and U is the error term with zero mean and constant variance.

The above equations do not allow to directly capture the role of adaptation on food productivity as the characteristics of the two groups could be different. Following Di Falco et al. (2011) and the impact evaluation literature, we compute the average food productivity (in terms of net value) for both adapters and non-adapters by comparing the expected food productivity under the actual and counterfactual cases. The actual Regime1 and Regime2 scenarios are those observed in the data. The counterfactual scenarios show the hypothetical case of what would have happened had the adapted farm households did not adapt, and that the non-adapted farm households adapted. The estimates from the endogenous switching regression permit computing the expected net gains in the actual and hypothetical scenarios. The endogenous switching regression framework can also be used to calculate the treatment and heterogeneity effects. The heterogeneity effects are important to understand the differences in net benefits between farm households that adapted and those that did not adapt, and to anticipate the potential effects of changes in agricultural policy (Di Falco et al. 2011).

2.5. Results of the Quantitative Analysis

2.5.1. Descriptive statistics

Table 2.1 displays the descriptive statistics of the socio-economic characteristics used in the regression analysis. In terms of independent variables, we have included several household characteristics, such as age (which captures the effects of experience in dealing with rainfall shocks), household size and educational attainment.The average age of the household head in our study area is 42 years. The average educational attainment level of the household head is two years and the average household size is six members, with high dependency ratio. To capture the wealth (income) effect we included Tropical Livestock Units (TLU) (total

livestock endowment) as a proxy for the capacity to cope with shocks and invest in other non-farm diversification options.

In the survey, 66 percent of the heads of the households responded that at least one member of their family worked on someone else's land or in some other employment, against payment in cash or in kind. The off-farm employment also involves participation in the Productive Safety Nets Programme (PSNP). PSNP provides cash or food for people who have predictable food needs in exchange for public work to protect environmental degradation. Farm characteristics are represented by soil quality and slope. Based on farmers' self-assessment of their plots, soil quality is rated as fertile, medium or infertile. Similarly, depending on the slope farmers categorize their plot as flat, gentle or steep slope. Climatic conditions are represented by the three agro-ecological zones covered in the survey: Dega, Woyna-dega and Kolla.

Table 2.1: Variable list and descriptive statistics

Variable	Mean	Std dev	Min	Max
Household size (family members)	6.0	2.0	1	14
Age of household head(in years)	42.0	10.75	18	82
Sex household (1= male, 0= female)	0.77	0.42	0	1
Education (head)	2.45	2.82	0	14
Access to off-farm (1=yes,0=otherwise)	0.66	0.47	0	1
Soil fertility[10](1=Lem, 2=Lem-Tef, 3=Tef)	1.82	0.51	1	3
Access to safety nets	0.13	0.34	0	1
Access to extension (1=yes,0=otherwise)	0.78	0.42	0	1
Slope(1= flat, 2= medium,3=step)	1.22	0.36	1	3
Land tenure[11] (1=yes,0=otherwise)	0.73	0.44	0	1
Membership in informal associations(1= member, 0=otherwise)	0.77	0.42	0	1
Membership in formal associations(1= member, 0=otherwise)	0.03	0.16	0	1
Membership in agricultural cooperatives(1= member, 0=otherwise)	0.03	0.18	0	1
Tropical Livestock Unit (TLU)	0.13	0.73	0	23
Agro-ecology (1=Dega, 2= Woyna-dega, 3=Kolla)	2.22	0.50	1	3
Improved seed (1=yes, 0,otherwise	0.41	0.49	0	1
Irrigation (1=yes, 0 otherwise)	0.12	0.32	0	1
Rainfall Anomaly Index	-0.82	0.64	-1.8	2.4
Crop value (ETB/ha)	9200	7598	3200	32890

Source: Author's calculation based on FIF data set

[10]Lem, Lem-Tef and Tef are traditional soil quality categories representing respectively; fertile, moderate and infertile soil.

[11]Land holding is said to be secured when the household receives a certificate and can transfer the land.

We also include membership to formal and informal associations as proxies for social capital. Access to extension is also another important institutional variable that is included in our regression analysis. Other potential productivity enhancing measures such as the use of improved seed and irrigation were also included in the regression analysis. In the region, irrigation coverage is very small. Finally, out shock measure (rainfall anomaly index) ranges between -1.8 and 2.4. This clearly indicates that rainfall shock was quite prevalent in the region. Based on the rainfall anomaly index, we created a dummy variable which takes a value of one if the district experience a rainfall shock which is one standard deviation from the long term mean.

2.5.2 Effect of climate variability

Table 2.2 presents the ordinary least squares (OLS) estimation of the effect of climate variability on value of crop production. We found that households with access to irrigation have higher value of crop production compared to households without irrigation access. Not only the direction and significance of the estimated effect, but also the magnitude of the effect is interesting. In particular, the value of crop production for households with irrigation access is approximately 5,350 birr higher than farm households without access to irrigation. This finding is relevant as irrigation coverage is quite limited in Ethiopia. The magnitude of the effect is almost twice as high as the magnitude of the shock. Expectedly, this result suggests that expansion of irrigation may help households cope the effects of rainfall shock.

Another relevant finding from the regression is that the positive and significant effect of improved seeds, which is also expected. The interaction term between access to irrigation and the use of improved seed is positive and significant, suggesting the complementarily of the two inputs. The magnitude of the estimated effect clearly indicated that expansion of irrigation and the use of improved seed would be crucial to improve the value of production (and hence enhance food security) under climate variability. Finally, the result underscore the important role that access to extension plays for improving productivity. The results suggest that farm households with access to extension have a significantly higher income from production than farm households without access to extension (without, however, controlling for sample selection bias in access to extension).

Rainfall shock which is our main variable of interest has a significant negative effect on the value of production. As mentioned above, in our specification, rainfall shock is measured by a dummy variable equal to one if the village experienced a rainfall shock (if the rainfall levels in the village in the 12 months preceding the survey fall one standard deviation below the

long-term mean (over its 40 years average (1970-2011)), 0 otherwise. The result underscored that farm households that are exposed to random negative rainfall shocks are more likely to be food insecure. In particular, our result suggests that experiencing a rainfall shock which is one standard deviation from the long term mean, reduces per hectare value of production by approximately 2600 birr.

Table 2.2: OLS estimation of the effect of climate variability on value of production

Dependent variable value of production (in Birr/ha)	Coefficient	Std. Err	P>t
Access to safety net	2494.48	2070.26	0.23
Soil fertility	626.61	901.81	0.49
Slope	-1996.50*	1205.31	0.09
Land tenure	-1942.29	1315.58	0.14
Household size	503.03	339.68	0.14
Sex of household	1391.29	1700.14	0.41
Age of household head(in years)	-14.11	62.25	0.82
Education (head)	234.01	217.74	0.28
Access to off-farm	-201.97	1501.84	0.89
Tropical Livestock Unit (TLU)	-2338.50***	740.46	0.002
Membership to formal association	18257.97***	3734.05	0.00
Membership to informal association	-2652.36	1695.09	0.12
Membership to agri-cooperatives	5734.18	3864.38	0.14
Access to extension service	9133.10***	1425.12	0.00
Woina-dega climate	3051.37	2500.99	0.22
Kollaclimate	-2569.73	2946.64	0.38
Used improved seed	4996.71***	1349.82	0.00
Used irrigation	5346.18**	2447.48	0.02
Improved seed*irrigation	54691.36***	3631.77	0.00
Shock	-2608.08*	1382.93	0.06
Constant	-7933.05	4794.86	0.09
F (20,3413)	32.83		
R-squared	0.16		

$^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$

Source: Author's compilation, based on FIF data

Given the above reported effect of climate variability, the next important policy question is therefore, does adaptation to climate variability reduce vulnerability and hence improve food security? Is there any significance difference between adapter and non-adapter farm households in terms of value of crop production and hence food security? The next section presents the results of our heterogeneous treatment model and discusses the above policy questions.

2.5.3 The role of adaption on food productivity and food security

To examine the role of adaptation on food production, we considered adoption of soil conservation practices and tree planting in response to climate variability as an adaptation

strategy. As can be seen from the endogenous regression results (Table 2.3), farmers' decisions to implement tree planting and soil conservation in response to changes in climate variability depends on household characteristics (household size, sex and education level of the head) and their social networks (membership to informal association).

Table 2.3: Results of the endogenous regression model

	(1)	(2)	(3)
Model	Adaptation	Adapted	None adaptation
Dependent variables	(1/0)	Per hectare value	Per hectare value
Household size	0.031***(0.011)	-219.78(159.21)	95.24*(55.59)
Education	0.028***(0.008)	45.18(104.77)	-107.63***(38.23)
Sex	0.127*(0.070)	-182.00(990.22)	74.96 (291.77)
TLU	0.028(0.023)	8834.49**(3964.33)	152.19 (124.88)
Woyena-dega climate	0.194**(0.087)	-2808.94**(1284.71)	698.39**(276.10)
Dega climate		1986.83 (1842.31)	1488.31***(483.37)
Fertile soil		147.43 (946.55)	350.04*(193.99)
Medium slope		-750.90 (849.60)	177.07(179.26)
Flat slope		-1127.5 7(1656.43)	-336.14(380.90)
Middle slope		-1561.95 (1762.62)	-339.98(396.72)
Improved seed		2732.09*** (676.34)	2193.09***(144.44)
Irrigation		-132.40 (1375.63)	918.13***(270.99)
Improved seed*Irrigation		-54.63 (1738.21)	-1986.23***(374.68)
Shock		-135.49 (717.04)	-1622.98***(139.37)
Membership to formal association	0.035(0.093)		
Membership to informal _associatio	-0.088**(0.040)		
Membership toAgri_cooperative	-0.044(0.070)		
Kolla climate	-0.186*(0.103)		
Constant	-1.063***(0.114)	14272.82***(3258.50)	4045.73***(565.85)
σ_i		7575.95***(172.88)	5666.54***(88.01)
ρ_i		-0.116(0.174)	-0.993(0.002)

Standard error in parentheses, $^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$

Source: Authors calculation, based on FIF data

The results show that, farm households with large family size and households headed by male and educated farmers are more likely to adapt to climate variability through the implementation of tree-planting and soil conservation. Similarly, farmers in woyna dega agro-ecologies are more likely to implement climate change adaptation strategies compared with farmers in kolla agro-ecologies. When we look at the value of production (productivity) implication of adaptation, the value of production function is different for the two groups. We find that while climate shock did not significantly reduce the value of production of farmers that implemented tree-planting and soil conservation, it did significantly reduce the value of

production of farm households that did not adopt tree-planting and soil conservation. This implies that adaptation to climate change through the implementation of tree-planting and soil conservation makes farmers more resilient to climate shock which is mainly caused by shortage of rainfall.

Table 2.4 presents the expected crop values per hectare under actual and counterfactual conditions. Cells (a) and (b) are the actual conditions representing the expected values per hectare observed in the sample. The expected crop values per hectare for farmers that adapted and did not adapted to climate change are respectively, approximately 12,290 and 8940 birr. The treatment effects of adaptation on net revenues are reported in the last column of Table 2.4. In the counterfactual case (c), farmers who actually adapted would have lost approximately 1010 birr per hectare if they did not adapt to climate change. On the other hand, in the counterfactual case (d) where farmers that did not adapt assumed to be adapted, they would have gained nearly 9590 birr more if they had adapted. These results suggest that farmers who implemented climate change adaptation strategies have significantly increased their food productivity and food security compared to non-adopters.

Table 2.4: Mean expected net revenues in birr per hectare and treatment effects

Sub-samples	Adaptation	No adaptation	Treatment Effects
Farmers that adapted	(a) 12,289	(c) 11,277	ATT= 1012***
Farmers not adapted	(d) 18,529	(b) 8937	ATU= 9592***

*** Significant at the 1% level

2.6. Results of the Qualitative Analysis

In this section, we present the results of the qualitative analysis and examine to what extent they are in line with the quantitative results. The metrological data (temperature and rainfall) was compared with the perceptions of farmers on climate change using the CVCA tools and FGDs. The CVCA and FGDs were conducted in sub-districts of Merewa (from now on kolla), Dengolt (from now on dega) and Adet (from now on weyna dega).

2.6.1. Perceived effects of climate hazards on livelihoods resources

Using climate vulnerability matrix, we identified farmers' perception about four major climate hazards that have the most serious impact on four important livelihoods resources in each sub-district. The tables indicate the extent, measured on a score from 0 to 3, to which a particular hazard affects each livelihood resource that is considered to be relevant. As the tables show the perceived impact of the four major climate hazards on the different livelihood

resources varied from sub-district to sub-district. For example, farmers in dega ranked snow, erratic rainfall, soil erosion and crop diseases as the greatest climate hazards in their kebeles.

Table 2.5: Vulnerability matrix of Dega

	Snow	Erratic rainfall	Soil erosion	Crop disease
Agriculture	3	2	3	2
Livestock	3	2	3	0
Local trade	3	2	2	2
Employment	3	2	2	2

Source: Data collected by author

Farmers in kolla ranked drought, crop and animal diseases, flood and seasonal migration as the most serious climate hazards.

Table 2.6: Vulnerability matrix of Kolla

	Drought	Crop & animal diseases	Flood	Seasonal migration
Agriculture	2	3	1	2
Livestock	3	2	1	2
Local trade	1	2	1	0
Employment	0	0	0	0

Source: Data collected by author

Similarly, crop pests, crop diseases, erratic rainfall and landslides were ranked from first to fourth in weyna dega areas. Farmers in each agro-ecology were asked to score on the degree of the impact of each of the hazards on livelihood resources. Based on farmers' score; crop agriculture, livestock, paid works and petty trade (handicrafts) were ranked in descending order to be affected by the climate hazards.

Table 2.7: Vulnerability matrix of Woyna dega

	Crop pests	Crop diseases	Erratic rainfall	Soil erosion
Agriculture	3	2	3	2
Livestock	2	2	3	2
Handicrafts	0	0	3	1
Paid work	1	1	3	1

Source: Data collected by author

2.6.2. Perceived effects of climate hazards on agriculture and food security

Focus group discussion participants in the dega agro-ecology reported in the historical timeline that *Belge* rain (short rainy season from March to May) is disappearing. In the kolla agro-ecology, it was mentioned that animal diseases and conflicts with neighbouring communities are increasing as a result of low rainfall and the attendant seasonal migration.

Farmers in all agro-ecologies reported a significant decline in both crop and animal production. FGDs participants from dry kola and weyna dega agro-ecologies reported that the majority of farm households in their districts depend on the Productive Safety Net Program (PSNP)[12] and on paid works.

Table 2.8: Major climate related shocks in Kolla

Year	Events
2012	Snow affected crop production
2011	Drought affected human and animals
2010	Natural resource management program started
2003	Local government started issuing land certificate
1991	High deforestation following change of government

Source: Data collected by author

Table 2.9: Major climate related shocks in Dega

Year	Events
2012	Production loss due to army of birds
2011	Crop production failure due to drought
2004	Land taken away from farmers/pastoralists for development projects
1998	Livestock death due to drought
1996	Teff production loss due to Flood

Source: Data collected by author

For example, the poor households in kolla agro-ecology temporarily or permanently migrate to neighbouring countries such as Djibouti and Saudi Arabia. Similarly, farmers in the dega agro-ecology reported that they have been replacing their traditional crops (barley , wheat) with drought tolerant and early maturing crops (sorghum and millets).

Table 2.10: Major climate related shocks in Woyenadega

Year	Events
2010	Introduction of natural resource management practices
2009	Crop production loss due to crop diseases
2006	Local government started providing land certificate
1990	Change of the military government and drought and outspread of diseases causing animal and human death
1984	A widespread famine affected human and animals

Source: Data collected by author

[12]Is designed to help chronically food insecure households through the provision of food aid and/or cash.

Focus group participants from all agro-ecologies also indicated in the historical timeline, that the production of crops has been declining due to the erratic nature of Kiremet rain (long rainy season from June to September). According to the FGD participants, crop production requires regular rainfall patterns. However, in recent years, they had observed erratic[13] and unevenly distributed rainfall patterns leading to droughts, soil erosion, low yields and food insecurity.

Farmers' perception of erratic and declining rainfall was also supported by meteorological data. Meterological data as shown in the figure below reveals that kolla agro-ecologies in the region receive the lowest rainfall compared to dega and weyna dega agro-ecologies and the high temperature of kolla agro-ecologies increases evaporation and affects crop production and food security.

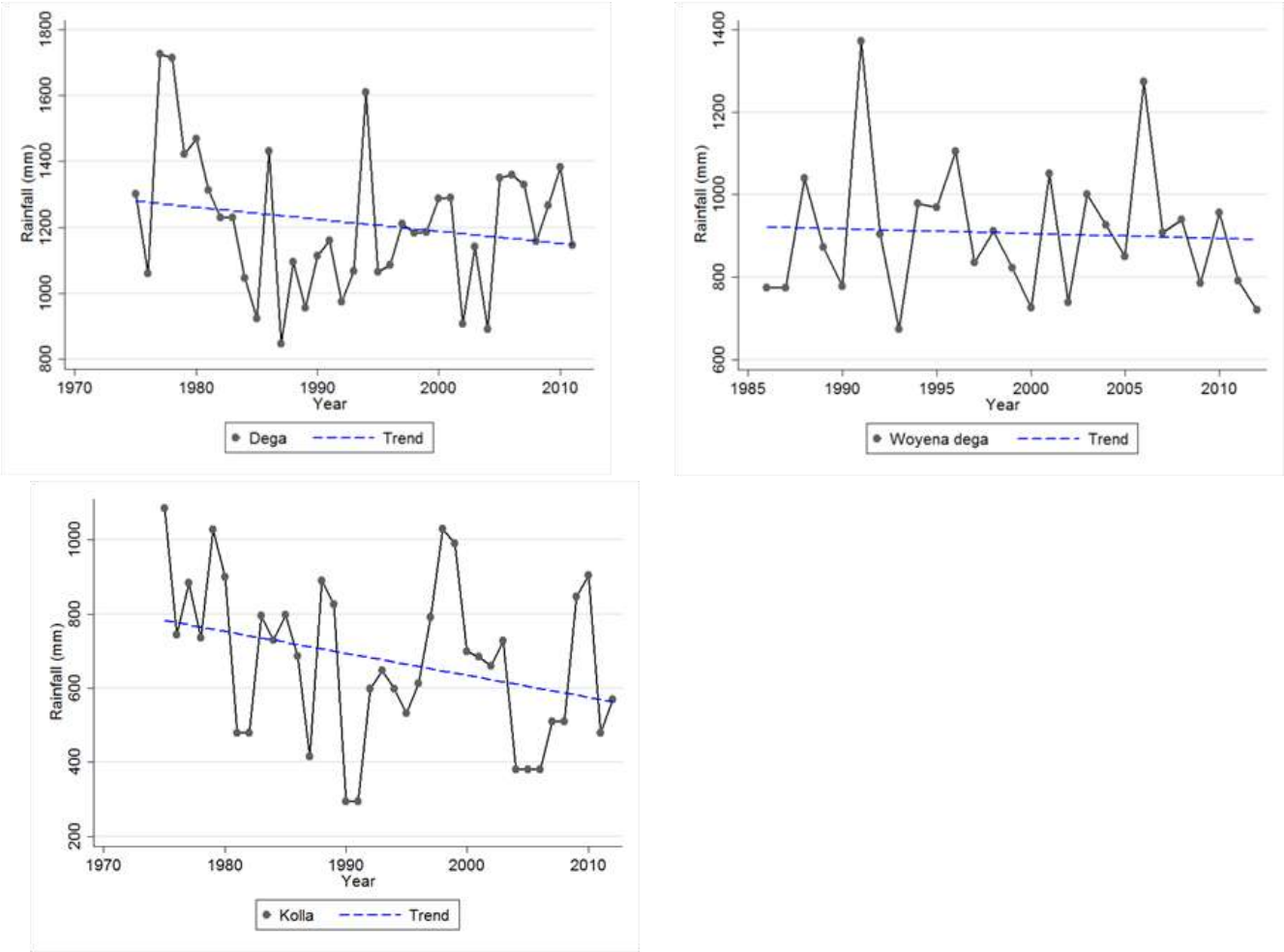

Figure 2.5: Trends in rainfall, by agro-ecology

Source: Author's calculation based on official meterological data

[13]Long dry periods after the first rains or the first rain starts after long periods of the farming seasonal.

The decline in crop and animal production was also documented by other climate change studies in the region (Bewket et al., 2007; Ayalew et al., 2012; Desta et al., 2000; World Bank, 2010). Experts, such as development agents and subject matter specialists, also reported that farmers in the region are highly vulnerable to climate related hazards as they depend on rain-fed agriculture. Particularly, farmers in kolla are highly vulnerable. Unlike weyna dega agro-ecologies that have one long rainy season, crop production in kolla areas is based on two short rainy seasons. Any delay in rainfall and planting during the short period results in crop losses and drought in that year.

In order to reduce the impact of the climate variability (shock) on their livelihoods, FGDs participants from all agro-ecologies suggested that they would like to have drought insurance; both for crops and animals, better access to credit[14] and markets during periods of food scarcity, particularly in August. Moreover, they demanded drought tolerant crop varieties, income diversification (handicrafts, petty trade), herd mobility right, quick land certification process, irrigation and water harvesting technologies to cope with climate hazards.

2.6.3. Perceived effects of climate hazards on natural resources

During the hazard mapping exercise with farmers, all FGD participants from all agro-ecologies reported that high intensity and low duration of rainfall was the main cause of soil erosion and low productivity. Farmers from kolla agro-ecology further claimed that the drought have affected communal grazing and rangelands. These in turn reduced their income from sale of crops and livestock.

As reflected in the hazard mapping, the increasing trend of natural resource degradation, particularly, soil erosion and deforestation were stated as major derivers of vulnerability in the region. For example, farmers in the kolla agro-ecology mentioned that their livestock production has been affected by shortage of water and poor quality of grazing lands. These hazards arise due to the cutting of trees for fuel wood and over utilization of natural resources. The hazards further aggravated conflicts between neighbouring communities for water and grazing lands. Similarly, farmers in the woyna dega agro-ecology reported that their crop sales were decreasing year after year due to high soil erosion. During the field research, we also observed farmers cutting trees from their homestead and mountain forests for domestic cooking and heating without replacing with new trees.

[14] According to Tesfahun et al. 2004, relatives and friends are the main source of credit (44%) in Amhara region and farmers spend 51% of their total borrowing on household consumption.

During the field research, five factors were identified as the main reasons of natural resource degradation. Firstly, the absence of communal land and natural resource use policy was encouraging farmers to over utilize natural resources as coping strategy to droughts. Secondly, the long delay in land use rights (certification) were discouraging farmers from making long term investments, like tree planting and soil conservation, on their land. Third, the expansion of rural roads is accelerating the cutting and sale of trees to towns. Fourth, until recently extension services put less emphasis on natural resource management and the focus was mainly on crop production. Finally, soil erosion and deforestation has been intensified due to the expansion of agricultural production into marginal lands by the landless rural youth.

2.6.4. Agro-ecology based differences in vulnerability and adaptation

Results from the three hazard maps showed that there were differences in vulnerability between the three agro-ecologies as shown above.

Households' adaptation strategies (response to hazards) were also different based on agro-ecology. Farmers from the kolla agro-ecology changed their consumption patterns (eat less preferred meals or reduce daily meals) during drought periods. They also send their family members to the nearby cities or neighbouring countries (Dijbouti, Yemen and Saudi Arabia) for labour work during difficult periods. Livestock selling was also a common coping strategy for farmers in the kolla agro-ecology. Other adaptation practices on communal and private lands include expansion of irrigation to grow economic trees (vegetables, animal pasture and fodder), natural resource management and rangeland preservation (soil conservation, and planting of trees and various grasses).

In the dega and woyna dega agro-ecologies, the most common adaptation strategies were adoption of drought resistant crops (sorghum and millet), integrated watershed management, zero grazing, water harvesting and natural resource management practices (soil conservation and tree planting). An increasing trend of home-garden agriculture and poultry production as income diversification strategy was also implemented in these areas. Changing consumption patterns during the drought periods was also a common strategy in dega and woyena dega agro-ecologies. FGD participants in these agro-ecologies further reported that they are implementing new technologies promoted by extension (e.g., planting in rows, crop selection, fertilizer and pesticide application).

2.6.5. The role of policy and local institutions on adaptation

In line with Biomass Energy Strategy of Ethiopia (Geissler et al., 2013), the Amhara region has adopted different policies to counter the negative effects of climate change. For example, the energy policy (Amhara Regional State, 2002) encourages the utilization of alternative energy sources (biogas stoves, electricity and fuel saving) and afforestation programs. Similarly, the agricultural policy promotes extension and sustainable land management programs to improve agricultural productivity through soil and water conservation measures (Tesfahun, et al., 2004). The health policy (Federal Ministry of Health, 2007) also introduced health extension services to control climate change related human and animal diseases.

During the field research, agricultural extension, health extension, NGOs, cooperatives, indigenous institutions (Iddir, Kirre, Jiggie, Debo, Iquib), microfinance institutions, schools, local governments, youth and women's groups were identified as key institutions providing rural services. The linkages between the farmers and these institutions are displayed in the network diagram below, which was constructed based on the qualitative information collected.

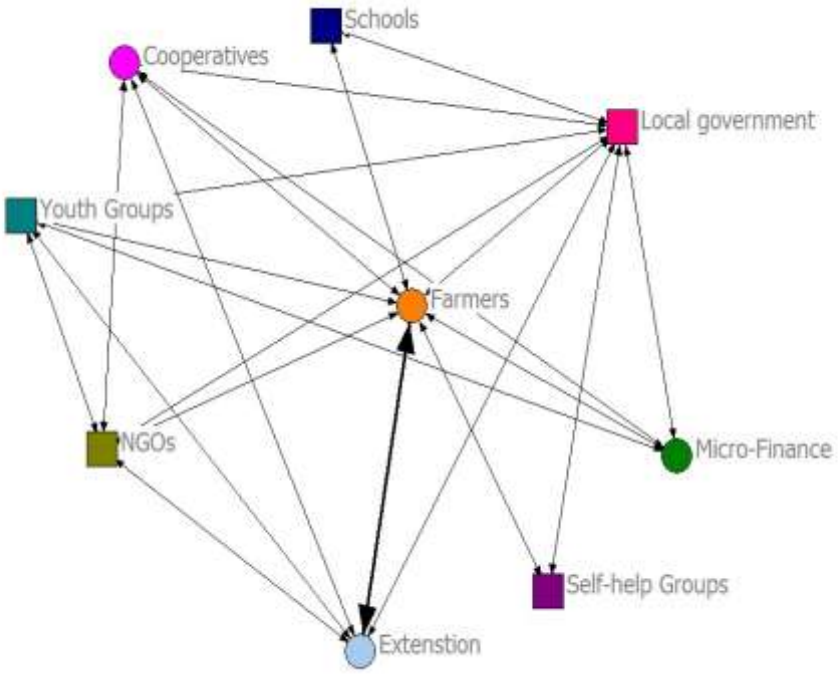

Figure 2.6: Institutional mapping

Source: Author's mapping based on qualitative data collection

The results of the FGDs indicate that extension organizations, cooperatives/unions, local governments and NGOs were the only institutions providing services relevant for climate change adaptation. During the focus group discussion, farmers' identified extension organizations and local governments as the most influential institution supporting climate change adaptation. This finding is in line with the quantitative results, which also showed that agricultural extension supports adaptation efforts of farmers through its positive impact on crop production.

However, extension support was perceived to be very weak on other important adaptation strategies, like increased marketing, water management techniques[15] and income diversification. The institutional mapping further showed that local governments were supporting adaptation efforts through communal programs[16] and provision of administrative support to all institutions operating in their respective districts.

The vulnerability matrix and institutional mapping showed that the presence of non-government organizations, like SG-2000[17], Oxfam America, GIZ[18], USAID[19] and World Vision, was strong in the area of natural resource management and provision of facilities and seed capital to the Farmers Training Centres (FTCs). However, their focus was placed on high potential areas (woyena dega agro-ecologies). Similarly, microfinance institutions provide credit to farmers for the purchase of agricultural inputs from primary cooperatives. However, they charge high interest rates compared with the local money lenders.

Indigenous institutions like Iquib, also provide rotating credit to members but the amount is too small to be used for the implementation of adaptation strategies. Similarly, indigenous institutions supporting risk minimization (Iddir, Kirre) and labour sharing (Debbo, Giggie) during climate hazards were not accessible to poor farmers due to contribution requirement. Although women and youth groups have been established in all survey districts with the aim to diversify income, such as through homestead agriculture, expansion of irrigation, marketing of non-timber products, the groups were non-functional due to financial and training shortages. Surprisingly, important local institutions (schools and religious organizations) had not any short or long term plans to support climate change adaptation efforts despite the fact that they have the social capital to plan and implement some communal

[15]Water harvesting, irrigation, terraces and check dams
[16]Natural resource management, including; mountain forests and range land preservation
[17]Extension program
[18]Supports SLM
[19]PSNP

strategies such as communal terracing and planting trees on communal lands (see also World Bank, 2010).

2.7. Conclusions

Farmers' perception of climate change is largely coincided with meteorological data that climate variability is adversely affecting the livelihoods of farmers in the study area. With rain-fed agriculture as the only source of livelihoods, farmers in the study area were affected by climate variability and extreme events. Crop and livestock production, the two most important livelihoods sources, were becoming risky due to erratic rainfall, soil erosion, floods and frequent drought. Similarly, grazing and collection of firewood were also under threat due to changing weather patterns and over-exploitation of natural resources. Although the effects of climate change and the adaptation options varied amongst agro-ecology zones, reforestation, communal irrigation, soil erosion prevention and rangeland preservation were major communal adaptation strategies promoted by local governments. Moreover, common adaptation strategies implemented by individual farmers include; soil and water management, crop diversification, crop selection, adjusting planting dates, adopting drought resistance and early maturing crops, home-garden agriculture and changing consumption patterns.

These traditional coping strategies were used for many years on an ad hoc basis. Institutional support in promoting alternative rural energy sources, alternative livelihoods for rural youth, water harvesting techniques, irrigation schemes, integrated pest management practices, rangelands rehabilitation, multipurpose tree planting, controlled livestock size and grazing are required by the farmers in the study areas. With erratic nature of rain, there was also a need for crop and animal insurance. Moreover, farmers and agro-pastoralists needed better access to credit and markets during hunger seasons, income diversification (handicrafts, petty trade), herd mobility right and quick land certification process.

Within the agro-ecology zones, the kolla agro-ecology has limited adaptation options due to the restrictive herd mobility rights and livestock reduction policy. Farmers in dega and woyna dega agro-ecologies were traditionally utilizing governmental and non-governmental extension services. Moreover, they diversify income by adopting several coping strategies including: paid work; sale of chickens, eggs, sheep and goats during religious festivals and sale of eucalyptus trees for construction in towns.

The food security implications of the above climate change adaptation strategies are obvious. For example, based on our quantitative evidence from the survey of sample households in the study areas, farmers who planted trees and implemented soil conservation practices (our

indicators of climate change adaptation strategies) have significantly increased their food productivity and food security compared to non-adopters. However, farmers who did not implement the strategies would have benefited the most had they adopted the strategies. This implies the regional and national policies should support farmers and agro-pastoralists adaptation strategies through the introduction of communal land and natural resource use policy and speedy land certification process. In this regard adaptation requirements of farmers from kolla agro-ecologies are much costly than farmers from woyna dega agro-ecologies and hence there is a need for allowing herd mobility and communal land rights.

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Appendix

Seasonal calendar in each agro-ecology zone

1) Dega

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.
Land preparation				xxx	xxx							
Planting					xxx	xxx	xxx	xxx	xxx	xxx		
Short rainy season seed sowing					xxx	xxx						
Main rainy season seed sowing								xxx			xxx	
Irrigation	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	
Weeding	xxx									xxx	xxx	xxx
Soil and water conservation										xxx	xxx	
Harvesting			xxx	xxx								
Major holidays and festivals		xxx										xxx

2) Woyna dega

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.
Land preparation						xxx	xxx					
Planting									xxx			
Weeding										xxx		
Harvesting and storage	xxx	xxx	xxx	xxx	xxx	xxx	xxx					
Labour Hiring		xxx			xxx	xxx	xxx					
Expenditure	xxx			xxx	xxx		xxx	xxx				
Periods of food scarcity												xxx
Timing of crop pests		xxx	xxx	xxx	xxx				xxx			
Timing of Malaria		xxx										
Timing of soil erosion												xxx
Starting period of rain									xxx			
Ending period of rain		xxx										
Starting period of irrigation	xxx											
Staring period of natural resource managment					xxx							
Major holidays and festivals	xxx			xxx	xxx		xxx	xxx	xxx			

3) Kolla

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.
Land preparation	xxx	xxx			xxx	xxx	xxx	xxx				
Planting	xxx								xxx	xxx	xxx	
Weeding	xxx										xxx	xxx
Harvesting and storage	xxx	xxx	xxx	xxx	xxx	xxx						
Staring period of natural resource management					xxx	xxx						
Starting period of irrigation					xxx	xxx						
Compost making	xxx											xxx
Tree planting										xxx	xxx	
Periods of snow	xxx	xxx	xxx							xxx	xxx	xxx
Timing of crop disease (Wag)	xxx	xxx										xxx
Timing of rain shortage								xxx	xxx			
Timing of soil erosion										xxx	xxx	
Periods of food scarcity	xxx											xxx
Times of migration	xxx	xxx									xxx	xxx
Major holidays and festivals	xxx			xxx	xxx			xxx				

Table 9: Dengolt

Source: Authors

Chapter Three

3. Adoption of Land Management Practices in Ethiopia: Which Network Types Matter?

Abstract

In recent years researchers have begun to discuss the impact of social networks on the adoption of land management practices. However, key research questions about both the types of social networks and how specific networks influence adoption are not sufficiently addressed. Analyzing a household data set collected by the World Bank, we contribute to filling this research gap by exploring the impacts of three different types of social networks (relatives, friendship and neighborhood) on the adoption of soil conservation and tree-planting in the context of Ethiopia. The results show that networks with relatives have a positive impact on tree-planting but the impact of this type of network on soil conservation is negative. This finding can be interpreted as an incidence of self-interested "egoistic" behavior, since farmers may plant trees as a means of securing land holdings. When farmers are faced with the risk of losing their land to relatives, due to common heritage, they prefer planting trees instead of soil conservation. This is because farmers can reclaim all their investment costs, by cutting trees, should they lose their land holding rights to relatives. However, it would be difficult to regain soil conservation investment costs in case they lose their land holding rights to relatives. On the other hand, friendship networks were found to be insignificant in both planting trees and soil conservation and neighborhood ties were significant only in tree planting. This finding suggests the potential contributions of friendship and neighborhood networks that can significantly affect sustainable land management practices remain untapped.

3.1. Introduction

Land degradation induced by climate change is considered as one of the major reasons for low productivity and food insecurity in Ethiopia (Kassie et al., 2010a; Kassie et al., 2008; Shiferaw and Holden, 1998; Gebremedhin and Swinton, 2003). Soil erosion and nutrient depletion in the Ethiopian highlands is estimated to be 130 to 170 tons of fertile soil per hectare per year on tested plots (Shiferawu, 2011). As a result, total crop losses due to erosion and nutrient depletion is estimated to reach up to 10 percent of total production between 2000 and 2010 (Yesuf and Pender, 2005).

Land degradation is more severe in the Amhara region, the study area, than any other regions of Ethiopia. According to Desta et al., (2000), 29 percent of the total area of Amhara region experiences high erosion rates (51-200 tons per hectare per year); 31 percent moderate erosion rates (16-50 tons per hectare per year); 10 percent very high erosion rates (more than 200 tons per hectare per year) and the remaining 30 percent low erosion rates (lower than 16 tons per hectare per year). The authors further noted that nearly twenty thousand hectares of forest is harvested annually in the region for fuel wood and construction purposes. However, harvested trees are not replaced and, thus, deforestation alone costs the region 1.9 to 3.5 billion tons of fertile soil per year (Desta et al., 2000).

Since 1991, various land management techniques have been promoted in Amhara region (Benin, 2006; Kassie et al., 2010b). These include structural methods (soil and stone walls), agronomic practices (minimum tillage, grass strips, planting tree) and water harvesting (tied ridges and check dams) (Benin, 2006; Desta et al., 2000). Despite the availability of these technologies, the adoption process is slow due to lack of new approaches. One such new approach for successful Sustainable Land Management (SLM) is through enhancing farmers' social networks (Foster and Rosenzweig, 1995; Maertens and Barrett, 2012; Matuschke and Qaim, 2009; Bodin et al., 2006; Di Falco and Bulte, 2013).

In the case of Ethiopia, one can distinguish two forms of informal social networks that farmers have. Networks based on bloodline and marriage, which are referred to as strong networks here, and networks based on non-blood line friendship and neighborhood ties, which are referred to as weak networks here (Dercon et al., 2006; Di Falco and Bulte, 2013). Both kinds of informal social networks are more complex than networks considered in conventional "extension" approaches and do significantly influence the adoption of SLM technologies (Spielman et al., 2010; Di Falco and Bulte, 2013).

The introduction of social networks into SLM studies, therefore, allows for a range of policy alternatives. For example, funds for agricultural extension are declining and extension managers should look for alternative source of funding and move away from a "one-size-fits-all" thinking to a "best fit" approach (Birner et al., 2009; Davis et al., 2010). Hence, understanding whether rural social networks matter and which types of social networks matter most for technology adoption needs to be a priority of the current extension system (Maertens and Barrett 2012; Matuschke and Qaim 2009). However, current research in Ethiopia focuses mainly on the effects of network size (instead of type) on natural resource management practices and also has not yet identified how different types of networks influence the specific types natural resource management practices (e.g., Wossen et al.,2013). To the best of the author's knowledge, there is no empirical study on which types of social networks matters the most, and how such types of social networks matter for tree planting and soil conservation, two important types of natural resource management practices.

The main objective of this paper is, therefore, to fill this knowledge gap by assessing how the different types of social networks (relatives, friendship and neighborhood) are related with the adoption of SLM practices (tree-planting and soil conservation) in the Amhara region. The survey used for this study is well suited to address this knowledge gap as it required the respondents (the head of the household and his/her spouses) to specify the types of relationships they have with their network members listed by themselves. Moreover, a unique contribution of this study is that it combined and compared the information from two respondents in each household, the main respondent (generally a male head), and a second respondent (a female spouse in male-headed households) to increase the accuracy of the information.

The remainder of the paper is organized as follows: Following this introductory part, section two reviews the theoretical links between social networks and natural resource management. Section three presents the description of the data used for the analysis and biophysical characteristics of the study area. Descriptive statistics and regression results will be presented in section four. Section 5 discusses the results, and the final section presents the conclusions.

3.2. Social networks and adoption of SLM practices

In the past, researchers have focused on input and output markets, farmers' behavior and quality of extension services as the main determinants of technology adoption (Feder et al., 1985; Rogers, 1995). Application of social networks on technology adoption model is of recent origin (Maertens and Barrett 2012; Foster & Rosenzweig 1995; Savage and Ribaudo,

2013). A social network as defined by Maertens and Barrett (2012: 353) is "individual members (nodes) and the links among them through which information, money, goods or services flow." According to Bandiera and Rasul (2006) and Monge et al. (2008), social networks affect technology adoption through social learning, joint evaluation, social influence, and collective action. Models of social learning hypothesize that, farmers learn about the existence and characteristics of new technology from their friends, neighbors or relatives and take advantage of their networks' experiences during adoption decision (Monge et al., 2008). According to Maertens and Barrett (2012) models of social learning try to answer questions such as what do farmers value and over what time period? What type of information does the farmer absorb and from whom? How do farmers learn or how do they update their beliefs? How do beliefs translate into actions? And do agents interact strategically?

Research on technology adoption in the context of Ethiopia also shows that farmers with large networks are fast adopters and learners of technology (Gebremedhin and Swinton 2003; Bewket 2007; Kassie et al. 2013). This is because farmers with large network sizes are likely to enjoy more trust among each other and can jointly evaluate new technologies. The joint evaluation will in turn help network members to reinterpret and redefine the technology so that it will become more realistic and meaningful to their local context (Monge et al., 2008).

The literature on social network and resource management also extensively discusses how networks influence individual actors and groups. Social influence refers to "the enforcement of social norms, opinions and attitudes on individual's preferences and behaviors" (Monge et al., 2008:9). According to the social influence theory, the outcomes of the network are different for different types of networks, for example, strong networks (comprising relatives)[20] versus weak networks (based on friendship and neighborhoods) (Bodin et al. 2006). Similarly, Prell et al. (2009) notes that actors with strong networks have the tendency to: influence one another more than weak networks; share similar ideas; offer one another emotional support and help during crises; communicate effectively regarding complex issues such as SLM and be more likely to trust one another for risk technology.

Based on the arguments presented above, the benefits of strong networks for SLM are obvious. However, the advantages of strong networks may be countered by the redundancy of information if strong networks are shared for a long period of time. In this regard, several authors (see for example, Bandeira and Rasul, 2006; Besley and Case, 1994; Foster and

[20]In this study, a strong network is defined by bloodline and marriage networks.

Rosenzweig, 1995; Munshi, 2004) argued that social networks limit an individual's opportunities for social learning and sometimes may constrain their members from adopting the new technology by limiting membership or participation in a given innovation process. This implies strong ties such as relatives may involve free-riding problems with potential adverse incentives for adopting costly and long term investments on land, such as planting tree and soil conservation (Di Falco and Bulte 2013).

In contrast, diverse information and knowledge may flow best through weak[21] and non-blood line ties, such as friendship and neighborhood ties (Bodin et al. 2006). Research has shown that friendship and neighborhood ties offer farmers access to diverse pools of information and resources (Bandiera and Rasul 2006; Bodin et al. 2006). Within the context of resource management, friendship and neighborhood ties can make a network more resilient and adaptive to climate change. A potential drawback of friendship and neighborhood ties, however, is that they may be easy to break. In addition, friendship and neighborhood ties may lack the trust and understanding needed for costly and long term investments on land (Newman and Dale 2005).

3.3. Study area, data and econometric methods

3.3.1. Study area

The study was conducted in Amhara regional of Ethiopia. Amhara region is located in the north western part of Ethiopia covering an area of 150,374 square kilometers and having a population size of over 17 million (Tesfahun et al. 2004). In terms of the traditional agro-ecological classification, the region is composed of 3% below 500 meters above sea level, 22% between 500 and 1500 meters above sea level, 44% between 1500-2300 meters above sea level, 27% between 2300 and 3000 meters above sea level, 4% above 3000 meters above sea level. The recorded annual mean temperature of the region ranges from 12.4 degree centigrade to 27.8 degree centigrade (Desta et al., 2000).

The pattern of land utilization in the region is as follows: 28.2 percent arable land, 30 percent pastoral land, 2.1 percent forest land, 12.6 percent bush land, 7.2 percent settlement, 3.8 percent water bodies and 16.2 percent unusable land (Desta et al. 2000). The topography of the region is composed of diverse setups, including lowland, midland and highland plains, mountains, rugged lands, chains of plateaus. ANRS is one of the most vulnerable regions to

[21]As indicated above, in this study, a weak tie is defined by no bloodline and marriage connection.

climate change induced land degradation in Ethiopia. Over the last few years, the region has experienced intense rainfall, shorter rainy seasons and higher temperatures which are characteristics of climate change (Yesuf and Pender 2005; Desta et al. 2000).

To counter the effects of climate change induced land degradation, people in the region have adopted land management technologies such as terracing along mountain slopes, water harvesting and tree planting, which help in both preserving soil moisture and increase biodiversity (Desta et al. 2000). Some of these activities are done collectively by community members through well-established community mobilization efforts. At the individual level, farmers in the region have adopted SLM technologies on their plots, mainly soil conservation techniques (soil and stone walls) and agro-forestry (tree planting) (Benin 2006; Mekonnen 2009).

3.3.2. Data and sampling

For the analysis, the data collected in 2011 by the World Bank on its Farmer Innovation Fund (FIF) was used. The survey was administered by the International Food Policy Research Institute (IFPRI) with the support from the Ministry of Agriculture and Rural Development of Ethiopia and the World Bank. As former employee of IFPRI, the author was also involved as the coordinator of the FIF survey. The sampling was designed in such a way that a multi-stage stratified sampling procedure was followed, in which FIF project woredas (districts) were first randomly selected within each agro-ecological zone, followed by kebeles (sub-districts) and then, ultimately, households. Using this method, 19 kebeles and between 35 and 88 households in each kebele were randomly sampled. Two respondents were interviewed in each household, the main respondent (typically the male household head), and a second respondent (typically a female spouse in male-headed households, or “other main farmer” otherwise).The dataset used in this study combines responses from both interviewees, for a total sample size of 1338 households, from which 401 4 where female headed households. The dataset has detailed information on household characteristics, agro-climatic zones, production (crop, livestock and nonfarm activities), input use (fertilizer, chemicals and seed), and institutional services (credit, extension service, technology adoption, groups and networks). Interestingly, the data set provides detailed information on how many farmers adopted soil conservation and tree planting. Specifically, farmers were asked “what types of long term investments have you made on this plot in the last 12 months?” and “who do you speak with the most, excluding development agent, when you make such investments outside of your household but in your kebele?” After farmers listed the five most important

information sources, they were further asked "how do you know this person?" Based on farmers own classification, their network type were classified according to a taxonomy of "types of social networks", which included the categories of relatives, friends and neighbors. The relative networks in this study comprise bloodline and marriage ties including nephews, nieces and in-law families.

3.3.3. Econometric methods

To investigate how social networks determine farmers' adoption of two important land management practices (tree-planting and soil conservation), the paper estimated plot-level probit models using cross-sectional data. Using this model, the paper also tested the hypothesis that farmers who communicate most with relatives tend to implement more of tree-planting and soil conservation due to strong ties. Following other technology adoption models, the probit model is specified as;

$$\mathrm{Y}_{\mathrm{hi}}^{*} = \mathrm{Y}(x_{hi}, x_{hi}^{p}, x_{hi}^{n}, x_{hi}^{a}; \beta) + e_{hi} \qquad (1).$$

The adoption decision (Y_{hi}) of household i is assumed to depend on a set of explanatory variables such as household characteristicsx_{hi}, plot characteristicsx_{hi}^{p}, as well as on the household's interaction with social and other networksx_{hi}^{n}. We also include agro ecology $x_{hi}^{a}$to control for location differences that may influence adoption. βis a vector of parameters to be estimated and$e_{hi}$is the error term assumed to be normally distributed and uncorrelated with any of the variables. Adoption of soil conservation and tree-planting (Y_{hi})was modeled as binary choice problem {0, 1}, and hence for the latent variableY_{hi}^{*}, the estimation is based on the following observable binary choice of adoption or non-adoption of tree-planting and soil conservation.

$$Y_{hi} = \begin{cases} 1 \text{ if } \mathrm{Y}_{\mathrm{hi}}^{*} > 0 \\ 0, \text{Otherwise} \end{cases} \qquad (2).$$

Wherex_{hi} refers to variables that affect soil conservation and tree planting. These include: household characteristics x_{hi}(age, education, off-farm job, household size, asset); plot characteristics x_{hi}^{p} (soil fertility, slope); social networks x_{hi}^{n} (relatives, friends, neighborhood) and other networks such as group participation (formal and informal, cooperatives) and institutional networks (extension and land tenure). Asset holdings are represented by Tropical Livestock Unit (TLU) and plot location by agro-ecology (x_{hi}^{a}).

Since a household-level model does not capture plot specific characteristics (soil quality and slope) and other important determinants such as land tenure, we estimate a plot level model as

in Di Falco and Bulte (2013). The plot varying effects are taken care of by running a random effects model where the mean values of plot-varying explanatory variables are included (pseudo-fixed effect model) to control for unobserved heterogeneity (Mundlak, 1978; Wooldridge, 2002; Di Falco and Bulte 2013; Wossen et al, 2013). As in Mundlak (1978) and (Di Falco and Bulte 2013) the auxiliary regression model that included the mean values of the plot varying covariates is specified as:

$$e_{hi} = \alpha\bar{\chi} + \omega_h \ , \quad \omega_h \sim iid(0, \delta_w^2) \qquad (3).$$

Where $\bar{\chi}$ represents the mean of the plot-varying explanatory variables within each household (cluster mean), α is the corresponding vector coefficient, and $\omega_{i,}$ is a random error term uncorrelated to the explanatory variables. The advantage of this Mundlak model specification is that it allows controlling for plot-varying explanatory variables (slop, soil fertility, land tenure) as well as measuring the effects of plot-invariant household variables specified in equation 1.In effect, the Mundlak specification unifies both the fixed and random effects estimation approaches. One potential problem of the model specification could be the endogeneity of social network variables. Social network variables, such as the size of relatives and friends networks, may vary depending on the wealth status and other unobserved household characteristics. In our case, we assumed (as in Isham 2002; Di Falco &Bulte 2013) that our variables are exogenous for the following reasons. First, our social network variables measure network type instead of size. This reduces the potential endogeneity problem as the quality of information (trust) from such networks is more important than the size of networks in the adoption decision. Second, we used Mundlak's (1978) approach, which eliminates the endogeneity problems caused by plot invariant unobservable effects as the mean values of plot-varying explanatory variables are included (pseudo-fixed effect model) to control for unobserved heterogeneity.

3.4. Results

This section presents the descriptive statistics, adoption rates and probit model results. With respect to adoption rates and when sampled farmers were asked with whom they had spoken the most (where each farmer may respond more than once if using more than information source) about tree planting and soil conservation: on average 21% of the farmers responded that they received advice from relatives, of whom 71.7% adopted tree planting and 29.3% adopted soil conservation; 27% of the farmers received advice from neighbors, of whom 23.2% adopted tree planting and 70.2% adopted soil conservation; 36% of the farmers

received advice from friends, of whom 21.4% adopted tree planting and 20% adopted soil conservation (tables 3.1 and 3.2).

Table 3.1: Variable list and descriptive statistics

Variable	Mean	Std dev	Min	Max
Friends (1= acquired information from a friend, 0= otherwise)	0.36	0.48	0	1
Neighbours(1= acquired information from a neighbour, 0= otherwise)	0.27	0.44	0	1
Relatives (1= acquired information from a relative, 0= otherwise)	0.21	0.41	0	1
Household size (family members)	6.0	2.0	1	14
Age of household head(in years)	42.0	10.75	18	82
Sex household (1= male, 0= female)	0.77	0.42	0	1
Education (head)	2.45	2.82	0	14
Access to off-farm (1=yes,0=otherwise)	0.66	0.47	0	1
Fertile soil (1=fertile, 0= otherwise)	0.29	0.41	1	3
Moderately fertile soil (1=fertile, 0= otherwise)	0.48	0.36	0	1
Infertile soil (1=fertile, 0= otherwise)	0.22	0.47	0	1
Access to extension (1=yes,0=otherwise)	0.78	0.42	0	1
Slope(1= flat, 2= medium,3=step)	1.22	0.36	1	3
Land tenure (1=yes,0=otherwise)	0.73	0.44	0	1
Membership in informal associations(1= member, 0=otherwise)	0.77	0.42	0	1
Membership in formal associations(1= member, 0=otherwise)	0.03	0.16	0	1
Membership in agricultural cooperatives(1= member, 0=otherwise)	0.03	0.18	0	1
Tropical Livestock Unit (TLU)	0.13	0.73	0	23
Dega agro-ecology (1=Dega, 0= otherwise)	0.22	0.49	0	1
Weyna-dega agro-ecology (1=Weyna-dega, 0= otherwise)	0.53	0.43	0	1
Kolla agro-ecology (1=Kolla, 0= otherwise)	0.29	0.37	0	1

Source: Authors' calculations based on FIF data

Table 3.2: Adoption rates

	Relatives	Neighbors	Friends
Tree planting	71.7%	23.2%	21.4%
Soil conservation	29.3%	70.2%	20%

Source: Authors' calculations based on FIF data

Besides the informal networks, cooperatives and extension services constitute also formal networks widely used for technology adoption in Ethiopia. Nearly 78% of the farmers have received advice on SLM from extension workers. Iqqub and Iddir are other important indigenous local institutions (informal associations) in Ethiopia that are providing self- help against risks. Iqqub provides rotating savings and credit services, while Iddirs are established for providing mutual aid during death of members. These indigenous institutions are not only

providing self-help services, but also serve as a forum for discussing social and technological issues.

Data was also collected on farmers' household characteristics, their plot characteristics, land-tenure, wealth, as well as geographic location. The average age and education level of the head of the household is 42 and 2 years respectively with a family size of 6 people. 66 percent of the head of the households responded that at least one member of their family worked on someone else's land or in some other employment, against payment in cash or in kind. The off-farm employment also involves participation in the Productive Safety Nets Programme (PSNP)[22] .

Farm characteristics are represented by soil quality and slope. Based on farmers' self-assessment of their plots, soil quality is rated as fertile, medium or infertile. Similarly, depending on the slope; farmers categorize their plot as flat, gentle or steep slope. Climatic conditions are represented by traditional agro-ecological zones; Dega, Weyna-dega and Kolla. While the survey distinguishes many categories of livestock ownerships, we aggregated these categories together into one asset indicator called Tropical Livestock Unit (TLU) using FAO conversion factor.

Plot-level results of the probit models are presented in Table 3.3. The first model shows the effects of three social network types, i.e., networks with friends, neighbors and relatives, on soil conservation and the second on tree-planting. In the first model (Table 3.2), we found that information exchange with relatives will decrease the probability of investing in soil conservation by 7 percent. For friendship and neighborhood based network ties, we found insignificant effects for the adoption of soil conservation.

For the second model, a different result, showing a positive relationship between networks with relatives and planting trees was obtained. According to the model results, securing land rights through certification reduces the probability of planting tree by approximately 10 percent. Neighborhood ties also positively influence households decision to invest in planting tree. The average marginal effect shows that the probability of tree planting will increase by 6.2 percent. Regarding the other community networks, becoming a member of formal association (credit and saving associations) increases the probability of planting tree by 12% while membership to informal associations (Iqqub and Iddir) and cooperatives decreases that probability, respectively, by 14% and 12%.

[22]PSNP provides cash or food for people who have predictable food needs in exchange for public work to protect environmental degradation.

Looking at the non-network variables, farmers do more SLM on highlands (Dega and Weyna-dega) than on lowlands (Kolla). Farmer's probability of planting trees and conserving soil is respectively 14 percent and 21 percent higher in Weyna-dega than in Kolla. Similarly, farmers' inclination to planting trees is 19 percent higher in Dega than in Kolla.

Table 3.3:Probit regression results on the effects of Networks

	Soil conservation (dy/dx)	Planting tree (dy/dx)
Fertile soil	-0.001161(0.041)	-0.002236(0.040)
Medium soil	-0.019879(0.029)	0.006603(0.029)
Steep slope	-0.053844(0.081)	0.086735(0.079)
Middle slope	0.018005(0.029)	-0.029181(0.029)
Land tenure	-0.030888(0.018)	-0.100505***(0.021)
Household size	0.013357**(0.005)	1.3165**(0.005)
Sex	0.169003(0.097)	-0.267514*(0.117)
Age	0.004505***(0.001)	0.001783(0.001)
Education	0.006999*(0.003)	0.001241(0.003)
Access to off-farm	-0.016672(0.020)	0.023265(0.020)
TLU	-0.024784***(0.005)	-0.000941(0.004)
Friends	0.036857(0.025)	0.019178(0.024)
Neighbors	-0.040283(0.025)	0.062450**(0.025)
Relative	-0.069939**(0.025)	0.092374***(0.025)
Membership in formal association	0.011797(0.050)	0.127322*(0.057)
Membership in informal association	0.048667*(0.025)	-0.140349***(0.026)
Membership in agri-cooperatives	-0.097715(0.052)	-0.120621***(0.028)
Extension service	0.030673(0.023)	0.027514(0.021)
Dega	-0.030174(0.042)	0.193837**(0.063)
Weyna-dega	0.137558***(0.025)	0.209744***(0.018)
Plot fixed effect	Yes	Yes
N	2503	2503
Pseudo R2	0.0881	0.0867

Standard error in parentheses, $^{*}p< 0.1$, $^{**}p< 0.05$, $^{***}p< 0.01$

Source: Authors' calculations based on FIF data

Regarding the other socio-economic variables, average education significantly influences soil conservation but not planting trees. According to the model results, an additional year of experience raises the probability of soil conservation by 0.5 percent. Average household size positively and significantly influences both planting trees and soil conservation. On the other hand, one unit increase in Tropical Livestock Unit (TLU) will decrease the probability of soil

conservation by 2.5%. Finally the extension network as represented by contact with the development agents is insignificant for both soil conservation and planting trees.

3.5. Discussion

Given the objectives of this paper, the discussion focuses mainly on the impact of social networks on soil conservation and tree-planting. Similar with the results of this paper, few studies such as Di Falco and Bulte (2013) found a negative relationship between kinship ties and adoption of soil conservation. But the majority of the previous studies documented a positive association between networks with relatives and adoption of new technologies (e.g., Bandiera et al., 2006; Isham, 2002). The difference between the findings of this paper and the previous studies might be due to differences in the measurement of networks. Unlike this paper, all of the previous studies represent networks either by network size (Di Falco and Bulte 2013) or by membership in groups (often formal groups). The negative relationship between relative ties and soil conservation in our case, as also argued by Di Falco and Bulte (2013) might be due to potential free riding problem or adverse incentives induced by relative relations. Acknowledging the adverse incentives associated with such networks, Guirkinger and Mali (2011) also branded relative (kinship) ties as “forced solidarity”.

For the tree planting model, a different result, showing a positive relationship between networks with relatives and planting of trees was obtained. This result is similar with the findings of Di Falco and Bulte (2013) and supports the view that tree growing is used as a means of securing land holdings in Ethiopia (e.g., Deininger and Jin, 2006; Mekonnen, 2009). This could be due to common heritage; farmers may resort to planting tree when faced with the risk of losing their land to kinship members. However, once land tenure security is realized through certification, tree planting might not necessarily serve as a means of securing land holdings. This hypothesis is supported by our model as we found a negative relationship between planting tree and land tenure security. Other studies, such as Saint-Macary et al. (2010) also found that in the absence of a reallocation threat, land titles do not influence agro forestry adoption in Vietnam.

Regarding the role of experience on the adoption of sustainable land management practices, average education and age significantly influences soil conservation but not planting trees. This is an indication that soil conservation is more of labor and knowledge intensive technology than tree planting. For example, Kassie et al. (2008), showed that construction of soil or stone walls on a quarter-hectare plot of land requires 100 personal working days.

The extension network was not found to be an important determinant of soil conservation and planting trees. This is worrying given the substantial role extension workers should have played in SLM. Although the extension service in Amhara region has a strong foundation of Farmers Training Centers (FTCs) and trained development agents (DAs), they are providing limited service on SLM due to lack of infrastructure and resources (Davis et al. 2010). This might have forced DAs to focus only on relatively short term results such as crop and livestock and the long term and costly practices of SLM might have taken a back-seat.

The roles of local institutions (cooperatives and land tenure) need to be revisited as well. For example, cooperatives should incorporate SLM in their development agenda in addition to their current role of distributing agricultural inputs. As we witnessed during our field visit, land registration in the region entails a long procedure[23] and obtaining maps of land holdings is very difficult. From the overall sample, only 20 percent of the farmers had a secondary certificate and until this study was conducted, no farmer had a map of land holdings. Even though farmers may receive a map of land holdings in the future, their probability of making a long term investment in planting trees and soil conservation might still be jeopardized as the land belongs to the government and it is not allowed to be subject to sale or to other means of exchange.

3.6. Conclusion

This paper investigated the impact of social networks on the adoption of sustainable land management practices. The paper found that some social networks may induce adverse incentives to the adoption of certain sustainable land management practices. Understanding how some types social networks hinder adoption of sustainable land management practices is important for policy intervention. Land degradation problems such as accelerated erosion and depletion in soil fertility are projected to reduce crop productions in many Sub-Saharan Africa countries. Ethiopia is particularly vulnerable to land degradation problems as the country is largely mountainous and adoption of land management practices is very low. Long periods of land degradation associated with accelerated soil erosion and depletion in soil fertility, have underlined the importance of promoting land management techniques to effectively respond to land degradation problems. A good understanding of how farmers' response to land degradation problems is therefore crucial to design effective land management strategies. The

[23]Land registration involves at least seven steps: preparation and awareness raising, application and identification, temporary certificate, public hearing, registration, primary certificate and secondary certificate.

results of this paper suggest that social networks have a significant role in promoting the adoption of sustainable land management practices.

Although this paper made novel contributions in terms of different network measurements and addressed some of the endogenity problems inherent in network studies, by considering network types instead of network size, some of the results of this paper must be interpreted carefully. For example, the relative network variable captures information exchange regarding natural resource management, but there are various forms of relationships among relatives such as mutual support during crises, social learning and influence. Therefore, a simple representation of relative networks shows whether the overall impact of relative networks on natural resource management is negative or positive. Moreover, our social network variables do not consider network members residing outside the village.

In spite of the above limitations, this study challenged the commonly held view that strong networks, such as networks with relatives, are associated with more trust to one another for adopting risk technologies. This implies overplaying the importance of strong networks (based on relatives) over weak networks (based on other types of relations) in technology adoption decision may be misleading in the sense that the hypothesis underestimates the existence of selfish behavior in strong networks. The results of this paper support the proposition that egoistic behavior incentives exist in stronger ties such as relatives. In Ethiopia, land tenure rights are contested or challenged by relatives, due to common heritage, and farmers often plant trees to signal ownership. According to the different literatures, tree planting in Ethiopia has a dual purpose: first, it protects soil erosion and second, it sends a strong signal to relative members that they no longer have land claim rights. Our results also support this proposition as information exchange with relatives is more likely to induce tree planting than soil conservation. This is because farmers can reclaim all their investment costs, by cutting trees should they lose their land holding rights to relatives. However, it would be difficult to regain all investment costs made for soil conservation should they lose their land holding rights to relatives.

The ultimate outcome may be low implementation of sustainable land management practices where soil conservation is under implemented in contested lands, and tree planting could be abandoned once land holding right is ensured. Although the socially beneficial decisions would have been the universal adoption of tree planting and soil conservation by all farmers, individual farmers may have selfish interests to implement only tree planting with the motive to ensure land ownership and not with the objective of implementing socially beneficial sustainable land management practices.

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Chapter Four

4. Agricultural Extension Reforms in Ethiopia: What Works and What Does Not Work Well?

Abstract

With the aim to improve the income and food security of farmers, the government of Ethiopia has carried out successive agricultural reforms. Following the introduction of the Agricultural Development Led Industrialization program in 1993, major organizational, management and institutional changes have been introduced to the agricultural extension system. This paper analyzes the outcomes of the reform initiatives by taking the extension system in Amhara region as a case study. In particular, the study assesses the effects of the demand and supply side reforms on service users and providers and on the reform outcome in terms of . The main objectives of the study were to: (1) understand what works and what does not work well in the public agricultural extension system; (2) identify knowledge gaps and; (3) employ new analytical tools for the empirical analysis of extension services.

The paper builds on the existing literature on agricultural extension reforms in Ethiopia. It aims to address knowledge gaps regarding site-specific ("best-fit") extension approaches by employing qualitative and quantitative performance evaluation methods. More importantly, the main contribution of this paper is that it quantified the components of the extension reform programs in Ethiopia.

Based on the results of this study, some of the reform approaches do not fit well into the current extension challenges, and service providers also lack the soft skills, incentives and resources to do their job in the best way possible. These have affected the work motivation and job performances of service providers. Moreover, the planning, monitoring and evaluation system was not very effective in assessing from time to time what has been achieved at the farmers' training centers and what remains to be done in the future. Similarly, the partnerships and linkages between the different actors were not strong, and key actors such as the private sector and universities, research institutes and NGOs were either missing or only partially available. One policy implication, therefore, is that the private sector and NGOs should be encouraged to participate in extension services where they have a comparative advantage.

4.1. Introduction

Over the past few years, different extension models have been tested in many Sub-Saharan Africa countries with the aim of achieving national food security, improving rural livelihoods and natural resource management practices (Davis, 2008; Swanson et al., 2010). Despite these efforts, the role of extension in increasing agricultural productivity has remained limited in Ethiopia, as in many of the other African countries (Ashworth, 2005; Davis, 2008; Davis et al., 2010). The shortcomings have been attributed to the triple challenges of market, state and community failures (Swanson et al. 2010).

The private sector might not be effective on account of market failures. The state faces the challenges of high supervision costs and standardization problems. For NGOs or communities, there are always the dangers of capacity constraints and local elite capture.

Given these challenges, there is no single extension approach that is adequate for effective provision of extension services in different situations (Birner et al., 2012). Instead, the institutional and economic development level of the country determines the way extension services should be organized and provided (Anderson, 2007). Therefore, the choice of "best-fit" extension approaches should consider the following four basic contextual factors; the policy environment, the capacity of potential service providers and partners, the production system, market access and the socio-economic characteristics of the communities (Birner et al., 2009). The extension models in Sub-Saharan Africa cover a diverse set of different approaches. They range from purely market-based extension services in Uganda to public funded and privately managed extension systems in Mozambique (Swanson et al., 2010).

A prominent example of purely public extension system in Sub-Saharan Africa is Ethiopia (Davis, 2008). Within the framework of the Agricultural Development Led Industrialization strategy adopted in 1993, the current government reformed the governance, management and methods of agricultural extension delivery. The agricultural extension reform includes the following elements: decentralization, introduction of a Participatory Demonstration and Training Extension System (PADET), establishment of Farmer Training Centers (FTCs) and Agricultural Technical and Vocational Education and Training institutions (ATVETs) to build the capacity of farmers and extension agents. They are referred to as Development Agents (DAs) in Ethiopia. While most governments in Sub-Saharan Africa reduced their public agricultural support and shifted towards market-based extension services, the government of Ethiopia continued to invest heavily on a public sector extension system. Until 2011, the government established 10,000 FTCs, 25 ATVETs and trained over 70,008 Development

Agents in different fields. Currently, the Ethiopian extension system is the densest in Sub-Saharan Africa with the average ratio of one Development Agent to 476 farmers (Davis et al., 2010).

The ultimate objectives of these reforms, as indicated in the rural development policies, strategies, and instruments document (FDRE, 2003), are to improve the income and food security of smallholder farmers. Some studies reported positive outcomes of the reforms (Ashworth, 2005; Davis et al., 2010), while others criticized the reforms (Belay, 2003; Berhanu et al., 2014). Given these contradictory views, a case study that disentangles the reform approach and tries to examine what works-or does not work-where and why can be expected to contribute to clarifying the controversies surrounding Ethiopia's extension reforms.

In order to evaluate the effects of the reforms, we used the agricultural advisory framework developed by Birner et al. (2009). The framework, alongside with the data collection and analytical tools used in this study, aimed to answer the following key research questions: Does the reform enable farmers to voice their demands and hold service providers accountable? Has the reform strengthened the capacity of service providers to respond to the needs of farmers? Has the reform created a market-lead, farmer- driven, knowledge based and pluralistic extension system?. By answering these research questions, the paper aims to achieve the following objectives: (1) To understand what works and what does not work well in Ethiopia's public agricultural extension system; (2) To identify knowledge gaps and, (3) To develop and test new tool for the analysis of extension services.

This chapter is structured as follows: After this introduction, section 2 reviews the literature on extension reforms. Section 3 presents the conceptual framework and Section 4 describes the methodology and data used in the analysis. Section 5 presents the results and Section 6 the conclusion.

4.2. Literature review

This literature review distinguishes between demand-side approaches of agricultural extension reforms, which aim to increase the ability of farmers to demand extension services and hold extension providers accountable, and supply-side approaches, which aim to improve the capacity and incentives of service providers to provide (supply) extension services.

Major agricultural extension reforms in Ethiopia started in 1995 when the current government introduced PADETS. This system was designed to enhance the productivity of smallholders

by increasing their access to extension and training services. It involved the use of Extension Management and Training Plots of the FTCs. PADETS also involve package approaches such as provision of information, credit, improved seeds and chemical fertilizers (Davis et al., 2010).

PADETS included the following combination of demand-side and supply-side reforms: introduction of new extension packages for livestock, post-harvest and natural resource management; identification of technology packages for different farming systems; reducing the burden of DAs by shifting away input distribution responsibility to cooperatives and revision of the curriculum of the ATVETS (Spielman et al., 2011). An evaluation of PADETS in 2002 revealed that sustaining the achievements of the demand-side reforms became a challenge due to supply-side reform constraints (Ashworth, 2005; Davis et al., 2010). In order to solve these constraints the government introduced the Rural Capacity Building Program (RCBP) in 2007. RCBP aimed at strengthening PADETS by making the extension system more responsive to client needs and building institutional capacity to efficiently generate client-driven, gender-responsive and market-oriented technologies (MoARD, 2012a). The RCBP involved five broad components: (i) Agricultural Technical and Vocational Education and Training (ATVET), (ii) Agricultural Extension Services, (iii) Agricultural Research, (iv) Improving Information and Communication Systems within the MoA line departments, and (v) Development of Agricultural Marketing Institutions.

Some components of the RCBP are also specifically designed to improve women's and farmers' group access to agricultural extension services. Prominent examples are the Development Innovation Grants (DIG) and Farmers Innovation Fund (FIF) projects (MoARD, 2008). The DIG focuses on increasing women's access to agricultural extension through training on home economics (e.g., horticulture, poultry and small ruminants). Similarly the FIF project mainly aimed at strengthening the productivity and income of farmers through providing funds directly to farmers' groups for implementing innovative ideas developed and partially funded by the groups themselves. The Farmers Research and Extension Groups (FREGs) component of the RCBP also encourages participatory research in which a group of farmers, extension workers and a multidisciplinary research team jointly participate in agricultural technology generation, verification, and improvement (MoARD, 2012b).

Apart from gender and group specific targets, other reform efforts are also designed to improve the livelihoods of poor farmers. The Productive Safety Net Program (PSNP) and the Household Asset Building Program (HABP) are cases in point. PSNP aimed to improve income and food security of poor farmers through protecting individual and community

assets, taking vulnerability and shocks into account (Gilligan et al., 2008). Similarly, the HABP extends credit to households of the PSNP so that they could graduate from food insecurity (Hoddinott et al., 2011). In order to increase productivity and market access for high agricultural growth potential areas, the Agricultural Growth Program (AGP) was also commenced in 2011 (Berhane et al., 2013). In addition to these programs, another prominent reform initiative is the establishment of the Agricultural Transformation Agency (ATA) in 2010. In line with other programs, ATA works to address systematic bottlenecks in the seed sector, input/output markets, cooperatives, soil health and fertility management, and extension and research (ATA, 2015).

The Ethiopian public agricultural extension system today is one of the largest and densest in the developing world. As indicated above, it has a development agent to farmer ratio of 1:476. Over the last two decades, extension service users have increased from 1600 households in 1994 to over 9 million, the number of extension agents have been increased from 15,000 during the initial periods of PADETES to over 70,000. This rapid expansion has been accompanied by the establishment of 10,000 FTCs and 25 ATVETs (Davis et al., 2010; Spielman et al., 2011). The rapid expansion was made possible due to high public investment on the agricultural sector. For example, in 2005 the share of agriculture in total public expenditure was 21 percent. This figure was five times more than the Sub-Saharan African average of 4 percent, or more than double the African Union target of 10 percent (Fan et al., 2009). As a result, the poverty and food insecurity status of the smallholders has been on declining trend (Dercon et al., 2008; Gilligan et al., 2008). Other positive outcomes of the reform include the modernization and revitalization of the agricultural sector through the development of new extension packages for livestock, post-harvest handling and natural resource management, taking into account different farming system and agro-ecological zones. The professional capacity and input utilization of farmers have also been improved (Gebremedhin et al., 2006; Spielman et al., 2011).

Despite these positive reports, a number of studies challenged the objectives and outcomes of the extension reforms. For example, Bonger et al. (2006) noted that the majority (up to a third) of the first adopters of PADETS had discontinued using the extension packages due to poor complementary services, such as limited access to inputs, credit and new markets. Similarly, Ashworth (2005) and Belay (2003) reported that despite the decentralization efforts, the hierarchical culture and practice of the public extension system limited the potential and resourcefulness of farmers, extension workers and NGOs in making the extension system more demand driven. Moreover, Berhanu et al. (2014) argued that the

government's primary motive is controlling the bulk of the Ethiopian electorate, not insuring services qualities.

4.3. Conceptual framework

This paper adopted the conceptual framework developed by Birner et al. (2009) to assess the quality and impact of agricultural advisory services in Ethiopia (Figure 4.1). Based on the framework, policy makers need to consider two types of variables in designing an agricultural extension system: "choice variables", which are under the policy makers' control when deciding on a reform approach (Box AAS) and "contextual factors", which are not under their (immediate) control (Box CF). The quality of the agricultural advisory services is then determined by the extent to which policy makers find the "best-fit" between the "contextual factors" and "choice variables" (Boxes H and I). The quality of service provided can be measured in terms of performance indicators such as farmer-orientation, efficiency and effectiveness. Ultimate outcomes in terms of increased productivity and food security, however, can only be achieved if the extension system is able to influence the behavior of farmers (Box I). The capacity of farmers in exercising their voices and holding service providers accountable in turn influences the performance of extension services (Box H).

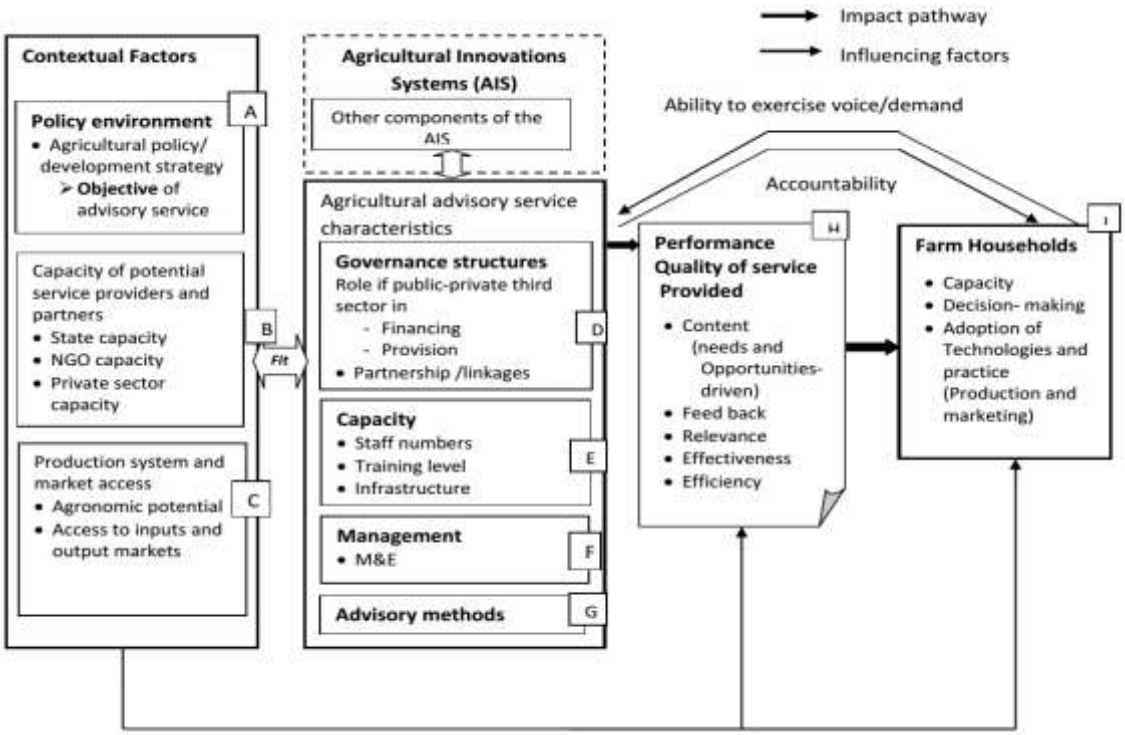


Figure 4.1: Conceptual frame work of agricultural advisory services

Source: Adapted from Birner et al. (2009).

4.4. Methodology and data

4.4.1. Research design and sampling strategy

This study uses data from a survey using semi-structured questionnaires as well as from key-informant interviews (KII) and Focus Group Discussions (FGDs). Data was collected in three kebeles (sub-districts) of different administrative zones and woredas (districts). The kebeles and households were selected using two-stage stratified random sampling. The strata were based on FTC rollout phases and agro-ecological conditions: (1) Woyna dega agro-ecologies where FTCs were established in 2004, (2) Dega agro-ecologies where FTCs were established in 2002, (3) Kolla agro-ecologies where FTCs were established in 2003. West Gojjam and South Gondar represent woyna dega and dega farming systems, which represent respectively, high and medium agricultural potentials. The Oromia special zone represents the Kolla farming system which is a low potential agro-ecology.

Sampling was done in such a way that first, lists of farmers were obtained from the records held in the FTCs and then these lists were used to randomly select 12 farmers from each of the three FTCs for the focus group discussions and individual scoring. Of the total 36 farmers requested, only seven could not participate in the FGDs (Table 4.1). In addition to the farmers and ten of their FTC-MCs, a total of 51 woreda, zone, region and federal officials and nine development agents (DAs) were also interviewed (Table 4.2).

Table 4.1:Number of farmers, FTC-MCs and DAs sampled in each sub-district

Kebele/sub-district	Farmers	FTC-MCs	DAs
Dengolt	12	-	4
Adet	7	5	2
Merewa	10	5	3
Total	29	10	9

Table 4.2:Number of experts interviewed at different administrative levels.

Administrative level	Administrative unit	KII	FGDs with scoring
Federal	Ethiopia	2	5
Regional	Amhara	2	7
Zone	South Gondar	2	11
	West Gojjam	2	
	Oromia	2	
Woreda/district	East Eastie	3	9
	Yilmanadensa	3	8
	JileTimuga	3	11
Total		19	51

4.4.2. Data collection methods

At each administrative level, KII were done prior to the FGD with about 2-3 extension managers from extension and planning departments. KII was a form of mini-FGD in which we discussed the planning, monitoring and evaluation process all together in a group. The FGDs and individual scoring of participants were experts from crop production, animal production, natural resource management, irrigation, planning, inputs and extension teams.

Data collection tools include semi-structured questionnaires, FGDs and net-mapping (a participatory mapping technique for social networks). The FGDs were corresponding to the semi-structured questionnaires and respondents were asked to give an individual scoring after an intensive discussion on each of the discussion points in the questionnaire. Later, this quantified rating made it possible to aggregate the outcomes of the FGDs at different level.

During the FGDs with farmers and with FTC-MCs, the individuals participating in the discussions were required to conduct an individual scoring on extension performance indicators, using seeds. This procedure was done as follows: First, we arranged FGD participants to sit in a circle and gave five seeds to each participant to score each extension and advisory service out of five. When farmers were ready to score, we asked them to put the number of seeds in their right hand and put their hand behind their back. Then, the facilitator walked around the back of the circle and counted everyone's score. This way each farmer decided on their own score privately, without showing anyone what score he/she gave. Satisfaction scores were quantitative values ranging from one to five, where 1 mean "strongly disagree", 2 "disagree", 3 "somehow agree", 4 "agree" and 5 "strongly agree". The advantage of this method is that the participants conduct their scoring after an intensive deliberative group discussion. Yet, the scoring is not influenced by peer-pressure since the group members do not see the scores that the participants assign.

4.5. Results

This section presents the results of the assessment of the extension reform in Amhara region in two parts: (1) extension service characteristics, and (2) effects of agricultural extension reforms. A range of indicators has been developed to measure the characteristics of the extension services and to measure the outcomes.

4.5.1. Extension service characteristics

In order to assess the governance reforms, we mapped the institutional set-ups and found three main functional components: field-level execution, higher-level extension organization and enabling environment (Fig. 4.2).

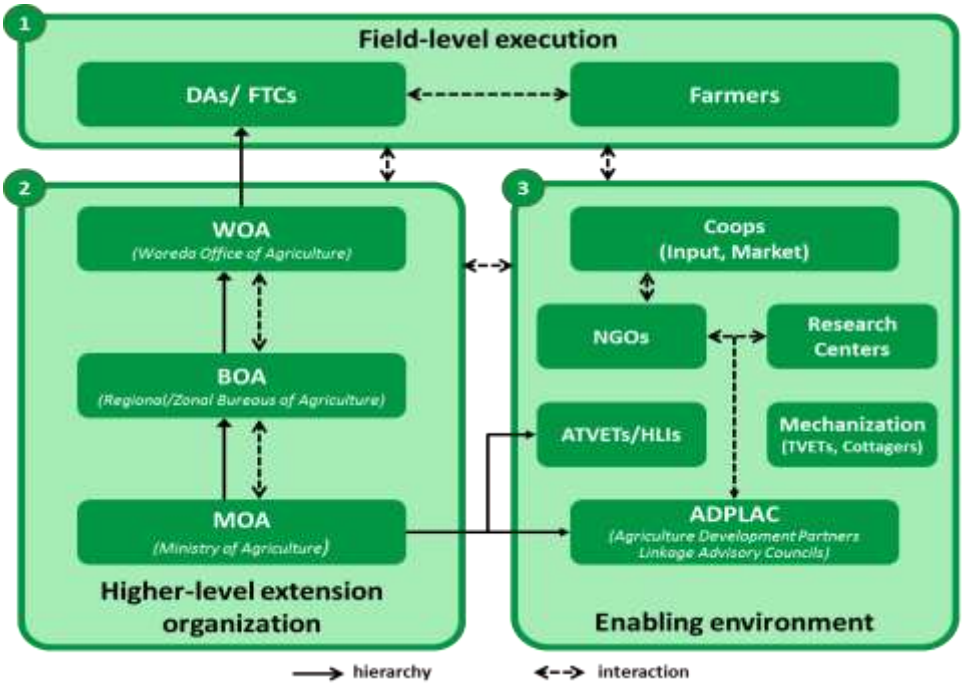


Figure 4.2: Institutional set -up of agricultural advisory services in Amhara region

Source: Adapted from Amhara BoA, Ministry of Agriculture and ATA (2013).

To identify the factors that influence capacity, we measured human resources (staff numbers, level of training, skills and experiences). Table 4.3 shows that the extension services were provided by 7765 DAs and 270 DA supervisors with technical backstopping support from 1066 SMS.

Table 4.3: Number of Professional and Technical Extension Personnel in Amhara region

Zone	1998			2000			2014		
	DA	Supervisors	SMS	DA	Supervisors	SMS	DA	Supervisors	SMS
West Gojjam	324	39	79	462	39	121	813	56	27
East Gojjam	452	58	106	460	50	116	1196	30	184
Awi	231	35	54	228	24	83	553	10	82
South Gondar	472	49	100	537	37	159	773	41	20
North Gondar	598	67	128	682	63	152	1141	40	360
Waghimra	114	17	31	108	16	23	338	22	55
North Wollo	404	64	71	449	37	79	792	34	12
South Wollo	520	85	144	782	60	161	1167	28	224
Oromia	94	18	29	107	12	36	212	18	20
North Shewa	519	53	124	502	54	136	780	21	210
Total	3728	485	866	4317	392	1066	7765	270	1194

Source: Jackson et al. (2000) for 1998 to 2000 and ANRS BoA (2014) for 2000 to 2014.

Furthermore, we investigated the availability of infrastructures and trainings. Based on the results, service providers were dissatisfied by the availability of infrastructure (Table 4.4) and they were not fully satisfied with the knowledge gained from the training (Table 4.5).

Table 4.4: Service providers' satisfaction on facilities and resources.

I have what I need in order to do my job in the best way possible?			
Statement	FTC-MC	DA	SMS
Facilities and materials at the FTC/Woreda	2.9 (0.88)	1.4 (0.72)	2.1 (0.83)
Equipment and materials for training and demonstration	-	2.1 (1.5)	1.9 (0.98)
Resources and budget for logistics (visiting farmers, FTCs)	2.7 (1.2)	1.9 (0.92)	1.8 (1.0)
Inputs for providing to farmers/FTCs	-	2.3 (0.87)	2.4 (1.1)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

Table 4.5: Service providers' satisfaction on trainings and information

Whenever I need trainings and technical information, I know who to ask for it and I am able to get it?		
Statement	DA	SMS
The trainings received have given me the knowledge and skills	3.2 (0.41)	3.4 (0.82)
I have been able to apply the trainings with positive results	3.5 (0.58)	3.4 (0.7)
I know who to ask for new information	3.7 (0.87)	2.9 (1.2)
I am able to get the information	3.1 (1.2)	2.4 (0.97)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

In order to identify the missing links, we asked service providers "what is the most important support you require, but are not currently getting or are not getting enough of? Please specify both the actor you require support from and the nature of the support required". Nearly, 21 different roles and functions of actors were identified and the roles were in harmony with each other (Table 4.6).

Table 4.6: Service providers' satisfaction on supportive linkages.

I get the support I need from each of the following actors in order to do my work in the best way possible?			
Actor	FTC-MC	DA	SMS
Farmers	3.4 (0.97)	3.7 (1.1)	3.4 (0.99)
Kebele/sub-district Officials	3.2 (1.2)	3.4 (0.88)	3.0 (1.0)
Das	3.4 (1.1)	-	3.5 (1.1)
DA supervisor	3.9 (0.93)	3.9 (1.4)	3.6 (1.1)
SMS	2.9 (0.74)	2.6 (1.0)	-
Woreda/district Officials	2.6 (0.97)	3.6 (0.53)	3.5 (1.0)
Zone officials	-	-	2.8 (0.88)
Regional officials	-	-	2.5 (1.1)
NGOs	2.2 (1.3)	2.0 (1.1)	2.4 (1.1)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

In order to assess the effects of the reforms, we identified 28 motivation and performance indicators and asked service providers how much they agree or disagree to the indicators. Based on the results, the work motivation and performance of service providers could not be regarded as highly satisfactory (Table 4.7), though they believed that they had the capacity to carry out their job in the best way possible (Tables 4.8 and 4.9).

Table 4.7: Service providers work motivation

How much do you agree or disagree to the following statements?		
Statement	DAs	SMS
I am appreciated and rewarded for doing good work	3.3 (1.0)	2.4 (0.97)
Every day I go to work feeling positive about the work I have to do	3.7 (1.2)	3.4 (1.1)
Being a DA/SMS offers good career prospects	3.3 (1.8)	2.9 (1.1)
I would like to stay in this job because I find it satisfying	3.0 (1.6)	2.8 (1.2)
I am able to dedicate all my time to my core responsibilities	4.1 (0.93)	3.6 (0.89)
I receive my full allowance on time	3.6 (1.1)	2.1 (1.2)
The demands made of me by my managers are fair and realistic	3.3 (1.0)	3.1 (1.1)
The demands made of me by my co-workers are fair and realistic	3.5 (1.1)	3.5 (0.80)
The demands made of me by those I support are fair and realistic	3.2 (1.2)	3.6 (0.64)
I am able to make the best use of my time to achieve positive results for the farmers I work with	4.2 (0.83)	3.2 (1.1)
I have the space to make choices and decisions to do my work in the way I think is best	3.6 (1.3)	2.9 (1.1)
The department of Agriculture treats me in the way that I would like to be treated	2.6 (1.1)	-
I am able to treat farmers in the same way that I would like to be treated by others	4.0 (0.87)	-
The technologies I promote can be adopted even by the poorer farmers	3.2 (1.1)	-

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

Table 4.8: Capacity/performance self-assessment of DAs.

I feel confident that I am in a position to carry out my roles/functions in the best possible way?	
Roles/functions	Average score
Planning activities at FTC and with farmers	4.4 (0.73)
Mobilizing and interacting with farmers	4.2 (0.44)
Providing technical trainings and advice to farmers	4.1 (0.93)
Demonstrating new technologies to farmers	4.0 (1.0)
Providing climate information and supporting adaptation practices	3.6 (0.88)
Collecting and reporting information about extension activities	4.4 (0.73)
Assessing technologies, adoption and outcomes with farmers	4.1 (0.78)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

Table 4.9: Capacity/performance self-assessment of SMS.

I feel confident that I am in a position to carry out my roles/functions in the best possible way?	
Roles/functions	Average score
General administrative activities (budget, official work)	3.2 (1.0)
Planning activities at Woreda and FTC levels	3.5 (0.85)
Monitoring and reporting on progress	3.6 (0.75)
Assessing and evaluating progress and achievements	3.4 (0.75)
Coordination and logistics (visiting farmers, attending meetings)	3.5 (1.1)
Providing technical and practical back-stopping support to Das	3.6 (0.84)
Managing and supervising Das	3.6 (0.89)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

In order to assess the effects of the reforms, we identified 13 key PME indicators and asked service providers at all levels. The survey results showed that, on average, the performances was moderately satisfactory (Tables 4.10, 4.11, 4.12).

Table 4.10: Service providers' satisfaction on planning

Actor/Statement	FTMCs	Das	SMS	Zone officials	Regional officials	Federal officials
Current plans are set realistic.	3.8 (1.1)	3.3 (0.5)	3.2 (0.7)	3.4 (0.9)	3.7 (0.8)	3.0 (1.2)
Current plan targets are achievable.	2.8 (0.6)	3.3 (0.5)	3.2 (0.7)	3.5 (0.9)	3.6 (0.9)	3.4 (1.3)
Current plans reflect the real needs and priorities of farmers.	4.3 (0.8)	3.3 (0.5)	3.3 (0.6)	3.9 (0.7)	3.9 (0.7)	3.0 (0.7)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

Table 4.11:Service providers' satisfaction on monitoring and reporting.

Actor/Statement	FTC MCs	Das	SMS	Zone officials	Regional officials	Federal officials
I have accurate information about the farmers I am responsible for.	3.8(1.1)	3.8(0.7)	3.1(1.2)	3.2 (0.4)	3.1 (1.3)	2.8 (0.8)
I have timely information about the progress being made (or not) and the reasons for this.	3.1 (0.9)	4.0(0.7)	3.0(0.9)	3.3 (0.9)	3.1 (1.2)	2.6 (0.9)
The reports I submit to others are useful to me and don't take up too much of my time to prepare.	4.2(0.9)	3.7(0.7)	3.6(0.9)	3.5 (0.8)	3.1 (1.3)	3.2 (0.8)
The reports I receive from others identify the issues that need attention in the area for which I am responsible.	4.0(1.4)	3.6 (0.7)	3.3(0.9)	3.3 (0.8)	3.9 (1.5)	2.8(0.8)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

Source: Authors' survey (2014)

Table 4.12: Service providers' satisfaction on evaluating, reviewing, assessing and learning.

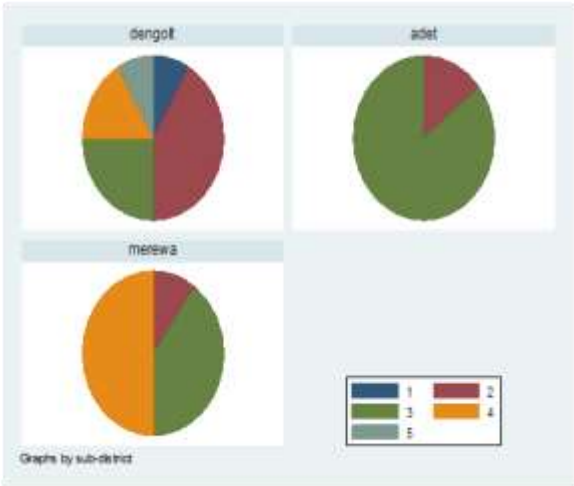
Actor/Statement	FTC-MCs	Das	SMS	Zone officials	Regional officials	Federal officials
I have the skills I need to use data to learn and improve.	4.1 (0.9)	4.2(0.7)	3.5 (0.8)	3.7 (0.5)	3.7 (0.9)	2.6 (0.6)
I have the time I need to use data.	3.7 (1.1)	3.4(1.2)	3.3(0.7)	3.5(0.5)	3.6(0.8)	2.4(0.6)
The data I collect and report helps meto communicate my achievements and get the support I need.	3.7 (0.7)	4.0(0.9)	3.3(0.9)	4.0(0.8)	3.7 (0.7)	3.2 (0.5)
I have the opportunity to reflect with others on progress and performance and find it useful.	4.2 (0.8)	3.4(0.9)	3.0(0.9)	3.9 (0.9)	3.4 (0.9)	3.2 (0.5)
I have a clear picture of the changes that have been brought about through my work and the problems that need to be addressed.	3.8 (1.4)	4.0(0.7)	3.5(0.8)	3.3 (0.8)	3.9 (1.3)	2.6(0.6)
I have a clear picture of the performance of the FTC and area for which I am responsible, of the changes achieved to date and the problems that need to be addressed.	4.3 (0.5)	3.9(0.8)	2.8(1.2)	3.0 (0.9)	3.4 (0.9)	2.4 (1.1)

* Note: Value represent average scores on a range from (1) fully agree to (5) fully disagree. Standard deviation in parenthesis

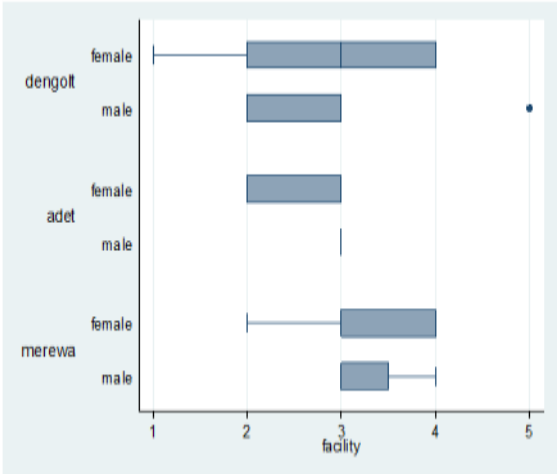
Source: Authors' survey (2014)

4.5.2. Effects of agricultural extension reforms

In order to investigate the participatory nature of the extension reforms, we asked farmers: "How satisfied are you with the facilities and equipment at the FTC?". The results showed that 45 percent of them were moderately satisfied (Fig. 4.3a). However, there were some differences in the level of satisfaction between FTCs and between male and female farmers within each FTCs (Fig.4.3b).



(a) by sub-district



(b) by sub-district and gender

Figure 4.3 : Farmers' satisfaction on FTC facilities and resources

Source: Authors' survey (2014).

Similarly, we also asked farmers "how satisfied are you with the training provided by the DAs in the last year". The average responses showed that they were highly satisfied (Table 4.13)

Table 4.13:Farmers' Satisfaction with Trainings

Satisfaction score (1 = bad, 2 = some problem, 3 = good, 4 = very good, 5 = Excellent)						
Kebele	Gender	**1**	**2**	**3**	**4**	**5**
Dengolt	Male	0	0	50.0	33.3	16.7
	Female	0	16. 7	33.3	33.3	16.7
	Average	0	8.3	41.7	33.3	16.7
Adet	Male	0	0	50.0	50.0	0
	Female	0	0	0	100.0	0
	Average	0	0	28.6	71.4	0
Merewa	Male	0	0	0	75.0	25.0
	Female	0	0	0	33.3	66.7
	Average	0	0	0	50.0	50.0
Total		0	3.5	24.1	48.3	24.1

Source: Authors' survey (2014).

Farmers were asked to rate the usefulness and implementation of the advisory services. The results showed that the advisory services were very useful and their implementation was also high (Fig. 4.4).

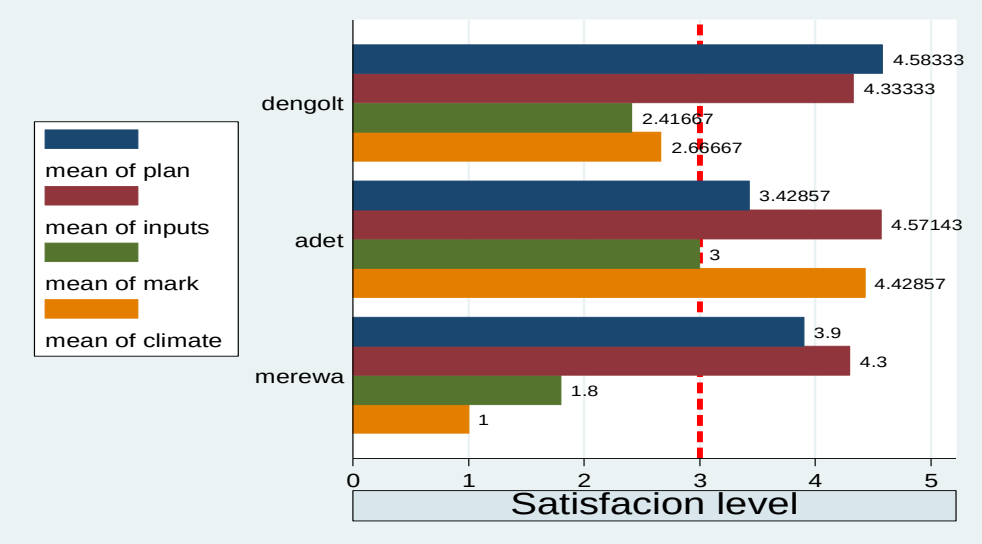


Figure 4.4: Satisfaction on advisory services, by sub-district.

Source: Authors' survey (2014).

To identify the most important institutions and analyze their roles, we asked farmers a list of questions such as "which organizations are found in the village and how do they work?, How do they interact with you and other organizations? Who is linked to whom?". Using the net mapping tool, we listed ten institutions/actors and from the list farmers identified DAs as the most influential actors in their livelihoods (Fig. 4.5).

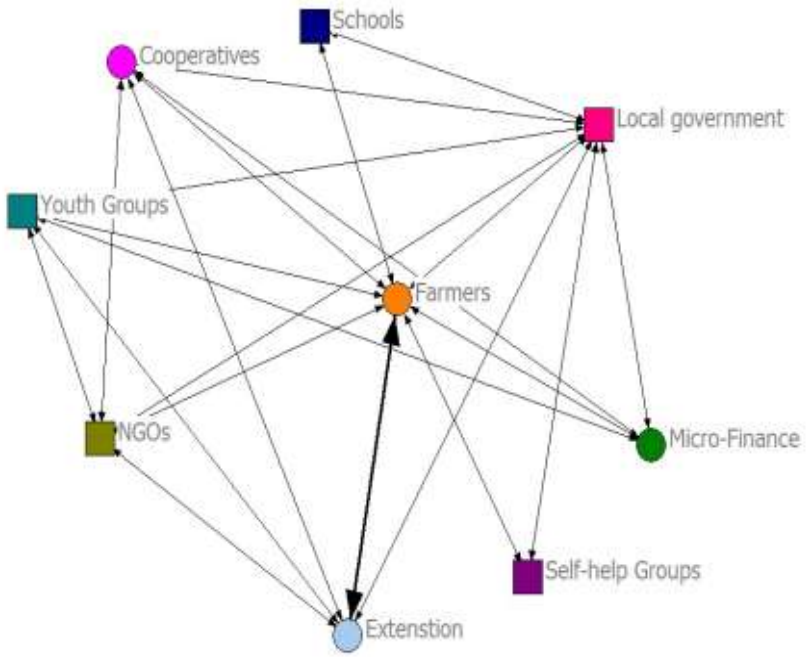


Figure 4.5: Mapping of local institutions

Source: Authors' survey (2014)

After identifying DAs as the most influential actor, we asked farmers the following five key partnership and linkages questions; "do you believe that DAs have the knowledge you need? Treat you with respect? Are fair and dedicated to helping all farmers? And are you ready and willing to participate in the extension and try new things suggested by DAs?". The results showed that, on average, farmers have rated their partnerships and linkages with DAs as "very good". (Fig. 4.6).

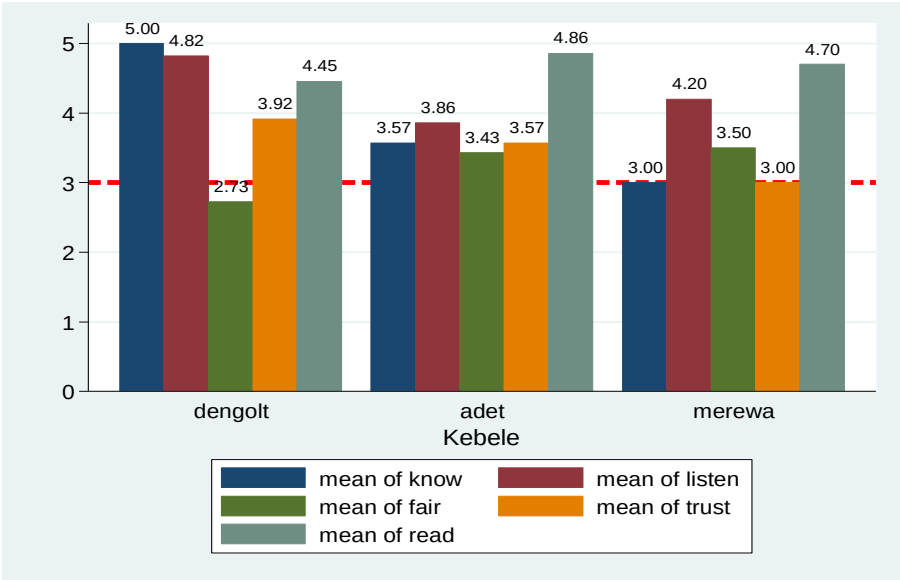


Figure 4.6: Farmers' satisfaction on partnership and linkages, by Sub-district.

Source: Authors' survey (2014).

Similarly, we asked farmers how they agree or disagree to the statement "the technologies demonstrated at the FTC can be adopted even by the poorest famers in the Kebele?". Their response showed that it was somehow medium (Fig. 4.7).

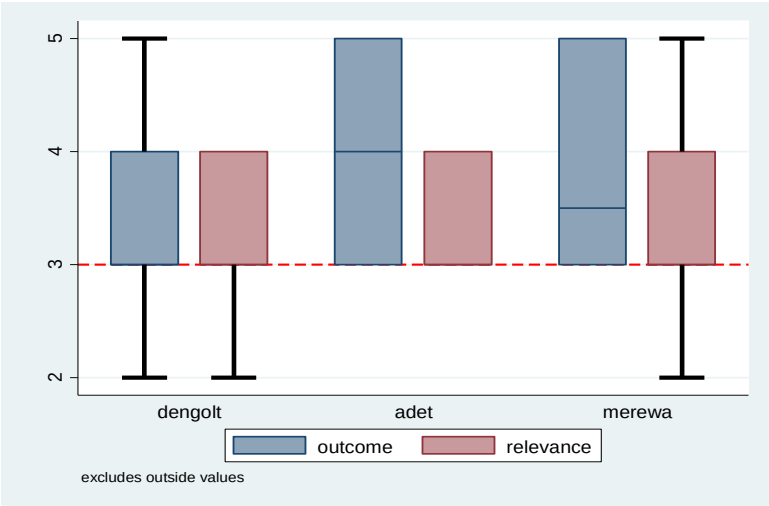


Figure 4.7: Impact of extension service, by Sub-district.

Source: Authors' survey (2014).

4.6. Discussion

This section uses the framework presented above for a discussion of results. The findings are also compared with the existing literature on extension reforms in Ethiopia.

4.6.1. Contextual factors

In Ethiopia, the introduction a five-tired governance structures (federal, region, zone, woreda and kebele) in 1995 transferred technical, managerial and policy decision-making from the federal to the region and finally to the woreda level (Cohen et al., 2011). Woredas manage and implement extension programs through the Kebeles, the lowest administrative units. The kebeles operate through two implementation mechanisms: development teams (consisting of 30 farm households) and Farmers Training Centers (consisting of three to five DAs). The decentralization is part of the reforms to improve local governance in terms of transparency, accountability and flexibility in service provision (MoFED, 2010). The extension programs are derived from the ADLI policy. The ultimate objective of the extension system is to improve the income and food security of smallholder farmers through more knowledge based and farmer-driven extension services.

In order to ensure farmers' participation, the government has/will established one FTC in each kebele. The FTCs are build based on the three major farming systems existed in the country:

dega agro-ecologies, woyna dega agro-ecologies and kolla agro-ecologies (Chamberlin et al., 2013). The purpose of FTCs is to shift from costless public extension service to cost-sharing community and farmer-driven extension services. Currently, the extension service is almost entirely funded and provided by the public sector, with few NGOs funding and operating in limited areas. However, the role of the private sector is insignificant due to lack of policy support (Cohen et al., 2011; Gebremedhin et al., 2006).

4.6.2. Reform of governance structures

The extension governance reforms combine three main functional components: field-level execution, higher-level extension organization and an enabling environment (Figure 4.2). The field level sector has four key responsibilities; delivering core extension services, popularizing new technologies, scaling up local innovation, and ensuring the sustainability of FTCs. Similarly, higher level extension organizations are responsible for supporting market and farmer-oriented extension; capacitating FTCs; managing and strengthening the capacity of extension organizations; facilitating linkages. Finally, the enabling environment has the responsibility to strengthen the capacity of field level and higher level extension organizations through training and financing. The enabling environment contains many actors: Regional research centers; higher learning institutes (HLIs); Agricultural Technical and Vocational Education and Training (ATVETs); Agriculture Development Partners Linkage Advisory Councils (ADPLACs); Cooperatives; agricultural mechanization and NGOs.

4.6.3. Capacity, performance and motivation

At the time of this survey, the extension services were provided by 7765 DAs and 270 DA supervisors with technical backstopping support from 1066 SMS (Table 4.3). Some studies in Ethiopian and Amhara region reported that the capacity, performance and motivation of extension providers were poor to efficiently and effectively provide extension services (e.g., Davis et al., 2010; Jackson et al., 2000). However, the results of these studies are in most cases based on simple narratives and not supported by empirical qualitative and quantitative evidence. For that reason, that assessment of service providers is likely to be arbitrary given the lack of sound evidence.

Moreover, the previous studies did not identify indicators according to which facilities, trainings, linkages and performance of service providers are regarded to be more or less satisfactory. Addressing this methodological gaps, the current study presents an approach for identifying and quantifying major indicators for facilities, trainings, linkages, motivation and performance. This section discusses the results of the focus group discussions and evaluates

the satisfaction and performance of frontline service providers (FTC-MC, DAs and SMS) in three districts of the Amhara region, namely Adet (from now on Woyna dega), Dengolt (from now on Dega) and Merewa (Kolla).

i. Infrastructure and training

The extension reform emphasized the need for building and strengthening the capacity of extension management at the woreda level, and extension implementation at the kebele level. In order to understand what works and what does not work well in the management and implementation of extension services, we asked DAs, FTC-MC, SMS and woreda managers regarding the availability of infrastructures and trainings.

The results (Table 4.4) indicate that, overall, the respondents were not satisfied with the availability of infrastructure. In addition to shortages of equipment and materials, there was a lack of operating funds. This in return reduced their ability to do their job in the best way possible. For example, DAs in dega agro-ecologies said "*due to lack of facilities, we are not able to make the best use of our knowledge to achieve positive results".* Similarly, DAs in kolla agro-ecologies claimed *"we are laboring to strengthen the capacity of farmers, but we do not have the capacity ourselves"*. Similarly, SMS from dega and kolla agro-ecologies said *"despite our realistic annual operation plans, we couldn't effectively implement the plans due to lack of operating funds".* Further, the woreda officials responded *"a large proportion of the vehicles (cars, motorcycles, bicycles) lie idle due to inadequate funds for fuel and repairs"*. As a result, large numbers of staff remained underutilized and SMS could not keep pace with the latest technological developments. For the regional officials, the extension system was not operating at its full potential either. They indicated that to reach all farmers, 3216 FTCs are required. However, until 2009, only 1725 FTCs were established, and of those 318 were functional.

Regarding training, DAs and SMS confirmed that they have access to in-service training. However, they are not fully satisfied with the knowledge gained from the training and applicability of the training for solving practical problems (Table 4.5). The woreda office offers training workshops every three months. Nevertheless, the training was mainly on the implementation of plans and data collection or on regular extension packages with which they were already familiar with. Moreover, SMS emphasized that there was little effort to modify the training content to fit the needs of the current extension challenges such as "climate change, markets, organizing farmers and dryland agriculture". To this end they demanded training on marketing, group organization and management, financial management and leadership skills.

ii. Partnerships and linkages

In order to identify the missing links, we asked FTC-MC, DAs and SMS "what is the most important support you require, but are not currently getting or are not getting enough of? Please specify both the actor you require support from and the nature of the support required". As mentioned above, 21 different roles and functions of actors were identified and the roles were in harmony with each other (Table 4.6). However, we found some "missing links". Particularly, the private sector, universities, research institutes and NGOs were among the actors either totally missing or were not supporting enough.

Apart from identifying the missing links, this study examined the degree of supportive relationships between the existing institutions. The response matrix showed that although the supportive relationship between frontline extension providers (FTC-MC, DA, and SMS) and farmers was not one of 'the best', it could be regarded as moderately satisfactory.

On the other hand, DA supervisors were providing "very good" support to SMS, DAs and FTC-MC, followed by kebele officials and somehow woreda officials, whom they regarded the supportive relationships as moderately satisfactory. Similarly, DAs were giving good support to SMS and FTC-MC, but the feedbacks from SMS to DAs and FTC-MC could not be regarded as a "good one". SMS had also accepted DAs' and FTC-MCs' claim, however, the reasons were that they had no enough support from zonal and regional officials as well. For example, SMSs claimed that "*we have very limited or no linkages with universities, research institutions and NGOs due to inadequate information and communication technology support from zonal and regional officials*". All service providers also reported their dissatisfaction over NGOs. The most important support that they have required from NGOs, but not getting from were: facilities and materials, trainings and budgetary support. During the FGDs, national, regional and zonal officials also acknowledged the weak partnerships and linkages.

iii. Motivation and performance

The extension reform in Ethiopia seeks to change the incentive systems so that service providers could be motivated for better performance. In order to assess the effects of the reforms, we identified 28 motivation and performance indicators and asked DAs and SMS how much they agree or disagree to the indicators (Tables 4.7, 4.8 and 4.9). Based on the results, the work motivation and performance of DAs and SMS could not be regarded as highly satisfactory (Table 4.7), though DAs and SMS believe that they have the capacity to carry out their job in the best way possible (Tables 4.8 and 4.9). The reasons for low

motivation and work performance were: organizational management problems (allowance and career prospects); institutional factors (high output demands with low rewards and performance appraisal) and mind-set problems. For example, DAs and SMS had the belief that their job does not offer good career prospects and as a result they would not like to stay in their job. Further, DAs reported that although the recent extension reforms freed them from non-extension activities (input and food distribution, collecting loans, organizing and facilitation political meetings) they wanted better treatment from the WoARD in the form of rewards, carrier prospects, operational flexibility and authority. Similarly, SMS claimed that the extension reform has not substantially changed the traditional upward accountability and hence they have less space to make choices and decisions.

Low work motivation and performance had been further reinforced by poor working conditions and lack of adequate incentives. DAs and SMS, who dedicated all their time to core extension responsibilities had been underpaid and had no good logistical support. During our discussion with DAs, they said that "we could not perform our duties in the best possible way because of lack of mules, horses or bicycles". Similarly, SMS mentioned that only one or two motorcycles were available for more than ten experts in the woreda and this had negatively affected their work performances.

4.6.4. Management and Organization

In addition to the governance changes, the reform also seeks to improve the management and implementation of the extension services through a decentralized planning, monitoring and evaluation (PME) system. In order to assess the effects of the reforms, we identified 13 key PME indicators and asked service providers at all levels. The survey results showed that, on average, the performances were moderately satisfactory (Tables 4.10, 4.11, 4.12). Regarding planning, DAs and FTC-MC said "*the initial targets are usually realistic, achievable and reflect the real needs and priorities of farmers as the plans start from the farmers themselves. However, our efforts to set realistic plans get lost when the woreda tries to aggregate and harmonize our plans with the regional indicative plans*".

Similarly, respondents reflected that there were lacks of information communication technologies (ICT) and management information systems (MIS) to coordinate, monitor and evaluate extension performances. During the survey period, the quality of information flows (accuracy, timeliness and usefulness) was not so good due to lack of ICT support and this has reduced transparency and accountability along the line departments. Regarding the MIS, regional and federal officials claimed that "*despite RCBP's plan to develop a computerized*

reporting system at the federal, regional, zonal and woreda levels, there were lacks of simple tools, software and computers to collect, store and access information".

4.6.5. Advisory methods

In addition to the governance and organizational changes, the agricultural reform introduced new advisory methods. The most common approach that has been promoted in the region is the Farmers Training Center (FTC) approach, which was designed to promote new and improved technology packages. DAs train farmers at the FTCs on technical production, post-harvest handling, marketing and natural resource management using both classrooms and demonstration fields. The FTCs have buildings, demonstration plots, animal shelter and water harvesting infrastructures where farmers learn about the use of new technologies.

The FTCs approach relies on the Participatory Demonstration and Training (PADETS) method to transfer knowledge to farmers and to help them "increase their income and food security". FTCs provide modular green certificate training (for six months) and certificate training (for three months) to all farmers in the kebele (Tefera et al., 2011). The extension methodology at FTCs also involve a group approach called lematibudin (development teams), where a group of 25-30 farm households work closely with DAs for a group experimentation and evaluation (Cohen et al., 2011). Successful farmers are selected to serve as model farmers, who then take up the responsibility of transferring knowledge to their kebeles with DAs back-stopping support.

4.6.6. Farmer-orientation

Extension service is client-oriented and participatory if it provides farmers equal access to facilities, trainings, advice and information (Cohen et al., 2011). In order to investigate the participatory nature of the extension reforms, we asked farmers "how satisfied are you with the facilities and equipment at the FTC?". The response showed that 45 percent of them were moderately satisfied (Fig. 4.3a). However, there were some differences in the level of satisfaction between FTCs and between male and female farmers within each FTCs. For example, female farmers' satisfaction level is more variable than male farmers and satisfactions of women are below average in woyna dega agro-ecologies where there are relatively better facilities (Fig. 4.3b). This shows how women farmers have less access to extension facilities.

Similarly, after intensive discussion on the nature of trainings (types, access, timing, place, and implementation) we also asked farmers "how satisfied are you with the training provided

by the DAs in the last year?". The average responses showed that they were highly satisfied (Table 4.13). Despite the high satisfaction, farmers were concerned that trainings on improved livestock production and beekeeping technologies were not sufficient. Regarding other problems, FGDs participants had felt that some training was not provided on time and the lack of inputs and resources (land, livestock, and labor) had limited practical application of the trainings.

Following the same research techniques as the facilities and trainings, i.e., discussions on access, methods and communication, usefulness, implementation, we asked farmers "how satisfied are you with the advices offered by the DAs?". As can be seen from Fig. 4.4, on average, farmers have rated planning and inputs advices above average. However, their satisfaction on market and climate advices was below average. This is an indication that the extension approach was not holistic during the survey period. For instance, farmers in dega and kolla agro-ecologies reported that they wanted DAs to organize and link them to new markets so that they can diversify their farming system to increase income. Further, farmers said "*although the home to home and on farm advisory methods were good, DAs focus was on technical issues and not on social issues*".

In related questions, farmers were asked to rate the usefulness of the advisory services. All FGDs participants in all surveyed FTCs responded that the advisory services were very useful. The feedbacks regarding the implementation of the advices were also similar. Implementation of the advices were particularly high on improved seeds, crop management (diseases and pest control, row planting, plant spacing, and weeding) and soil fertility management practices (chemical fertilizers, animal manure, compost and organic residue management). However, advisory services on climate, post-harvest handling (drying and storage techniques) and marketing (collective marketing, information on prices and new markets) were very low during the survey period.

4.6.7. Efficiency

To identify the most important institutions and analyze their roles, we asked farmers a list of questions such as "which organizations are found in the village and how do they work?, How do they interact with you and other organizations? Who is linked to whom?". Using the net mapping tool (Schiffer et al., 2010), we listed ten institutions/actors[24] and from the list farmers identified DAs as the most influential actors in their livelihoods (Fig. 4.5).

[24]Extension, iddir/iqquib, NGOs, cooperatives/unions, microfinance, schools, health extension, kebele administration, women and youth groups.

After identifying DAs as the most influential actor, we asked farmers the following five key partnership and linkages questions; “do you believe that DAs have the knowledge you need? Treat you with respect? Are fair and dedicated to helping all farmers? And are you ready and willing to participate in the extension and try new things suggested by DAs?”.

As can be seen from Fig. 4.6, except few cases in dega and kolla agro-ecologies, on average, farmers have rated their partnerships and linkages with DAs as “very good” or *“good”*. During the discussions, farmers reported that DAs have the knowledge they need to help them become more successful. DAs also listen to what farmers say and try their best to provide what they need. Moreover, since DAs are “fair, fulfill their promises and are dedicated to helping them”, they are ready and willing to participate in the FTC activities and would try new things suggested by them.

4.6.8. Effectiveness

In order to assess the relevance and effectiveness of the reforms, we asked farmers how they agree or disagree to the following statement “the DAs have helped you make real improvements to your lives?”. As can be seen from Fig. 4.7, it seems that farmers are happy with the positive outcomes created on their living as a result of the extension services. On average, FGDs participants ranked the outcomes of the extension services as “very good”. According to the farmers, DAs have helped them make real improvements to their lives in the form of higher productivity and income, improved housing, better natural resource management. Farmers in woyna dega and kolla agro-ecologies have felt better impact than farmers in dega agro-ecology implying that the current extension system neglects remote and hardship areas such as dega agro-ecologies. Despite these differences, however, the data generally exhibits less variability on the positive outcomes (Fig. 4.7).

Similarly, we asked farmers how they agree or disagree to the statement “the technologies demonstrated at the FTC can be adopted even by the poorest famers in the Kebele?”.Their response showed that it was somehow medium (Fig.4.7) and some of the constraining factors were; limited access to inputs and credit, larger investment required for some technologies and lack of labor during harvesting seasons. Except few cases, such as row planting of Teff, almost all FGDs participants agreed that the technologies are appropriate to their local specific conditions and further they believed that the technologies were helpful even for poor farmers.

4.6.9. Accountability

The "good governance" reforms, especially after 2005, aimed at improving governance and service provision by deploying DAs at the kebele level and establishing upward and downward accountability. Regarding the upward accountability, DAs are bound by strict quotas for enrolling farmers in technology packages, which can easily be verified by the local supervisors (kebele cabinets and councils). Kebele cabinets, and particularly the chairpersons, are the local representatives of the government tasked with implementing government policies and strategies. According to the federal policy, the senior DA should be represented in the kebele cabinets as the local director of agriculture and during our survey we also confirmed DAs representation in the kebele councils (See also Cohen et al., 2011).

Considering the downward accountability, continuous interaction with development teams (*limatbuden*) creates accountability to the group and individual farmers, which is enhanced by the participatory nature extension methods. Given DAs continuous interaction with farmers, accountability is likely to be greater and farmers can take their grievances and demands to the kebele manager if DAs are underperforming. These local governance reforms have thus enhanced farmers' voice and DAs accountability to the farmers.

4.7. Conclusions

This paper has analyzed the agricultural extension reforms in Ethiopia by taking the extension system in Amhara region as a case study. In particular, the study assessed the effects of the demand and supply side reforms on service users and providers and on the ultimate extension outcomes (qualities). Mixed methods were used to answer the following key research questions: Does the reform enable farmers to voice their demands and hold service providers accountable? Has it strengthened the capacity of service providers to respond to the needs of farmers? Has it created market-lead, farmer- driven, knowledge based and pluralistic extension system?.

Based on the empirical evidence, it appears that the extension reforms in Amhara region have brought some positive results in making real improvement to farmers' lives in terms of enabling them solve their own problems and do more things by themselves (compost preparation, soil and water conservation techniques and planting tree crops for biomass and food consumption). It also appears that there is a trustful alliance between farmers and frontline extension service providers and this has helped greater absorption of crop management technologies (row planting, plant spacing, weeding, diseases and pest control),

soil fertility management practices (chemical fertilizers, animal manure, compost and organic residue management) and improved seeds- this fits well into the regional goal of enhancing more knowledge-based and farmer-driven extension services.

Despite these positive outcomes, it seems that some of the reform initiatives do not "best fit" with the current extension challenges. In the highland cereals based farming system, the main challenges were getting information on climate change related hazards (rainfall and temperature), commercial marketing (cooperative development, price and new markets), post-harvest handling (drying and storage technique). In the lowland semi-pastoral farming system, the major problems were lack of dryland farming methods (contour plowing, mulching, strip farming, summer fallow, seedbed preparation and planning in rows).

Inconsistent with the regional goal of promoting commercially oriented agriculture, service providers lack the soft skills, incentives, resources and facilities to do their job in the best way possible and address location-specific challenges. These have affected the work motivation and job performances. A number of reasons were mentioned, including; low salary, harsh working conditions, limited promotion and career up-gradation opportunities, a workload that is too high, low recognition and less incentives for extra work. In addition to these organizational management and institutional challenges, the planning, monitoring and evaluation system was not found to be very effective in assessing from time to time what has been achieved at the farmers' training centers and what remains to be done in the future.

Similarly, the partnership and linkages of actors were not strong and key actors such as the private sector and universities, research institutes and NGOs were either totally missing or partially available. A policy implication derived from this finding is that the private sector and NGOs should be encouraged to participate in some of the private nature extension services such as the provision of improved seeds, fertilizers, pesticides, vaccination, deworming and artificial inseminations. This will allow the regional government to free up and reallocate more funds to its broader extension strategies such as; development of new incentive schemes, education and training, technical advisory services, sustainable natural resource management practices and organizing farmers to link them with new markets. Similarly the capacity of the FTC-MC needs to be strengthened so that they can effectively manage and evaluate the performance of FTCs and DAs.

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Chapter Five

5. Comparative Discussion and Conclusions

This thesis addressed three main research objectives. Firstly, it investigated how climate change affected livelihood resources and agriculture and how adaptation practices in response to climate change enhanced crop productivity and food security. Secondly, it examined the impact of social networks on natural resource management practices that have the potential to facilitate climate change adaptation. Finally, the thesis assessed what works and what does not work well in the Ethiopian agricultural extension reforms, considering that extension could play a major role in facilitating climate change adaptation. These three main objectives are addressed in chapters 2, 3 and 4 of this thesis. The Amhara region was chosen for the study because the region is a good representative of Ethiopia in terms of its diverse agro-ecology, topography and extension reform efforts.

The thesis is relevant to the contemporary research on the dynamic links between climate change, social networks and extension as it sought to answer the following three current research questions. First, what is the role of climate change adaptation in crop productivity and food security? Second, how are the different types of social networks (relatives, friendship and neighbourhood) related with the adoption of SLM practices (tree-planting and soil conservation) for climate change adaptation? Third, what works and what does not work well in the agricultural extension reforms in Ethiopia?. The climate change and food security framework and the best-fit agricultural advisory framework were used to guide the analyses and derive policy implications.

The insights from this thesis can inform future research on how to empirically apply climate change and food security framework in order to analyze the food security implication of climate change and the role of adaptation. Moreover, the methodology developed for this thesis can help to empirically evaluate what works and what does not work well in agricultural extension reform programs in Ethiopia as well as other countries. The research methodology in this thesis comprised both quantitative and qualitative approaches.

5.1. Summary of the main results

This section summarizes the empirical findings of the different thematic studies in relation to the main research questions of the thesis:

1. How do adaptation practices in response to climate hazards affect crop productivity and food security?

i. **Farmers' perception of climate change largely coincides with meteorological data**. Analysis of metrological data from 23[25] stations over 36 years period reveal that there has been a steady increase in the average maximum temperature. Rainfall, however, declined over the last 30 years when averaged over the region. The historical temperature and rainfall data also exhibits higher special and temporal variability. The metrological data (temperature and rainfall) was compared with the perception of farmers on climate change using our Climate Vulnerability and Capacity Analysis tools and focus group discussions. The field survey results show that farmers also perceived the changes in temperature and rainfall and that the climate variability is adversely affecting their livelihoods.

ii. **The role of adaption on food productivity and food security is significant.** Based on quantitative evidence from the survey of sample households in the study areas, farmers who planted trees and implemented soil conservation practices (our indicators of climate change adaptation strategies) have significantly increased their food productivity and food security compared to non-adopters. However, farmers who did not implement the strategies would have benefited the most had they adopted the strategies.

iii. **The effects of climate change and the adaptation options varied amongst livelihood zones.** The case study found that there were differences in vulnerability between highland cereals based agriculture and lowland agro-pastoralist areas. It has been found that drought, floods, and migration have been the main hazards affecting the lowland agro-pastoralist areas. In contrast, snowfall, landslides and crop diseases have been the major hazards in highland areas. However, erratic rainfall, soil erosion, livestock and crop diseases were common hazards to both highland and lowland areas. Households' responses to the hazards were also different based on agro-ecology. Food aid, livestock selling, changing consumption patterns or reducing the number of daily meals and migration were common coping strategies for agro-pastoralist households. In the highland areas, the most common copying strategies were adopting drought resistant crops (sorghum and millet), integrated watershed management, zero grazing, water harvesting and natural resource management practices (soil conservation and tree planting). An increasing trend of home-garden

[25] These are selected from 134 stations that have missing or less than 30 years data.

agriculture and poultry production as income diversification strategy was also implemented in the highland areas.

iv. **The role of policy and local institutions on adaptation need to be revisited.** During the field research, agricultural extension, health extension, NGOs, cooperatives, indigenous institutions (Iddir, Kirre, Jiggie, Debo, Iquib), microfinance institutions, schools, local governments, youth and women's groups were identified as key institutions providing rural services. However, extension organizations, cooperatives/unions, local governments and NGOs were the only institutions providing services relevant for climate change adaptation.

2. How are the different types of social networks (relatives, friendship and neighborhood) related with the adoption of sustainable land management practices (tree planting and soil conservation)?

i. **The potential contributions of social network in natural resource management should be utilized.** The empirical study found that networks with relatives have a positive impact on planting trees but its impact on soil conservation is negative. This finding can be interpreted as an incidence of self-interested "egoistic" behavior, since farmers may plant trees as a means of securing land holdings. When farmers are faced with the risk of losing their land to relatives, due to common heritage, they prefer planting trees instead of soil conservation. This is because farmers can reclaim all their investment costs, by cutting trees, should they lose their land holding rights to relatives. However, it would be difficult to regain soil conservation investment costs in case they lose their land holding rights to relatives. On the other hand, friendship networks were found to be insignificant in both planting trees and soil conservation and neighbourhood ties were significant only in tree planting. This suggests that the potential contributions of friendship and neighbourhood networks that can significantly affect SLM remain untapped.

ii. **Natural resource management should be the priority of extension.** The empirical study found that extension network is not an important determinant of soil conservation and planting trees. This is worrying given the substantial role extension workers should have played in sustainable land management practices. Although the extension service in Amhara region has a strong foundation of Farmers Training Centres (FTCs) and trained development agents (DAs), it is providing little service on sustainable land management practices due to lack of infrastructure and resources

(Davis et al. 2010). This might have forced DAs to focus only on relatively short term results such as crop and livestock and the long term and costly practices of natural resource management practices might have taken a back-seat.

iii. **The roles of local institutions (cooperatives and land tenure) need to be revisited.** It was found that cooperatives need to incorporate natural resource management practices in their development agenda in addition to their current role of distributing agricultural inputs. As the empirical study witnessed during the field visit, land registration in the region entails a long procedure[26] and obtaining maps of land holdings was very difficult. From the overall sample, only 20 percent of the farmers had secondary certificate and until this study was conducted, no farmer had a map of land holdings. Even though farmers may receive a map of land holdings in the future, their probability of making a long term investment in planting trees and soil conservation might still be jeopardized as the land belongs to the government and it is not subject to sale or to other means of exchange.

3. What works and what does not work well in the agricultural extension reforms in the Amhara region of Ethiopia?

i. **Further reforms in polices and public extension services are needed**. The case study found that although the extension reforms have brought some improvements in terms of enabling farmers uptake crop management technologies (row planting, plant spacing, weeding, diseases and pest control), soil fertility management practices (chemical fertilizers, animal manure, compost and organic residue management), it seems that some of the reform initiatives do not 'best fit' with the current extension challenges. In the highland cereals based farming system, the main challenges were getting information on climate change (rainfall and temperature), commercial marketing (cooperative development, prices and new markets), and post-harvest handling (drying and storage technique). In the lowland semi-pastoral farming system, the major problems were lack of dry-land farming methods (contour ploughing, mulching, strip farming, summer fallow, seedbed preparation and planning in rows). Moreover, the study found that the private sector and NGOs were excluded from the provision of services. This implies the private sector and NGOs should be encouraged to participate in some of the private nature extension services such as the provision of

[26]Land registration involves at least seven steps: preparation and awareness raising, application and identification, temporary certificate, public hearing, registration, primary certificate and secondary certificate.

improved seeds, fertilizers, pesticides, vaccination, deworming and artificial inseminations. This will allow the regional government to free up and reallocate more funds to its broader extension strategies such as; development of new incentive schemes, education and training, technical advisory services, sustainable natural resource management practices and organizing farmers to link them with new markets.

ii. **Development of a new incentive system is required:** The case study found that service providers lack the soft skills, incentives and resources to do their job in the best way possible and these have affected their work motivation and job performances. This requires improving the salary of frontline extension providers, allowance for harsh working conditions, more promotion and career up-gradation opportunities and recognition and more incentives for extra work.

iii. **Strong linkages between farmers, NGOs and research institutes are required.** When measured against indicators such as: information sharing and feedbacks, joint planning, monitoring, evaluation and implementation, the case study found that the linkages between farmers, NGOs and research institutes were very weak. The study also found that the governance and management structures of the Agricultural Development Partners' Linkage Advisory Councils (ADPLACs), were not properly designed to facilitate the partnership and linkages of extension actors in the region. This calls for the proper institutionalization of ADPLACs through allocation of enough funds and strengthening their governance structures by minimizing the dependence on individuals.

5.2. Contribution to the literature and practical implications

Using qualitative or quantitative approaches, most of climate studies in Ethiopia or other sub-Saharan Africa countries focus on the impact of climate change on agriculture. Chapter two of this thesis contributes to the literature on climate change by providing quantitative and qualitative evidence from Ethiopia, using mixed methods approach. The qualitative approach assessed the perceived effects of climate hazards on agriculture and livelihood resources and the quantitative approach investigated the food security implication of adaptation by measuring the productivity and income differences between farmers who implemented and who did not implement adaptation strategies. The insights from this study can inform policy makers on how adaptation and copying strategies by farmers varies in time and space and on the role of adaptation in increasing productivity. Thus, the thesis will contribute for planning effective adaptation strategies both in Ethiopia or other countries.

Unlike the previous studies, which focused on the effects of network size on technology adoption, chapter three of this thesis employed plot-level probit model to understand whether rural social networks matter and which types of social networks matter for natural resource management and climate change adaptation. The results from this study can inform policy makers in Ethiopia as well as other countries regarding the contribution of social networks as informal communication channels for delivering information on any technology. Based on the findings of this thesis, farmers' informal social networks are more effective in natural resource management than the formal extension approach. These is because, compared to the formal extension approach, farmers' informal social networks are both time efficient and cost effective, since these social networks are durable and would not have to be constructed by government agencies.

The approach used in the fourth chapter can be applied to the agricultural extension study in different country contexts and thus generate consistent data for empirical case study. Chapter four generates new insights on extension reforms in Ethiopia by developing a new method that combines qualitative focus group discussions with anonymous quantitative ratings by the participants. The insights from the study can inform the extension reform efforts in Ethiopia as well as other countries. The method developed in chapter four, which combines group deliberations with individual scoring, is particularly suitable to evaluate sensitive aspects of extension reforms.

5.3. Limitations and recommendation for future research

While the thesis contributed the values and practical implications discussed in section 5.2, it is not free of limitations. In chapter two climate vulnerability and capacity analysis was combined with the endogenous switching regression model to analyze the effects of climate hazards on livelihoods resources, and also to investigate the food security implication of adaptation. Although the seasonal calendar tool was beneficial for understanding the relationships between climate change, agriculture and adaptation practices, the construction of it permitted little time for discussion. Similarly, the drawing of historical timelines was time consuming and farmers can easily get off track in their discussion of historical events. The matrix rating was also difficult as it represents complex special and contextual differences between districts. For future research, it would be advisable to do the climate vulnerability and capacity analysis in two sessions: The first day could be used for the construction of the drawings (seasonal calendar, mapping and historical timeline) and the second day for the discussion on the drawings.

In chapter three, the potential limitation of the model specification could be the endogeneity of social network variables. Social network variables, such as the size of relatives and friends networks, may vary depending on the wealth status and other unobserved household characteristics. This study assumed (as in Isham, 2002; Di Falco & Bulte, 2013) that the network variables are exogenous for the following reasons: First, our social network variables measure network type instead of size. This reduces the potential endogeneity problem as the quality of information (trust) from such networks is more important than the size of networks in the adoption decision. Second, we used Mundlak's (1978) approach, which eliminates the endogeneity problems caused by plot invariant unobservable effects as the mean values of plot-varying explanatory variables are included (pseudo-fixed effect model) to control for unobserved heterogeneity. However, for comparison of different models, future research could identify good instruments for social network variables and include them in the standard survey questionnaire so that instrumental variable (IV) estimation technique could be applied later. Unfortunately, we could not find good instruments for social network variables in the World Bank questionnaire that we used for this study.

Evaluating the effect of agricultural extension reforms involves a range of methodological challenges such as sample size, data and attribution problems (Birner et al., 2009). This thesis also confronted with some limitations in relation to sample size and time coverage for its objective in chapter four. Although the study was guided by the agricultural advisory framework (Birner et al., 2009), which is helpful for identifying "best fit" solutions and applied innovative approaches to collect data, the sample size could not be regarded as large enough to make a generalization and further analysis. Given the very limited fund and time, the study included 29 farmers, 10 Farmers' training centres management committees, 9 development agents, 28 subject matter specialists in three different administrative districts and a total of 23 zonal, regional and federal officials. The study may be considered as a pilot test, and future studies could use the methodology and the indicators developed for a representative survey involving a larger sample. Moreover, the time coverage in this study was only for one period (cross-sectional data). Two or more periods of data collection (panel data) would have given a complete picture of the effects of the extension reform programs. Therefore, future research could increase not only the sample size, but also the time coverage in order to apply more rigorous impact evaluation tools such as propensity score matching and double difference estimation techniques.

5.4. Policy implications

The insights from this thesis can inform policy makers on a range of issues. A number of policy implications can be derived from the thesis, including the following:

i. **The potential capacity of schools and religious organizations in supporting climate change adaptation should be tapped.**

The case study identified agricultural extension, health extension, NGOs, cooperatives, indigenous institutions (Iddir, Kirre, Jiggie, Debo, Iquib), microfinance institutions, schools, local governments, religious organizations, youth and women's groups as key institutions providing rural services. However, extension organizations, cooperatives/unions, local governments and NGOs were the only institutions providing services relevant for climate change adaptation. Indigenous institutions providing rotating saving (Iquib) provide credit to members but the amount is too small to be used for the purchase of agricultural inputs or for the implementation of adaptation strategies. Similarly, indigenous institutions supporting risk minimization (Iddir, Kirre) and labour sharing (Debbo, Giggie) during climate hazards were not accessible to poor farmers due to contribution requirement. Although women and youth groups have been established in all survey districts with the aim to diversify income, the groups were non-functional due to financial and training shortages. Surprisingly, important local institutions (schools and religious organizations) had not any short or long term plans to support climate change adaptation efforts despite the fact that they have the social capital to plan and implement some communal strategies such as communal terracing and planting trees on communal lands.

ii. **The regional and national policies should support the local climate change adaptation strategies.**

The study showed that although the food security implication of climate change adaptation are more reflected at the local and individual farmer levels, the adaptation efforts should not be left to only farmers and local governments. Rather the regional and national policies should support the local adaptation strategies. In this regard, the absence of communal land and natural resource use policy was encouraging farmers to over utilize natural resources and the long delay in land use rights (certification) were discouraging farmers from making long term investments on their land (e.g., tree planting and soil conservation). Therefore, we suggest the introduction of communal land and natural resource use policy and speedy land certification process.

iii. Land policy should support the potential contributions of social networks in natural resource management.

The study revealed that while relative networks increases the incentive for tree planting, it has a disincentive effect on soil conservation. These is because of land tenure insecurity in Ethiopia, particularly on common heritage, farmers may plant trees as a means of land holdings. When farmers are faced with the risk of losing their land to relatives, due to common heritage, they prefer planting trees instead of soil conservation. This is because farmers can reclaim all their investment costs, by cutting trees, should they lose their land holding rights to relatives. However, it would be difficult for them to regain soil conservation investment costs should they lose their land holding rights to relatives. If tenure insecurity may create such selfish (egoistic behavior), speedy land holding right (certification) can increase the potential contribution of relative networks in natural resource management.

iv. Reform efforts should consider current extension challenges.

The results from the fourth chapter revealed that although the decentralization increased the efficiency and effectiveness of the extension service, some of the reform elements still does not "best fit" into the current extension challenges. In the highland cereals based farming system, new advisory methods on climate (information on rainfall and temperature), commercial marketing (cooperative development, price and new markets), post-harvest handling (drying and storage technique) are required. In the lowland semi-pastoral farming system, new advisory methods on dry-land farming methods (contour ploughing, mulching, strip farming, summer fallow, seedbed preparation and planting in rows) and more extension services on livestock than crop are needed. Contracting out some of the private nature extension services is also important.

v. The government should design a new incentive system for extension providers.

The case study showed that inconsistent with the regional goal of promoting commercially oriented agriculture, service providers in the region lacked the soft skills, incentives and resources to provide commercially oriented services. This calls for designing a new incentive system (such as better salary, allowance, career up-gradation, recognition and more incentive for extra work) that would motivate and enable frontline service providers.

vi. **The governance and management structures of the Agricultural Development Partners' Linkage Advisory Councils (ADPLACs) should be redesigned.**

The case study revealed that when measured against indicators such as: information sharing and feedbacks, joint planning, monitoring, evaluation and implementation, the linkages between farmers, NGOs and research institutes were very weak. This calls for redesigning the governance and management structures of the Agricultural Development Partners' Linkage Advisory Councils (ADPLACs),which was responsible for facilitating the partnership and linkages of extension actors in the region.

vii. **The role of NGOs and the private sector in the provision of extension service should be enhanced.**

The case study found that key actors such as the private sector and NGOs were missing from the provision of extension services. This calls for the private sector and NGOs to participate in some of the private nature extension services such as the provision of improved seeds, fertilizers, pesticides, vaccination, deworming and artificial inseminations. This will allow the regional government to free up and reallocate more funds to its broader extension strategies such as; development of new incentive schemes, education and training, technical advisory services, sustainable natural resource management practices and organizing farmers to link them with new markets.

5.5. Conclusion

This thesis attempted to fill knowledge gaps on the dynamic links between climate change, extension and social networks through case study and empirical analysis of three inter-related research topics. In the second chapter, it investigated farmers' vulnerabilities to climate change and the role of adaptation in increasing productivity at the household level. In the third chapter, it assessed how the different types of social networks are related with the adoption of sustainable land management practices for climate change adaptation. In the fourth chapter, the thesis examined whether the agricultural extension reforms were best-fit for natural resource management and climate change adaptation in Ethiopia.

Most quantitative studies on the impact of climate change on food security in Ethiopia or sub-Saharan Africa employed simulation modeling and process based bio-physical models such as crop growth models. While this approach is important to analyze the effects of future climate scenarios on future crop yield levels, adaptation also plays a significant role in mitigating the

negative effect of climate change and improving food security. Climate change adaptation refers to "the process of adjustment to actual or expected climate and its effects". The qualitative approaches on climate change adaptation indicated that adaptation and copying strategies by farmers varies in time and space and therefore local-level studies are important for implementing effective adaptation plans and policies.

The methodological approach implemented in chapter two of this thesis demonstrates how to empirical apply the climate change and food security framework and hence contribute to the literature on the relationships between climate change, adaptation and food security. Apart from analyzing the impact of climate change on food production, the thesis also demonstrated how farmers' implementation of climate change adaptation strategies are influenced by their social networks and their access to human, financial, natural and physical capital. Implementation of adaptation strategies in turn has implications for food security. Although these relationships are also noted in organizations that are seeking to enhance agricultural production under the changing climate, such as the World Bank, the Food and Agriculture Organization and the Climate Change, Agriculture and Food Security (CCAFS) of CGIAR, the empirical approaches employed in chapter two of this thesis might helpful to guide their studies at the community level.

Chapter three of this thesis also challenged the commonly held view that strong networks, such as relatives, are 'more likely to trust one another for adopting risk technologies'. This implies overplaying the importance of strong networks over weak networks in technology adoption decision is wrong in the sense that the hypothesis underestimates the existence of selfish behavior in strong networks. The findings in chapter three of the thesis revealed that egoistic behavior incentives exist even in stronger ties such as that of relative networks. In Ethiopia land tenure rights are contested or challenged by relatives, due to common heritage, and farmers often plant trees to signal ownership. According to the different literatures, tree planting in Ethiopia has dual purpose: first, it protects soil erosion and second, it sends a strong signal to relative members that they no longer have land claim rights. Our results also support this proposition as information exchange with relatives is more likely to induce tree planting than soil conservation. This is because farmers can reclaim all their investment costs, by cutting trees, should they lose their land holding rights to relatives. However, it would be difficult to regain all investment costs made for soil conservation should they lose their land holding rights to relatives.

The ultimate outcome may be low implementation of sustainable land management practices where soil conservation is under implemented in contested lands and tree planting could be

abandoned once land holding right is ensured. Although the socially beneficial decision would have been the universal adoption of tree planting and soil conservation by all farmers, some individual farmers have selfish interest to only implement tree planting with the ultimate motive of ensuring land ownership and not with the grand objective of implementing sustainable land management practices. The implication from chapter two of this thesis is that countries that are overwhelmed by land tenure insecurity will have less probability of promoting sustainable land management practices.

Chapter four of this thesis develops assessment tools for empirically applying the agricultural advisory services framework. By focusing on the “best-fit approach”, the thesis generates new insights on extension reforms in Ethiopia and the insights from the study can inform the extension reform efforts in Ethiopia as well as other countries. Moreover, a method was developed that combines qualitative focus group discussions with anonymous quantitative ratings by the participants .This method is particularly suitable to evaluate sensitive aspects of extension reforms.

Overall, the thesis has underscored the need to strengthen the efforts of governments, development partners, the private sector and NGOs in assisting smallholder farmers in Sub-Saharan Africa to cope with climate change. As the thesis has shown, harnessing the potential of social networks and of improved extension services can play an important role in this regard.

5.6. References

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6. Appendices

6.1. Farmers Voice Questionnaire on Extension

Part 1: Extension services

1. Facilities and equipment
⅄ What facilities exist now at your FTC? ⅄ What facilities would you need?
<u>How satisfied are you with the facilities and equipment at the FTC?</u>

2. Training
⅄ Who has had training from DAs in the last year? ⅄ What training has been provided at this FTC? ⅄ How easy was it to access the training? ⅄ How did you find out about training? ◦ At what time did it take place? Was the timing appropriate for you? If not, why not? ◦ Where did the training take place? How comfortable was this location for you? ◦ How do you judge the implementation of the training? ⅄ Were you able to implement what you learned? ⅄ Which trainings were most needed / important?
<u>How satisfied are you with the training provided by the DAs in the last year?</u>

3. Support with planning
⅄ Who has had planning support from DAs in the last year? ⅄ How was the planning support given? ⅄ Did everyone get the same? ⅄ How easy was it to access the support? ◦ Did you know it was available? ◦ At what time did it take place? Was the timing appropriate for you? If not, why not? ◦ Where did the support take place? How comfortable was this location for you? ⅄ How useful was the support? Are you doing what you planned?
<u>How satisfied are you with your plans?</u> (the planning support?)
4. Advice
⅄ Has anyone received advice from the DAs in the last year? ⅄ Can you get advice when you need it? ⅄ Does the DA visit you? ⅄ Is it easy to ask for advice? ◦ Are the DAs responsive? ◦ Did anyone have difficulty getting advice? (record how many face what difficulties) ⅄ Did they give good advice?

- Did it solve your problem?
- Are you implementing it?

How satisfied are you with the advice offered by the DAs?

5. Inputs

(Note: DAs do not provide inputs, but should be able to help farmers to get what is needed at the best price)

- What inputs (seed, fertilizer etc.) do you need?
- What difficulties do you face in getting them?
- Did anyone get help from the DAs to get the inputs they need?
- Did the DAs know what inputs were available and how to get them?

How satisfied are you with the help DAs provide to get the inputs you need?

6. Marketing

- What market opportunities exist now? (Where do farmers sell their products now?)
- Do the DAs know what other opportunities are available?
- Have you been able to access new markets because of DA advice?
- Have you been able to sell for better prices?

How satisfied are you with the marketing advice and support from DAs?

7. Climate information

- What climate information is available now?
- Where or from whom do you get climate information now?)
- Do DAs give you climate information?
- Have you been able to reduce risk because of DA advice?

How satisfied are you with the climate information and support from DAs?

8. What are the major challenges you face in adopting the advice, inputs and technologies that the DAs recommend?

What other things do you expect / want from the FTC?

Part 2: Relationships

9. Knowledge
⅄ We already discussed the advice and training that DAs give you. ⅄ Now can you say what you think about the knowledge DAs have.
<u>The DAs have the knowledge we need to implement NRM that are important for climate change adaptation.</u>

10. Listening
⅄ Do I have the opportunity to speak my views regarding NRM? ⅄ Do I feel completely free to ask questions and say what I really think? ⅄ Do the DAs listen to my questions and my views? ⅄ Do they respond in a sincere and respectful way? ⅄ Do DAs learn things from us farmers?
<u>The DAs treat you with respect: they listen to what you say and try their best to provide what you need.</u>

11. Readiness
⅄ We believe that the more ready and willing farmers are to invest their own time and effort to participate in extension activities, the better the system will function.
<u>You are ready and willing to participate in NRM practices and try new technologies suggested by DAs.</u>

12. Fairness
⅄ In many of the previous questions we talked about whether all farmers are able to get services if they want to. ⅄ Now please let us know how fair you think the DAs and FTC management are in
<u>You believe the DAs are fair and dedicated to helping all farmers.</u>
13. Trust
⅄ It is important that farmers and the DAs trust each other to be honest and do what they say they will do. ⅄ The DAs will also have a chance to say what they think about farmers
<u>You believe that DAs fulfill their promises.</u>

Part 3: Impact

14. Outcomes
⅄ Are you more able to solve problems or do more things by yourself? ⅄ Can you describe any lasting improvements in your lives that improved extension services have helped to create?
<u>The DAs have helped you make real improvements to your lives.</u>

15. Management of the FTC
⅄ Was anyone here consulted on the preparation of the FTC Plan (E.g. relating to activities, technologies, etc.) ? ⅄ Do you feel that the Plan reflects the real needs and priorities of farmers in this Kebele? ⅄ Is anyone here involved in reviewing and discussing progress made by the FTC or suggesting improvements? ⅄ Is the FTC well managed? ⅄ How effective is the FTC Management Committee? ⅄ Does it make sure that the DAs work well and provide what farmers need?
<u>How satisfied are you with the way the FTC is managed?</u>

16. Relevance of demonstrated technologies
⅄ Do you think that the technologies demonstrated at the FTC could actually be adopted by most of the people in this Kebele or only a few? ⅄ What about the poorer people?
<u>The technologies demonstrated at the FTC can be adopted by even t</u> **<u>the poorest farmers in the Kebele.</u>**

6.2. Farmers Questionnaire on Climate Change and Adaptation

Part 1: Climate vulnerability matrix

Objectives:

- To determine the hazards that have the most serious impact on important livelihoods resources.
- To determine which livelihoods resources are most vulnerable.
- To identify coping strategies currently used to address the hazards identified.

Discussion points
◦ What are the most important livelihoods resources (human, social, physical, natural and financial) in your village? ◦ From the list you mentioned, what are the four resources you consider to be the MOST important in achieving well-being? ◦ What are the greatest hazards (natural or man-made) to your livelihoods? ◦ Can you decide on the degree of the impact each of the hazards has on each of the resources by scoring for the hazards against the livelihoods resources (3 = significant impact on the resource; 2 = medium impact on the resource; 1 = low impact on the resource; 0 = no impact on the resource) ◦ What coping strategies are currently used to deal with the hazards identified? Are they working? If not, what are the obstacles? ◦ What are the constraints to adopting these new strategies? ◦ Are there different strategies that you would like to adopt which would reduce the impact of hazards on your livelihoods? If yes, what are these strategies? ◦ What resources do you have that would help you to adopt these new strategies?

Part 2: Timeline

Objectives:

- To get an insight into past hazards, changes in their nature, intensity and behavior.
- To make people aware of trends and changes over time.
- To evaluate extent of risk analysis, planning and investment for the future.

Discussion points
◦ Can you recall major events in your village (such as major hazards, and their effects, changes in land use, i.e., crops, forest cover, houses, etc, changes in land tenure, changes in food security and nutrition, changes in administration and organization, major political events ◦ Have there been any trends or changes in the frequency of events over time? ◦ What are current strategies to cope during the difficult events? Are they working? ◦ Have coping strategies changed based on the changing frequency of events? If yes, in what way? ◦ What events do you expect will occur in the future? When? ◦ Does this perception of future events affect your plans for the future? If yes, how?

Part 3: Seasonal calendar

Objectives:

- To identify periods of stress, hazards, diseases, hunger, debt, vulnerability, etc.
- To understand livelihoods and coping strategies.
- To analyze changes in seasonal activities.
- To evaluate use of climate information for planning.

Tool: See participatory tool one in the annex.

Discussion points
◦ Can you list us the different seasons, events, conditions, etc (holidays and festival, planting and harvesting seasons, periods of food scarcity, times of migration, timing of hazards such as drought and flood, , etc) that occurred during the year? (use seasonal calendar) ◦ What are the most important livelihoods strategies employed at different points of the year? ◦ What are current strategies to cope during the difficult times? Are they working? ◦ Are there any differences in the timing of seasons and events as compared to 10/20/30 years ago? If yes, what has changed? ◦ Have livelihoods/coping strategies changed based on the changing seasons or events? If yes, how? ◦ How are decisions made on timing of livelihoods strategies?

Part 4: Actors-Map

Objectives:

- To analyze the role of institutions in supporting or constraining farmer's capacity to adapt to climate change.
- To analyze engagement of different institutions in local planning processes.
- To understand which institutions are most important to farmers in the target community?

Discussion points
◦ Which organizations(government, NGO, community-based) are found in the village and which other ones from elsewhere are working with you? ◦ What do they do? ◦ Where do they work? ◦ How do they interact with you and other organizations? "who is linked to whom? ◦ Where are the overlaps with other organizations? ◦ Where are the gaps in capacity? ◦ How might some organizations impede the work of others? ◦ What are their longer term plans for working in the area? ◦ What are the strengths and weakness of the institutions? ◦ What is the institution's level of influence over planning and implementation of adaptation? Put influence tower?

6.3. Service providers' questionnaire

General Information	
Date	Day: Month: Year (Eth):
Zone	
Woreda	
FTC or Kebele	
Agro-climatic zone	1= Wurch (> 2400 meter); 2= dega (2200-2400 meters) 3= woinadega (1800-2200 meters); 4= Kola; 5= Bereha
Gender	
Age	
Education	
Years of experience	
Sector	Crop ☐ Livestock ☐ NRM ☐

PART 1 - GENERAL

A) FTC facilities, equipment, resources and materials

I have what I need in order to do my job in the best way possible:							
A	**Item**	**N/A**	**Strongly disagree**		**<--------->**		**Strongly agree**
1	Facilities for living at the FTC	0	1	2	3	4	5
2	Facilities and materials for administration of the FTC	0	1	2	3	4	5
3	Equipment and materials for training farmers	0	1	2	3	4	5
4	Equipment and materials for demonstrations	0	1	2	3	4	5
5	Resources and budget for logistics	0	1	2	3	4	5
6	Inputs for providing to farmers	0	1	2	3	4	5
7	Other (specify)	0	1	2	3	4	5
8	Other (specify)	0	1	2	3	4	5

B) Supportive relationship

I get the support I need from each of the following actors in order to do my work in the best way possible							
B_1	**Actor**	**N/A**	**Strongly disagree**	<---------->			**Strongly agree**
1	Farmers	0	1	2	3	4	5
2	Kebele Officials	0	1	2	3	4	5
3	Other DAs	0	1	2	3	4	5
4	DA supervisor	0	1	2	3	4	5
5	SMS	0	1	2	3	4	5
6	Woreda Officials	0	1	2	3	4	5
7	NGOs	0	1	2	3	4	5
8	Other (specify) _____	0	1	2	3	4	5

B_2	**What is the most important support you require, but are not currently getting? Please specify both the actor you require support from and the nature of the support required.**	
	Actor	**Type of support**
1		
2		
3		

C) Trainings

C_1 Trainings Received

0. Did you receive any in-service training during the last 12 months?

YES ☐ **NO** ☐

If yes, please provide a score for the following statements, considering ALL the trainings you received during the last 12 months.

	Statement	Strongly disagree		<-------->		Strongly agree
1	The trainings I received last year have given me the knowledge and skills I need to do my job in the best possible way	1	2	3	4	5
2	I have been able to apply what I learned through the trainings with positive results	1	2	3	4	5

C_2 Accessing Information

Whenever I feel like I need more technical information, new _skills or trainings, I know who to ask for it and I am able to get it

	Statement	N/A	Strongly disagree		<---------->		Strongly agree
1	I know who to ask for it	0	1	2	3	4	5
2	I am able to get it	0	1	2	3	4	5

D) Motivating and enabling factors (includes incentives)

For each of the following statements, please circle the number that indicates how much you agree or disagree.

D	Statement	N/A	Strongly disagree		<------>		Strongly agree
1	I am appreciated and rewarded for doing good work	0	1	2	3	4	5
2	Every day I go to work I feel positive about the work I have to do	0	1	2	3	4	5
3	Being a DA offers good career prospects	0	1	2	3	4	5
4	I would like to stay in this job because I find it satisfying	0	1	2	3	4	5
5	I am able to dedicate all my time to my core responsibilities	0	1	2	3	4	5
6	I receive my full allowance on time	0	1	2	3	4	5
7	The demands made of me by my managers are fair	0	1	2	3	4	5
8	The demands made of me by my managers are realistic	0	1	2	3	4	5
9	The demands made of me by my co-workers are fair	0	1	2	3	4	5
10	The demands made of me by my co-workers are realistic	0	1	2	3	4	5
11	The demands made of me by those I support are fair	0	1	2	3	4	5
12	The demands made of me by those I support are realistic	0	1	2	3	4	5
13	I am able to make the best use of my time to achieve positive results for the farmers I work with.	0	1	2	3	4	5
14	I have the space to make choices and decisions to do my work in the way I think is best	0	1	2	3	4	5
15	The department of Agriculture treats me in the way that I would like to be treated	0	1	2	3	4	5
16	I am able to treat farmers in the same way that I would like to be treated by others.	0	1	2	3	4	5
17	The technologies I promote can be adopted even by the poorer farmers in the Kebele	0	1	2	3	4	5

E) Capacity/performance self-assessment

I feel confident that I am in a position to carry out my roles/functions in the best possible way:							
E	**Roles/Functions**	**N/A**	**Strongly disagree**		**<--------->**		**Strongly agree**
1	Planning activities at FTC and with farmers	0	1	2	3	4	5
2	Mobilising and interacting with farmers	0	1	2	3	4	5
3	Providing technical trainings and advice to farmers	0	1	2	3	4	5
4	Demonstrating new technologies to farmers	0	1	2	3	4	5
5	Providing climate information and supporting adaptation practices	0	1	2	3	4	5
6	Collecting and reporting information about extension activities	0	1	2	3	4	5
7	Assessing technologies, adoption and outcomes with farmers	0	1	2	3	4	5
8	Other (specify) _____	0	1	2	3	4	5
9	Other (specify) _____	0	1	2	3	4	5

PART 2 - PME

A) Planning

Discussion questions

- **At what levels** is planning carried out?
- What is the **periodicity** of these plans (annual, quarterly, etc.) and how are they revised?
- What kinds of **targets** (activities vs. results) are included in the plans?
- Are **indicators** set as part of the planning process? If so, what indicators?
- **Who is involved** in the process **and how** (we will emphasize on how farmers are involved in this process and the role of different actors at all levels)?
- How is planning across different levels and departments **coordinated**? Is there any individual or department dedicated to planning?
- **Who influences** the plans and targets **the most**?
- What **data** is used in the planning process and where does it come from?
- What are the main **challenges** faced in the planning process?

A	**Statement**	**N/A**	**Strongly disagree**		**<----->**		**Strongly agree**
1	Current plans are set realistic	0	1	2	3	4	5
2	Current plan targets are achievable (activities and results)	0	1	2	3	4	5
3	Current plans reflect the real needs and priorities of farmers in this area.	0	1	2	3	4	5

B) MONITORING AND REPORTING

Discussion questions

- What **data** do you **collect or receive at this level**?
  - Data about **activities and results**?
  - Data about **problems and feedback**?
- How do you **collect or receive** it?
  - **Whois involved** and in what way?
  - Is there any dedicated individual, team, department or unit responsible data collection and management? If so, what is it's role? [**We will check what data**]
  - Do you use **special formats or tools** to collect it? [**We willask to see them**]
  - Do you use **meetings or household visits** to gather information?
  - Do you think you are able to get **accurate data**?
  - How **useful** is this data for you?
- What **challenges** do you face **in collecting data**?
- What do you do with the data once you have collected it?
  - Where do you **store** it? (digital vs. paper, accessibility)
  - What **reports** do you prepare?
  - What information is included in these reports?
  - Who do you submit them to and how frequently?
  - Does anyone report back to you? Who? What reports and how frequently?
  - How else is the data used?
  - How **useful** are these reports for you?
- What **challenges** do you face **in reporting data**?

B	Statement	N/A	Strongly disagree		<------->		Strongly agree
1	I have accurate information about the farmers I am responsible for	0	1	2	3	4	5
2	I have timely information about the progress being made (or not) and the reasons for this	0	1	2	3	4	5
3	The reports I **submit**to others are useful to me and don't take up too much of my time to prepare.	0	1	2	3	4	5
4	The reports I **receive**from others identify the issues that need attention in the area for which I am responsible	0	1	2	3	4	5

C) EVALUATING, REVIEWING, ASSESSING AND LEARNING

Discussion questions

- How do you review (I) **progress** and (ii) **performance**?
  - Of **individuals**, of different **areas** or **levels**, of **FTCs** of **your department**?
  - What **periodicity**?
  - What kinds of **events**, **reports**, **methods**, **approaches** or **processes** are in place for this?
  - Who is involved and in what ways (we particular emphasis on involvement of farmers)?
  - What **data** do you **use and analyse**in order to do this? We will ask about different sources of data.
  - How does this translate into learning? Do you have any specific mechanisms or activities in place to support learning in order to improve performance?
- What **challenges** do you face **in evaluating or reviewing performance**?

C	Statement	N/A	Strongly disagree	<---------->			Strongly agree
1	I have the skills I need to use data to learn and improve.	0	1	2	3	4	5
2	I have the time I need to use data	0	1	2	3	4	5
3	The data I collect and report helps me to communicate my achievements and get the support I need	0	1	2	3	4	5
4	I have the opportunity to reflect with others on progress and performance and find it useful	0	1	2	3	4	5
5	I have a clear picture of the changes that have been brought about through my work and the problems that need to be addressed.	0	1	2	3	4	5
6	I have a clear picture of the performance of the FTC and area for which I am responsible, of the changes achieved to date and the problems that need to be addressed.	0	1	2	3	4	5

7. Curriculum Vitae

Personal information	
First name(s) / Surname(s)	**Teferi Mequaninte Tensay**
Address	Schiesshausstr. 19b 70599 Stuttgart (Germany)
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Nationality	Ethiopian
Date of birth	08/05/1977
Gender	Male
Desired employment / Occupational field	**Research and teaching**
Work experience	
Dates	01/06/2012-Present
Occupation or position held	**PhD student in the Division of Social and Institutional Change in Agricultural Development (490c) at University of Hohenheim/Germany**
Dates	04/03/2009 – 30/05/2012
Occupation or position held	**Research Assistant**
Name and address of employer	International Food Policy Research Institute (IFPRI) CMC road, 5689 Addis Ababa (Ethiopia)
Dates	17/01/2005 – 22/02/2009
Occupation or position held	**Senior Research Officer**
Name and address of employer	National Bank of Ethiopia (NBE) Churchill road, 5550 Addis Ababa (Ethiopia)
Dates	06/10/2002 – 28/12/2005; 20/08/2000 - 25/09/2001
Occupation or position held	**Marketing Research and Advertising Division Head; Marketing expert**
Name and address of employer	Tikurabay Transport S.C. Bole road, 844 code 1110 Addis Ababa (Ethiopia)
Dates	01/01/2000 - 31/03/2000
Occupation or position held	**Research Assistant**
Name and address of employer	Addis Ababa University Entoto road, 1176 Addis Ababa (Ethiopia)

Education and training

Dates	20/10/2006 - 21/10/2007
Title of qualification awarded	**Master of Globalization and Economic Development**
Name and type of organisation providing education and training	University of Antwerp (Development Policy and Management) Lange Sint-Annastraat 7, B-2000 Antwerpen Antwerp (Belgium)
Dates	15/09/2002 - 15/07/2004
Title of qualification awarded	**Master of Since in International Economic (International Trade and Finance)**
Name and type of organisation providing education and training	Addis Ababa University (Business and Economics) Entoto road, 1176 Addis Ababa (Ethiopia)
Dates	15/09/1996 - 07/07/2000
Title of qualification awarded	**Bachelor of Arts in Economics**
Name and type of organisation providing education and training	Addis Ababa University (AAU) (Business and Economics) Entoto road, 1176 Addis Ababa (Ethiopia)

Scholarships

Dates	June2012 – November, 2015.
Name and type of organisation providing scholarship	**DAAD (German Academic Exchange Service) scholarship**
Dates	20/10/2006 - 21/10/2007
Name and type of organisation providing education and training	**Institute of Development Policy and Management (IOB), Belgium**

Journal articles

Tesfamicheal Wossen, Thomas Berger, **Teferi Mequaninte** and Bamlaku Alamirew (2013). Social network effects on the adoption of sustainable natural resource management practices in Ethiopia. International Journal of Sustainable Development & World Ecology, Volume 20, Issue 6.

Teferi Mequaninte; 2009: Financing the Millennium Development Goals in Ethiopia. Institute of Development Policy and Management (IOB), Newsletter No 15.

Teferi Mequaninte; 2007: Aid and the Dutch disease in Ethiopia. Ethiopian Journal of Economics, Vol. XVI, No. 2: 85-99.

Teferi Mequaninte; 2006: Estimating the Real Exchange Misalignment of Ethiopia: Dynamic OLS approach. Ethiopian Journal of Economics, Vol. XV, No. 2: 29-50.

Conference presentations

Teferi Mequaninte, Regina Birner, Ulrike Mueller (2015)

Adoption of Land Management Practices in Ethiopia: Which Network Types Matter?. International Conference of Agricultural Economists (ICAE), Milan, Italy.

Teferi Mequaninte and Ulrike Müller; 2013: Coffee innovation systems in Ethiopia and Rwanda. Jahrestagung der Gesellschaft fur Wirtschafts und Sozialwissenschaften des Landbauesev (GEWISOLA), Berlin, Germany.

Teferi Mequaninte, Regina Birner (2015). Agricultural extension reforms in Ethiopia: What works and what does not work well?.Tropentag, Berlin, Germany.

Book Chapters

Teferi Mequaninte, Paul Thangata; 2013: The impact of the rural capacity project on household efficiency in Ethiopia. Proceedings of the ninth international conference on the Ethiopian economy, Volume I.

Teferi Mequaninte; 2009: Financing the poverty MDGs in Ethiopia. Proceedings of the six international conference on the Ethiopian economy, Volume I

Teferi Mequaninte and BirukAsmelash; 2009: Remittance Inflows in Ethiopia: The practice and the potential for Improvement. Proceedings of the six international conference on the Ethiopian economy, Volume I.

Computer skills

Econometrics softwares: STATA, SPSS, RATS, Eviews; Sociological Software: UCINET; Project design and costing software: Costab 32; Marketing and Business Software: Tableau 6, Bass forecasting and Resource allocation

Language

Amharic (Mother tongue) and English

Hohenheim / January, 2016

Teferi Mequaninte Tensay

Author's Declaration

I hereby declare that this doctoral thesis is a result of my own work and that no other than the indicated aids have been used for its completion. All quotations and statements that have been used are indicated. Furthermore, I assure that the work has not been used, neither completely nor in parts, for achieving any other academic degree.

Hohenheim / January, 2016

Teferi Mequaninte Tensay