Tef, Khat, and Community Resilience: A Mixed Methods Examination of Smallholder Adoption of Sustainable Intensification Practices.

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

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presented by Anne M. Cafer,

a candidate for the degree of doctor of philosophy of Rural Sociology,

and hereby certify that, in their opinion, it is worthy of acceptance.

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ACADEMIC ABSTRACT

Climate induced rain variability, extensification into marginal lands, an inability to penetrate the agricultural knowledge information system (AKIS), and limited access to credit all hinder Ethiopian farmers' ability to be effective producers, which consequently reduces their ability to achieve food security (Dar and Twomlow 2007; Davis et al. 2012; Hounkonnou et al. 2012; Rosell and Homer 2007). Currently, the Government of Ethiopia, in an effort to improve food security and provide essential agricultural on-farm educational services, has greatly expanded its extension program. This expansion is intended to promote access to the AKIS in the hopes that farmers will achieve food security through sustainable (cereal) intensification with the implementation of new technologies and improved management practices. This is critical to greater food availability and improved access which to this point has been universally unrealized in Ethiopia (Feed the Future 2013; ATA 2013; FAO 2003). However, to-date, despite the expansion of extension services, adoption rates of new technologies and improved management practices remain low. Understanding how farmers come to the decision to adopt or not adopt a particular technology or management practice is essential to successfully changing behaviors around agricultural production. Additionally, understanding how farmers incorporate both socio-cultural and bio-physical systems into a unified reality necessitates an understanding of that system in order to develop appropriate practices and technologies; an oversight that crippled Green Revolution efforts to increase smallholder production in Africa. This study will address some of these deficiencies and endeavor to examine variables affecting adoption or non-adoption of a particular management practice related to tef (Eragrostis tef)—among these variables are access to capital, access to the AKIS, and competition with cash crops. This study

will also examine the impact that at least one of the critical factors, khat production, has on household food insecurity.

This dissertation consists of three separate but related pieces which demonstrate the complexity of on-farm decision making. Relationships with extension and access to AKIS were important factors in non-adoption, but were not the most critical. Access to capital was essential for adoption, but nature of capital in facilitating adoption is complicated. This capital, often in the form of income generated from khat, comes at the cost of community and environmental health, and also, continues to undermine cereal production in the region.

INTRODUCTION

The nature and impact of food insecurity are severe in Ethiopia. More than 38 percent of Ethiopians live below the international poverty level ($1.25/day) and families, particularly in the highlands, are often marginally food secure at best, as even with good harvests, they face consistently poor production (Awulachew 2007; Central Statistical Agency [CSA] 2012a; Croppenstedt and Muller 2000; Makombe et al. 2007; Devereaux 2000; FAO 2002, 2003; World Bank Group 2013; WFP 2011). Because of chronic food insecurity nearly half of families in Ethiopia are malnourished, despite a clear majority (85%) of the population engaging in food production (Central Statistical Agency [CSA] 2012a; Croppenstedt and Muller 2000; Makombe et al. 2007; FAO 2002, 2003; World Bank Group 2013).The acute negative consequences of persistent malnutrition, such as stunting and wasting, underwritten by chronic states of poverty and food insecurity, often result in more devastating costs. One in eleven Ethiopian children dies before their fifth birthday, often as a result of malnutrition weakening autoimmune responses to conditions such as anemia, acute respiratory infections, and diarrheal disease, all of which disproportionately impact rural populations (Wenhold et al. 2007; CSA 2012b).

In recognition of such dire circumstance, Ethiopia received more than $3.8 billion in official development assistance (ODA) in 2013, the third only to Afghanistan and Viet Nam (Global Humanitarian Assistance 2016). However, the USAID Initiative, Feed the Future, (2013) estimates that seven to eight million Ethiopians remain chronically hungry. As the national population size continues to increase at an annual rate of 2.9 percent, the demands on food resources are likely to continue to overwhelm current domestic production capacity (Feed the Future 2013).

Climate induced rain variability, extensification into marginal lands, an inability to penetrate the agricultural knowledge information system (AKIS), and limited access to credit all hinder Ethiopian farmers' ability to be effective producers, which consequently reduces their ability to achieve food security (Dar and Twomlow 2007; Davis et al. 2012; Hounkonnou et al. 2012; Rosell and Homer 2007). Currently, the Government of Ethiopia, in an effort to improve food security and provide essential agricultural on-farm educational services, has greatly expanded its extension program. This expansion is intended to promote access to the AKIS in the hopes that farmers will achieve food security through sustainable (cereal) intensification with the implementation of new technologies and improved management practices. This is critical to greater food availability and improved access which to this point has been universally unrealized in Ethiopia (Feed the Future 2013; ATA 2013; FAO 2003). However, to-date, despite the expansion of extension services, adoption rates of new technologies and improved management practices remain low.

Understanding how farmers come to the decision to adopt or not adopt a particular technology or management practice is essential to successfully changing behaviors around agricultural production. Additionally, understanding how farmers incorporate both socio-cultural and bio-physical systems into a unified reality necessitates an understanding of that system in order to develop appropriate practices and technologies; an oversight that crippled Green Revolution efforts to increase smallholder production in Africa.

This study will address some of these deficiencies and endeavor to examine variables affecting adoption or non-adoption of a particular management practice related to tef (Eragrostis tef)—among these variables are access to capital, access to the AKIS, and competition with cash crops. This study will also examine the impact that at least one of the critical factors, khat production, has on household food insecurity.

Why Tef?

Because of its agricultural, nutritional, and social significance the cereal crop, *Eragrostis tef* (tef), is a priority for the newly expanded extension program. Its use in the major food staple, injera, is one of the reasons why despite having significantly lower yields than most cereal crops tef has more resources (energy, land, and inputs) dedicated to its production (Roseberg et al 2005; CSA 2012). Tef is grown by more than six million smallholder farmers and accounts for 21% of total cereal production and 28% of total productive acreage in Ethiopia, with an average yield growth rate of 7.7% annually from 2005-2008 (Dercon and Hill 2009; CSA 2012, Viswanath 2012).

In terms of addressing malnutrition, tef contains the largest amount of protein (12-17%) and has the second largest energy content of any cereal (Stallknecht et al. 1993). This is not insignificant as tef makes up approximately two-thirds of the average Ethiopian's daily protein intake and accounts for 600 and 200 daily calories of the urban and rural diet respectively (Fufa et al 2011; Refera 2001). Tef also contains significant amounts of the essential amino acid lysine, as well as high levels of iron, calcium, phosphorus, iron, copper, barium and thiamine, all crucial to a child's growth and development (Roseberg et al 2005; Refera 2001; Stallknecht 1993).

In addition to its nutritional value, this C4 self-pollinating annual is both carbon-dioxide and water efficient which makes it naturally drought resistant, to a point (Rosell and Holmer 2007; Roseberg et al 2005; Refera 2001). This drought resistance combined with its origins in Ethiopia explains its widespread use and production (Roseberg et al 2005; Refera 2001). The plant's drought resistant properties come at the expense of high yields, which farmers and extension agents are increasingly combating with the strategic use of irrigation, improved management practices, and mechanized threshing (Araya et al 2010; Roseberg et al 2005; ATA 2013).

Why Row Planting?

A great deal of time and fiscal resources have been dedicated to increasing tef production in Ethiopia (IFPRI-ESSP/EDRI 2013a; IFPRI-ESSP 2013). Thought there are several agronomic and

post-harvest issues to address, row planting is an area where extension officers and local farmers, working together, could make inroads to finding solutions. Traditionally, tef, as with many other crops in Ethiopia, is sewn using a hand broadcast method which is highly inefficient in terms of seed use and typically produces much lower yields than row planting (ATA 2013a). Row planting allows for the correct and predictable seed rates and seedling space, reducing the amount of seed required by tenfold (ATA 2013a). Row planting also allows for easier weeding and crop maintenance, and consequently improved yields (ATA 2013a). In Ethiopia, row planting has shown to increase farmers' yields up to 100%, though perceived yields by farmers are much lower (around 12%) (IFPRI-ESSP 2013).

Where does khat fit in?

Khat (*Catha edulis*) is a perennial tree crop, native to Ethiopia, that once established becomes a permanent agricultural crop (Getahun and Krikorian 1973; Tefera et al. 2003). Khat is propagated using suckers rather than seeds, which can make investment start-up costs, as well as expansion costs, very low and once established khat fields often remain productive for generations (Getahun and Krikorian 1973; Feyisa and Aune 2003). Khat can be produced under both irrigated and rain-fed conditions, making it attractive to even resource poor farmers (i.e. those who cannot afford irrigation). Under rain-fed conditions it will produce up to two crops each year, and though not as productive as irrigated khat, has substantial implications for household income. When irrigated, khat can produce a harvest as many as five times a year, substantially increasing household income ($230 and up), with relatively little effort. Khat also has consistently garnered a greater net return than any other agricultural product in Ethiopia, including coffee. Khat's unit price is often double that of coffee, the leading cash crop and export (NBE 2010, 2016; Table X). This relatively low capital threshold to enter the market combined with the quick return on investment has resulted in widespread adoption of khat

production among smallholders, especially those with irrigation. The growing international market for this crop also explains khat consistently ranking among Ethiopia's top three agricultural exports by value and among the top five for all exports, including gold (NBE 2010, 2016).

Also known as chat, qat, and mirra, khat has become an exceeding popular topic in both the health and policy arenas. Dating back to 1984, there have been no less than 20 separate international conferences dedicated to the discourse of use, health, and addiction associated with khat use, and a growing concern for issues related to khat production and use related to terrorism.There have been a number of papers and conference presentations related to cardiovascular and oral health, mental health and cognitive processes, and monitoring and policy. However, there has been relatively little research on khat's association with food security (see Gezon 2012), which is foundational to human health and well-being, and research linking khat to validated cross-cultural measures of food security is non-existent. The majority of studies contextualizing khat production in terms of food security, focus on khat's displacement of food crops, namely cereals.

Theoretical Framework(s) and Methods

This dissertation utilized data collected in South Wollo Ethiopia during the spring of 2015 to examine issues around sustainable intensification, community resilience, and food security. The analysis is separated into three separate but related chapters. The study as a whole utilized a mixed methods approach to improve validity and draw stronger conclusions based on a holistic framework. Two of the three chapters incorporate both qualitative and quantitative methods. The third and final chapter utilizes only quantitative data.

- Adoption Facilitation

This chapter utilizes Everett Rogers' adoption of innovations theory as a starting point for examining the relative importance of information access and extension as a mechanism for mitigating farmers' perceptions of risk associated with row planting. This chapter combines the adoption of innovation theory with literature on the importance of capital in helping, mitigate the risk of adoption of new management practices. Using adoption of innovation theory, supplemented with a brief discourse on capital as a guide for statistical analysis, this chapter found extension and training associated with row planting to be less important in row planting adoption than cash money from the production of khat and capital as measured through livestock holdings.

- Land Fragmentation and Compulsory Agricultural Modernization

This chapter builds upon the discussion of adoption facilitation, which examines the more immediate, farm and village level characteristics important in facilitating adoption. This chapter, instead, looks at the two primary road blocks to adoption, which occur at the national level. This particular chapter examines the uneven power relations between actors within a socio-ecological context. As such, this chapter a political ecology (PE) framework to discuss findings. Using the PE framework, this chapter tells the story of conflicting agendas—a national government bent on industrial agriculture led development and marginalized smallholders, fighting for economic stability and food security on increasingly fragmented plots of land.

The Ethiopian government has enlisted the national extension system to push agricultural inputs and new management practices, of which row planting is a part. Under this national agenda, extension agents have become little more than input retailers responsible for collecting payment from farmers, who are given a simple choice—purchase inputs or risk confiscation of their land. The compulsory nature of input use has further perpetuated smallholder poverty by forcing farmers to sell assets to pay for the expensive agricultural inputs or take out loans with

unbearable interest rates. Additionally, the role of local agricultural officials as input retailers reinforces the disproportionate power dynamic, by making smallholders beholden to extension. In PE tradition, this paper discusses, albeit briefly, mitigation strategies marginalized communities seek out as a buffer between their households and hardship.

- Khat and Food Security

This final chapter examines the use of khat as a mitigation strategy within the context of community resilience. Khat production in this region is a response to both environmental and socio-economic shocks as well as political and demographic stress, including drought, food insecurity, and financial shocks. This study examines khat's relationship with one measure of resilience—food security, which to-date has not been systematically measured (see Gezon 2012). Other resilience boosting features of khat production and the potential for increased vulnerability from unchecked khat production and subsequent water use are discussed.

Lessons Learned

This study, in its entirety, provides insight into a shifting smallholder livelihoods. Outside pressure from the international and Federal Government of Ethiopia to modernize agricultural production is instigating change at the local community level. A drive to improve income and reduce poverty through increased use of capital intensive inputs (improved seed and fertilizer), is leading to a shift toward cash crop production. This shift, promotes the adoption of sustainable intensification practices and household food security in the short-term, but in the long-term will potentially undermine households' ability to self-provision and reduce community resilience, through degradation of community natural resources. Additionally, as documented in this study, there is a significant gap in earning potential, which favors resource rich farmers, and leaves those entering into the cash crop market with fewer resources (namely access to irrigation) churning at the margins.

METHODS

Purpose

This research was designed to explore the major barriers to the adoption of row planning in smallholder tef production and the context of those barriers within a specific highland community in rural Ethiopia.

Study Area, Participants, Internal Review Board

This research was conducted in South (Debub) Wollo—11°8'N 39°38'E (Fig. XX), a zone within the northern Amhara region of Ethiopia. Ninety-nine percent of South Wollo's households self-identified as being of the Amhara ethnic group, (CSA 2007). Though in the Amhara region Ethiopian Orthodox Christion makes up more than 80% of households, in South Wollo, Islam is the dominant religion; making up more than 70% of households (CSA 2007). South Wollo is located in a semi-arid ecozone, characterized by a bimodal rainfall pattern (Fig. 5) (Assefa et al. 2008). This bimodal rainfall results in two growing seasons and a dry period (Rosell and Holmer 2007). The short rainy growing season is known locally as *belg* and lasts from approximately March to April or May (Rosell and Holmer 2007). The long rainy season is known as *meher* and lasts from July to September (Rosell and Holmer 2007). All villages utilize both rainy seasons for crop production. The *woredas*, or administrative districts visited, included Dessie Ketema and Tehuledere (Fig. 6). One hundred fifteen households were selected for participation: 40 from Boru Seyu; 22 from Amemo; 53 from Kuty; (Table 1).

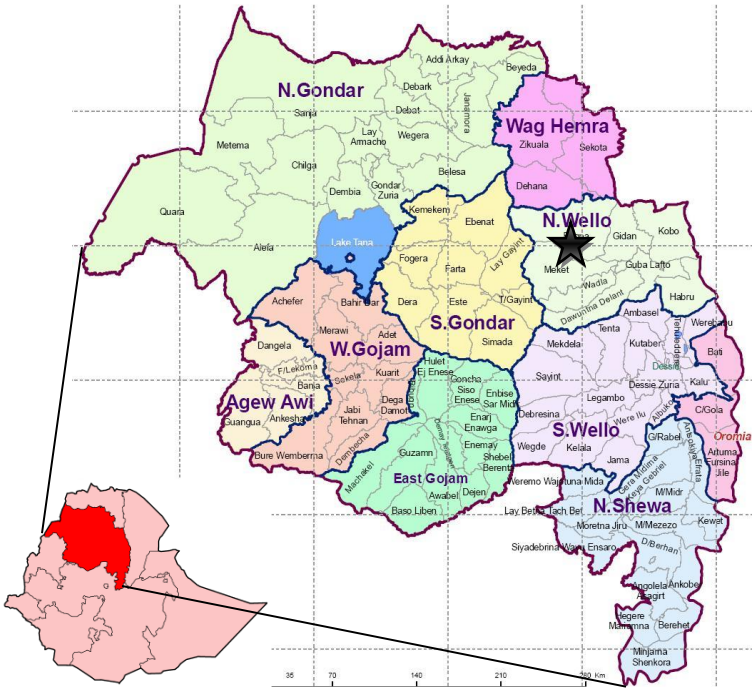

Figure XX. Map of Administrative Zones in the Amhara Region
Adapted from United Nations Office for the Coordination of Humanitarian Affairs (OCHA 2005)

Site One

Woreda: Dessie Ketema; Kebele: 012; Boru: Boru Seyo

Farmers in Boru Seyo are the most marginalized group within this sample. There is no cash crop production and cereal production is marginal at best. Farmers on average have much smaller plots of lands then in the other villages. Additionally, this village has far fewer farmers reporting practical exposure to the technology because their farmer training center is often unused by extension workers. Farmers in B. Seyo are more likely to produce during both the Belg and Meher growing seasons, and incorporate a mix of cereals, pulses, and livestock into the overall production scheme.

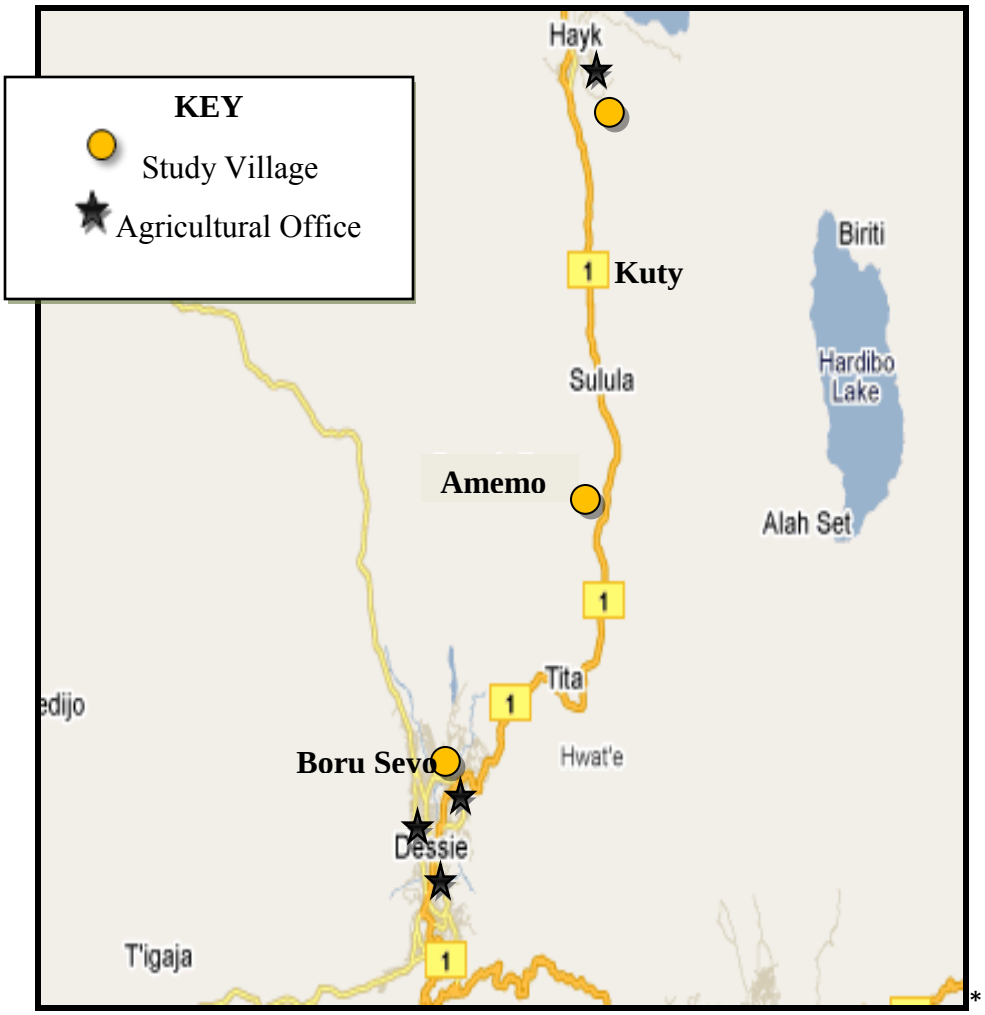

Figure 4. Map of All Four Study Sites
Locations are approximate and unofficial. Adapted from Google Maps

Site Two

Woreda: Tehuldedere; *Kebele*: 08; *Boru*: Amemo

In Amemo farmers are more like to have a highly diversified production system, growing mangoes, oranges, coffee, and guava in addition to some cereal and pulses production. However, farmers rely most on khat in terms of economic activity. Amemo was the wealthiest village in the sample with several farmers owning condominiums in nearby towns. Though traditionally a tef growing area, tef production in Amemo is fairly limited. Despite its expense, tef is easily purchased in the market by farmers who produce and sell khat. Because of the widespread use of khat in this area, irrigation is heavily used.

Site Three

Woreda: Tehuledere; Kebele: 005; Boru: Kuty

Kuty farmers, like those in Boru Seyo, live at the edge of an urban area. Many of the families in this village of members who work in the village as an income diversification strategy. Additionally, a number of farmers produce khat in this village as well as tef, but irrigation is not common and farmers rely primarily on rainfed agriculture.

TABLE 1: Village Characteristics

Woreda (district)	Kebele	*Boru* (village)	N	Altitude (MASL)	Market Distance (km)	*Belg* Rainfall (mm)	*Meher* Rainfall (mm)
Dessie Ketema	012	Boru Seyo	41	Highland Alt. 2500	<1	276	912
Tehuledere	008	Amemo	23	Midland Alt. 1900	8	341mm	828
	005	Kuty	29	Midland Alt. 1900	<1	341mm	828

Internal Review Board and Collaborative Institutional Training Initiative

To insure compliance with University of Missouri research policies and the federally-mandated ethical treatment of research subjects, Institutional Review Board (IRB) approval was obtained and the online Collaborative Institutional Training Initiative (CITI) was completed. The IRB, which works to insure the ethical treatment of human research participants, requires all projects and research involving human subjects to submit proposals for approval. Documentation that indicated procedures for research administration included informed consent, recruitment, and debriefing scripts for participants and exempt status was requested per IRB regulation 45 CFR 46.101b(2). IRB approval was granted 01 December 2015. Project ID: 1213563.

Obtaining Local Permission

Due to political tensions that arose during the national election which was held a few weeks prior to data collection, it was imperative to obtain permission from local officials before

conducting the study. Wollo University representatives, data collectors, and the lead primary investigator met with local officials in each of *woredas*: Dessie Ketema and Tehuledere. A copy of the survey instrument and a comprehensive list of measurements were provided to each agricultural office and assurances were made that all data and analyses resulting from the study would be provided to their offices upon completion.

Instrumentation

This proposed study utilized a mixed method approach, incorporating both quantitative and qualitative tools to investigate barriers to technology adoption and the context of farmer decision on technology, particularly with reference to extension services. Mixed method research has been critical to the investigation of technology adoption. The blending of quantitative and qualitative methods allows for a more holistic approach necessary to delineate the relationship between a broad range of actors and influences in smallholder systems (Hall et al 2001; Biggs and Clay 1981; Chambers and Jiggins 1987; Biggs 1990). A mixed method approach is particularly useful in helping mitigate the influences of biases of a particular method and improving the overall validity of a given study (Greene et al. 1989, Campbell and Fiske 1959, Denzin 1978, Webb et all 1966, Cook 1985). The combination of tools used for this study are designed to work together in a way that provides clarification and better interpretability of data collected by each instrument (Green et al 1989; Mark and Shotland 1987).

Quantitative Assessment

Questionnaire

The questionnaire combined household demographics, information on household production and food security, income and assets, as well as access to and visits from extension and other agricultural institutions (Appendix XX). Questionnaire modules from the Ethiopian Rural Household Survey housed at the International Food Policy Research Institute, USAID's

Household Food Insecurity Access Scale (HFIAS), and Abede et al. 2013, all validated measures with previous successful utilization in the study region, were used. Some adjustments to the initial questionnaire were made after piloting with a small group of farmers as well as with extension. The questionnaire consisted of three general areas: food insecurity, extension and agricultural production, and demographics. The questionnaire took approximately forty-five minutes to administer, and was administered in the native language. All participants were compensated for their time.

Anthropometrics

To compliment the HFIAS portion of the questionnaire, anthropometric measurements for heads of household were taken. BMI and weight for height are common assessments in studies of food security as they tend to be better indicators of recent food shortages and malnutrition as opposed to indicators of chronic malnutrition (Magkos, 2004). Anthropometric measurements provide a straightforward, non-invasive snapshot of a population's nutritional status (Food and Agriculture Organization, 1996). Participants were asked to remove shoes and head scarves for the height measurements. Standard research protocol (see Appendix XX) was followed for all cases. All measures were taken to the nearest centimeter and kilogram.

Qualitative Assessment

Focus Groups & In-Depth Interviews

Focus groups are important instruments in helping delineate social norms and facilitating discussion on topics generally viewed as taboo (such as political grievances) (Kitzinger 1994). Similarly, in-depth interviews provide the opportunity explore issues in more depth and seek explanations of concepts that are unclear (Curry et al. 2009)

Farmers were asked to participate in either an in-depth interview or focus group process as part of their participation in the research study. In all of these cases, participants were asked a single

question: “What are the reasons you do/do not use row planting for growing tef?” Venues were a mix of kitchen tables, living rooms, open fields, and local granaries.

Key Informant Interviews

Key informant interviews were conducted with state level Productive Safety Net Programme (PSNP) personnel (1), kebele chairmen (from kebeles different from those selected for study-1), and extension personnel (7—3 from Dessie Ketema, 2 from Tehuledere, 2 from the Zonal Office in Dessie Town). These interviews were coded for general themes but were often used to clarify statements or references from farmers and to inform statistical analysis.

Research Design

Data were collected during January, February, and March of 2015. To aid in the collection of survey responses, translators who were proficient in written and oral English were selected to conduct in-depth interviews and administer the questionnaire. All translators were from the study area and familiar with the study population and culture of South Wollo.

In this study, samples were stratified according to geographic region and types of agricultural production. Boru Seyo is primarily a grain producing village in the highlands, whereas Kuty and Amemo are a mixture of tef and khat producing farmers. All villages produce *tef* at some point during the year, though most typically during the *meher* growing season. The employed method of stratification provides samples from the major economic and production types—short and long rainy season, irrigated and rain-fed, cereals versus cash crops, and highland and mid-land.

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CHAPTER 1. TEF, KHAT, AND THE SMALLHOLDER DILEMMA: A MIXED-METHODS ANALYSIS OF INNOVATION ADOPTION IN THE ETHIOPIAN HIGHLANDS

Abstract: Agricultural intensification and extensification are standard responses to ecological and economic vulnerability among smallholder communities. Climate change has exacerbated this vulnerability and thrown the critical need for managing the demands of maintaining a healthy natural resource base and increased on-farm productivity into sharp light. Sustainable intensification is one of many mechanisms for accomplishing this balancing act. This study examines the adoption of sustainable intensification practices, namely row planting of tef, which is used to boost yield and promote more efficient use of inputs. This utilized a mix methods approach to survey 115 smallholder farmers in the South Wollo zone of the Amhara region in Ethiopia. This study found practical training (i.e. demonstration plots) and access to cash income to be critical in facilitating the adoption process. More importantly, this study found that cash income, from the production of khat, though important in facilitating adoption, is likely to undermine cereal and other food crop production in the region.

Introduction

Agricultural intensification and extensification are standard responses to ecological and economic vulnerability among smallholder communities (Awulachew et al. 2007; FAO 2003). Climate change has exacerbated this vulnerability and thrown the complexity of and critical need for managing the demands of maintaining a healthy natural resource base and increased on-farm productivity into sharp light. Sustainable intensification (SI) is one of many mechanisms for accomplishing this balancing act, and has gained critical leverage in the international agricultural development arena (Montpellier, USAID, etc). This emphasis by the international development community and its potential for mitigating environmental and ecological uncertainties places SI squarely at the nexus of ecological sustainability and the social and economic viability of smallholder farms. While there are a number of studies documenting the role of risk perception and farm(er) characteristics in the adoption (or non-adoption) of innovations, there is a marked gap in the number of studies documenting farmers' self-described motivations for adoption or non-adoption of SI practices and technologies. This gap is due, in part, to a lack of empirical household-level studies. This study is designed to address this gap in reference to a particularly compelling case—Ethiopia. As a USIAD designated Feed the Future country, Ethiopia has been given priority by the US and other international donors in terms of funding and capacity building efforts around SI.

Background

As a developing country where 85% of the population is engaged in agricultural production, Ethiopia relies heavily on its natural resources (Downing et al. 1997; Dejene 2003; Bekele 2006; Desalegn et al. 2006; Makombe et al. 2007; Feed the Future 2013). The sustainable utilization of these resources is crucial to the Ethiopian government's plans for national progress through agricultural-led economic development (World Bank 2007; MoWR 2001a,b). However, in many

areas of Ethiopia, particularly in the highlands which are more vulnerable to climactic changes (variation in rainfall, drought, flooding), farming is dominated by rain-fed agriculture, and typically associated with low productivity (Devereaux 2000). Feed the Future (2013) estimates that seven to eight million Ethiopians remain chronically hungry as a result of not only poor production but extreme levels of poverty. As a result, food insecurity is a severe and endemic issue for Ethiopians. Thirty-eight percent of Ethiopians live on less than $1.25/day, which exacerbates the nature and impact of food insecurity (Central Statistical Agency [CSA] 2012; World Bank Group 2013; WFP 2011). As the national population size continues to increase at an annual rate of 2.9 percent, the demands on food resources are likely to continue to overwhelm current domestic production capacity (Feed the Future 2013).

Consequently, smallholders continue to increase the amount of land put into production annually. In cereal production alone, farmers have increased the area under cultivation by more than 4 percent annually from 2004 to 2008 (Dercon and Hill 2009). This expansion process necessarily means marginalized lands—slopes vulnerable to erosion, degraded soil quality, moisture stress, and over-grazed plots—are farmed (Awulachew et al. 2007, Admassie and Abebaw 2014). By expanding production into these areas, farmers contribute to further degradation of Ethiopia's natural resource base and limit their options for future production intensification (Awulachew et al. 2007; FAO 2003). In an effort to simultaneously prevent further degradation and improve food security through increased production, the Ethiopian Government has invested heavily—more than 2 percent of the nation's GDP—in expanding their national agricultural extension system. This investment supported the training of more than 60,000 diploma holding extension agents who work with communities through more than 10,000 farmer training centers (FTCs) (Gebremedhin, Hoekstra, and Tegene 2006; ATA 2013). Each village is assigned three extension agents, with expertise in livestock, horticulture, and crop

sciences, among others (Gebremedhin, Jaleta, and Hoekstra 2009). This expansion was initiated to promote access to the agricultural knowledge information system and improved agricultural inputs, in the hopes that farmers would achieve food security through sustainable (cereal) intensification with the implementation of new technologies and improved management practices. However, significant improvements in either poverty status or in food security have been largely unrealized in Ethiopia.

Why Tef?

Because of its agricultural and nutritional significance the cereal crop, *Eragrostis tef* (tef), is a priority for Ethiopia's Agricultural Transformation Agency, a government agency under the Prime Minister designed to shape national agricultural strategy and deliver associated programming. Subsequently, tef is also a priority for the newly expanded extension program. Its use in the major food staple, injera, makes tef an in-demand cereal both domestically and internationally, with the Ethiopian diaspora (ReliefWeb 2006; Refera 2001). This demand has resulted in continually increasing prices, which at one point resulted in an export ban for tef (ReliefWeb 2006; Refera 2001). This is one of the reasons why despite having significantly lower yields than most cereal crops, tef has more resources (energy, land, and inputs) dedicated to its production (Roseberg et al 2005; CSA 2012). Tef is grown by more than six million smallholder farmers and accounts for 21% of total cereal production and 28% of total productive acreage in Ethiopia, with an average yield increase of 7.7% annually (Dercon and Hill 2009; CSA 2012, Viswanath 2012).

In terms of addressing malnutrition, tef contains the largest amount of protein (12-17%) and has the second largest energy content of any cereal (Stallknecht et al. 1993). Tef also contains significant amounts of the essential amino acid lysine, as well as high levels of iron, calcium, phosphorus, iron, copper, barium and thiamine, all crucial to a child's growth and development

(Roseberg et al 2005; Refera 2001; Stallknecht 1993). This is not insignificant as tef makes up approximately two-thirds of the average Ethiopian's daily protein intake and accounts for 600 and 200 daily calories of the urban and rural diet respectively (Fufa et al 2011; Refera 2001). As a note, the differences between rural and urban diets, is a product of overall reduced food intake in rural areas, as well as the inclination of rural households to substitute sorghum, wheat, or maize for tef in their injera.

A great deal of time and fiscal resources have been dedicated to increasing tef production in Ethiopia (Engeda and Benson 2013; IFPRI-EDRI 2013). Though there are several agronomic and post-harvest issues to address, row planting is one critical area where extension officers and local farmers, working together, could make inroads to finding solutions. Traditionally, tef, as with many other crops in Ethiopia, is sewn using a hand broadcast method which is highly inefficient in terms of seed use and typically produces much lower yields than alternative methods, particularly row planting (ATA 2013a). Row planting allows for the correct and predictable seed rates and seedling space, which allows for easier weeding and more efficient fertilizer application, and consequently, improved yields (ATA 2013a).

Despite its potential role in boosting yield and increasing input use efficiency, there has been relatively limited adoption of row planting to-date, though the reasons are unclear. One potential barrier, may be the tediousness associated with the practice. Though there are mechanical aids used in row planting trials conducted by the ATA, most farmers are being asked by extension to row plant by hand (ATA 2013a). This reduces some of the financial barriers to adoption, but increases the tediousness of the practice.

Theoretical Framework and Literature Review

Adoption Diffusion Theory: Barriers and Promoters of Adoption

Smallholders manage 80% of farmland and provide up to 80% of the food supply in Sub-Saharan Africa and Asia. As such, barriers to adoption of SI practices smallholders in these nations have been at the forefront of the agricultural development discourse. Without systematic adoption of these innovations, widespread gains in agricultural productivity, environmental sustainability, and food security will remain unrealized. Ethiopia is no exception, 95% of agricultural GDP is produced by the poorest sector of the population—smallholders.

In order to facilitate adoption it is important to understand the adoption process and the socio-cultural norms guiding adoption. Rogers (1995) outlines four major influences in the adoption process—the innovation itself; how information about the innovation is spread; time; and the characteristics of the society in which the innovation is introduced. This framework provides an initial tool for assessing potential barriers. However, Rogers' (1995) theory of perceived attributes outlines specific areas of potential resistance to the adoption of an innovation: (1) perceived advantage; (2) compatibility; (3) complexity; (4) triability; (5) and observability. Use of this theory provides specific options for targeted and proactive troubleshooting. Each of these areas is intimately tied to mechanisms for mitigating farmers' perceptions of risk associated with the innovation and are influenced by the types and delivery methods of information.

Information Access and Other Influencers

Not surprisingly, access to information on agricultural innovations is one of the most critically examined aspects of adoption and diffusion, especially in the developing world (see Rogers 1995; Napier and Cockerill 2010). Increased access to information and improved knowledge on the use and potential benefits of a technology allow farmers to properly assess, and to some extent mitigate, the (potential) risk associated with adoption of a new innovations (Schultz 1964; Bandiera and Rasul 2006; Foster and Rosenweig 1995; Moser and Barrett 2006).

Information, both theoretical (textbook, oral presentation, etc.) and applied (demonstration, on-farm trial, farmer field days), is critical to overcoming complexities associated with using the innovation, and accurately assessing the advantages of and ability to meet famers' needs of innovation (Rogers 1995). Perhaps most important is the ability of farmers to see the new innovation in action—the ability to try the technology or process before committing scarce resources and observe tangible benefits are important to long-term and systematic adoption of the practice (Rogers 1995). Wier and Knight (2004) and Krishnan and Patnam (2012) noted the ability to observe neighbors using the practice, successfully, was particularly important for less educated farmers in Ethiopia.

The AKIS, and specifically agricultural extension, has traditionally been the institutional response to information or knowledge barriers. As a "translator" of institutional knowledge, extension agents facilitate the flow of information, reducing barriers to access (Rogers 1995). The current Ethiopian Extension System is implementing the National Agricultural Extension Intervention Program (NAEIP), a scaled-up version of the post-civil war system of Participatory Demonstration and Training Extension Systems (PADETES), which focused almost exclusively on technology transfer and cereal production (Gebremedhin, Hoekstra, and Tegene 2006; Speilman, Mekonnen, and Alemu 2012; Egziber 2013). NAEIP relies on the Extension Management and Training Plots model and input packages. In this model farmers manage demonstration plots as educational tools for the community and other extension agents and are supplied with agricultural packages that include information on agricultural technology or practices, the necessary inputs, and credit to support their adoption (Ibrahim 2004; Alemu and Demese 2005).

In the Amhara region, the study region for this research, extension agents typically focus on a type of input package designed to increase household income above the national poverty line (1

USD) (Gebremedhin, Jaleta, and Hoekstra 2009). This package tends to focus on adoption and implementation of improved technology or management practices and input use (Gebremedhin, Jaleta, and Hoekstra 2009). As the purveyors of these input packages extension agents often see themselves as little more than fertilizer and credit distributors, rather than extension specialists (EEA/EEPRI 2006; Spielman, Mekonnen, and Alemu 2012).

The continued emphasis in extension on input-use rather than efficacy and profitability, though perhaps better suited to the agroecological context, has resulted in limited adoption of new methods and technologies generally (Spielman et al. 2010; Bonger, Ayele and Kumsa 2004). Additionally, research suggests extension still focuses little on resource poor farmers and as extension agents are responsible for selecting participants for on-farm demonstrations and participation in extension activities, the impact on the most vulnerable farmers is likely to be minimal (Assefa et al 2008; Belay and Abebaw 2004).

Like the extension system itself, research on extension systems in Ethiopia has emphasized production outcomes and frequency of contact rather than quality of extension contact with farmers (Egziabher 2013; Binam et al 2004; Feder et al 2004; Haji and Andersson 2006; Cunguara and Moder 2011; Benin and Pender 2001; Solis et al. 2009; Bekele and Drake 2003; Bewket 2007; de Graff et al. 2008; Abede 2013). Yet, the research on extension's role in promoting adoption is unclear, while in some cases it has improved the uptake of new technologies and management practices, in others it has had no remarkable or significant impact (see Abede 2013 and Krishnan and Patnam 2012).

Critical Capital

Though quality information and delivery, both quality and quantity of contacts, are critical to the adoption process, there is evidence to suggest that an emphasis on information alone is short-sighted. Mendola (2007) and Gebissa (2004) note that among smallholders, the real barrier to

adoption is in resource constraints experienced by farmers. This is particularly true for capital intensive inputs, such as fertilizer or inputs in short supply, such as seed (Dercon et al 2009; Davis et al 2010). In addition to capital, researchers have explored, with mixed results, the role of a variety of farm and farmer characteristics which reduce the barriers to adoption, by improving farmers ability to absorb shocks—including farm size, income, land tenure, education, and family size (see Napier 2010, Weir and Knight 2004; Duflo et al 2011).

Perhaps because of the emphasis on information dissemination, the call for in-depth understanding of how smallholder producers' make decisions, initiated in 1985 by Feder et al. (1985) has gone largely unanswered. This study, in an effort to answer that call, used a combination of qualitative and quantitative techniques to examine smallholder decision making processes. This investigation examined extension activities and agents' relationships with farmers, quality and quantity of information on tef row planting available to smallholders, as well as key characteristics of both farmers and farms.

Methods

Study Site and Data Collection: Data were collected from December 2014 to March 2015. Research participants were selected from three peri-urban highland villages in the South Wollo zone of the Amhara region—Boru Seyu, Amemo, and Kuty. Villages were stratified in a way to provide information on a variety of production systems, agroecological conditions, and differing experiences with the AKIS. Within each village accessibility sampling was used. A total of 116 farmers were surveyed. Only farmers currently growing tef were included. In addition to interviews with farmers, this research included interviews with five extension agents, two regional extension directors, one kebele chairmen, and one regional Productive Safety Net Programme administrator.

Table 1. Village level characteristics.

		Dessie Ketema		Tehuledere
		Boru Seyu/012 (N = 40)	Amemo/008 (N = 23)	Kuty/005 (N = 53)
Crops	Belg *(Mar-April)*	Barley; wheat	Wheat	Wheat; vetch
	Meher *(July-Oct)*	Tef; barley; maize; pea; fava	Tef; sorghum; vetch; maize	Tef; sorghum barley; chickpea
Production	Cultivated Area (Ha)	0.92	0.68	0.68
	Belg (%)	0.56	0.25	0.22
	Meher (%)	0.44	0.75	0.77
	Tef (%)	0.10	0.60	0.48
Rain	Belg	276	341	341
	Meher	912	828	828
Altitude (MASL)		2500	1900	1800
Distance to Market		<1	8	<1

This zone is characterized by small diversified production, integrating cereals, pulses, livestock, and some cash crops. B. Seyu is located on the periphery of Dessie town, a major urban area in the region. Farmers in Boru Seyo are the most marginalized group within this sample. There is no cash crop production and cereal production is marginal at best. Farmers in B. Seyu tend to work in Dessie town or sell forestry products (firewood, charcoal, building materials) to supplement household income. In Amemo farmers are more like to have a highly diversified production system, growing mangoes, oranges, coffee, and guava in addition to cereal and pulses production. However, farmers rely most on cash crop production and farmers here tend to be much wealthier than in surrounding communities as a result. Kuty farmers, like those in Boru Seyo, live at the edge of an urban area, Hyke. Many of the families in this village have members who work in the village as an income diversification strategy.

Demographic characteristics for each village are available in table 1. Of important note are the data on hectares cultivated. These refer strictly to hectares of land under food crop cultivation.

Area under cash crop (I.e. *Catha edulis*—khat) cultivation is not included. This is significant, as most households in Amemo, for example, engage almost exclusively in khat production, suggesting that despite smaller cultivated food crop areas than Boru Seyu, they do in fact, have significantly larger plots.

Quantitative Analysis

To test the impact of access to information and access to cash and capital, both indicated by the literature to be critical in adoption of SI practices, data on interactions with the AKIS (extension, research centers, cooperatives) and a proxy for household cash availability—khat income—were collected. Because row planting in the study area is part of a capital intensive input package, including fertilizer, cash availability and capital came up as significant barriers during interviews and focus groups. This study uses khat income specifically because it represents a reliable, steady, and in irrigated production a non-time-constrained financial resource. There is some cash crop production in fruit, vegetables, coffee, and forest products in this region, but these forms of income are limited in several ways. Fruit and coffee production are time sensitive and the prices, even locally, are relatively volatile, making it an inconsistent source of income. The vegetable market is relatively saturated, as farmers in another nearby village have discussed their use of carrots and tomatoes as animal food because they cannot sell the produce in the market. Additionally, forestry products are often low return and time sensitive.

<u>Adoption</u> (DV): The purpose of this study is to discern the factors which influence increase the likelihood of adoption of row planting. In this study area, because mechanized row planters are not commercially viable, farmers are being asked to row plant by hand. This means they are not only forming rows in their fields, which requires time and labor above and beyond traditional broadcasting, but they are being asked to distribute tiny tef seeds, less than one millimeter in diameter, evenly within those rows. Interviews and focus groups revealed that in the farmers'

hands, these tiny seeds, have a tendency to clump up, resulting in uneven distribution, which negates the beneficial features of row planting (competitive advantage over weeds, easy access for fertilizer application and weeding). Additionally, this new practice is presented in conjunction with an input package including improved seed (in some cases), and fertilizer—a very capital intensive input. Improved seed, which is not always available, can cost farmers 1200ETB/quintal (55USD/100kg), though they typically only purchase a half quintal or less. Fertilizer is nearly double this cost at 2000ETB/quintal (93USD/100kg), though farmers typically spend between 300-800ETB for fertilizer purchases. Adoption was coded, (0) for no, (1) for yes.

Standardized Khat Income (IV): Income from khat was collected as part of a land use survey. For each crop listed farmers indicated yield and amount sold. Because khat is a perennial shrub with no specific season or traditional measure of yield (e.g. quintal, tons) farmers reported only their income from khat. It was recorded as a continuous variable. Income from khat was standardized to better determine the odds ratio during logistic regression analysis. Standardization was calculated [(χ – mean khat income) / standard deviation for khat income)] → (χ – 5591)/ (9599) = 1 unit of standardized khat income.

The next set of variables are related to contact with the different agencies within the Ethiopian AKIS. These variable were adapted from Abede et al. (2013) who conducted research near the study region on the adoption of a new variety of potato. These questions are designed to get at the quantity or number of contacts with AKIS as well as the quality (variety of contacts, use of demonstration plots).

Extension Services (IV): "How many times in the last 12 months have you used your village extension services. Recorded as a continuous variable. Though a major critique of the literature on extension is the reliance on measures of "frequency of contact" it is still an important

component of the smallholder ability to access the AKIS. Additionally, in order to build relationships which might promote the use of a new management practices such as tef row planting, extension must be present in the village and accessible to farmers. Frequency of contact is use as an approximate value.

Local Research Institutes: "How many times have you used services provided by the local research institute in the last 12 months?" Recorded as a continuous variable. This refers to services provided by non-extension associated agricultural research entities, such as Wollo University. In Ethiopia extension and research institutions operate independently of each other but often carry out research and interventions in the same communities. Though not specifically related to extension these institutions are part of the AKIS, and is included in the model.

Cooperatives (IV): How many times have you used technical services from cooperatives in the last 12 months?" Recorded as a continuous variable. Cooperatives are one of many strategies used by the Government of Ethiopia to promote increased and sustainable intensification among smallholders (Abebaw and Haile 2013; Bernard and Spielman 2009). Association with cooperatives is important, particularly for more marginalized farmers (illiterate, poor), in technology adoption through their role in potentially providing access to high quality inputs, such as fertilizer and improved seeds and credit (Abebaw and Haile 2013). Credit is readily available from the government in this particular region, but accessing credit through cooperatives usually provides the borrower with more favorable interest rates. Again, though not directly associated with extension, cooperatives are an important part of accessing elements of the AKIS.

Farmer Training Center (FTC) (IV): "Days spent in farmer training centers in last 12 months." Recorded as continuous variable. Ability to see the technology or management practice in the

case of tef row planting, and seeing it work well are major tenets of Rogers' Adoption of Innovation Theory (observability). Seeing is believing. Additionally, this variable begins to examine the quality aspects of extension. Farmer Training Centers are a hallmark of the newly expanded extension system, but their use and maintenance are a collective responsibility of the extension and the community—so their use by smallholders and inclusion in the model reflects, potentially, the quality of the relationship between extension and communities.

Total Livestock Units (TLU) (IV): The number of each species of typical kinds of livestock was recorded for each household. These numbers were then consolidated into a single indicator, TLU. Livestock were weighted according to Sub-Saharan African specific weights (Chilond and Otte, 2006): cattle/oxen/horses (0.5); camels (0.7); goats/sheep (0.1) chickens (0.01). In this region of Ethiopia TLU and specific types of livestock have been used as proxies for household wealth and savings (see Cafer et al. 2015; Little et al. 2004; 2006). Farmers often draw upon these stocks in times of emergency, and as qualitative analysis revealed as a means of repaying loans to pay for inputs.

Head of Household Age (HH Age, IV): A self-reported measure of age of head of household. Recorded as a continuous variable.

Cultivated Area (IV): This is a measure of the number of hectares cultivated for food crops. This measure combined hectares cultivated in the Belg (early) growing season and the Meher (late) growing season, meaning double cropped hectares were counted twice. This departs from more traditional measures of land size, such as the FAO measure of arable land, which includes land under temporary crops (double cropped areas only counted once), pasture, gardens, and areas temporarily left fallow. This departure is important for two reasons: (1) it allows for the approximation of "activity" dedicated to tef among all food crop activities. Most households in

this region of South Wollo, have a diversified system which includes a number of cereals, pulses, and market crops.

Economically Active Members (IV): This is a measure of members of the household between the ages of 15 and 65, and serves as a proxy for available labor for both on-farm and off-farm activities. Farmers revealed during focus groups that row planting tef was a tedious practice and required additional labor, at least three people. This was an important barrier discussed across all villages, suggesting additional labor would entice farmers to adopt row planting, if the labor shortage could be overcome.

Logistic regression was used to determine the impacts of these independent variables (IV) on the dependent variable (DV) "adoption." It is expected exposure to multiple facets of the AKIS, FTCs in particular, are significant predictors of adoption among smallholders. Also, given the qualitative data, it is expected the number of individuals available to participate in the planting process is be critical in adoption. In terms of farmer assets, it is expected both khat income and TLU will be significant predictors of adoption. A Box-Tidwell test was conducted to ensure predictor variables did not violate statistical assumptions.

Qualitative Analysis

A mix of both in-depth interviews and focus group interviews were used to delineate reasons for adoption or non-adoption of tef row planting. Farmers not using row planting were asked, simply, "[w]hat are the reasons you do not use row planting when growing tef?" Farmers who did use row planting were asked, "[w]hat are the reasons you use row planting when growing tef?" These responses were recorded and transcribed. The transcriptions from these interviews were analyzed using open and axial coding (Table 4). Axial codes were then grouped into themes.

Results

Quantitative

In this sample 13% of farmers used row planting (Table 2). The highest concentration of adopters was in Amemo, this is also the village where farmers have the highest incomes from khat and were more likely to report having seen row planting in practice through an extension supported demonstration plot. Average khat income for the sample was roughly ETB 5,065 ($232).

Table 2. Descriptive Statistics

	Sample N = 115	B. Seyu N = 40	Amemo N = 22	Kuty N = 53
Adoption (# of farmers)	15 (13%)	2 (5%)	10 (45%)	3 (6%)
PA Extension Services (# of visits)	0.77	1.35	1.14	0.14
Local Research Institutes (# of visits)	0.76	0.70	1.64	0.41
Cooperatives (# of visits)	2.45	3.20	4.77	0.82
Farmer Training Centers (# of visits)	0.29	0.10	1.32	0.00
Khat Income (USD, $)	232	0.00	887	138
TLU	1.97	2.30	2.20	1.66
HH Age (years)	44.01	44.28	39.00	45.9
Cultivated Area (hectares)	0.73	0.92	0.63	0.68
Economically Active Members	2.66	2.92	2.67	2.45

*Exchange rate as of January 2015 0.0459USD = 1ETB

Table 3. Logistic Model for Predictors of Adoption of Row Planting

	Model 1 (N = 111)		Model 2 (N = 103)		Model 3 (N = 92)	
	B	S.E.	B	S.E.	B	S.E.
Extension Services	-0.071	0.320	-0.097	0.411		
Local Research Institutes	0.251	0.204	0.230	0.280		
Cooperatives	0.318**	0.119	0.199	0.130	0.166	0.177
Farmer Training Centers	-0.036	0.262	-0.704	0.414		
Khat Income			1.456**	0.449	1.412**	0.501
TLU			0.338	0.338	1.180*	0.516
HH Age					0.043	0.023
Cultivated Area					-8.391*	3.722
Economically Active Members					-0.379	0.424
Constant	-3.032***	0.594	-2.670**	0.901	0.158**	2.395
Sig.	0.040		0.000		0.000	
X^2	10.020		25.699		32.243	
-2 Log Likelihood	77.900		59.802		44.873	
df	4		6		6	
% of Adopters Predicted	13.3		46.7		71.4	
% of Non-Adopters Predicted	99.0		98.9		98.6	
Total Sample Predicted	87.4		91.3		94.3	

Nagelkerke R Square	0.158	0.392	0.526

P<0.05* p<0.01** p<0.001***

Model 1-AKIS only [Extension Services, Research Institutes, Cooperatives, and FTCs]

This model looked only at the effects of farmer engagement with AKIS actors (extension, local research centers, cooperatives, and farmer training centers) on the likelihood of adoption (Table 3). This model correctly classifies 87.4% of cases for the sample (99.0% of non-adopters and 13.3% of adopters). Though this correctly classified a significant number of research participants, it does not do a good job of classifying adopters. A test of the AKIS model against a constant-only model was statistically significant, and indicated that the predictors as a group, reliably distinguish between the adoption and non-adoption of tef row planting (chi square = 10.020, p< 0.040 with df = 4). The Wald criterion demonstrated that only the number of times farmers engaged cooperatives (0.007) made significant contributions to prediction of adoption. Number of interactions with extension (0.824) and research institutes (0.218) as well as the number of days spent at a farmer training center 0.889) were not significant. The EXP(B) value suggests that for every additional interaction with cooperatives a farmer increases the likelihood of adoption by 37.5%.

Model 2-AKIS and Capital [Khat Income and TLUs]

The second logistic model combined AKIS and the two most common forms of capital available to farmers in this region—cash income from khat and livestock. This model correctly classifies 46.7% of cases for the sample (98.9% of non-adopters and 46.7% of adopters). A test of the AKIS and capital model against a constant-only model was statistically significant, and indicated that the predictors as a group, reliably distinguish between the adoption and non-adoption of tef row planting (chi square = 25.699, p< 0.000 with df = 6). The Wald criterion demonstrated that only standardized khat income (0.001) made significant contributions to prediction of adoption. Again, number of interactions with extension (0.814), research institutes (0.411), and days spent

at FTCs (0.089) were not significant. Additionally, after adding capital to the model, cooperatives also lost significance (0.126). TLUs were not significant in the model (0.272). The EXP(B) value suggests that for every unit increase in standardized khat income (~$697.22) a farmer increases the likelihood of adoption by 429%.

Model 3-Optimized model [AKIS, Capital, Farm(er) Level Characteristics]

The third and final logistic model, used a mixture of AKIS, capital, and variables (land size, extra labor) indicated by the qualitative analysis to be important in farmers' decision to adopt as well as variables indicated by the literature to be important (HH age). This model, correctly classifies 94.3% of cases for the sample (98.6% of non-adopters and 71.4% of adopters). A test of the optimized model against a constant-only model was statistically significant, and indicated that the predictors as a group, reliably distinguish between the adoption and non-adoption of tef row planting (chi square = 32.243, $p < 0.000$ with df = 6). The Wald criterion demonstrated that standardized khat income (0.005), total livestock units (0.022), and cultivated hectares (0.024), all made significant contributions to prediction of adoption. Cooperatives (0.347), age of head of household (0.062), and number of economically active household members (0.371) were not significant predictors of adoption in this model, but all increased the predictive power of the overall model. The EXP(B) value suggests that for every unit increase in standardized khat income (~$697.22), unit increase in TLU, and additional hectare cultivated a farmer the likelihood of adoption increases by 310%, 225%, 9.5% respectively.

Qualitative

Several themes emerged as significant barriers to row planting (Table 4); tediousness, need for additional labor, land, or rather land size was a major issue for farmers, particularly in Boru Seyu, where multiple farmers commented on how small their land was due to land fragmentation. These farmers were also much more sensitive to agroecological constraints,

particularly rainfall and the ability to plant in a timely manner using row planting. In this particular region of Ethiopia there has been a documented increase in rain variability over the last two decades (Rosell and Homer 2007). This increased rain variability requires farmers to be able to plant quickly, and farmers noted during focus groups and in-depth interviews that row planting require an additional two to three days. Issues of debt and resource allocation as well as the cost and effectiveness of inputs were major concerns for farmers in Kuty. Perhaps of most interest are the Market, Learning, and Input themes as they help illuminate and the nature and context of farmers' engagement with the AKIS as well as khat production in the study area and their relation to adoption of SI practices.

Table 4. Reasons for non-adoption of tef row planting among farmers

Themes	Axial Codes	Open Codes	Count
Time Constraints	Labor Constraints	Too old; not enough help; need to work cooperatively	9
	Tedious	Tedious, heard it was tedious; time consuming; energy consuming	26
Land	Land Size	Smallness of the land; land too small; need at least 2 timod; small farm size	5
	Shared Land	Shared Land	1
	Land Fragmentation	Land Fragmentation	5
Market	Debt	Loan for inputs has unbearable interest; tef production only for household consumption—not willing to borrow to purchase input; avoid debt; because not sell at market, unable to repay loan	15
	Resource Allocation	Only use irrigation for vegetable (market) production; Need irrigation for khat production; prefer to spend labor on income generating activities; uneconomic use of land	21
	Khat	Want to focus on khat production	8
Learning	Personal Experience	Tried with lower productivity; tried but bad results	8
	Neighbor Experience	Heard from neighbor less productive; Heard from neighbor it's disadvantageous; saw neighbor try with poor results; negative experiences of neighbors	9
	Training and Knowledge	Demonstration plot failed; Need to watch before I try it; Need to see it; No information; No training	21
Agroecology	Rainfall	Rain inconsistent; Race against the rain; lack of rain	8
	Soil	Black soil not suitable (too muddy to plant)	1
	Frost	Heard from neighbor RP makes tef vulnerable to frost; Frost	2

Perceptions	Negative Perceptions	Negative attitude toward RP; Believe conspiracy to make farmers more dependent on safety nets	8
Inputs	Inputs-General	No free seed or fertilizer; Input ineffective—wag; selected seed and fertilizer very bad results;	1
	Seed	Not using selected seed; seed clumping	3
	Fertilizer	Not use fertilizer because it damages the crop; Fertilizer aggravate/cause wag—refuse to purchase; fertilizer unaffordable; fertilizer bad for soil; use compost instead	21
	Irrigation	(no) Irrigation; only just started using irrigation	11

For example, open codes within the market and input themes clearly demonstrate farmers are keenly aware of their economic situation and are more likely to invest scarce resources such as irrigation, labor, and financial capital in an agricultural product, such as khat, likely to return the most cash for their investment, rather than invest resources, particularly financial, in the purchase of improved seed and fertilizer associated with row planting of tef. Tef I these communities is almost exclusively for household consumption and would not provide any return on investment, other than reducing the amount of food purchased in the market. In this region even farmers who grow their own cereals are still forced to purchase food in the market because of small plot sizes. Khat allows them to make those purchases *and* maintain a cash flow.

Discussion

Training Matters…Less than we thought…

There were several questions in the structured questionnaire that were designed to capture the extent and nature of farmers' relationship with AKIS personnel and to some extent the level of training and exposure farmers received related to row planting. Results from the first model suggest that the combined positive effect of these interactions on row planting adoption is relatively minimal. In fact, the two pieces of AKIS which might have the greatest impact, extension and the farmer training center—where the Government has invested the most resources, did not significantly increase the likelihood of adoption. Additionally, as other

explanatory variables are added to the model the importance of AKIS related variables becomes significantly smaller. In the case of all but accessing cooperatives, the inclusion of AKIS variables actually decreases the predictive power of the model, and were excluded from the final model.

Cooperatives have been used by the Government as a strategy of agricultural led industrialization and have documented positive spillover effects for communities, often with poor more marginalized farmers, who are not members of the cooperative, benefiting (Bernard and Spielman 2009). Cooperatives have also been linked to other sustainable intensification practices (see Abebaw and Haile 2013) and increased likelihoods of technology adoption in Ethiopia, suggesting increased investment in these types of organizations and policy to facilitate their operation may provide a larger return on investment for the Ethiopian Government.

However, it is important to note the in-depth interviews revealed, training and practical information on the technique was a significant barrier for 18% of farmers, to its utilization in their production practices.

Qualitative analysis also revealed that the most vulnerable households (those with less productive land, smaller plots, and contentious relationships with extension) were not targeted for practical training (demonstration plot). Instead these households, concentrated in Boru Seyu and Kuty were more likely to receive only oral training from extension, or no training at all but still expected to implement row planting and purchase inputs (see table 4, Learning theme). Interviews with farmers from B. Seyu revealed local extension agents are rarely in the village and the demonstration plot routinely go unused. Farmers in Kuty made repeated remarks, captured in the “perceptions” theme, they believe extension has malicious ulterior motives for promoting row planting, which is perhaps inflated by the lack of practical training from extension and observed negative outcomes on neighbors’ plots who do use row planting.

Khat, Livestock, and the Importance of Capital

Information on row planting practices is offered in conjunction with other agricultural inputs, namely fertilizer and improved seed, as a comprehensive input package to by purchased and used by farmers. These inputs are incredibly expensive, particularly for farmers who are producing tef exclusively for household consumption, rather than market. The average cost, as revealed through one particular focus group, is roughly 900-1000 birr ($41-46). For Amemo farmers this represents less than 5% of documented income (from khat), but for farmers in Kuty this represents nearly 30% of income (from khat). For farmers in B. Seyu who are engaged less in cash cropping, this would represent a significantly larger portion of household income. As such, lack of capital is an important gap to bridge for smallholders and cash income is essential in bridging that gap (Chirwa 2005). Income from khat played a critical role in the facilitation of row planting input package adoption in both the second and third models, and had the largest significant predicative impact on a farmer's likelihood of adoption. In this particular study area khat is one of the most culturally and economically important crops, outside of tef. Income from khat is used to improve household building materials, pay school fees, and provide a financial buffer between a family and chronically severe food insecurity. Yet this study, through mixed methods revealed that the nature of khat income is more complicated. The benefits of khat income in mitigating the risk associated with adoption of new technologies and helping farmers overcome the capital gap were only realized at an income level equivalent to USD $697.22 (X = (9599*1) + 5591 = 15190*0.0459 (exchange rate) = 697.221. Fewer than 26% of farmers earned this much in khat income. Additionally, farmers who were likely to produce khat at this level were concentrated in one village, Amemo, and were more likely to have access to well-equipped extension services and irrigation—a critical component of intensive khat production.

Livestock are another important source of capital for Ethiopian. The land tenure system has prevented the building of wealth through accumulation of land, and consequently livestock have become an important economic tool (Desalegn et al. 2006). A number of farmers indicated, during focus groups, their need to liquidate smaller assets, such as sheep, to pay for agricultural inputs. This economic role of livestock, outside of their use for agricultural means (plowing, planting, etc.), is even more prominent among smallholders who do not produce khat, and indicates how important access to capital is in facilitating adoption of new practices tied to input purchases.

It's Complicated

Though training and capital are the major foci of this particular study, there is general recognition that technology adoption is more complicated than merely information access and the ability to purchase inputs. There are important farm and farmer level characteristics rooted in place that influence farmers' decision to adopt or not adopt new practices, including head of household age, cash and capital, access to information on the practice, and area of land cultivated. This study supports this assertion. In addition to capital, this study found age, cultivated land, and available labor to be important in the overall model.

Of most interest in this study is the role of cultivated area. There are mixed reviews on the relationship between land size and technology adoption, but almost no research on cultivated hectare on willingness to try new processes (see Mwangi and Kariuki 2015). Bonabana-Wabbi (2002) suggested a measure of total land to be affected by the new technology would be appropriate, however this study found that neither the number of

hectares under tef cultivation nor tef hectares as a percent of total cultivation were significant.

However, the total number of cultivated hectares (those under food crop production) was significant. In this survey, cultivated hectares is not an indicator of available land but rather of agricultural activity that takes place. Farmers with a larger number of cultivated hectares, are typically producing during both seasons, and have a majority of their land under food crop cultivation. These farmers tend to conduct more labor intensive production (vs. khat farming which after initial establishment, requires relatively little labor). As such these farmers are perhaps more amenable to the additional labor required for tef cultivation using row planting as they rely more heaving on their own production for household consumption.

Short Sighted Adaptation…

Khat's role in technology adoption though significant, is perhaps short-lived. A number of farmers indicated their reservation in adopting row planting was tied, in part, to a lack of irrigation (mostly Kuty), but simultaneously revealed they would reserve such resources for khat production. This is reinforced by observations in Amemo, where irrigation is reserved specifically for khat production and was given as a reason for non-adoption of row planting. Furthermore, a number of farmers revealed they hoped to rely exclusively on khat production in the future and would gradually replace cultivated area in tef with khat. Other countries, namely Yemen, have experienced similar shifts in agricultural production related to khat (qat). As infrastructure improved and markets became more accessible, khat eventually replaced food crops and other important cash crops, such as coffee in Yemen (Keffez 2012). Additionally, as an extremely water

intensive crop, increased khat production has serious implication for natural resource management in the region (Heffez 2013).

However, khat's role in poverty reduction and subsequent potential for increased food security through improved household purchasing power, will likely make it a go to strategy for households.

Conclusion

The adoption of a new technology or practice is risky business, particularly among extremely vulnerable populations dealing with chronic hunger and extreme poverty. A degraded resource base combined with weak market access and episodes of climate-induced drought crescendo into devastating cycles of poverty. These cycles of poverty and uncertainty can increase farmers' perceptions of vulnerability which impact their willingness to adopt modern agricultural inputs, which can be translated to an unwillingness to adopt new technologies or crop management practices (Shiferaw and Bantilan 2004; Shiferaw et al. 2009).

This study supports previous findings. Access to the AKIS and capital are critical elements in promoting SI technology and management procedures adoption in Ethiopia. This study found the extension system has, even where fully engaged, not been critical to the adoption process. In many cases a lack of quality management and exposure to demonstration plots and practical training has resulted in non-adoption within the region. This demonstrates the importance of quality extension services. However, this study also found that in regards to the AKIS, non-extension activities (research institutes and cooperatives), were more significant and impactful, suggesting the Government may look at investing in the expansion of these services.

Additionally, this study found cash and capital to be important elements in adoption facilitation. Income earned through khat production provided farmers with the needed capital to purchase

inputs associated with row planting and mitigate the risk of a poor yield. However, the income needed to overcome these barriers, was earned by less than 26% of farmers, and the benefits of khat production in facilitating SI practices related to food crops is likely to be minimal. Khat will continue to play a critical role in agricultural production in this region, but will likely result in a shift from predominately cereal and pulse based production to cash crop production.

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CHAPTER 2. LAND FRAGMENTATION AND COMPULSORY AGRICULTURAL MODERNIZATION: THE POLITICAL ECOLOGY OF AGRICULTURAL INPUT PACKAGES IN SOUTH WOLLO, ETHIOPIA

Abstract:

Rural life in Ethiopia is often depicted as an idyllic agrarian existence, with peasants working the land and reaping the benefits of a good harvest. However, the effects of rural population growth have increased land fragmentation and exacerbated already negative impacts of poor land tenure policies and increased environmental shocks, such as drought. This has culminated in devastating realities for rural peoples—including malnutrition, starvation, migration, and a degraded natural resource base. What was once considered a stable livelihood has become intimately tied to pictures of farm families struggling to survive on small plots of government owned land. In an effort to mitigate food insecurity, and the depreciatory images of "starvation plots," the Ethiopian government has enlisted the national extension system to push agricultural inputs and new management practices. However, the often compulsory nature of input use has further perpetuated smallholder poverty by forcing farmers to sell assets to pay for expensive agricultural inputs or take out loans with unbearable interest rates. This paper looks at the specific role of land fragmentation, a product of increasing population pressure, in preventing rural Ethiopian's from adopting new agricultural practices aimed at improving productivity as well as the changes in rural identity among Ethiopian highlanders. This paper combines qualitative and quantitative approaches and employs data collected during winter 2015 in the South Wollo Zone of the Amhara state in Ethiopia. Data include questionnaire responses and key informant interviews from more than 115 households, government officials, and local authorities.

[Ethiopia, land fragmentation, agricultural modernization, rural identity, sustainable intensification]

Introduction

The issues to be explored in this study have become critical to the global food security discourse. In paradox, the systematic failure of the agricultural knowledge and innovation system (AKIS) to develop technologies which support rather than threaten smallholder practices and values has failed to achieve widespread food security in Sub-Saharan Africa (Sumberg 2005; Hounkonnou et al 2012; Barrett et al. 2010; Feder et al. 1985; Rivera 1997, 2001; Egziabher 2013). Paramount among which is the lack of discerning the cause of these failures. Smallholder farmers, because of their reliance on ecological systems are often inherently aware of the environmental balances which exist in a particular place, yet technologies and practices are often developed in isolation of this knowledge and with little respect for local environmental conditions or the socio-cultural influences of implementation.

Compounding this tension between the AKIS and smallholders is the issue of population growth. Population growth in Ethiopia is highest in rural areas (2.6%), where cultural and religious practices have prevented national and international efforts to reduce family size. This growing pressure on Ethiopia's natural resource base, particularly in terms of land availability, combined with poorly developed and implemented national policy has resulted in an intolerable situation for rural communities and smallholder farmers. Two policies in particular, (1) disaggregated land holdings based on family size and (2) compulsory input purchases have driven many farming households into a situation of abject poverty, where the few resources they have are liquidated to pay insurmountable debt.

The effects of these policies are felt acutely by those farmers in the Amhara region, particularly in the highland areas of South Wollo (Fig. 1)—the study area for this research. This region has been termed the "famine belt" of Ethiopia and the land holdings labeled little more than "starvation plots" (Little 2002; Little 2004; Little 2006). This paper will discuss the impacts of

land fragmentation, a product of poor land tenure policy, accelerated by population growth and the Ethiopian Government's subsequent efforts to mitigate these impacts through compulsory agricultural modernization. Additionally, this paper combines the use of qualitative and quantitative approaches to provide a more holistic view of farmer reactions to the implementation of these policies and to discuss potential impacts in light of continued rural population growth.

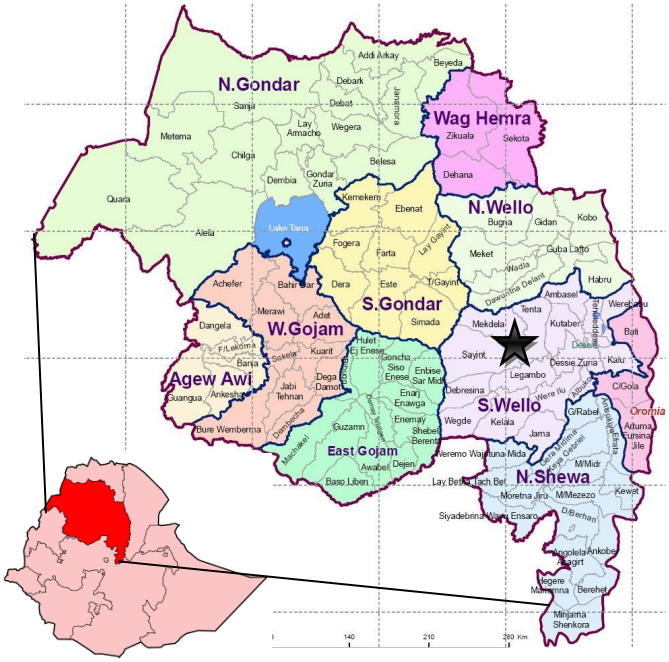

Figure 1. Map of Administrative Zones, Amhara State

Background

The Ethiopian economy relies heavily on agricultural production. Forty-five percent of gross domestic product and 90% of exports are comprised of agricultural outputs (Feed the Future 2013). Necessarily, Ethiopian farmers have continued to increase the amount of land put into production annually (Dercon and Hill 2009). This expansion process means more marginal lands,

which are not ideal or even appropriate for agricultural production, are being farmed, essentially degrading Ethiopia's natural resource by accelerating soil and land degradation (Awulachew et al. 2007; FAO 2003). A deteriorating natural resource base limits smallholder abilities to be effective producers and confines future options for intensification. Additionally, at an aggregate level this deterioration hinders national efforts toward agricultural led economic development (Dar and Twomlow 2007; Davis et al. 2012).

Land Tenure and Land Fragmentation

However, the Government still maintains land tenure policies which hinder farmer investment and promote land fragmentation. The land tenure system, established during a previous military regime (the Derg period—mid-1970s to mid-1980s), specified all land was property of the state (Ogbaharya 2009). Under this system, which is still in place under the new federal parliamentary republic, the Ethiopian People's Revolutionary Democratic Front (EPRDF) which overthrew the Derg regime in 1991, each household was provided with a given amount of land based on household size, and the land had to be farmed to retain land user-rights (Bigsten et al. 2003). As population, particularly in rural areas, continues to grow plots continue to shrink (Hounkonnou et al. 2012; Feed the Future 2013). To meet the land needs of increasing numbers of farm families, the local administration (*kebele*), responsible for the division and distribution of land, is forced to combine several plots from different parts within the *kebele* boundary. On average farmers produce on 2.3, 0.35 hectare plots, and one-third of farmers, farm three or more plots (Gebreselassie 2006). This national policy, implemented at the local level, restricts access to land, which is often the sole source of income and food production for those whose livelihoods are built around food production. The current land tenure system has prevented the building of wealth through land acquisition, as land purchases are prohibited. This tenuous relationship with the land is an important contributor to farmers' heightened perceptions of vulnerability

and limits their willingness to invest in their natural resource base through implementation of long-term sustainable practices (Bigsten et al. 2003; Gebremedhin and Sinton 2003; Shiferaw and Bantilan 2004; Shiferaw et al. 2009; Teklewold et al. 2013).

Push for Agricultural Industrialization

Recognizing the problems which stem from poor land tenure, though unwilling to address the larger policy issue, Ethiopia has instituted national programs as part of their Agriculture Development Led Industrialization plan and, on average, invested more than 15% of the national development budget to agriculture from 2002-20012 (MARD 2010; Berhanu and Poulton 2014). These new programs are designed to 'modernize' subsistence agriculture and to help farmers produce more with less space. These often compulsory programs force farmers to purchase improved seed, fertilizer, and implement new management practices (ATA 2013a; Interview with *kebele* chair February 19, 2015).

One such new management practice is row planting of *Eragrostis tef* (*tef*), an important food staple, which is being researched and implemented as a way of sustainably increasing production for smallholders. Traditionally, *tef*, as with many other crops in Ethiopia, is sewn using a hand broadcast method which is highly inefficient in terms of seed use and distribution, and typically produces much lower yields than alternative methods, particularly row planting (ATA 2013a). Row planting allows for correct and predictable seed rates and seedling space, which allows for easier weeding and efficient fertilizer application, and consequently improve yields (ATA 2013a). In Ethiopia, row planting has shown to increase farmers' yields up to 100%, though yields perceived by farmers are much lower (around 12%) (IFPRI-ESSP 2013).

Information on tef row planting is often part of an input package system promoted by local agricultural experts and extension agents. This input package includes improved seed and

fertilizer to be purchased by the farmer, and information on techniques related to row planting which would optimally allow for increased yield and efficient application of inputs, namely fertilizer, provided freely by extension. Traditionally, fertilizer purchase and use in Africa minimal, and in regions of Ethiopia less than 40% of farmers purchase and apply fertilizer (Negatu and Parikh 1999; Assefa et al. 2008). In this specific region of South Wollo, fertilizer use has been documented at 59% (Cafer et al. 2015). However, farmers often complain the cost of fertilizer is too high (Cafer et al. 2015). According to one particular focus group, the average input costs for farmers in this regions are between 900-1000 birr. Highland farmers, who only grow for household consumption and do not sell their product at market, are increasingly seeking other money making activities (paid labor, cash crop production) to pay these types of expenses related to production (Wale et al. 2006; Assefa et al. 2008).

A Political Ecology Perspective on Land Tenure and Agricultural Modernization

Despite the use of demonstration plots, provision of input packages, and more participatory approaches in the National Agricultural Extension Intervention Program (NAEIP), extension has failed to achieve widespread adoption of new agricultural practices and technologies by farmers (also despite empirical evidence that these methods do in fact increase yields substantially) (Gebremedhin, Hoekstra, and Tegene 2006; ATA 2013). Among leaders in the international development community the explanation for this failure has been tied, almost exclusively, to improper economic incentives. Namely a failure of input packages to entice farmers to financially invest in these practices on a systematic level. However, from a political ecology perspective, this dominant discourse which relies almost exclusively on economic incentives and their role in adoption prevention, has failed to incorporate the political tensions between smallholders and regional governments and minimalized the historic marginalization of

smallholder farmers in Ethiopia, particularly by extension and the agricultural development machine.

Political ecology is a multidisciplinary framework which provides social scientists with the intellectual tools necessary to integrate concepts of political economy and ecological analysis (Greenberg and Park 1994). The traditional link between power relationships and productivity are augmented by a broader contextualization of the natural environment within which those relationships and productive activities take place (Greenberg and Park 1994). Robbins (2004) uses two metaphors which aptly characterize the goals of political ecology: the hatchet and the seed. The hatchet refers the use of political ecology to serve as a critique for dominant development discourse (Robbins 2004). Political ecology as a critique calls into question a historic dialogue that has removed issues of power, economic exploitation, political forces and subsequent marginalization from conversations on natural systems, in particular environmental degradation (Robbins 2004). Dominant discourse depicts environmental degradation as an inevitable phenomenon of ill-educated farmers or dysfunctional local communities, with no reference to the displacement or marginalization of previous caretakers of the environment (indigenous groups, native peoples, rural communities) and willfully negates the impact and role of powerful entities (industry, governments, urban populations) on the displacement of these marginalized groups and the degradation of the ecological system (Robbins 2004).

The seed refers to the ability of political ecology to serve as an avenue for understanding how marginalized populations cope with endogenous and exogenous drivers of environmental degradation and natural resource appropriation, with particular reference to the dominant system within which they operate (Peet and Watts 1996; Robbins 2004). The seed aspect of

political ecology draws on the importance of cultural adaptation to environmental change (Wolf 1972; Walker 2005).

The Hatchet and the Seed—In Ethiopia

Extension (The Hatchet)

Extension in Ethiopia has historically been a top-down process of information and technology dissemination to farmers from extension agents and researchers housed in national educational institutions, such as Alemaya University (Gebremedhin, Hoekstra, and Tegene 2006; Gebremedhin, Jaleta, and Hoekstra 2009; Egziabher 2013). Later, during the Derg period, Ethiopians saw the implementation of extension services as a mechanism for collectivist reform and later as a tool of political control (Spielman, Mekonnen, and Alemu 2012).

These centralized top-down approaches, despite improvements in agricultural technologies coming out of the green revolution, hindered realizations of the potential agricultural innovations in Ethiopia (Feder et al. 1985; Rivera 1997, 2001; Egziabher 2013). This failure, though not necessarily a reflection of the technology itself, but of the poorly conceptualized implementation, political turmoil, and restrictive land tenure policies, has prevented Ethiopian agriculture from keeping up with population growth and ultimately contributed to increased food insecurity in rural areas. Combined with extension's focus on large, resource rich farmers loyal to the ruling party and marginalization of the most vulnerable farmers, intervention failure pushed Ethiopia into the role of food importer (Aredo 1990; Assefa et al 2008; Belay and Abebaw 2004; Egziabher 2013). In light of this failure and in an effort to extend the EPRDF's reach, Ethiopia has expanded its extension system significantly—it now spends more than two percent of agricultural GDP (Spielman et al. 2010). This system is comprised of more than 60,000 diploma holding extension agents who work with communities through more than 10,000 farmer training centers (FTCs), funded by local agricultural offices (Gebremedhin, Hoekstra, and

Tegene 2006; ATA 2013). With the expansion of agricultural technical and vocational education and training (ATVET) colleges each village houses three extension agents (Gebremedhin, Jaleta, and Hoekstra 2009). This growth in extension infrastructure and personnel is unparalleled in the developing world; with 60,000 agents, Ethiopia's extension personnel make up nearly 40% of extension workers in Sub-Saharan Africa (Berhanu and Poulton 2014; Davis et al. 2010).

The newly expanded extension system is driven by a national and international agenda focused on economic incentivization, commodity production, and internationally defined nutrition goals—all couched within the dominant discourse focused on food security, export markets, and agricultural industrialization (Berhanu and Poulton 2014; Ethiopian Economics Association, 2005). To accomplish these goals, extension relies on the Extension Management and Training Plots model and input packages. In this model farmers manage demonstration plots as educational tools for the community and other extension agents and are supplied with agricultural packages that include information on agricultural technology, the necessary inputs, and credit to support their adoption (Ibrahim 2004; Alemu and Demese 2005).

As the purveyors of input packages extension agents often see themselves as little more than fertilizer and credit distributors, rather than extension specialists (EEA/EEPRI 2006; Spielman, Kelemwork, and Alemu 2012). Additionally, as extension agents are also charged to serve in the capacity of debt collectors for farmers who have borrowed in order to use capital intensive inputs, tensions between the government endorsed extension and farmers have increased as the power relations shift from knowledge exchange to creditor/debtor (EEA/EEPRI 2006; Spielman, Mekonnen, and Tegegne 2012). This role as creditor has contributed to extension's focus on wealthier, party-affiliated, farmers rather than resource poor farmers; and, since extension agents are responsible for selecting participants for on-farm demonstrations and

participation in extension activities, the impact on the most vulnerable farmers is likely to be minimal (Assefa et al 2008; Belay and Abebaw 2004).

To understand the power extension agents have in their role as input suppliers, it is important to understand how they are selected and ultimately function within the local governance system. Though applicants for extension training are required to meet minimum educational and testing requirements, affiliation with the political party in power, EPRDF, is an important selection criteria (Berhanu and Poulton 2014). Once these applicants have successfully completed the program they are assigned by the state to a district (kebele, village level) (e.g. Amhara, Oromo, Gambella, etc.). After being assigned to a *kebele*, one of the extension agents, usually the one with expertise in crop production, is assigned by the *kebele* Council, which also selects the members of the *kebele* governing body, the Cabinet, to serve on the Cabinet (Berhanu and Poulton 2014). The Cabinet is responsible for local planning (i.e. land assignments), mobilization, service provision (i.e. food aid distribution), and security (Berhanu and Poulton 2015; Interview with local PSNP Officer, January 29th, 2015). This appointment to the Council, makes extension workers important decision makers within the community, which has potentially severe consequences for smallholders who disapprove of or present a problem for the local extension agents.

Farmers (The Seed)

Farmers are at the front lines of a war between the national and international agendas on agricultural led industrialization and the uncertainty of producing under climate change-induced volatility intensified by a politically charged environment. Furthermore, smallholders' historical exclusion from sources of power, displacement from their land, and dismissal by the AKIS, have created a pervasive distrust of government sponsored programs within highland communities and stunted smallholders' ability to access information on agricultural innovation or practices.

This marginalization has ultimately contributed to the demise of each of Ethiopia's subsequent regimes, and is perhaps why the current Government, comprised (99.5%) of EPRDF party members, has increased their presence in rural communities via extension (Berhanu and Poulton 2014). Extension at the village level is part of a governance system designed to promote national and donor agendas, commodity export production and food security in-particular. To enforce policies at the local level there is a kebele Committee. This Committee is referred to by local farmers as the "1-5 (Interview with Kebele head, January 19th, 2015)." This "1-5" organization is comprised of one coordinator and four other members, who are responsible for handling issues related to household disputes, "disruptive behavior," and politics (Interview with Kebele head, January 19th, 2015).

In reality this governance structure is in place to ensure election of EPRDF party members to positions of power, restrict access to productive land, credit services, food aid, and agricultural inputs to farmers as a mechanism for social and political control in areas traditionally friendly to opposition (Berhanu and Poulton 2014; Dessalegn 2012; Abegaz 2011; Gudina 2003). As a result, Ethiopian smallholders in this region have developed a number of adaptive strategies to mitigate the uncertainty of small scale agricultural production under climate change and political marginalization. These farmers continue to increase the amount of land put into production, diversify production, migrate for labor, develop social networks around inputs necessary for production (e.g. seeds, see McGuire 2008) subverting government or government associated retailers, and convert significant parts of their plots to cash production which is generally outside the authority or interest of extension (based on data from World Bank 2012).

Two of these approaches have important implications for the quality of the highland natural resource base. Extensification has resulted in the crop farming of marginalized lands, which are

not ideal or even appropriate for agricultural production, further taxing Ethiopia's natural resource base and placing smallholders in even more precarious situation in terms of their ecological environment (Awulachew et al. 2007; FAO 2003). Additionally, the conversion to cash crop production such as *Catha edulis* (khat), a water intensive perennial shrub which is consistently one of Ethiopia's top five export goods. The amount of land under khat cultivation has increased 160% in the last 15 years, with the second largest gain in khat hectares in the Amhara region with a 252% increase (Cochrane and O'Regan 2016). This bloom of khat production has important implications for sustainable resource use, water in particular.

Methods

This analysis is based on fieldwork conducted in South Wollo (11°8'N 39°38'E), Ethiopia, from December 2014 to March 2015. South Wollo is located in the south east corridor of the Amhara region located in northern Ethiopia. A total of 3 villages in three administrative districts, *woredas*, were visited (Dessie Zuria, Dessie Ketema, Tehuledere). The study included one highland villages (Boru Seyu) and two midland villages (Amemo, Kuty).

This study utilized a mixed method approach, which is particularly useful in helping mitigate the influences of biases of a particular method and improving the overall validity (Greene et al. 1989, Campbell and Fiske 1959, Denzin 1978, Webb et all 1966, Cook 1985). Mixed methods research has been critical to the investigation of technology adoption. The blending of quantitative and qualitative methods allows for a more holistic approach necessary to delineate the relationship between a broad range of actors and influences in smallholder systems (Hall et al 2001; Biggs and Clay 1981; Chambers and Jiggins 1987; Biggs 1990). A combination of semi-structured questionnaires, in-depth interviews, and focus groups were used for this study and are designed to work together in a way that provides clarification and better interpretability of data collected by each instrument (Green et al 1989; Mark and Shotland 1987). In total 115

households are included in the study and interviews were conducted with five extension officers (also known as development agents or development officers), two extension administrators for the South Wollo Zone, one faculty administrator from the local agricultural university, one Productive Safety Net Program (PSNP) officer, and one *kebele* administrater. Qualitative data was analyzed through thematic coding.

A stratified sample based on agroecological context and production types (household production based vs. cash crop production) was utilized to determine which villages would be included. Within each village farmers were selected using accessibility sampling. All data collectors were from the study area and familiar with the study population and culture of South Wollo.

Qualitative Instrument: A mix of both in-depth interviews and focus group interviews were used to delineate reasons for adoption or non-adoption. Farmers not using row planting were asked, simply, "what are the reasons you do not use row planting when growing tef?" Farmers who did use row planting were asked, "what are the reasons you use row planting when growing tef?" These responses were recorded and transcribed. The transcriptions from these interviews were analyzed using open and axial coding (Table 1).

Quantitative Instrument: Use of a structured questionnaire allowed for the collection of key demographic and agricultural data as well as information on the relationship between smallholders and extension personnel in each village. For the purposes of this analysis descriptive statistics are reported (Table 2).

Results

Table 1. Reasons for non-adoption of tef row planting among farmers

Themes	Axial Codes	Open Codes	Count
Land	Land Size	Smallness of the land; land too small; need at least 2 timod;	5

		small farm size	
	Shared Land	Shared Land	1
	Land Fragmentation	Land Fragmentation	5
Market	Debt	Loan for inputs has unbearable interest; tef production only for household consumption—not willing to borrow to purchase input; avoid debt; because not sell at market, unable to repay loan	15
	Resource Allocation	Only use irrigation for vegetable (market) production; Need irrigation for khat production; prefer to spend labor on income generating activities; uneconomic use of land	21
	Khat	Want to focus on khat production	8
Perceptions	Negative Perceptions	Negative attitude toward row planting; Believe conspiracy to make farmers more dependent on safety nets	8
Inputs	Inputs-General	No free seed or fertilizer; Input ineffective—wag; selected seed and fertilizer very bad results;	1
	Seed	Not using selected seed; seed clumping	3
	Fertilizer	Not use fertilizer because it damages the crop; Fertilizer aggravate/cause wag*—refuse to purchase; fertilizer unaffordable; fertilizer bad for soil; use compost instead	21
	Irrigation	(no) Irrigation; only just started using irrigation	11

*wag is the local term for tef rust, Uromyces eragrostidis

Land Fragmentation

"[I] didn't continue with [row planting] because of [my] small farm size." Hussein (Kuty, February 4, 2015)

"At the moment, almost every day [I am] aware of row planting, but the problem lies in the smallness of the land size…" Endris (Amemo, February 2, 2015)

"…too small a land to try. The minimum amount [of land] needed is two timad." Seid (Boru Seyu, January 30, 2015)

As indicated by the above testimonies, farmers are keenly aware of row planting, even if only marginally, but they see small plot size and disaggregated holdings as critical barriers to systemic use of row planting in tef production. Farmers noted the minimum amount of land needed to practice row planting was two *timad*, a local unit of measurement (50m X 60m), or

approximately two-thirds of a hectare. This two timod threshold is, in part, a product of the extra labor and need for plow animals to prepare a field for row planting. Less than two timod would negate the extra effort of row planting. Quantitative data from the structured questionnaire reveal on average farmers in each village have enough land under cultivation of food crops to accommodate this requirement, but because of the diversified nature of agricultural production, no farmer was able or willing to dedicate more than half the required land needed for row planting tef (Table 2).

Table 2. Average cultivated hectares for Belg and Meher growing seasons.

	Sample N = 115	Boru Seyu N = 40	Amemo N = 22	Kuty N = 53
Total Hectares cultivated[1]	0.75 (0.28)	0.94 (0.39)	0.66 (0.12)	0.69 (0.21)
Tef Hectares cultivated	0.26 (0.12)	0.09 (0.09)	0.33 (0.06)	0.31 (0.07)
Tef as % of Cultivated hectares (%)	40.54	10.28	59.52	47.85
Adoption of row planting (%)	13.04	5.00	45.45	5.66
Use of fertilizers (%)	50.43	70.00	95.45	16.98
Average Input Cost (birr)[2]	636.43 (237.43)	470.69 (163.95)	770.00 (236.64)	744.23 (198.66)

[1]Cultivated area refers specifically to food crops, land under cultivation of cash crops (i.e. khat) is not included and is a combined total of area planted in the Belg and Meher growing seasons, which allows for double counting and should not be confused with plot size.
[2] Exchange rate as of January 2015 0.0459USD = 1ETB

Nearly half of the farmers prioritizing this reason specifically mention land fragmentation, and which was also mentioned repeatedly during focus groups. The specific mention of land fragmentation reveals that several farmers work disjointed plots, often two or three plots making up the total farmland. *"No one's fetching a quintal"* referring to the amount of seed purchase,*" only a single harvest['s worth]…50 kilo…because the land is fragmented, it's fragmented! Fragmented!* [Boru Seyu focus group, conducted January 24, 2015]*"* At this point

in the focus group farmers reveal their land is only large enough for 50 kilograms of grain, which is approximately one quintal. This amount, as verified by farmers during a number of in-depth interviews and other focus groups, is only what is needed to sow one *timad*, or one-third of a hectare—one-half the amount of land farmers say is need to invest in row planting. This helps explain why in many cases, despite having total land holdings which would be enough for row planting, land fragmentation, and the subsequent additional effort it takes farmers to prepare multiple plots for row planting, prevent widespread adoption (Table 1).

The Heavy Cost of Compulsory Modernization

Historically there has been little inorganic fertilizer or improved seed use in this region. Previous studies reveal farmers do not believe fertilizer to be an appropriate part of their production scheme, instead they prefer compost and animal litter (Cafer et al. 2015). Though farmers still find fertilizer to be inappropriate in their production practices, the newly expanded agricultural extension has pushed its use extensively.

> *"…not using fertilizer because the soil type is not suitable for it; [we] use only compost."*
> Omer (Kuty, February 5, 2015)

Extension agents push fertilizer and improved seed as necessary components of a row planting system, and in most cases extension agents are the exclusive providers of improved seed and fertilizer. This seed and fertilizer is provided by the Government or Government affiliated suppliers (Berhanu and Poultin 2014; Alemu 2012). In the case of the South Wollo Zone improved seed, though expensive, is not a compulsory purchase for farmers using row planting. This is due in part to the heavy reliance by most Ethiopians on the informal seed systems, a mechanism for reinforcing social connections and subverting government management of

important agricultural decisions (Alemu 2012). However, fertilizer, if brought to the village by "agricultural experts" (i.e. extension agents) is a compulsory purchase.

> *"The government fetches [fertilizer]. It fetches it to the kebele. The kebele distributes it to each village…Of course, we're collecting this one from the government because it's a must"* Shimye (Boru Seyu, February 24, 2015)
>
> *"…the agricultural people/government would like to sell fertilizers to the farmers in order to push them to use row planting…"* Tedessa (Kuty, February 5, 2015)
>
> *"It's [referring to fertilizer] compulsory…or else his land will be confiscated….Because [the land] belongs to the government; because you've got a land owned by the government. He's afraid of that, [so] he pays"* Dejene (Amemo, February 2, 2015)

Farmers who refuse to purchase the fertilizer are threatened with confiscation of their land. Though not a formal law, extension typically shares office space with the local land authorities, and in some cases makes determinations on who has access to more productive plots, or for those who do not make the required input purchases, who is relegated to more marginal areas. The money to be paid for the fertilizer is collected immediately upon its disbursement. This often requires cash-poor farmers to liquidate assets—often smaller livestock, which are used in this region as insurance against shocks such as poor production related to increased rain variability/drought (Little et al. 2004). In many cases farmers are not producing tef for the market and so will have no potential for monetary return on their investment.

> *"It's just like this...by selling sheep…particularly if they oblige us to buy [fertilizer]. One with some wood...[or] like a cow, sells it and pays by obligation….The fertilizer is an obligation!* Boru Seyu focus group (January 24, 2015)
>
> *"We harvest…barely enough for the family, not enough for trade"* Temaw (Kuty, February 5, 2015)
>
> *"We would prefer to buy the same fertilizer from the market and some few shops where we find it affordable, [rather] than that of the agricultural/extension people."* Adem (Kuty, February 4, 2015)

Another option for farmers to access cash is the Amhara Credit and Savings Institute (ACSI). The Organization for the Rehabilitation and Development in Amhara (ORDA) developed this financial institution. ORDA is a local NGO established in response to drought and war in 1991 (Brislin and Dlamini 2006). ACSI is a registered micro finance share company, with the primary mission of improving access to financial services among poor rural people (Brislin and Dlamini 2006). However, the loans for the purpose of purchasing agricultural inputs secured through this institution have a hefty interest rate of 18 percent. Until recently, farmers also had the option of securing interest free loans from local NGOs (interview with *kebele* administration February 19, 2015 AND PSNP personnel January 26, 2015). However, new policies on the roles and capability of NGOs in Ethiopia have forced many to discontinue services in the country or limit their services. In the Amhara region, particularly around Dessie Town, NGOs operated to provide no interest loans to farmers. These NGOs were forced out of Dessie leaving farmers the ACSI, associated with local political elite, as the only means of financial refuge. This high interest was one of the top five reasons farmers in the study area refused to adopt new technologies tied to fertilizer purchases.

> *"…reserved from borrowing money from the [ACSI] because we know it brings a lot of interest; aware that those already involved are desperate and hopeless, finding themselves unable to repay"* Seid (Kuty, February 4, 2015)
>
> *"…there is loan but with unbearable interest. [A]lready loaded with interest we can't cover any time in our life. Government pushed us to be more dependent on the safety nets and provide us some 8000 birr" Kedege (Kuty, February 5, 2015)*

The extension of credit to increase fertilizer purchases has been a hallmark of the dominant discourse (Holden and Shiferaw 2004). Advocates of this solution proposed that increased grain production would increase household food security and hence a household's overall welfare.

Yet this study suggests even when credit is available, land fragmentation and contentious relations between farmers and extension will continue to limit household production capacity. A third, and more permanent option for meeting the demands for purchasing expensive inputs is a shift, or at least a partial shift, to cash crop production. In this region, a number of farmers have focused attention on the production of Catha edulis (khat), a perennial bush, sold as a legal narcotic in the local urban market town of Dessie. Though traditionally used in a variety of religious ceremonies, khat has seen a marked increase in recreational use, and is consistently one of Ethiopia's top five exports. This plant requires a great deal of irrigation, but is also an incredibly lucrative crop for smallholders.

The Dangers of Inputs

"[We are] not using fertilizer because commonly known it is partially dangerous for tef." Assefa (Kuty, February 5, 2015)

"[I] tried modern fertilizer but unfortunately I believe it attracted 'wag', [the] red one, and decided not to use it. [I] depend on compost …no side effects." Kedega (Kuty, February 4, 2015)

"[We] think that fertilizer could aggravate 'wag'…" Kuty focus group (February 4, 2015)

[I] am not using fertilizer with tef because it kills the plant—first the tef seedling appears to be flourishing; later it collapses and gets unproductive." Dawit (Kuty, February 5, 2015)

In addition to the heavy cost of fertilizer and the associated interest in loans needed to make the purchase, there is an endemic perception that fertilizer causes, or at the very least aggravates a *tef* disease farmers refer to as '*wag*.' Wag is the common term for *tef* rust [*Uromyces eragrostidis*], a fungal infection of *tef* leading to 10-40% yield losses in production (Dawit and Andenew 2005). This was the second most commonly described reason farmers refused to adopt row planting—which they believe or have been taught, requires fertilizer. These responses reflect similar findings from previous work in these villages where farmers

often lamented the damage fertilizer did to crops (Cafer et al. 2015). They described the fertilizer as “burning the crop” or “not suitable for their land” or their kind of production, which is mainly rain-fed.

Farmers in the study area explained that in the absence of rain within days of application, fertilizer simply burned the soil and crop and there was a reduction in production for that particular growing season, a finding supported by previous work (Cafer et al. 2015). In support of this finding, many of the farmers who utilized irrigation, did not offer up the “burning” of crops or soil as a reason for their hesitancy to use fertilizer. Further probing into how fertilizer is used, dispersed on the field, and the rates of application revealed farmers have very little practical knowledge about appropriate amounts of fertilizer to use or rates of application, highlighting critical gaps in extension services.

Juxtaposition of Perspectives

The rural population in Ethiopia is projected to increase from 69 million in 2010 to more than 90 million in 2030 (Headey et al. 2013). The inevitability for further land fragmentation under current land tenure policies is clear. Land fragmentation is not a novel issue to Ethiopian farmers, but the specific role it plays in keeping farmers from implementing new technologies is not well documented from the farmers’ perspectives. This study helps shed light on how the outcomes of poorly conceptualized land policies, exacerbated by a growing rural population, are preventing farmer investment and innovation on small farms. Land fragmentation is clearly a major barrier for farmers to adopt row planting, particularly in light of the extra work required to implement the practice on multiple plots.

However, interviews with local PSNP officers and extension agents reveal that at an administrative level land fragmentation is seen as a mechanism to distribute well-endowed land

and degraded plots evenly among farmers. Soil health and land degradation have very sharp spatial boundaries in the Ethiopian highlands and often the difference between a productive plot and a degraded plot is only a few meters (Interview with PSNP personnel January 24, 2015). A PSNP official who works in the study villages noted that a farmer may have his land divided among several plots, but this increases his chances of having at least part of his land located in a highly productive area then all of his land located in a more degraded location [Interview with PSNP personnel January 26, 2015 and Zonal Extension Officers February 18, 2015].

The juxtaposition of these viewpoints often places farmers and extension workers at odds with each other. This is further compounded by the compulsory nature of input purchases and the role extension agents play in them. This tension also means farmers are unable to communicate their on-farm observations properly to extension and receive the appropriate information. In this sample farmers experienced increases in episodes of *tef* rust, yet there has been very little research on the potential impacts of fertilizer application on *tef* rust and farmers felts as though they were not receiving proper information. Furthermore, in some extreme cases, farmers will make outward appearances of compliance but simply make a show of using the new technology to keep the extension agents at bay. An enumerator made a noteworthy observation of farmer behavior and with further probing was able to establish:

> *"They are using row planting on a much smaller piece of land only to avoid being detected by the government people and labeled as trouble makers; instead, they are using broadcasting much more regularly and on a much bigger piece of land."* Eyob Gebremehdin (February 4, Kuty field visit)

Conclusion

While the national government and extension system promote agricultural modernization as part of the nation's strategic economic plan, farmers are navigating an increasingly volatile system—environmentally, economically, and politically. As such, production in the Ethiopian highlands is hardly the idyllic agrarian past time portrayed by the government through their national and international media campaigns. Rather, farming has become a life of compulsory practice and shrinking means of production. In order to support agrarian livelihoods and improve farmer investment, Ethiopia must reconsider its land tenure policy, beyond the symbolic "permits" provided to farmers. Farmers must also be able to access the AKIS without the complications of dealing with an agricultural input retailor—the simultaneous role extension agents have taken on under government pressures to modernize.

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CHAPTER 3. KHAT: ADPATIVE COMMUNITY RESILIENCE STRATEGY OR SHORT-SIGHTED MONEY MAKER

Abstract

Khat (Catha edulis) is perennial bush originating in East Africa. This shrub's leaves and twigs are sold in East African and Middle Eastern markets for their narcotic effect. Also known as chat, qat, or mirra, khat has become an exceeding popular topic in both the health and policy arenas. Dating back to 1984, there have been no less than 20 separate international conferences dedicated to the discourse of use, health, and addiction associated with khat use, and a growing concern for issues related to khat production and use related to terrorism, and migration into both Europe and the US. There have been a number of papers and conference presentations related to cardiovascular and oral health, mental health and cognitive processes, and monitoring and policy. However, there has been relatively little research on khat's association with food security (see Gezon 2012), which is foundational to human health and well-being, and research linking khat to validated cross-cultural measures of food security is non-existent. The majority of studies contextualizing khat production in terms of food security, focus on khat's displacement of food crops, namely cereals. This study, surveyed 115 farmers, in the Amhara Region of Ethiopia, and found khat to be positively associated with food security, as measured through the Household Food Insecurity Access Scale. This study also found khat producers do, in fact, continue to dedicate portions of their land to food crop production. However, there is reason for caution before embracing khat as a community resilience strategy, given its heavy reliance on irrigation for intensive production, and the relatively unregulated nature of water withdraws in Ethiopia.

Khat as an (Mal)Adaptive Community Resilience Strategy among Ethiopian Smallholders?

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Khat (Catha edulis) is perennial bush originating in East Africa. This shrub's leaves and twigs are sold in East African and Middle Eastern markets for their narcotic effect. Also known as chat, qat, or mirra, khat has become an exceedingly popular topic in both the health and policy arenas. Dating back to 1984, there have been no less than 20 separate international conferences dedicated to the discourse of use, health, and addiction associated with khat use, and a growing concern for issues related to khat production and use related to terrorism. There have been a number of papers and conference presentations related to cardiovascular and oral health, mental health and cognitive processes, and monitoring and policy. However, there has been relatively little research on khat's association with food security (see Gezon 2012), which is foundational to human health and well-being, or its place in the agrifood system. Furthermore, research linking khat to validated cross-cultural measures of food security is non-existent. The majority of studies contextualizing khat production in terms of food security, focus on khat's displacement of food crops, namely cereals. In this study 115 farmers in the Amhara Region of Ethiopia were surveyed. Data revealed khat to be positively associated with food security, as measured through the Household Food Insecurity Access Scale. This study also found khat producers do, in fact, continue to dedicate portions of their land to food crop production. However, there is reason for caution before embracing khat as a community resilience strategy, given its heavy reliance on irrigation for intensive production, and the relatively unregulated nature of water withdraws in Ethiopia combined with the detrimental health impacts of khat addiction endemic in the region today.

Khat as an (Mal)Adaptive Community Resilience Strategy among Ethiopian Smallholders?

Introduction

Community resilience has become a dominant theme in the international development arena. Understood generally as a community's ability to withstand, mitigate, or adapt to outside pressures and shocks, community resilience encompasses the geospatial qualities of community, important to programming and intervention implementation AND the capacity building component critical to sustainable development (Adger 2008; Cutter et al 2008; Longstaff et al 2010; McAslan 2010; Norris et al. 2008; Oxley 2013, Twigg 2009). Community resilience is also important in conceptualizing particular adaptive strategies within the matrix of community capacities and understanding the implications for resilience outcomes—food security, nutrition, economic security, and environmental security. This study will examine khat production as a specific adaptive strategy situated within a larger resilience strategy. By looking at khat's potential in bolstering resilience through improved food and economic security, while subsequently increasing vulnerability through reduced health outcomes and potentially severe natural resource degradation. Examination of khat's role in bolstering resilience will use primary data from a mixed methods study conducted in South Wollo, Ethiopia, while the latter issues of increasing vulnerability will utilize a vast literature documenting poor health outcomes from khat consumption in Ethiopia and a popular case, Yemen, where khat production has depleted scarce water resources.

Community Resilience Framework

The framework presented here (Fig. 1) is a simplified version presented by Frankenberger et al. (2013, p. 9) in their conceptual framework paper, which is subsequently adapted from CARE (2002), DFID (2011), Frankenberger et al. 2012, TANGO (2008), USAID (2012).

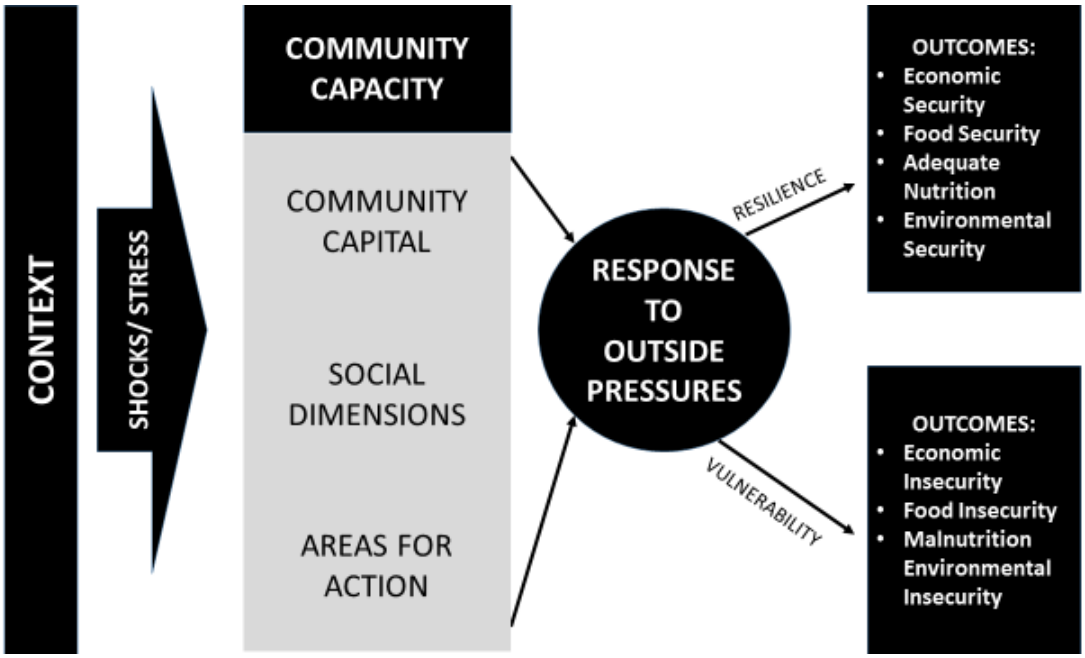

Figure 1. Resilience Framework adapted from CARE (2002), DFID (2011), Frankenberger et al. 2012, TANGO (2008), USAID (2012).

This framework is useful in its ability to integrate a variety of situational nuances in context, capacity, and outcomes to explore the absorptive, adaptive, and transformative capacity possibilities at a community level. This allows for the possibility of targeting specific strategies to help limit exposure (absorptive), facilitate proactive strategies (adaptive), and rework regulatory institutions (transformative) in order to increase resilience to shocks in a sustainable and systematic way. The framework consists of five major components: (1) context; (2) disturbance; (3) Community Capacities; (4) Resilience and Vulnerability Pathways; and (5) Livelihood Outcomes. Context encompasses the conditions which impact the nature of disturbances and of community resilience. Disturbances are the specific shocks (short-term or rapid onset) and stresses (long-term) which a community may experience, given the context. These events can

affect the community as whole (covariate), or only specific households (idiosyncratic), in many cases the most vulnerable (Frankenberger et al. 2013).

There are three elements to community capacities—assets, social dimensions, and areas for collective action. The community assets component utilizes the USAID community capitals framework and outlines the measurable and immeasurable assets communities possess to meet basic needs. There are six types of designated capital within the community capitals framework—social, human, financial, natural, physical, and political. Social dimensions of the community refers to a sub-set of qualities which allows the community to manage its assets, including flexibility, innovation, and diversity, among others (Frankenberger et al. 2013). In order for communities to effectively leverage their assets and maximize the benefits of their situationally specific social dimensions, communities must work strategically within specific areas of risk management or mitigation. These areas are related to specific elements of resilience such as conflict management, natural resource management, and social protections. As communities work within these areas of risk mitigation they necessarily set a path for improved resilience or increased vulnerability. These pathways are not static and are continually evolving as communities work or neglect different areas or risk management and degrade or build specific assets. Each of these pathways leads to certain, universally accepted outcomes, which are indicative of resilient (or vulnerable if they are absent) communities: economic security, food security, adequate nutrition, and environmental security (Frankenberger et al. 2013).

This conceptual framework is particularly useful when discussing smallholder systems. Within this framework community is understood to be a coupled social and ecological system (Wilkinson1999). Understanding that smallholders rely heavily on their available natural resource base is key to understanding how they make decision about their resilience strategies.

Within these systems social interactions, the hallmark of a community, are shaped and in turn shape the natural environment within which they take place (Wilkinson 1999). Agriculture is the expression of this dynamic interaction between society and the environment. Though this simplified framework might visually relegate this concept to environmental context, the environmental condition is paramount among other conditions for smallholders. This study will examine how the natural system has provided a context which promotes the use of khat as a resilience strategy and will subsequently discuss the implication of khat production for the environmental conditions within which smallholders live.

What is Khat

Khat (*Catha edulis*) is a perennial tree crop, native to Ethiopia, that once established becomes a long-lasting agricultural crop, producing harvests for up to 75 years (Gebissa 2004; Getahun and Krikorian 1973; Tefera et al. 2003). Khat is propagated using suckers rather than seeds, which can make investment start-up costs, as well as expansion costs, very low and once established khat fields often remain productive for generations (Feyisa and Aune 2003; Getahun and Krikorian 1973). Khat can be produced under both irrigated and rain-fed conditions, making it attractive to resource poor farmers who may not have access to irrigation. Under rain-fed conditions it will produce up to two crops each year, and though not as productive as irrigated khat, has substantial implications for household income. When irrigated, khat produced a harvest as many as five times a year, substantially increasing household income, with relatively little effort. Khat also has consistently garnered a greater net return than any other agricultural product in Ethiopia, including coffee. Khat's price is also relatively stable compared to that of coffee, the leading cash crop and export (NBE 2010, 2016; Fig. 2). This relatively low capital threshold to enter the market combined with the quick return on investment, (2-3 years before yielding harvest) has resulted in widespread adoption of khat production among smallholders, especially those with irrigation (Gebissa 2004). The growing international market for this crop

also explains khat consistency in among Ethiopia's top three agricultural exports by value and among the top five for all exports, including gold (NBE 2010, 2016; Fig. 2).

Khat's role in increasing cash income for smallholder households makes it an important buffer between households and hardship in East Africa and the Arabian Peninsula (Cafer et al. 2015; Gezon 2012). However, it is increasingly examined through the lens of public health and concerns with addiction, in addition to its role in soaking up productive land and water resources. Though originally used for Muslim prayer ceremonies, known as wodaja, khat has become widely utilized by Ethiopians for recreational purposes (Getahun and Krikorian 1973). Khat's stimulant and appetite suppressing properties make it important for Ethiopian farmers working long hours who may be required to forgo sleep and meals (Feyisa and Aune 2003; Getahun and Krikorian 1973). This stimulant property, a product of cathinone, which is recognized as a controlled substance by the US and much of Europe, tied to significant decreases in household productivity (Feyisa and Aune 2003). Khat addiction, and its associated health problems, are becoming recognized problems in many East African nations, particularly Ethiopia. There have been a number of papers and conference presentations related to cardiovascular, digestive, and oral health (Birhane et al. 2014; Al-Hebshi et al 2010; Al-Motearreb 2010; Hassan et al. 2007), mental health and cognitive processes (Bhui and Warfa 2010; Dhadphale et al. 1981; Hoffman and Al-Absi), and monitoring and policy (Csete 2014; Griffiths et al 2010; Klien and Metal 2010).

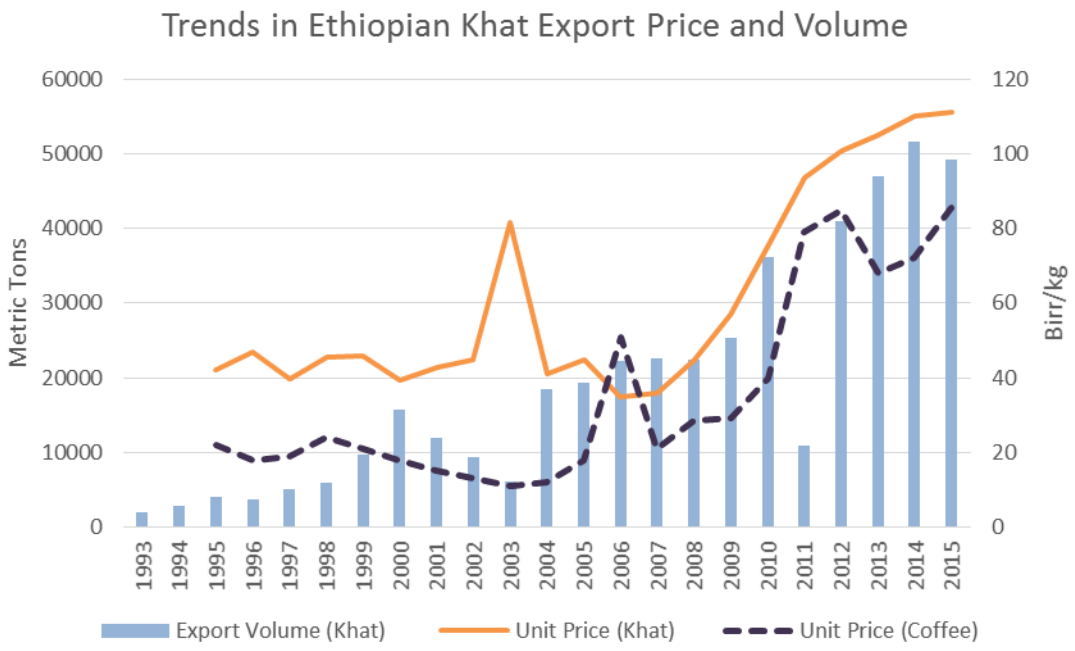

Figure 2. Export Data for khat and coffee in Ethiopia 1993-2015. Data from National Bank of Ethiopia

Food Security in Ethiopia

According to the United Nations Food and Agriculture Organization (FAO 2016), one in eight people globally (842 million) are chronically hungry, in that they are not regularly getting enough food. Ninety-eight percent of those who experience chronic hunger live in developing countries and 75 percent of these live in rural areas (FAO 2016; Feeding the Future 2013; WFP 2011). And despite significant shifts in agricultural production experienced throughout Asia and Latin America as part of the Green Revolution, Africa has largely failed to benefit from these types of innovations, often as a result of poor infrastructure, political instability, and a failure of the global agricultural information and knowledge system to appreciate the nuances of smallholder agriculture in Africa. Consequently there was no real increase in per capita food production prior to the 1990s (Barrett 2010). However, despite a 12% increase in per capita food production since

1990, Africa is the only continent to experience an increase in the number of hungry people from 1990-2012 (Barrett 2010; FAO 2016). As the conditions under which smallholders are forced to farm continue to shift with climate change, continuing exposure food insecurity seems inevitable.

Ethiopia is no exception. The nature and impact of food insecurity is much higher in Ethiopia. More than 38 percent of Ethiopians live below the international extreme poverty level ($1.25/day) and families, particularly in the highlands, are often marginally food secure at best, as even with good harvests, they face consistently poor production (Awulachew 2007; Central Statistical Agency [CSA] 2012a; Croppenstedt and Muller 2000; Devereaux 2000; FAO 2002, 2003; Makombe et al. 2007; WFP 2011; World Bank Group 2013). Because of chronic food insecurity nearly half of families in Ethiopia are malnourished, despite a clear majority (85%) of the population engaging in food production (CSA 2012a; Croppenstedt and Muller 2000; FAO 2002, 2003; Makombe et al. 2007; World Bank Group 2013).The acute negative consequences of persistent malnutrition, such as stunting and wasting, underwritten by chronic states of poverty and food insecurity, often result in more devastating costs. One in eleven Ethiopian children dies before their fifth birthday, often as a result of malnutrition weakening autoimmune responses to conditions such as anemia, acute respiratory infections, and diarrheal disease, all of which disproportionately impact rural populations (CSA 2012b; Wenhold et al. 2007).

In recognition of such dire circumstance, Ethiopia received more than $3.8 billion in official development assistance (ODA) in 2013, third only to Afghanistan and Viet Nam (Global Humanitarian Assistance 2016). However, the USAID Initiative, Feed the Future,

(2013) estimates that seven to eight million Ethiopians remain chronically hungry. As the national population size continues to increase at an annual rate of 2.9 percent, the demands on food resources are likely to continue to overwhelm current domestic production capacity (Feed the Future 2013).

Khat in a Community Resilience Framework

Context and Shocks: Khat production in this region is a response to both environmental and socio-economic shocks as well as political and demographic stress (Cafer et al. 2015; Gebissa 2010). The primary environmental shock is drought. Severe drought, which results in massive livestock and crop loss, in addition to a significant loss of human life on a national scale, occurs every eight to ten years in Ethiopia, while seasonal drought, the result of rainfall shortage during critical times in the growing season, occurs every two years (Croppenstedt and Muller 2000; Kebede 2008; Salama et al. 2001). However, climate change has increased rain variability and as a result seasonal drought is a much more frequent occurrence (Araya and Stroosnijder 2011; Deressa and Hassan 2009; Desalegn et al. 2006). Drought combined with a highly variable access to quality natural resource base and increasing costs of food and services, push farmers to explore a variety of mitigating and adaptive strategies (Dar and Twomlow 2007; Davis et al. 2012; Hounkonnou et al. 2012). To compound these drivers of insecurity, farmers must also deal with the added pressures of population induced land fragmentation (Feed the Future 2013; Hounkonnou et al. 2012). All land is property of the Ethiopian Government, which redistributes land and determines plot size in part by family size. Often, to achieve the desired number of hectares, local land authorities must piece together several plots in various locations, increasing both the amount of work needed to eke out a living, and the

variability of good quality natural resources (i.e. productive land, reliable water source) available. This variability is due to the sharp spatial boundaries of good soil and productive land in the Ethiopian highlands. In many cases the difference between a productive plot and a degraded plot is only a few meters (Interview with PSNP personnel January 24, 2015).

Capacities: Khat requires the mobilization of natural (planting space, soil, water), and early in a crop conversion cycle, a minimal amount of financial and social capital. Khat is also part of historic system of production and rotation which embraces diversity. Ethiopia smallholders are intimately acquainted with risk, and have for centuries, cultivated social, and subsequently agricultural, systems which embrace flexibility and diversity in response to dynamic climate and political conditions (Gebissa 2004; Mendola 2007). This said, as agricultural production continues to make shifts, i.e. from mostly cereals to predominantly khat in some cases, the need for collective management of natural resources, is critical. Khat is a water thirsty plant, which requires extensive irrigation to produce maximum yield (up to five crops a year). Even farmers who may initially produce khat under rain-fed conditions will soon earn enough income to establish an irrigation system. Yemen serves as stark warning. Khat production currently absorbs 30-40% of Yemen's water sources, and has accelerated drought in key khat producing regions forcing the government to relocate its citizens (Butters 2009; Kirby 2007). In the Ethiopian context, the role of community level organization around the collective management of water usage will be critical in mitigating some of these potentially environmentally caustic side effects of khat production.

Outcomes: The literature has mixed reviews on khat's ability to bolster the livelihood outcomes proposed in the framework. Though khat clearly increases household income (Cafer et al. 2015; Gebissa 2004), the impact on food security, the outcome being measured in this study, is less definitive. There has been relatively little research on khat's association with food security (see Gezon 2012), which is foundational to human health and well-being, and research linking khat to objective validated cross-cultural measures of food security is non-existent. The majority of studies examining khat production impacts on food security focus on khat's displacement of food crops, namely cereals, and the loss of self-provisioning efforts by farmers (Cafer et al. 2015; Feyisa and Aune 2003; Gezon 2012). This juxtaposition of khat and food crops is problematic for a number of reasons. The first being that farmers often intercrop cereals, such as maize, with khat for household consumption, and this practice actually reduces the labor associated with maize production (Feyisa and Aune 2003). Additionally, these houses, even prior to khat production, did not rely solely on household production for their household food provisions, and there for the added purchasing power that comes with khat income would serve as a food insecurity buffer, necessitating a validated, standardized measure of food security related to consumption rather than production (Cafer et al. 2015)

Khat could easily be classified as either an absorptive or adaptive strategy. As an income diversification method designed to increase economic security, khat's ability to help households absorb micro-shocks is documented (Cafer et al. 2015; Gebissa 2008; Gezon 2012). However, this paper will argue that khat is a more proactive approach by farmers to adapt to potential shocks, including increasing rain variability, and farmers' dedication

of significant tracts of productive land to the production of khat could be viewed as a shift in livelihood strategy—aligning more with adaptive strategies.

Methods

Study Site and Data Collection

Data were collected from December 2014 to March 2015. Research participants were selected from three peri-urban highland villages in the South Wollo zone of the Amhara region—Boru Seyu, Amemo, and Kuty. Villages were stratified in a way to provide information on a variety of production systems, agroecological conditions, and differing experiences with the AKIS. Within each village accessibility sampling was used. A total of 115 farmers were surveyed. Only farmers currently growing tef were included. In addition to interviews with farmers, this research included interviews with five extension agents, two regional extension directors, one kebele chairmen, and one regional Productive Safety Net Programme administrator.

This zone is characterized by small diversified production, integrating cereals, pulses, livestock, and some cash crops. B. Seyu is located on the periphery of Dessie town, a major urban area in the region. Farmers in Boru Seyo are the most marginalized group within this sample. There is no cash crop production and cereal production is marginal at best. Farmers in B. Seyu tend to work in Dessie town or sell forestry products (firewood, charcoal, building materials) to supplement household income. In Amemo farmers are more likely to have a highly diversified production system, growing mangoes, oranges, coffee, and guava in addition to cereal and pulse production. However, farmers rely mostly on cash crop production and farmers here tend to be much wealthier than in surrounding communities as a result. Kuty farmers, like those in Boru Seyo, live at the

edge of an urban area, Hyke. Many of the families in this village have members who work in the village as an income diversification strategy. Kuty farmers, like Amemo also have a more diversified production system, including khat, vegetables, cereals, and pulses. Demographic characteristics for each village are available in table 1.

Because this research seeks to explore the potential of khat as an adaptive resilience strategy the relationships between khat and food security, livestock (economic security) and food crop production were tested. Food security is a key indicator of community resilience, while livestock, in a system where wealth is not built through traditional methods (land ownership) is a proxy for economic security, a second important indicator of community resilience (Little et al. 2002, 2004, 2006). Additionally, in response to critiques that khat is responsible for subverting food security through limited ability to self-provision, this study includes the number of cultivated hectares, specific to food crops.

Table 1. Village level characteristics.

		Dessie Ketema	Tehuledere	
		Boru Seyu/012 (N = 40)	Amemo/008 (N = 23)	Kuty/005 (N = 53)
Cereal /Pulse Crops	Belg *(Mar-April)*	Barley; wheat	Wheat	Wheat; vetch
	Meher *(July-Oct)*	Tef; barley; maize; pea; fava	Tef; sorghum; vetch; maize	Tef; sorghum barley; chickpea
Production	Cultivated Area (Ha)	0.92	0.68	0.68
	Belg (%)	0.56	0.25	0.22
	Meher (%)	0.44	0.75	0.77
	Tef (%)	0.10	0.60	0.48
Rai n	Belg	276	341	341
	Meher	912	828	828
Altitude (MASL)		2500	1900	1800
Distance to Market		<1	8	<1

Questionnaire

A structured questionnaire was used to collect data on agricultural production, including khat production and animal stocks, as well as data on household food security status.

Standardized khat income

Information on income from khat was collected in Ethiopian Birr (ETB) and was standardized to better determine the odds ratio during multinomial logistic regression analysis. Standardization was calculated [(X – mean khat income) / standard deviation for khat income)] → [(X-5591) / 9599] = 1 united of standardized khat income. One unit of standardized income (15190 birr) is equivalent to $697 USD.

Total livestock units

Livestock were self-reported counts of the major productive types of animals (oxen, cow, sheep, camel, donkey, horse, chickens). This data was used to calculate the total livestock units (TLU) per household. TLU is an indicator using Sub-Saharan African weighted livestock counts: oxen/cattle/horses (0.5); camels (0.7); goats/sheep (0.1); chickens (0.01).

Food security status

This study also utilized the Household Food Insecurity Access Scale version 3 (HFIAS, Coates et al. 2007) to assess household food security status, which has been used extensively in the Ethiopian context. The HFIAS measures both anxiety levels related to difficulties accessing food as well as changes in both diet quality and quantity. The HFIAS is used to calculate two values—HFIAS score (0-27) and category (1-4).

Sample Question:

1. In the past four weeks, did you worry that your household would not have enough food? 0 = No (skip to Q2) 1 = Yes	occurrence
1.a. How often did this happen? *1 = Rarely (1-2 times in the past four weeks)* *2 = Sometimes (3-10 times in the past four weeks)* *3 = Often (>10 times in the past four weeks)*	frequency, used to calculate **HFIAS Category and Score**

HFIAS score is based on responses to the nine "frequency" questions which are designed to assess initial and increasing levels of food insecurity (Coates et al. 2007). For each of the nine follow-up questions a household established the frequency of a particular occurrence as rarely (1), sometimes (2), or often (3). Households, based on responses, receive a score ranging from 0-27, with 0 (for households answering "no" to occurrence questions) indicating completely food secure and 27 (answered "often" to all of the frequency questions) the most severely food insecure.

HFIAS category is also calculated using the frequency questions, and is used to classify households into one of four categories:

1. Food Secure: may experience some anxiety over access to food, but rarely
2. Mildly Food Insecure: experiences more anxiety over access, but only rarely experiences adjustments to their diet
3. Moderately Food Insecure: sacrifices diet quality frequently but rarely sacrifices quantity
4. Severely Food Insecure: frequently sacrifices both quality and quantity

Mulitnomial Logistic Regression

The relationship between khat income and livestock, khat income and HFIAS score, and khat income and hectares of cultivated food crops were tested through simple Pearson correlation. For this sample, the HFIAS score was not normally distributed, so HFIAS category was used as the dependent variable, which made multinomial logistic regression

analysis the most appropriate method of analysis. Additionally, the nuance captured by the HFIAS score is more important with regard to examining food insecurity over time, whereas this study is capturing merely a snapshot, making HFIAS category an equally appropriate measure.

Results

Pearson correlation revealed cash income from khat is significantly and positively associated with the number of camels a farmer owns, (0.245, $p = 0.012$), as well as the number of months of food stored (0.312, $p = 0.002$), and is significantly and negatively correlated with HFIAS Score (-0.425, $p = 0.000$). Table 2 provides a breakdown of these variable between khat and non-khat producers in the sample. Of special note is that the correlations are tied to khat income and not just khat production which is why for some categories there is not a large difference in numbers (e.g. TLU) between khat and non-khat. Additionally, TLU uses weights to value animals based on their usefulness and productivity. For khat farmers, their livestock holdings are made up of highly valued (oxen, cow, camel), but fewer animals, compared to non-khat farmers who own more animals with lower value (horses/donkeys, sheep, chickens). On average, farmers in this sample produced and stored enough food (self-provisioned) to last approximately eight months (±2.97 months), and had an average HFIAS Score of 12.3 (±5.38).

The overall average for khat income was 5065 ETB (±9531 ETB) and average TLU was 1.97 (±1.10). However, for khat producers, food stores were extended by at least a month on average (nine months, ±2.89) and the HFIAS score dropped by more than 1 (11, ±6.42). These farmers on average earned 10787ETB (±11512ETB) from the sale of khat.

Table 3 shows values for each of these variables across each of the HFIAS categories—severely food insecure, moderately food insecure, mildly food insecure, and food secure.

Table 2. Comparison between khat and non-khat producers

	TLU	Oxen	Cow	Camel	Sheep Goat	Donkey Horse	Chicken	HFIAS Score	Stored Food (months)	Cultivated Area (Ha)
Sample	1.97 (1.10)	0.98 (0.64)	0.76 (0.63)	0.03 (0.29)	2.07 (1.90)	0.05 (0.26)	2.63 (2.97)	12.30 (5.38)	8.09 (2.97)	0.73 (0.28)
Khat	1.98 (0.95)	1.15 (0.53)	0.94 (0.53)	0.06 (0.41)	1.72 (1.61)	0.02 (0.14)	2.34 (3.16)	11.02 (6.42)	9.13 (2.89)	0.69 (0.23)
Non-Khat	1.97 (1.24)	0.80 (0.69)	0.57 (0.67)	0.00 (0.00)	2.43 (2.12)	0.08 (0.34)	2.94 (2.75)	13.42 (3.99)	6.64 (2.45)	0.79 (0.33)

Table 3. Descriptive Statistics for Food Security and Khat Production

	Severely Food Insecure (N = 68)		Moderately Food Insecure (N = 31)		Mildly Food Insecure (N = 10)		Food Secure (N = 4)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Months of Food	7.63	2.62	8.33	3.64	9	2.87	9	3.56
HFIAS Score	15.57	3.09	9.53	2.74	3.60	1.84	0	0.00
Avg khat income	2713	5514	5484	10298	11300	13149	20500	22898

Multinomial Regression Analysis

Initial correlation showed a significant inverse relationship between khat income and HFIAS Score; indicating increased income from the production of khat was significantly correlated with positive food security status (reducing the HFIAS score reduces the likelihood of food *in*security). Because this correlation was significant, further analysis was needed to determine the nature of the effect of khat income on food security status. The model (Table 4) correctly classifies 98.5% of severely food insecure households, 9.7% of moderately food insecure households, no mildly food secure households, and 25% of food secure households. The Exp(B) values indicates that for every unit increase in khat (income households are 1.7 times more likely to be mildly food insecure than

severely food insecure, but more than 4 times as likely to be food secure than severely food insecure.

Table 4. Multinomial Logistic Regression for Khat and Food Security Status

	Severely Food Insecure (N = 68)		Moderately Food Insecure (N = 31)		Mildly Food Insecure (N = 10)		Food Secure (N = 4)	
	β	Std. Error	β	Std. Error	β	Std. Error	β	Std. Error
Khat Income	Reference group		0.531	0.324	0.995	0.368**	1.438	0.459**
Chi Square	14.270							
-2 Log Likelihood	87.47							
Cox and Snell	0.119		Nagelkerke	0.137				
Model Sig	0.003							

p < 0.05*; p < 0.01**; p < 0.001***

Discussion

*Eco*nomic and Food Security

Khat production in Ethiopia has increased exponentially in the last 20 years, making Ethiopian the leading source of khat worldwide. The amount of land under khat cultivation has increased 160%, from less than 100,000 hectares to more than 250,000 hectares, in the last 15 years, with the second largest gain in khat hectares in the Amhara region with a 252% increase (Cochrane and O'Regan 2016). This is in part due to the higher per unit prices khat earns over any other agricultural product in the market, and the consistency of price from season to season of khat (Cochrane and O'Regan 2016; NBE 2010 & 2016). Additionally, once established the labor needed to maintain khat fields is significantly less than for most other agricultural products, especially grains and pulses (Gebissa 2004).

This rapid rate of expansion, has led to some concern within the agricultural development arena that household and community level food security are being jeopardized. However, there is documented evidence in the literature that khat is often grown alongside other food crops, and in fact reduces the amount of work needed to produce those crops (Feyissa and Aune 2003; Gebissa 2008; Gezon 2012). This study supports those findings as income from khat, indicative of the extent of khat within the production scheme, was not significantly associated with the number of hectares cultivated for food crops—positively or negatively, but positively and significantly associated with the number of months of food stores families controlled. In 2010 farmers in Amemo, one of the study villages, grew food crops during both the Belg and Meher seasons, but were only able to secure a little less than 2 months of food (Cafer et al. 2015). However, today, these farmers are able to store over 9 months of food and only produce food crops during the Meher season, suggesting khat income has afforded them the ability to purchase more food in the market place and serves as a buffer between households and food insecurity (Cafer et al. 2015).

Additionally, this study found that khat is positively and significantly associated with food security as measured through the HFIAS score. Further analysis in the form of logistic regression found khat producers were more likely to be mildly food insecure or food secure than they were to be severely food insecure. This is the first time khat has been definitely associated with positive food security outcomes as measured through a valid standardized cross-cultural food security measure.

Though this initial analysis suggest khat is perhaps a good use of community capacities, particularly available natural capital, there is an important caveat to the role of khat

income. The benefits we see from increased khat income on food security status is only seen at a threshold of $697 USD. Less than 26% of khat producers earned that much from khat production, suggesting the food security and economic security benefits from khat are not experienced universally by all producers. For all khat producers to experience these same levels of protection, they would need to produce khat more intensively. Therefore it is important to discuss the implications of relying heavily on intensive khat production.

Potential for Environmental Insecurity

This particular study did not measure water withdraws for khat use. However, examination of other cases, namely Yemen, combined with relevant literature and interviews with farmers from this study reveal, khat production with unregulated water usage may ultimately be a vulnerability pathway toward natural resource degradation. In Yemen khat (or qat) is produced intensively, using more than 40% of potable water, and current water availability is only 150m^3/capita compared to the regional average of 1250 m^3/capita (Almas and Scholz 2006). Perhaps most alarming is that as a direct result of the intensive irrigation used for khat production, surface and groundwater resources have been exploited beyond rechargeable levels in Yemen, and households are now being forced to relocated to the coasts (Almas and Scholz 2006; Kirby 2007).

Despite an abundance of freshwater resources Ethiopia's challenge is access to these water resources, which is made difficult by their temporal and spatial distribution. Currently Ethiopia only withdraws roughly 4.5% of its total renewable water resources, 70% of which is used for agricultural purposes (FAO 2002; World Bank 2012). Though they are at low risk of exhausting their water resources at this level of use, there is some

cause for concern as the number of irrigated hectares has double since 2002 (FAO 2003). Though only 2-4% of arable land is irrigated within Ethiopia's current borders, it is important to recognize that the FAO through the Ethiopian government, only tracks medium and large-scale mechanized irrigation systems, so their estimates fail to incorporate the impact of individual farmers using small scale hand forged systems (FAO 2002, 2003). Previous studies have found in Ethiopia between 40-100% of surveyed farmers utilize irrigation in their everyday agricultural practices (Cafer et al. 2015). These small scale irrigation schemes are often rudimentary in their construction with temporary headwork, unlined canals, and storage ponds and are extremely vulnerable to water loss through evaporation as a result of poor scheduling, e.g., watering during mid-day as opposed to evening, and often have a water use efficiency of less than 35% (Bekele and Tilahun 2006; FAO 2003). The average cost to improve underdeveloped structures can range from $1000 to $10,000 USD with the highest associated costs in Sub-Saharan Africa, which would be cost prohibitive even to intensive khat producers (FAO 2003). FAO (2003) predicts the amount of irrigated area will increase by 33% by 2030, and perhaps more with the expansion of khat production into all regions of Ethiopia, but with little noticeable improvement in water use efficiency, less than 40%. The increased reliance on irrigation for intensive khat production will be both aggravated by and exacerbate drought in the region.

This inefficient exploitation of natural capital, despite being part of a diversified system, is unlikely to bolster resilience unless communities work collectively on natural resource management. Water is acknowledged as a common property of the Ethiopian people and as such, usage is fairly loosely regulated by the Central Government (MoWR 2001). And

though Ethiopia's Ministry of Water Resources (MoWR) acknowledges both the need for exploiting these resources sustainably and the rampant inefficiencies in current exploitation, there is relatively little regulation or enforcement of sustainable management practices at the local community level (MoWR 2001). As interviews revealed, a number of smallholders, who did not already produce khat intensively, had plans to divert more of their on-farm resources, especially irrigation, to khat production, suggesting a critical need in community action around water management.

A Shifting Political Context

Though this paper is largely focused on khat production and its use as a resilience mechanism for communities, the consumption of khat bears some discussion, as the negative health and psychological effects experienced by khat users, has potentially significant implications for farmers' ability to continue producing and exporting khat at a good price. Khat contains cathinone, a schedule I narcotic (Cochrane and O'Regan 2016). The stimulant effect experienced by khat users, is much milder than similar drugs, such as amphetamines, but extensive use can have severe clinical outcomes such as oral decay, gastritis, and in extreme cases psychosis (Astatkie et al. 2014; Hassan et al. 2007). There is also a growing concern in Ethiopia, and abroad about the increased use of khat among college and even secondary school students, and the potential cumulative effects of lifetime khat use, started so early (Adugna et al. 1994; Dachew et al. 2015; Feyissa and Aune 2003; Gebrehanna et al. 2014; Gebresalssie et al 2013; Gelaw and Haile-Amlak 2004; Lakew et al. 2014). One study found nearly 5% of secondary school students are daily chewers (Reda et al. 2012).

This rise in concern over addiction, along with the presence of cathinone, and to some extent the association of khat with other illicit activities, such as terrorism, have resulted in a number of countries banning khat (Cochrane and O'Regan 2016; McCraw 2003). This international inclination toward regulating consumption and banning khat sale, has not gone unnoticed in Ethiopia. There have been some domestic efforts to regulate khat consumption by limiting where khat houses (areas where men gather to chew khat) can be located as well as the implementation of new regional taxes to reduce consumption (Belete 2012; Gebrehanna et al. 2014; WHO 2006 a,b). However, the Amhara state, where this research takes place, is not among those regions implementing this tax scheme (Belete 2012).

The resistance of the Amhara state to implement this tax is perhaps more indicative of a general attitude toward khat at an administrative level. Most trade of khat is domestic and as such is an important part of regional tax revenues, additionally, the export of khat, is a significant income generator for the national Ethiopian Government (Dessie 2013). This makes it unlikely that national policy will restrict the production of khat, even if they attempt to curb consumption. Additionally, the international bans on khat, have done little to curb consumption abroad, and suggest there is still a viable, long-term market for khat, and economic security is still a realizable outcome of shifting to khat production (Cochrane and O'Regan 2016).

Conclusion

Khat is a potentially important *short-term* adaptive strategy for community resilience among Ethiopian smallholders. Its role in boosting food security and economic security

in smallholder communities is clear. Yet, if water withdraws for the purposes of intensive irrigation of khat go unchecked, the long-term viability of khat as a resilience strategy is questionable at best, as it will ultimately, reduce the community's' ability be responsive to future shocks, particularly around water shortages. Additionally prohibitive regulatory mechanisms around khat consumption and the potentially severe negative health consequences of consumption might be viewed as potential vulnerability pathways, reducing resilience.

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