Understanding the Differential Impact of Institutions and Institutional Interventions on Smallholder Behavior and Livelihoods in Rural Ethiopia

Saweda Onipede Liverpool[1*], Alex Winter-Nelson [1], Shahidur Rashid[2]

[1]Department of Agriculture and Consumer Economics, University of Illinois, Urbana-Champaign
[2] The International Food and Policy Research Institute (IFPRI), Addis Ababa, Ethiopia

Introduction

The limited payoff of macro policies on poverty reduction and the disparity in growth experiences within African countries has revealed the importance of diversity in constraints faced by agricultural households and communities in sub-Saharan Africa. Often these constraints relate to market failures that limit the ability of households to efficiently participate in input and output markets. These observations have motivated research to understand what micro and meso level interventions could address these different constraints and improve livelihoods[1] in agricultural households.

Since Ethiopia's political transition in the early1990's, the government has embraced market-oriented economic polices. In conjunction, there have been initiatives by the government, donor communities and NGOs to improve farmers' access to modern technology and agricultural markets (Shahidur, Assefa & Ayele, 2006). Despite the efforts of diverse actors to promote agricultural innovation, household participation remains low in rural Ethiopia (Spielman et al, 2007). Furthermore, while statistics show a positive trend in overall economic growth since early 1990's, the aggregate poverty incidence in Ethiopia remains staggeringly high and little has been done to link these

* *Email address*: lliverp2@uiuc.edu; Tel: (+251-911-788525)

[1] Livelihood refers to the wellbeing of a household determined by the return of their physical (e.g. land) and human assets. It includes the capabilities, assets and activities required to make a living (Chambers and Conway, 1992). In this study, it is measured by household per capita consumption expenditures relative to the value of per capita minimum requirement; food and nonfood items.

institutional interventions to poverty reduction within rural communities. (EEA, 2005; Liverpool, 2006).

This research examines the differential impact of specific institutional interventions[2] on farmer behavior and livelihoods in rural Ethiopia. It adopts a broad definition of the term institution that includes market based institutions like cooperatives and farmers organizations, formal and informal credit arrangements[3] as well as institutional interventions by NGOs and other organizations[4]. To assess the differential effects of these various institutions across households with different poverty profiles, this study classifies farmers based on their poverty status generated using an asset dynamics model for rural Ethiopia (Liverpool, 2006).

Major constraints to participation in agricultural innovations (and also cited as possible explanations for poverty traps) include access to input and output markets (Carter & Barret, 2006). Given low volumes of production and high transactions costs in agricultural markets, utility (profit) maximizing behavior can lead small scale farmers to participate only minimally in output markets. Alternatively, innovation may be inhibited by lack of sufficient credit to acquire inputs, make investments necessary for modern technology practices or smooth consumption in times of need. Households could also lack adequate information on prices or the appropriate practice of various modern

[2] While future research (currently underway) intends to look at all the various different institutions mentioned here, this particular paper focuses on micro credit institutions, Ngo's and extension services, with brief reference to cooperatives and local institutions.

[3] Formal credit institutions are micro credit institutions while traditional institutions include Iddirs and Equbs. ***Iddir:*** is traditional community based insurance scheme in which a household head contributes a predetermined amount of money to the membership in order to be insulated from cash shortfalls in the event of death of a specified member of his family or himself. **E*qub*** *is a t*ype of saving or revolving fund arranged by members of a community

[4] Here we focus on interventions in terms of: providing market linkages, enhancing the performance of already existing institutions as well as projects in areas of irrigation, water harvesting, farmer training etc.

techniques introduced from without. These are all possible explanations for the limited adoption of various modern technologies and a preference for the status quo.

In this light, the Government of Ethiopia (GoE) and various development agencies have recently been promoting information dissemination (mainly via extension agents and NGOs), improved market access (via cooperatives and NGOs as well) and credit access through micro credit organizations. However, little has been done to explore who exactly takes advantage of these newly created opportunities and what the livelihood impacts are. Do these institutional interventions as currently organized, consider and incorporate the heterogeneous (often multiple) constraints faced by different kinds of poor farmers or do they have a one size fits all approach?

This study finds that not only are very poor households not able to accumulate enough assets over time to grow out of poverty, but they tend not to benefit from the increased market opportunities provided by these institutions and the production behaviors they promote.

Research Questions:

1. Does pay off from modern technology differ by initial poverty status?
2. Do interventions to promote modern technologies serve households to varying degrees, depending on the household's initial poverty status?
3. Can changes in the design of institutional interventions make those interventions more effective for households currently underserved and thus not participating in and/or not benefiting from modern technology use?

Significance of the Study

As the Government of Ethiopia (GoE) and various development agencies try to improve rural livelihoods by increasing farmer participation in agricultural innovation[5], this study improves the existing understanding of *who* benefits from participation in agricultural innovations and why. The factors that explain adoption of agricultural innovations by different kinds of rural households will indicate what different constraints are faced by different classes of households. These results will inform institutional interventions to better address such constraints and create an environment that enables a broader spectrum of farmers to take advantage of the potential gains from improved market access as well as new technology or profitable but relatively risky production patterns.

For policy makers involved in monitoring and evaluation, this analysis also shows why recognizing target group differences (e.g. using asset poverty typologies) are an important consideration in program development as well as program evaluation.

Academically, this study adds to the body of literature and knowledge on applied development economics generally and literature on bottom up approaches to poverty reduction particularly. It provides an analysis that uses both econometric and descriptive tools to assess how institutional interventions influence agricultural production decisions and consequently the livelihood of different smallholder farmers.

[5] Agricultural innovation refers to new crop varieties, new cultivation techniques, new sources of knowledge, and new market opportunities (IFPRI, 2006)

Overview of Related Literature:

Poverty Measurements and Poverty Status Classification:

The concept of poverty and its measurement has been and remains a well discussed topic in the international development literature. A lack of consensus on the appropriateness of various poverty measures exists and definitions of the term poverty continue to be reviewed and expanded. Historically, the concept of poverty had been centered on material deprivation measured by some representation of income (Cutler, 1984). Recently, the concept has been expanded to incorporate other aspects of human wellbeing such as limited human capital measured by lack of education and health, infrastructure and other public services, property rights, inability to exercise political freedom and the presence of widespread corruption (UN, 2005).

Operationally, past measures of poverty were based on flows of income or consumption which give a static view of poverty, but enabled the categorization of individuals or groups of individuals into a poor or non-poor status. However, flow measures are more prone to measurement error than stock variables like land or livestock because they are not often directly observable (Carter and Barrett, 2006). More recent studies have adopted an asset-based approach where the productive assets of a household (land, cash or credit, number and skills of family members) are the key determinants of a household's livelihood. The asset-based approach to poverty is also more useful because since it is based on asset contributions to livelihood, it not only gives a sense of current wellbeing but also permits a prediction of future individual or household livelihood.

In this light, this study uses an asset based measure of poverty[6] and its dynamics over 10 years (See Liverpool, 2006) to classify rural households in 15 Peasant Associations (PAs) [7] in Ethiopia. Recognizing that there are numerous ways of classifying households even with the asset poverty measure (e.g. low vs. medium vs. high, or by quintiles), the classification used in this paper is based on the persistence of a household's asset poverty status. It classifies households into those who were *Asset Poor* in every survey period, those who were *Asset Non Poor* in every survey period and those who transitioned in or out of asset poverty in three survey periods spaced five years apart.

Agricultural Innovation and Household Livelihood

New knowledge and technology are considered vital to the success of smallholder farmers whose livelihoods depend on innovation—new crop varieties, new cultivation techniques, new sources of knowledge, and new market opportunities (IFPRI, 2006). The usefulness of new knowledge or technology is often related to access to markets to provide inputs and an outlet for production. In Ethiopia, such access to both information and markets is commonly provided through various rural service providers like extension services (training and input provision), micro credit institutions or programs (credit), NGOs (alternative source of training and inputs) and cooperatives (output market access and input provision). They all constitute players whose relationships and policies influence the ways in which knowledge is generated, exchanged, and utilized by smallholders. They also create new opportunities for farmers to engage in markets.

Seen as a basis for increased production and income, participation in agricultural innovation is highly discussed. As mentioned, by Coppenstedt et al, 2003, the seminal

[6] A summary of how the asset index is generated can be found in the appendix
[7] Peasant associations (PAs) are similar to villages.

work on the key factors that affect adoption decisions is found in the work of Feder et al in 1986 and most research studies use some form of limited dependent variable analysis to identify the relevance of various factors in determining adoption in particular sites, regions or countries. However, little research has been done on the differential impact of these adoption decisions on livelihoods of different kinds of farmers. While modern studies (like Feleke et al, 2006 and Gabre- Medhin et al, 2003) look at the distributional effect of various technological advances (such as fertilizer use) on net buyer and seller farmers, not much has been done to analyze the differential impacts of such decisions on different farmers, given their poverty levels nor to identify the differential determinants of these participation decisions for different classes of households.

Theoretical Framework

This research assumes that agricultural households maximize some utility function subject to a cash income constraint, family time constraint, endowments of fixed productive assets and production technologies (all of which may be combined into a single "full-income" constraint) and prices of inputs, outputs, and non-produced consumption goods (Singh, Squire and Strauss, 1986). The solution to this constrained utility maximization problem determines the household's behavior in terms of level of consumption, allocation of land and labor, production technique and use of other inputs. If constraints that limit farmers' ability to participate fully in various markets are identified, we can conclude that to improve farmer livelihoods, there is a need to remove or reduce the identified constraints to create an environment for producers to adopt appropriate technologies and participate more fully in markets.

The agricultural household model following Sadoulet and de Janvry, 1995 can be described as:

$$\text{Max } U(c,z) \tag{1}$$

$$\text{s.t. } \sum_{i\in T} p_i c_i \le \sum_{i\in T} p_i\left(q_i + T_i\right) + S \quad \text{cash income constraint} \tag{2}$$

$$G(q,z) = 0 \quad \text{production technology} \tag{3}$$

$$p_i = \overline{p}_{i,} \quad i \in T\,, \quad \text{exogenous market price for tradables} \tag{4}$$

$$q_i + T_i \ge c_i\,, \quad i \in NT\,, \quad \text{equilibrium for non tradables.} \tag{5}$$

where c refers to household consumption, z is a vector of characteristics of the household; p_i is the exogenous market price for tradable goods; T_i is the household's endowment of any commodity i; S corresponds to net transfers received; $\overline{p}_i$ is the opportunity cost of product i. T and NT correspond respectively to the tradable and non tradable goods. Household behavior can be distinguished into production and consumption decisions. Production decisions related to tradable and non-tradable goods are represented by a system of supply and factor demand functions in the decision price p^*:

$$q = q(p^*, z^q) \tag{6}$$

The demand system is:

$$c = c\,(p^*, y^*, z^h) \tag{7}$$

Where z^q and z^h are household characteristics related to production and consumption respectively; and y^* the income decision. On the consumption side, the household

chooses the level of consumption which maximizes its utility. On the production side the household maximizes profit at prices p^* through the choice and allocation of inputs.

Analytical approach

This study focuses on three areas where recent institutional interventions are expected to have had a measurable effect on household production decisions in Ethiopia. These are: the adoption of production technologies such as fertilizer, irrigation[8] and improved livestock.

Institutional participation and its impact on household livelihood are modeled in a two step procedure. The first step looks at the effects of production behavior and its change on household livelihood for a sample of rural Ethiopian households between 1994 and 2004. The second step focuses on identifying the determinants of such behavior (i.e. adoption of modern technology) for different kinds of rural agricultural households.

While institutional participation (participation in credit programs) has been shown to influence the adoption of modern technology such as hybrid maize in Zambia (Kumar, 1994), numerous concerns have been raised on the potential simultaneity bias that arises from using the endogenous institutional (credit) participation as a regressor in the behavior change equation (Zeller et al, 1996). It is our hypothesis in this study that behavior change such as the adoption of modern technology is a function of a vector, "K", consisting of exogenous variables and endogenous institutional participation, "I", such that

[8] Improved seed is also considered but not in depth due to data limitations.

$BC_i = K + \beta I + E$ (1)

where BC_i is the agricultural household behavior change including; adoption of modern technology like fertilizer, improved seed use, improved livestock use or irrigation practices) by household *i*. K refers to a vector of exogenous variables capturing household i's physical and human assets as well as demographic characteristics and ***"I"*** captures institutional participation variables.

As discussed by Zeller et al, 1997, an estimation problem arises because of unmeasured household-level variables which affect program participation, "I", and behavior change(BC_i). This endogeneity problem renders OLS estimates of the effect of access to an institution "I" on production behavior change inconsistent. Like Zeller et al (1997), we address this problem by estimating of a variant of the standard sample selection model

$I^* = \alpha_1 v + E_1$ (2)

$BC_i = \alpha_2 K + \gamma_1 I + E_2$ (3)

where **I** = 1 if **I*** > 0 and **I** = 0 otherwise.

Equation 2 states that access to an institution or institutional intervention program "I", depends on a set of variables represented by "v". Equation 3 states that a household's production behavior change and intensity, respectively, depend on another set of variables, "K" and access to institution program "I". Because the random error terms, E_1 and E_2 are likely to be correlated given that unobserved household variables affect both I and BC_i estimating equation 3 by OLS will lead to simultaneity bias. Thus we use a two-stage procedure to produce unbiased and consistent estimates of adoption, given that access to the institution is an endogenous variable (Maddala, 1983). In the first

stage, an estimate of I (I*), is obtained by probit maximum likelihood method for equation (2). The predicted probability is then used in the second stage to obtain estimates of modern technology adoption and intensity.

Data

This study uses both primary and secondary data. Primarily, the data used are from the Ethiopia Rural Household Survey (ERHS). This dataset contains detailed information on consumption, assets and agricultural activities of rural Ethiopian households and is the product of a longstanding data collection effort. It started in 1989, when a survey team visited seven Peasant Associations in Central and Southern Ethiopia. In 1994, the survey was expanded to encompass 15 Peasant Associations (PAs) across four regions, yielding a sample of about 1477 households. An additional round was conducted in late 1994, with further rounds in 1995, 1997, 1999 and 2004.

This data has already been used to understand the dynamics of livelihoods in rural Ethiopia[9] and set the stage for this further analysis of the roles of institutions on farmer livelihood. Secondary data is based on national reports on rural Ethiopia, interviews and documents from various institutions including microfinance organizations, cooperatives, NGOs international donor agencies (e.g. IPMS[10]) as well as from representatives of local organizations like Equbs and Iddirs.

Descriptive Statistics

[9] A livelihood dynamics model was developed with this data and has been used to categorize households based on a static Asset poverty measure as well as a dynamic asset poverty measure. For more details, see, An asset based approach to poverty status classification in Rural Ethiopia by Liverpool, S, 2006

[10] IPMS is a project coordinated by The International Livestock Research Institute (ILRI) the Ethiopian Ministry of Agriculture and Rural Development (MoARD), and the Canadian International Development Agency (CIDA) to improve the productivity and marketing success of Ethiopian farmers

Apart from weather shocks due to droughts in 1999 and 2002 and a price collapse for cereals experienced in 2001/2002, Ethiopia as a nation has recorded (on average) a positive growth trend since the nation's transformation to a market oriented economy in the early 1990's (EEA, 2005). This national experience is largely reflected in the ERHS data by general consumption growth (Dercon, S, 2006) as well as a generally positive trend in the asset poverty dynamics for most sample PAs (Liverpool, S, 2006). Table 1 shows the change in mean real consumption per capita[11] of households adjusted yearly by the consumer price index.

While the "Always Non Poor" households reflect a somewhat constant rate of consumption growth just above 10%, it appears that households in the "Always Asset Poor" category only began seeing improvements after 1999 with those in the transitorily poor class showing a slight decline (less than 1%) between 1999 and 2004. Breaking up the "Transitorily Poor" into those who ended up "Asset Non Poor" in 2004 and those who ended up "Asset Poor" that year, reveals that those who eventually grew out of poverty show the normal inverted "u" growth pattern, with consumption increasing rapidly (over 35%) between 1994 and 1999 and then slowing down (19%) between 1999 and 2004. For those who ended up declining into poverty, it appears that this was probably due to negative experiences between 1999 and 2004 as consumption increased by over 20% for that group between 1994 and 1999 but then fell between 1999 and 2004. This might be due the persistent effects of shocks such as the 2002 drought or the maize price collapse (Dercon, S. 2005).

[11] This study uses real consumption per capita in line with the argument stated by Dercon et al, 2005 (citing Dercon and Krishnan (2003)) that earlier survey rounds, using various permutations of adult equivalency does not fundamentally affect the analysis of the determinants of living standards than when per capita consumption ins used.

Modern technology practices are generally accepted as important contributors to improved agricultural productivity with their role in developing countries recognized.(Arndt et al., 1977). Increased cereal and pulse production (which could be directly affected by modern technologies) have also been associated with consumption growth in the ERHS households and are reflected in Tables 2-5. Though efforts to promote modern technology adoption in the form of irrigation techniques, improved seeds and fertilizer date back to the era of the green revolution, their success has been limited in Ethiopia and sub-Saharan Africa generally (Asiema, J. 1994). Adoption rates for some modern technologies (e.g. improved seed, improved livestock, fertilizer and irrigation) in the ERHS sample are generally low reflecting the national trends (IFPRI, 2007). However, the ERHS data reveals that there has been some growth in their use and where fluctuations or reductions exist, convincing logical explanations exist. (ERHS, 1994, 1999 & 2004).

Fertilizer use in Ethiopia increased significantly in the 1990's. Data on fertilizer use collected by the International Food Policy Research Institute and the Ethiopian Development Research Institute (IFPRI/EDRI) between 1995 and 2004 show a continued increase till about 2000 and then a decline in 2001 and 2002, slowly picking up in 2003 and significant growth again in 2004. Our data reflects the increased fertilizer use up to 1999. However, there is a general decline in the overall fertilizer use across the entire sample in 2004. Given that the survey questions ask about input use in the last 12 months, we can expect that they captured input use for 2003 when there was a general slack in input use following the price collapse of 2001/2002. [12] Table 2 shows the proportion of

[12] We could also be catching some of the effects of the price collapse. See Dercon et al, 2005 for detailed discussion on the effects of shocks between 1999 and 2004

the various categories of rural households who used fertilizer in the survey years used for this analysis.[13] While fertilizer use remained stagnant for the Always Asset Poor households, it increased by 5 percentage points for the Transitorily Poor[14] and 10 percentage points for the households who were constantly Asset Non Poor. However, by 2004 we see a general decline in fertilizer use and a more equal representation of fertilizer users amongst the different groups.

Similarly, Tables 3 and 4, describes irrigation and improved seed use amongst households in the different asset poverty classes. It can be seen that the experience of practicing irrigation shows higher usage as well as higher growth in proportion of households that adopt these practices in the Always Non Poor and Transitorily Poor group than amongst the Always Asset Poor. However, the case is the reverse in improved seed use[15]. Between 1994 and 1999, there was a higher growth in proportion of the Always Asset Poor who used improved seed than in the other two categories. This seems to be driven in part by improved seed use in a particular PA (Gara Godo) which accounts for 40% of the entire population of improved seed users in 1999. Gara Godo has been identified as one of the PAs whose initial poverty status generally was very low and for which relatively high consumption growth was observed between 1994 and 2004. (Hoddinott et al, 2007). Thus one hypothesis is that this growth could have been driven

[13] Though discussed in the data section, to allow for even time spacing as well as to address seasonality issues, data used for this analysis were that from round 2, 5 and 6 of the ERHS data set which are all 5 years apart and conducted at similar times of the year.
[14] Ninety percent (90%) of this group grew between 1994 and 1999, 75% of them fell between 1999 and 2004, but over 60% of them experienced growth over the entire 10 year period (1994-2004).
[15] Unfortunately, data on improved seed use was not available from the 2004 survey. This data will be collected for the 2 PAs surveyed in March/April 2007.

by expansion in cereal production spearheaded by improved seed use.[16] On the other hand it could be a case of measurement error due to a misunderstanding of the term "improved seed". In any case, data shows that about 85% of the households in Gara Godo who used improved seed in 1999 record growth in their asset index between 1994 and 2004.

Still in line with crop production, a descriptive summary of consumption growth by households in different PAs generated by Hoddinott et al (2007) reveals some correlation between increased average cereal and cash crop production and high consumption growth at the PA level. Furthermore, recent studies on the Ethiopian pulse market by IPMS have revealed significant potential gain for farmers who shift from growing cereals like barley to growing pulses like chickpeas (or increasing the proportion of land allocated to pulses) which fetch higher prices. This increased production is also revealed in the ERHS data and shown in Table 5.

There is a general belief amongst numerous researchers that the cereal market (mostly driven by maize but including wheat and Teff) is the best machine to propel economic growth and development in Ethiopia. With increased access to and correct application of inputs such as improved seed and fertilizers, farmers cereal yields can be expanded not only addressing food security issues, but also providing the opportunities for subsistence farmers to engage in commercialization. Table 5 shows dramatic growth in cereals and pulses production, but an uneven pattern across poverty groups.

In addition to institutional variables such as access to credit, and markets, the literature on technology adoption suggests a large role for household characteristics such

[16] The Production Data from the ERHS shows that maize production (cereals generally) production in Gara-Godo increased substantially from about 90 quintals in 1994 to about 370 quintals in 1999 and about 630 quintals in 2004.

as land size, human capital (education), labor (household size), age and sex of the household head. Consistent with expectations, the persistently poor households in our sample tend to have smaller landholdings, larger household sizes and less educated household heads (Table 6).

In summary, the simple descriptive statistics provide a sense of the trend in production changes for some major crops as well as the contributions of different classes of rural households to these trends. They also reveal the differential participation rates of these households in various modern agricultural practices generally expected to be beneficial to farmers and to provide them an opportunity to increase production and consequently income.

Empirical Results

Given the asset poverty classification of rural households in Ethiopia, the first step was to understand if there were significant differences in the effects of specific practices among the different classes of rural households. Since we have representation (and in some cases similar) of all poverty categories in the different innovative agricultural practices, a fixed effects regression and a growth estimation model were run, first for the entire sample and then individually for each poverty class. These estimations were used to determine the significance of various modern technology practices (e.g. fertilizer use, having improved livestock, improved seed use, chemical use and irrigation) in explaining household livelihood and its change between 1994 and 2004. These results of this are shown in Tables 7-11.

The results of the fixed effects estimation and the growth model are very similar. Both general estimations reveal a positive impact of modern input use on household livelihood and the growth model results show that for the most part[17], adoption of modern technology[18] positively contributes to improved household welfare. Apart from improved livestock which is significant at about 85%, all others are significant beyond the 95% significance level. (See Tables 7a and 7b).

However, when the sample is broken down into different poverty classes, the results take a different twist. While majority of the modern technology adoption variables (apart from mechanical services and irrigation) remain highly significant and positive in explaining improved household welfare for the Always Asset Non Poor, the reverse is the case for the Always Asset Poor. For this class of households, the only 2 modern agricultural practices that were significant were the improved seed variable and the improved livestock variable and the improved livestock is actually negatively related to livelihood change. (According to the fixed effects estimates, improved livestock does not affect their household livelihood). For the Transitorily Asset Poor however, there is a mix. While fertilizer, improved seed and chemicals positively explain welfare change, improved livestock and irrigation are not significant. (See Tables 10a and 10b).

While lumping all households together would lead us to conclude that participation in modern agricultural practices positively explains growth amongst rural agricultural households in Ethiopia, categorizing households into different poverty classes shows a significant difference between the experiences of different kinds of

[17] The estimation results show that mechanical services which captures if the household responded positively to some expenditure on improved ploughs, combined harvesters or tractors. This is puzzling and an explanation for this is still being investigated.
[18] The input use variables are discrete variables, with 1 indicating household use and 0 indicating that a household does not participate in the particular technology.

households. This raises 2 important questions; *"Why do we find this differential livelihood impacts?"* and *"What role do institutional interventions play in causing or reducing these results?"* Could it be that although households from different poverty classes are represented amongst modern technology adopters[19], there are different requirements for the successful use of these practices for these different kinds of households? Is there differential access to the benefits of institutional interventions or do we find that even where access to various markets is provided, the poorest households just can't take advantage of such opportunities?

The next set of estimations explores this issue by estimating the determinants of modern technology adoption for the three different poverty classes. In an attempt to explore the effect of institutional intervention on this behavior, a sample selection model is used. As mentioned in the empirical framework section, a probit maximum likelihood estimation was run to estimate institutional access. Given that land in Ethiopia is allocated by the government and not acquired under usual market conditions, land size is considered exogenous and thus used to determine the probability of household participation in various institutions.[20] The predicted probability of institutional access (participation) is then used in the second stage estimation of the determinants of modern technology use. Here we use a logistic regression model to identify the impact of various factors on the adoption of various agricultural technologies by different classes of households.

As can be seen from Tables 11, 12 and 13, land size is a significant determinant of fertilizer use amongst the Always Asset Poor (at about 90% significance level) and the

[19] Refer to Tables 2-5.
[20] Land was a significant determinant of access to the various institutions considered here and these estimations are available upon request from the author.

Transitorily Asset poor (beyond 95% significance). Apparently, for the Asset Poor households, larger land size makes it viable for investment in fertilizer use. For this group, using improved seed appears to be the most significant determinant of fertilizer use. This may be explained by the fact that most improved seed available in Ethiopia is for maize and requires fertilizer use. Past fertilizer use is also important at about 90% significance level. Growing cereal and pulses also positively affects fertilizer adoption. Generally older households are less likely to adopt fertilizer than younger ones. Interestingly, the quality of land does not appear to be significant for this group. This might be partially due to limited variation in land quality amongst this group or the existence of other alternatives to fertilizers. For example, the data reveals that over 91% of these poor households actually use manure on their plots. Finally, access to markets as well as institutional interventions were not significant for fertilizer use in this group.

For the Transitorily Asset poor and Always Non Poor households, land quality was important. Households in these groups were less likely to adopt fertilizer use on poor quality soil. For these 2 groups, market access, past fertilizer use and education were also strongly and positively associated with current use and cereal production was a significant determinant. Interestingly improved seed was not significant for either of these categories. The main differences between these 2 groups were in their participation in Micro credit institutions and irrigation. For the Always Asset Non Poor, irrigation is actually the most significant determinant of fertilizer use after previous fertilizer use. However, this variable is insignificant for the Transitorily Asset Poor. For this group, access to micro-credit finance is the most important determinant of fertilizer use. Given that the focus of micro credit institutions is the poor, it is not surprising that this variable

turns up insignificant for the Non Poor households. However, it is interesting that whilst it remains the most important determinant of fertilizer use by the Transitorily Poor (60% of which experienced growth between 1994 and 2004), it is not significant for the poorest of the poor (the supposed target of microfinance).

This might be due to the fact that despite access to micro-credit institutions, the transactions cost of participating in this newly created credit market is often so high (this could include filling of numerous forms or other program requirements) that it limits the ability of the poorest to take advantage of it. This might be combined with other factors such as availability of other cheaper even if less effective (in yield promotion) substitutes like manure use (over 90% of households in this category apparently make use of household manure). This might suffice for their subsistence production, given their poverty status and consequent constraints.

Discussions with some farmers in an ERHS PA revealed that often the loan sizes of micro credit organizations are too small to allow any meaningful investment. Thus, if farmers are too poor to raise alternative sources of funding to supplement the limited amount provided by micro credit institutions, they might not be able to purchase necessary equipment associated with complementary modern agricultural practices (e.g. fertilizer and irrigation) and may end up either not using such services or using them in emergency situations for other purposes such as consumption smoothing in periods of food insecurity.

While it is possible that the limited benefit from fertilizer use in the livelihood of the poorest households could explain the limited impact of institutional interventions on adoption for them, the complementarities observed with the use of various inputs and

other modern practices and the related costs indicate a need for these institutional interventions. Furthermore, the significance of credit provision via micro credit institutions for the transitorily poor[21] whose asset index growth is explained in part by fertilizer implies that there is some importance to the role played by these institutions on beneficiaries of fertilizer application. Thus there is a possibility that their services could benefit the poorest, though probably under different circumstances.

The same approach was run using the predicted probability of being a cooperative member. This variable turned up insignificant in all categories. Given that we don' t have information on actual membership but only the expected probability that households would take a loan from a cooperative, this may partially explain this result. In Ethiopia, many activities of cooperatives (such as fertilizer supply) are accessible by nonmembers. Thus in the follow up survey currently being administered, efforts are being made to better capture this variable.

A similar analysis was also conducted for irrigation use. In the fixed effects estimation, the practice of irrigation would lead to a 10.4% increase in the livelihood of the poorest households (see table 8a) and about 10% for the Transitorily Asset Poor. However, when we actually look at the effect of irrigation on growth during the survey years, we see that irrigation is no longer significant for the Transitorily Asset Poor households and less significant (at 85%) for the Always Asset Poor. Irrigation was actually not significant in the asset index for non poor households (based on the fixed effects estimation). But in the analysis of the determinants of fertilizer use for this Non Poor group (for which fertilizer use would increase their asset index by 5.1%) irrigation

[21] These households face asset poverty at some time within the research analysis time frame indicating their vulnerability and need of some level of assistance.

use was the second most important determinant (after past fertilizer use). This suggests that while irrigation on its own is important for poorer households, it is not important directly for richer households but adds value to their use of fertilizer. This makes sense when we consider the manner irrigation is practiced in most of these areas and the labor required. Irrigation practices are often in the form of surface storage in micro dams and/or river diversions are often provided with the assistance of government or NGOs. In these cases, such services are a public good. The use procedures are usually simple and devoid of technical complications. While the process is often labor intensive, this appears to be less of a constraint for the poorer households who we find to have larger household sizes. Consequently, the transactions costs associated with its use are negligible and thus more affordable to this class of households. The logistical regression estimations of determinants of irrigation use amongst the various classes reveals that for the poorest households, sloping land terrain and past irrigation use would significantly increase the likelihood of irrigation practices. Extension services and loans from micro credit organizations were significant but negligible in size (about 0). For Non Poor Households, households with larger land size were more likely to practice irrigation, past experience, fertilizer use and cereal production all positively affected current use. Access to extension services and loans from micro credit institutions both positively and largely determined irrigation use for this category. For the transitorily asset poor, past irrigation use, improved seed use and cereal production were the most significant (beyond 95% significance). Having good quality soil and fertilizer use were also positively related to irrigation use but only at around 85% significance.

In this case, we see that the services of extension agents and microfinance institutions actually seem to serve the Non Poor households and not the poorest or Transitorily Asset Poor households. It is in the Non Asset Poor class where we find significant positive and large effects of access to extension services and micro credit finance on irrigation use that we also find linkages between irrigation use and other modern agricultural practices. This seems to hint that fertilizer, improved seeds and irrigation are complements to some extent and depending on household poverty status, if all three can't be acquired, then the benefit to procuring the others might be reduced.

While we attempt to consider the determinants of improved seed use, the information on that is a little bit dated and thus not addressed in-depth here.[22] The general findings reveal that there is little significant institutional impact on improved seed for all categories, and we find links between improved seed use, fertilizer use and irrigation for the transitorily asset poor and Non Poor households, but no link to other modern agricultural practices for the poorest households (not even past improved seed use).

The last set of estimations run was on improved livestock use. Given that past improved livestock use and sex of household head were perfect predictors in the estimation for the poorest households, they were dropped. The only significant variable for the poorest households is their land. For the Transitorily poor households, the estimation failed to identify any key determinants of improved livestock use for this group. For the Non Poor households however, land size, market access, past participation and access to funding from micro credit institutions were all positively related to

[22] There is no data on improved seed use in 2004. Thus analysis would be looking at improved seed use in 1999 as a function of various household characteristics and modern agricultural practices. Whilst results from estimations are included in the appendix, they are not addressed in detail as follow up survey attempts to capture that and thus it is intended to delve deeper into this analysis after data has been collected.

adoption use. Here again, we find micro credit institutions serving the Non Poor households and not the poorer households. As inferred previously, these results could be driven by the fact that only the Non Poor households may be able to meet the criterion of micro credit institutions for loans or may have alternative sources of finance to augment what is provided by such institutions to make an investment in an improved livestock as well.

Conclusions and Future work

Generally, our results reveal that the Non Poor households are the households able to benefit from participation in modern technology practices. This seems to be linked to their ability to link positive externalities and complementarities amongst these modern practices. They also seem better able to take advantage of opportunities such as market access as well as the services provided by various institutional interventions.

The fact that the services of microfinance institutions have a positive impact on some categories of households means that there are some positive impacts of their activities in rural areas. Also the fact that they appear to be more significant in modern practices more recently promoted actively by the Ethiopian government shown in the 2004 data but less so in the data in the early 1990's implies that the strategy adopted by the GoE and other development actors have some benefits.

Given the role that modern practices can play in addressing food security and promoting economic growth and the potential role of the cereal market in this process in Ethiopia, there are potential benefits to expanding their use. This expansion necessitates understanding why poorer households are not apparently benefiting from these practices and associated institutional interventions. This study shows that recognizing target group

differences (e.g. using asset poverty typologies) are an important consideration in program development as well as program evaluation. Not only does it inform the development of appropriate strategies for different kinds of households but it prevents wrong assessment of government and other development programs. As seen from this study's results, a blanket assumption of success (failure) of a program evaluated without distinguishing between the program's effects on different kinds of households could be misleading.

Future studies (currently underway) will attempt to explore if the reason poorer households seem not to benefit from institutional interventions is due to lack of access or rather just their inability to take advantage of these opportunities. This will be explored using a model which captures the differential ability of households to take advantage of newly created market opportunities at the PA and household level over the last decade. It will attempt to identify the constraints limiting participation by poorer households both from the perspective of the farmer exhibiting utility (profit) maximizing behavior and from analyzing the packages offered by these institutions.

References:

1. Adato, M., Carter, M. and May, J. (2006). *Exploring Poverty Traps and Social Exclusion in South Africa Using Qualitative and Quantitative Data*. Journal of Development Studies, 42(2), 226-247.
2. Asiema, J.(1994). *Africa's Green Revolution.* Biotechnology and Development Monitor, 19, 17-18.

3. Carter, M. R., & Barrett, C. B. (2006). *The Economics of Poverty Traps and Persistent Poverty: An Asset-Based Approach*. Journal of Development Studies, 42(2), 178-199.
4. Croppenstedt, A.; Demeke, M.; Meschi, M.M (2003).*Technology Adoption in the Presence of Constraints: the Case of Fertilizer Demand in Ethiopia:* Review of Development Economics, 7(1), 58-70.
5. Culter, P. (1984). *The Measurement of Poverty: A Review of Attempts to Quantify the Poor, with Special Reference to India*. World Development 12, 11/12:1119-1130.
6. Dercon, S (2006). *Economic reform, growth and the poor: Evidence from rural Ethiopia*: Journal of Development Economics, 81(1), 1-24.
7. Dercon, S et al. (2005). *Shocks and Consumption in 15 Ethiopian Villages,1999–2004*. Journal of African Economies.
8. Ethiopian Economic Association (EEA), 2003/2004. Annual Report on the Ethiopian Economy. Nega, B. and Degefe, B. (Eds), Vol. 3
9. Ethiopian Economic Association (EEA), 2004/2005. Annual Report on the Ethiopian Economy. Nega, B. and Degefe, B. (Eds), Vol. 4
10. ERHS, 1997. *Village Studies on Ethiopian Rural Household Survey villages*.
11. Feleke, Shiferaw & Zegeye, Tesfaye, 2006. *Adoption of improved maize varieties in Southern Ethiopia: Factors and strategy options,* Food Policy, Elsevier, 31(5), 442-457.
12. Gabre-Medhin, E., Barrett, C., Dorosh, P.(2003). *Technological change and price effects in agriculture*: Conceptual and comparative perspectives. MTID Discussion Paper No. 62, IFPRI, Washington, DC.

13. JR and Zilberman, D.(1986). Adoption *of Agricultural Innovations in Developing Countries*: A Survey: Economic Development and Cultural Change, 1986.
14. Hoddinott, J. et al, (2007) Summary Statistics on Consumption and Production Data for ERHS Peasant Associations Between 1994 and 2004.
15. IPMS, (2004). *Atsbi Wemberta Pilot Learning Site Diagnosis and Program Design* Oct, 2004 Report
16. IPMS, (2005). *Ada'a –Liben Woreda Pilot Learning Site Diagnosis and Program Design*. Jan, 2005 Report
17. Liverpool, S, (2006).*An Asset Based Approach to Poverty Status Classification in Rural Ethiopia*. Working Research Paper
18. Kumar, S. K.(1994). *Adoption of hybrid maize in Zambia: Effects on gender roles, food consumption, and nutrition*. Research Report 100. Washington, D.C.: International Food Policy Research Institute.
19. Manfred Zeller, Aliou Diagne, and Charles Mataya, (1997). *Market Access by smallholder farmers in Malawi: Implications for Technology Adoption, Agricultural productivity and crop income.* FCND Discussion Paper No. 35
20. Maddala, G. S.(1983). *Limited dependent and qualitative variables in econometrics*. Cambridge: Cambridge University Press.
21. Rosenzweig, M. and K.Wolpin, (1993). *Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-income Countries: Investment in Bullocks in India*. Journal of Political Economy, 101, no.2, 223-244.
22. Sadoulet, E. and A.de Janvry. (1995). *Quantitative Development Policy Analysis*. Baltimore and London: The Johns Hopkins University Press.

23. Shahidur,R. Assefa, M. & Ayele, G. (2006) *Distortions to Agricultural Incentives in Ethiopia:* World Bank Working Paper

24. Singh, I., L. Squire, J.Strauss.(1986). *Agricultural Household Models.* Baltimore: Johns Hopkins University Press.

25. Spielman et al, (2007). *Social Learning, Rural Services, and Smallholder Technology Adoption: Evidence from Ethiopia.* Working paper

26. Morduch, J.(1994). *Poverty and Vulnerability.* The American Economic Review, Vol.84, No. 2, Papers and Proceedings of the Hundred and Sixth Annual Meeting of the American Economic Association ,. 221-225.

27. United Nations (2005) *Handbook on Poverty Statistics:* Concepts, Methods and Policy Use

TABLES

Table1.

	Always Asset Poor		Always Asset Non Poor		Transitory Asset Poor					
					General		Those who end up Non Poor		Those who end up Poor	
Variable	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Cons*94	*43.23*	2.3	*101.22*	3.04	*50.13*	2.28	45.54	2.97	54.41	3.4
Cons99	*41.07*	2.78	*116.21*	3.66	*64.86*	3.23	*63.72*	3.96	*65.92*	5.05
Cons04	*56.03*	4.32	*131.54*	6.03	*61.24*	3.22	*76.15*	5.65	*47.31*	2.97

Cons refers to percapita household consumption

Table 2.

	% using fertilizer in 1994	% using fertilizer in 1999	Change in percentage points	% using fertilizer in 2004
Always Asset Poor	40	40	0	25
Transitorily Asset Poor	35	40	5 +	20
Always Asset NonPoor	50	60	10 +	25

Table 3.

	% using irrigation in 1994	% using irrigation in 1999	Change in % points	% using irrigation in 2004	Change in % points
Always Asset Poor	1	8	7 +	13	6+
Transitorily Asset Poor	4	11	7 +	23	12+
Always Asset NonPoor	3	11	8 +	24	16 +

Table 4.

	% using improved seed in 1999	% using improved seed in 1999	Change in percentage points
Always Asset Poor	5	26	21+
Transitorily Asset Poor	8	16	8 +
Always Asset NonPoor	9	12	3 +

Table 5.

	Growth in cereal production 1994-2004	Growth in pulse production 1994-2004
Always Asset Poor	51%	750%
Transitorily Asset Poor	-1%	580%
Always Asset Non Poor	91%	230%

Table 6.

Variable	Always Asset Poor		Always Asset Non Poor		Transitorily Asset Poor	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Land Size (hectares)	0.89	1.06	1.82	3.59	1.22	4.39
House hold size	7.5	2.15	5.52	2.58	5.80	2.58
Age of Household head	51.12	13.19	51.36	15.38	50.38	14.98
Highest education in household	4.09	2.1	4.61	2.59	4.46	2.44
% of households that are female headed	14.81%		29.82%		29.23%	

Table 7a.

General Fixed Effects Estimation of The Effect of Modern Technology Use on Household Asset Index

Asset Index*	Coef.	Std. Err.	T	P>t
Fertilizer use**	0.042	0.01	3.46	0.00
Improved Livestock	0.030	0.02	1.40	0.16
Mechanical Services**	-0.118	0.02	-7.66	0.00
Chemical use**	0.075	0.01	5.25	0.00
Irrigation use**	0.028	0.02	1.81	0.07
Improved seed use**	0.048	0.02	2.98	0.00
Household size**	-0.654	0.01	-62.73	0.00
Age of household head**	-0.032	0.00	-8.91	0.00
Sex of household head**	0.021	0.01	2.03	0.04
Equb membership**	0.068	0.02	4.49	0.00
Constant**	1.683	0.02	76.74	0.00

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table 7b.

Estimation of Modern Technology Use on General Change in Household Asset Index

Asset Index*	Coef.	Std. Err.	t	P>t
Fertilizer use**	0.083	0.011	7.320	0.000
Improved Livestock	-0.001	0.017	-0.040	0.966
Mechanical Services Use	-0.290	0.014	-20.000	0.000
Chemical use**	0.060	0.012	4.810	0.000
Irrigation use	-0.024	0.015	-1.580	0.115
Improved seed use**	0.073	0.014	5.290	0.000
Household size**	-0.654	0.012	-56.680	0.000
Age of household head**	-0.028	0.003	-10.110	0.000
Equb membership**	0.044	0.015	2.990	0.003
Constant	0.068	0.005	13.090	0.000

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table 8a.

Fixed effects regression estimates of modern technology use on household asset index for the Always Asset Poor

Asset Index*	Coef.	Std. Err.	t	P>t
Fertilizer use	-0.018	0.04	-0.42	0.68
Improved Livestock	-0.137	0.15	-0.93	0.35
Mechanical Services**	-0.125	0.06	-1.93	0.05
Chemical use	0.041	0.06	0.70	0.48
Irrigation use**	0.104	0.05	1.93	0.06
Improved seed use**	0.180	0.04	4.32	0.00
Household size**	-0.607	0.05	-13.12	0.00
Age of household head	-0.011	0.01	-0.98	0.33
Sex of household head	-0.018	0.04	-0.44	0.66
Equb membership**	0.110	0.04	2.61	0.01
Constant	1.061	0.10	10.29	0.00

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table 8b.

Estimation of Modern Technology Use on General Change in Household Asset Index for the Always Asset Poor

Asset Index*	Coef.	Std. Err.	t	P>t
Fertilizer use	0.018	0.044	0.420	0.674
Improved Livestock**	-0.249	0.141	-1.770	0.078
Mechanical Services Use**	-0.305	0.056	-5.430	0.000
Chemical use	0.016	0.044	0.370	0.715
Irrigation use*	0.074	0.052	1.430	0.154
Improved seed use**	0.176	0.034	5.130	0.000
Household size**	-0.475	0.051	-9.260	0.000
Age of household head**	-0.020	0.008	-2.540	0.012
Equb membership**	0.083	0.044	1.880	0.061
Constant**	0.073	0.015	4.810	0.000

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table 9a.

Fixed effects regression of Modern Technology use on household Poverty Status for the Always Asset Non Poor

Asset Index*	Coef.	Std. Err.	t	P>t
Fertilizer use**	0.053	0.01	3.80	0.00
Improved Livestock**	0.055	0.02	2.45	0.01
Mechanical Services**	-0.085	0.02	-4.87	0.00
Chemical use**	0.059	0.02	3.60	0.00
Irrigation use**	-0.008	0.02	-0.41	0.68
Improved seed use**	0.026	0.02	1.26	0.21
Household size**	-0.622	0.01	-47.44	0.00
Age of household head**	-0.029	0.00	-6.84	0.00
Sex of household head**	0.024	0.01	1.95	0.05
Equb membership	0.032	0.02	1.64	0.10
Constant**	1.866	0.03	70.05	0.00

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table 9b.

Estimation of Modern Technology Use on General Change in Household Asset Index for the Always Asset Non Poor

Asset Index	Coef.	Std. Err.	t	P>t
Fertilizer use	0.091	0.013	6.770	0.000
Improved Livestock	0.031	0.017	1.840	0.066
Mechanical Services	-0.245	0.017	-14.200	0.000
Chemical use	0.052	0.015	3.430	0.001
Irrigation use	-0.054	0.018	-3.000	0.003
Improved seed use	0.043	0.018	2.390	0.017
Household size	-0.645	0.015	-44.180	0.000
Age of household head	-0.024	0.004	-6.460	0.000
Equb membership	0.002	0.018	0.090	0.924
Constant	0.065	0.006	10.200	0.000

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table10a.

Fixed effects regression of Modern Technology use on household Poverty Status for the Transitorily Asset Poor

Asset Index*	Coef.	Std. Err.	T	P>t
Fertilizer use	0.019	0.03	0.72	0.47
Improved Livestock	0.005	0.07	0.07	0.95
Mechanical Services	-0.213	0.03	-6.14	0.00
Chemical use	0.132	0.03	4.20	0.00
Irrigation use	0.101	0.03	3.26	0.00
Improved seed use	0.023	0.03	0.73	0.46
Household size	-0.706	0.02	-38.13	0.00
Age of household head	-0.044	0.01	-6.08	0.00
Sex of household head	0.029	0.02	1.44	0.15
Equb membership	0.102	0.03	3.55	0.00
Constant	1.486	0.04	36.57	0.00

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table10b.

Estimation of Modern Technology Use on General Change in Household Asset Index for the Transitorily Asset Poor

Asset Index*	Coef.	Std. Err.	T	P>t
Fertilizer use	0.079	0.025	3.230	0.001
Improved Livestock	-0.044	0.053	-0.830	0.405
Mechanical Services Use	-0.397	0.028	-14.150	0.000
Chemical use	0.099	0.024	4.040	0.000
Irrigation use	0.023	0.031	0.740	0.458
Improved seed use	0.062	0.027	2.270	0.023
Household size	-0.692	0.021	-33.390	0.000
Age of household head	-0.035	0.005	-7.420	0.000
Equb membership	0.087	0.028	3.130	0.002
Constant	0.071	0.010	6.860	0.000

* The Asset Index reflects the livelihood of the household in terms of the contribution of the various assets (physical and human) the household owns.

** Variables significant beyond 95% significance

Table11a.

General Determinants of Fertilizer use amongst ERHS Households

Fertilizer Use	Odds Ratio	Std. Err.	z	P>z
Land Size	0.685	0.234	-1.110	0.268
Improved seed use	1.732	0.387	2.460	0.014
Irrigation use	2.011	0.431	3.260	0.001
Past fertilizer use	7.867	1.934	8.390	0.000
Cereal produced	1.001	0.000	4.850	0.000
Pulse produced	1.000	0.000	-1.210	0.225
Sex of household head	3.548	4.101	1.100	0.273
Household size	0.951	0.036	-1.340	0.180
Education	1.110	0.028	4.170	0.000
Age of household head	1.026	0.027	0.980	0.328
Soil Quality	0.371	0.081	-4.530	0.000
Land Slope	0.748	0.149	-1.460	0.145
Micro credit participation	1.82E+09	2.62E+10	1.480	0.138
Extension services	2.745	21.114	0.130	0.896

** Variables significant beyond 95% significance

Table11b

General Determinants of Fertilizer use amongst Always Asset Poor Households				
Fertilizer Use	**Odds Ratio**	**Std. Err.**	**z**	**P>z**
Land Size	166.760	343.117	2.490	0.013
Improved seed use	13.988	13.050	2.830	0.005
Irrigation use	1.734	1.416	0.670	0.500
Past fertilizer use	3.868	3.664	1.430	0.153
Cereal produced	1.002	0.001	2.140	0.032
Pulse produced	1.021	0.006	3.350	0.001
Sex of household head	14.082	114.982	0.320	0.746
Household size	0.888	0.126	-0.840	0.401
Education	1.117	0.130	0.960	0.338
Age of household head	0.670	0.100	-2.690	0.007
Soil Quality	0.462	0.411	-0.870	0.386
Land Slope	0.562	0.401	-0.810	0.419
Micro credit participation	0.000	0.000	-0.980	0.325
Extension services	0.000	0.000	-2.870	0.004

** Variables significant beyond 95% significance

Table11c.

General Determinants of Fertilizer use amongst Always Asset Non Poor Households				
Fertilizer Use	**Odds Ratio**	**Std. Err.**	**z**	**P>z**
Land Size	0.939	0.369	-0.160	0.872
Improved seed use	1.145	0.359	0.430	0.666
Irrigation use	2.789	0.714	4.000	0.000
Past fertilizer use	6.789	2.153	6.040	0.000
Cereal produced	1.001	0.000	4.400	0.000
Pulse produced	0.999	0.000	-1.750	0.080
Sex of household head	0.966	1.331	-0.020	0.980
Household size	0.914	0.046	-1.780	0.075
Education	1.140	0.035	4.240	0.000
Age of household head	1.008	0.031	0.240	0.810
Soil Quality	0.368	0.093	-3.970	0.000
Land Slope	0.902	0.219	-0.430	0.670
Micro credit participation	45.222	757.622	0.230	0.820
Extension services	1.633	13.992	0.060	0.954

** Variables significant beyond 95% significance

Table11d

General Determinants of Fertilizer use amongst Transitorily Asset Poor Households

Fertilizer Use	Odds Ratio	Std. Err.	z	P>z
Land Size	0.134	0.105	-2.570	0.010
Improved seed use	1.393	0.642	0.720	0.472
Irrigation use	0.587	0.287	-1.090	0.276
Past fertilizer use	20.933	12.537	5.080	0.000
Cereal produced	1.001	0.000	2.440	0.015
Pulse produced	1.003	0.002	1.390	0.166
Sex of household head	91.657	247.431	1.670	0.094
Household size	0.928	0.084	-0.830	0.405
Education	1.092	0.063	1.530	0.127
Age of household head	1.152	0.067	2.420	0.016
Soil Quality	0.202	0.136	-2.370	0.018
Land Slope	0.255	0.170	-2.050	0.040
Micro credit participation	7.35E+39	2.28E+41	2.960	0.003
Extension services	5.60E+09	1.12E+11	1.120	0.262

** Variables significant beyond 95% significance

Table12a.

General Determinants of Participating in Irrigation Practices amongst Always Asset Poor Households

Irrigation use	Odds Ratio	Std. Err.	z	P>z
Land Size	0.042	0.152	-0.880	0.379
Improved seed use	0.264	0.300	-1.170	0.240
Past Irrigation Practice**	7.884	8.399	1.940	0.053
Fertilizer use	1.302	1.523	0.230	0.821
Cereal produced	1.001	0.001	1.470	0.142
Pulse produced	1.007	0.008	0.870	0.383
Sex of household head**	1.45E+43	6.90E+44	2.080	0.037
Household size	1.010	0.125	0.080	0.938
Education	0.764	0.179	-1.150	0.249
Age of household head	0.934	0.188	-0.340	0.735
Soil Quality	2.263	2.042	0.900	0.366
Land Slope**	0.143	0.100	-2.780	0.005
Micro credit participation**	.	.	1.970	0.049
Extension services**	0.000	0.000	-2.320	0.020

** Variables significant beyond 95% significance

Table12b.

General Determinants of Participating in Irrigation Practices amongst Always Asset Non Poor Households

Irrigation use	Odds Ratio	Std. Err.	z	P>z
Land Size	0.347	0.139	-2.640	0.008
Improved seed use	0.801	0.265	-0.670	0.504
Past Irrigation Practice	20.943	7.607	8.370	0.000
Fertilizer use	2.672	0.678	3.870	0.000
Cereal produced	0.999	0.000	-3.570	0.000
Pulse produced	1.000	0.000	0.310	0.756
Sex of household head	19.752	31.345	1.880	0.060
Household size	0.993	0.055	-0.130	0.893
Education	0.974	0.033	-0.770	0.440
Age of household head	1.084	0.032	2.680	0.007
Soil Quality	1.255	0.312	0.910	0.361
Land Slope	1.197	0.302	0.710	0.475
Micro credit participation	3.38E+23	6.54E+24	2.800	0.005
Extension services	6.92E+08	5.67E+09	2.490	0.013

** Variables significant beyond 95% significance

Table12c.

General Determinants of Participating in Irrigation Practices amongst Transitorily Asset Poor Households

Irrigation use	Odds Ratio	Std. Err.	z	P>z
Land Size	0.503	0.423	-0.820	0.414
Improved seed use	0.504	0.205	-1.680	0.092
Past Irrigation Practice**	14.194	6.876	5.480	0.000
Fertilizer use	1.884	0.859	1.390	0.165
Cereal produced**	1.001	0.000	1.660	0.097
Pulse produced	1.000	0.001	-0.130	0.894
Sex of household head	2.195	4.578	0.380	0.706
Household size	1.079	0.071	1.150	0.248
Education	1.028	0.051	0.560	0.575
Age of household head	1.067	0.066	1.050	0.295
Soil Quality	1.915	0.845	1.470	0.141
Land Slope	0.744	0.341	-0.640	0.519
Micro credit participation	3.11E+17	1.01E+19	1.240	0.216
Extension services	4.34E+08	8.19E+09	1.050	0.292

** Variables significant beyond 95% significance

Table13a.

General Determinants of Participating in Improved Livestock Practices amongst Always Asset Poor Households

Improved Livestock Practice	Odds Ratio	Std. Err.	z	P>z
Land Size	6.87E+54	3.06E+56	2.840	0.005
Household size	0.751	0.112	-1.920	0.054
Education	1.979	0.546	2.480	0.013
Age of household head	0.000	0.001	-3.180	0.001
Micro credit participation	0	0	-2.290	0.022
Extension services	3.30E+242	3.40E+245	0.580	0.562

** Variables significant beyond 95% significance

Table13b.

General Determinants of Participating in Improved Livestock Practices amongst Always Asset Non Poor Households

Improved Livestock Practice	Odds Ratio	Std. Err.	z	P>z
Land Size	0.282	0.131	-2.730	0.006
Past Improved Livestock use	25.708	10.557	7.910	0.000
Sex of Household Head	139.035	308.147	2.230	0.026
Household size	1.011	0.074	0.140	0.885
Education	1.061	0.055	1.130	0.258
Age of household head	1.093	0.040	2.400	0.016
Micro credit participation	3.82E+28	7.86E+29	3.190	0.001
Extension services	1399977	1.83E+07	1.090	0.278

** Variables significant beyond 95% significance

Table13c

General Determinants of Participating in Improved Livestock Practices amongst Transitorily Asset Poor Households

Improved Livestock Practice	Odds Ratio	Std. Err.	z	P>z
Land Size	8.869	30.750	0.630	0.529
Sex of Household Head	0.006	0.082	-0.350	0.723
Household size	1.093	0.294	0.330	0.741
Education	0.913	0.172	-0.480	0.630
Age of household head	0.818	0.219	-0.750	0.454
Micro credit participation	0.000	0.000	-0.650	0.517
Extension services	0.000	0.000	-0.530	0.593

** Variables significant beyond 95% significance

Appendix

Asset Index Generation:

The model used to generate the asset index referred to in this paper is similar to the model used by Adato et al (2006) in their study of poverty traps in South Africa. Their model estimates the following relationship:

$$L_{it} = \sum \beta_j (A_{ijt}) + e_{it} \qquad (1)$$

Where L_{it} is the livelihood of household "i" in period "t"; β_j is the coefficient of the current assets owned by household "i" in time "t"; A_{ijt} is the amount of asset "j" owned by household "i" in time "t"; and e_{it} is the time and household specific error term.

The estimates of $\beta_j(A_{ijt})$ are then used to calculate the asset index for a household as: $\Lambda_{ijt} = \sum \beta_j(A_{ijt})$ where Λ_{it} is the asset index and $\beta_j(A_{ijt})$ is the marginal contribution of assets to livelihood, i.e. the asset weight gotten from the regression of livelihood on assets. In the model used by Adato et al (2006), the scaled livelihood variable (consumption/poverty line=Lit) had a reference point of 1, where a household for which $L_{it} = 1$ was considered to be right on the poverty line whilst a household with $L_{it} < 1$ was poor and one with $L_{it} > 1$ was non poor. This model uses a log-log specification such that the reference point is zero.

To account for time and village level effects, our model estimated the following

$$L_{ivt} = \sum \beta_j(A_{ijvt}) + \sum \beta_k(A_{ijt})(A_{ikvt}) + \Psi_v + D_t + \varepsilon_{ivt} \qquad (2)$$

for all assets 'j' and 'k' and the asset index is:

$$\Lambda_{ijt} = \sum \hat{\beta}_j(A_{ijt}) + \sum \hat{\beta}_k(A_{ijvt})(A_{ikvt}) \qquad (3)$$

where L_{ivt} $\beta_j(A_{ijvt})$ and ε_{ivt} are as previously defined. $\hat{\beta}_k(A_{ijvt})(A_{ikvt})$ are the coefficients of the squared asset and asset interaction terms and Ψ_v and D_t are village and time dummies to capture village specific unobserved and time invariant characteristics such as seasonal variation or political or economic differences over time.

The assets used in this model have been categorized broadly into five; land, livestock, implements, other assets (e.g. jewelry and other home furnishings), and education. The asset values were calculated each year and then these values were adjusted yearly by a consumer price index. Given contextual considerations which indicate significantly different uses of livestock in Ethiopia, the livestock variable was further broken down into draught (oxen), dairy (cattle), transport (horses and donkeys)

and other livestock (e.g. chickens, goats and sheep). Since the value of livestock and other assets were based on survey responses (which are often fraught with error), average values of all assets were calculated for each village based on these responses.

After running the necessary specification tests a maximum likelihood random effects model was used to estimate equation (2) and generate the asset index; equation (3). Households are considered asset poor if their asset index is less than 0 and asset non poor if this index is greater than zero.