Migration and self-protection against climate change: a case study of Samburu district, Kenya

Stanley Karanja Ng'ang'a, Erwin Bulte, Ken E. Giller, John M. McIntire and Mari-ana C. Rufino

Invited paper presented at the 5th International Conference of the African Association of Agricultural Economists, September 23-26, 2016, Addis Ababa, Ethiopia

Migration and self-protection against climate change: a case study of Samburu district, Kenya

Stanley Karanja Ng'ang'a [a, b, c*], Erwin Bulte [b], Ken E. Giller [c], John M. McIntire [a] and Mariana C. Rufino [a]

[a] International Livestock Research Institute (ILRI), P. O. Box 30709, 00100. Nairobi, Kenya

[b] Development Economics Group, Wageningen University, The Netherlands.

[c] Plant Production Systems (PPS), Wageningen University, The Netherlands.

Abstract:

Climate change will affect the livelihoods of pastoralists in arid and semi-arid lands. We use new data from Samburu District, northern Kenya, to explore whether migration of household members affects adoption of adaptive measures. Specifically, we seek to test whether migration and adaptation are complementary mechanisms to protect the household against adverse shocks, or whether they are substitutes. Do remittances relax capital market constraints and facilitate the uptake of adaptive measures, or do they render adaptation superfluous? Our data suggests migration –via remittances – facilitates the adoption of self-protective measures in the areas of origin of the migrants. Supporting our interpretation that credit constraints constitute the main mechanism linking migration to adoption, we document that the effects of migration on self-protection are only significant in locations where villagers lack access to credit.

Key words: Adaptation to climate change, pastoralism, capital market imperfections, insurance, remittances.

1. Introduction

Weather shocks affect rural livelihoods, especially of pastoral and agro-pastoral households living in so-called arid and semi-arid lands (ASALs). Recent vulnerability mapping identified northern Kenya as one region that is vulnerable to climate change and the weather shocks it induces (Thornton, 2006). This region has historically suffered from frequent droughts and floods, causing the loss of human lives, decimating livestock herds, and reducing farm output (Ritho et al., 2012).[1] While northern Kenya, like other ASALs, has limited capacity to respond to such weather shocks (Scoones, 1992), some coping and adaptation does occur. Some herding households have incorporated crop farming as a way of enhancing food security (Bryan et al., 2011; Ritho et al., 2012). In crop-livestock systems, common adaptation measures include the use of new crop varieties and the adoption of drought-tolerant crop and livestock species (Rufino et al., 2013; Silvestri et al., 2012). Also, households may respond to climate shocks by relocating elsewhere (Bohra-Mishra et al., 2014), or by sending migrants to urban centers in search of jobs (Ramin and McMichael, 2009).[2]

In this paper we compare adoption behavior of migrant households and non-migrant households to examine whether migration enhances the adoption of adaptive measures in areas of origin, or not. Our main result is that migration is associated with enhanced adoption of adaptive measures, especially in credit-constrained areas – and that remittance flows are a key channel linking migration to adoption.

[1] During the last 100 years, Kenya experienced 28 major droughts—three of which occurred during the last decade (Maitima et al., 2009).
[2] A small literature explores how climate change may affect migration (e.g. McLeman and Smit 2006). In turn, such migration could trigger conflicts over scarce resources in areas of destination (e.g., Reuveny 2007).

In recent years, migration from rural to urban areas has become an important research topic in development studies. The economic literature distinguishes different motives for migration (see Mendola 2012 for a recent review). The traditional model by Todaro (1980) focuses on labor market imperfections, or the existence of wage differentials. It explains migration as an arbitrage strategy by individuals seeking to maximize expected income. This traditional perspective has proven incomplete because it does not consider other market imperfections (Katz and Stark 1986, Massey et al., 1993). The so-called New Economics of Labor Migration (NELM) provides for a broader set of motives, and also considers imperfections in capital and insurance markets. The importance of imperfect capital and insurance markets is demonstrated forcefully in a recent paper by Bryan et al. (2013). In this experimental study, the authors incentivize a random subsample of Bangladeshi villagers to (seasonally) migrate to urban areas to escape seasonal poverty. The intervention consisted of covering the round-trip cost of moving, which effectively insured the treated households against the worst outcome of engaging in migration – incurring the cost of moving but not finding a suitable job. The "insurance" treatment invited a large increase in migration rates in treatment areas, translating into substantial welfare gains. The average returns to seasonal migration, measured in terms of enhanced consumption in areas or origin, were high and far outweighed the costs associated with migration (Bryan et al., 2013).

One take-home message from the Bryan et al. (2013) study, in addition to the observation that capital or insurance market imperfections matter, is that the gains from migration are shared within the family. Indeed, the NELM perspective proposes that migration decisions are typically not taken by individuals but by (extended) households. Migration represents an opportunity for income diversification so that, via remittances and parental income pooling, families can reduce exposure to risk and relax financial constraints (Stark and

Levhari 1982, Katz and Stark 1986, Stark 1991, Taylor 1999).[3] Obviously a clear and direct link exists between the motives for migration and the economic consequences for areas of origin of the migrants. The NELM paradigm, emphasizing intra-household income flows, predicts that the informal insurance role of migration implies households in source areas are better able to smooth consumption or engage in high-risk, high-profit activities (such as the adoption of HYV rice – see Mendola 2008).[4] If intra-household income flows relax financial constraints imposed by imperfect capital markets, they also facilitate investment in human capital (Adams 2005) or productive capital (e.g. Lucas 1987, Rozelle et al. 1999, and Woodruff and Zenteno 2007). It has been observed in other contexts that remittances may also translate into extra consumption (e.g., DeBrauw and Rozelle 2008), perhaps even of the "socially wasteful" kind associated with social spending and local races for status (e.g., Brown et al. 2011).

This paper relates to two literatures. The first, as introduced above, focuses on the economic consequences of migration for households in areas of origin. The second is the literature on (incomplete) adoption of agricultural innovations. This literature has a long tradition, initially emphasizing the role of financial and non-financial returns, schooling, credit constraints, risk and the absence of insurance markets to adoption (see Feder et al., 1985). In recent years, this field has received an impetus from work focusing on social learning (e.g., Bandiera and Rasul 2006, Conley and Udry 2010) and departures from standard models of rationality (e.g., Duflo et al., 2011). For a recent overview, see Foster and Rosenzweig (2010). In this paper we will focus on a specific form of agricultural innovations, namely activities or investments that imply an adaptation to extreme weather events (droughts), reducing household exposure to climate change-induced risks.

[3] There may be other motives for migration. For example, the relative deprivation thesis predicts that people move to improve their (relative) rank in local society (Stark 1991).

[4] While Mendola (2008) found that migration enables households in source areas to take risks associated with certain productive investments, our context is different in the sense that *not* investing (in adaptive measures) may expose the household to higher risk.

The literatures on migration and adoption of innovations are linked via multiple channels, and the net effect of migration on adoption is unclear. Mendola (2012, p.107) writes "the real challenge of research on migration (…) is to answer how the 'development' impact of migration affects farm households' ability to achieve sustainable living standards and a better management of agricultural resources at origin." The NELM literature distinguishes between the following forces. On the one hand, since migration typically implies an inflow of remittances relaxing capital or liquidity constraints. This may facilitate investments in adaptive measures (as well as smoothen consumption, and so on) or may enable households to engage in risky projects. Similarly, migration may imply a loss of labor available for working on the farm (and possibly other resources used up in the migration process), which may limit the household's ability to adopt labor-intensive adaptive measures. Moreover, if income diversification (via spatial diversification of household members) provides insurance for households, this attenuates incentives to (further) engage in self-protection via alternative mechanisms. Indeed, this could constitute a wasteful form of double-insurance. For a very careful analysis of the interaction between migration and alternative forms of insurance (informal risk sharing), refer to Morten (2013). She demonstrates that migration and risk sharing are jointly determined, and that engaging in one activity affects (i.e. typically lowers) the net returns to engaging in the other.

The main objective of this paper is to analyze whether migration and adaptive measures are substitutes or complements in the process of farm household insurance. We analyze this issue by surveying 500 rural households from Samburu county, northern Kenya, and relating their adaptive behavior to a measure of household migration. In light of obvious endogeneity concerns – adaptive measures may obviate the need to migrate, and omitted variables may drive both adoption and migration – we use an instrumental variable approach to identify exogenous variation in migration. Selection issues plague the literature on migration (see Akee 2010), and among the solutions proposed in the literature to credibly estimate causal effects of migration are econometric approaches[5] as well as (quasi) experimental approaches (summarized in McKenzie 2012) leveraging, for example, exogenous variation in immigration policies. Overall, our study supports the hypothesis that migration and adaptive measures are complements, consistent with the notion that imperfect capital markets are a key determinant impeding the adoption of adaptive measures. We document that migration facilitates adaptive measures especially in regions where access to credit is very imperfect. Our results thus speak to a policy approach for rural development that integrates migration and the financial sector development.

This paper is organized as follows. In Section 2 we introduce the study area and explain the measures taken by households to reduce exposure to extreme weather events. In Section 3 we summarize our data and identification strategy. Section 4 contains our main results, and presents regression results explaining the determinants of migration and the consequences of migration for the adoption of adaptive measures. Section 5 presents a series of robustness analysis in which we vary the dependent variable, and the instruments we use. Section 6 concludes.

2. Farming and migration among the Samburu

The study was conducted in the Samburu county, located in the Rift Valley Province of Kenya. This county lies between 00^{o} 36 and 02^{o} 40 N and 36^{o} 20 and 38^{o} 10 E, covering an area of 21,000 km^2 with a population density of 11 inhabitants per km^2 (Government of Kenya, 2009). The climate is hot and dry, with mean monthly temperatures ranging between 24^{o}C (July) and 33^{o}C (December). Rainfall is highly variable, ranging between 250 and 700 mm in the plains, and between 750 and 1250 mm in highland areas. The distribution of rain-

[5] Examples, as summarized by Bryan et al. (2013), include selection correction models (Barham and Boucher 1998), matching models (Gibson and McKenzie 2010), instrumental variable models (Macours and Vakis 2010), panel data models (Beegle et al. 2011) and natural policy experiments (Gibson et al. 2013).

fall is bimodal, with long rains occurring between March and May, and short rains between July and August in the north and October and November in the east. The altitude ranges between 1,000 m on the plains to 2,752 m in the highlands. Samburu ranks as the fifth poorest district in Kenya.

Pastoralism is the main economic activity in Samburu, and about 80% of the households living there keep livestock. The most important livestock species are goats, sheep, cattle and camels. Cash for buying maize – the main staple food – is derived from livestock sales, but wage labour (mainly livestock herding) to supplement income is also common. Some cropping also occurs. Farming systems in the study area are traditional, and rain-fed maize cropping is the most common practice in our study region. Samburu county is classified as the fifth poorest county in Kenya, with 77 percent of household considered poor (Kenya National Bureau of Statistics, 2013).

We collected household data between February and May 2012, interviewing 500 households randomly sampled from five locations: Maralal (an urban centre), Londunokwe, Wamba, Swari, and Barsaloi. These five locations capture considerable variability in agro-climatic conditions (especially rainfall) and market access. The first three locations, roughly placed on a West-East gradient, capture differences in market integration and distance to an urban area, keeping geophysical conditions (rainfall) roughly constant. The other two locations are further north, where the environment is drier (and are also further away from the urban centre). In what follows we control for market access and rainfall.

Like in many semi-arid regions, migration can take two forms: seasonal and permanent migration. Seasonal migration captures off-farm employment spells for up to three months, typically involving farm work in highlands – where there is more cropping in general – or the movement of livestock. Occasionally it may also involve short-term contracts for government agencies or non-governmental organisations (NGO's) (e.g., for data collection).

Our main analysis focuses on permanent migration to urban areas. In our main analysis we focus on households of which at least one household member has moved out of Samburu County for a period of at least one year. In robustness analyses we probe the implications of a five year threshold, and also consider seasonal migration (defined as a household member moving out of Samburu for a period of three months, or less). According to our survey, most migrants live and work in seven urban centers, namely Meru, Isiolo, Nanyuki, Nyeri, Karatina, Thika and Nakuru. The remainder moved to Nairobi (38%) and a small group went to Mombasa city (2%). The great majority of these migrants works as watchmen (80%). Other migrants work as drivers (10%), private school teachers (7%), or are engaged in the cultural or tourism sector (3%).

3. Data and Identification

We selected households using a multi-stage cluster sampling strategy. From each of the five locations mentioned above we randomly sampled three sub-locations, from which we randomly selected 50 villages. With the aid of local chiefs we constructed a sample frame consisting of all households in these 50 villages, and we then randomly selected 10 households from each village. Hence, our sample size is 500 households. We collected information on a range of variables, including migration status and the adoption of adaptive measures. In total, 139 of the households in our sample are so-called 'migrant households[6],' who had sent out at least one household member to an area outside Samburu County for formal or informal employment for a period of more than one year. The remaining 361 households are 'non-

[6] Migrant households in our sample come from 43 villages (7 villages had no migrants). Aggregating seasonal and permanent migrants, we find that migrant families are spread across all five blocks (9, 12, 18, 38 and 62 migrant households). The block with most migrant families (block 5) is the block nearest to Maralal.

migrant households.'[7] Only nine households had more than one migrant member (typically two), and only one out of 139 migrant households reported it had not received remittances during the last 12 months. About half the households regularly receiving remittances were willing and able to indicate the amounts involved, and for this (possibly non-random) sub-sample remittances range between 720 and 360,000 Kshs (or between USD 8 and USD 4010) per annum.

<< Insert Table 1A, about here>>

Key explanatory variables are summarized in Table 1A, where we distinguish between migrant and non-migrant households. Household size is measured as the number of household members sleeping in the same home, sharing production and consumption activities ("eating from the same pot"). Arable farm area was measured by pacing the boundaries of each of the households' fields. Access to credit was measured by a dummy variable, taking the value 1 if the household had used credit during the last 12 months. We also use dummies to indicate financial savings (taking a value of 1 if the household had saved any money during the last 12 months), and when the household had participated in NGO activities during the same period (e.g., cash or food for work programs).

Table 1A also introduces our two instruments: distance to Nairobi and an interaction term. The interaction term is the product of a kinship variable and a variable measuring the frequency of migration in the village (see below for a motivation). Our kinship variable is defined as the (self-reported) number of relatives of the household living in the same village, but not staying in the same household (e.g., cousins, nephew and nieces). The proportion of migrants per village is defined as as the number of migrant household in our sample.

Table 1A also contains our dependent variable, measuring the number of adaptive measures adopted by the household. We include both cropping (i.e., the use of hybrid and fast

[7] Some members of such non-migrant households may actually be engaged in seasonal migration. This introduces some measurement error in our key explanatory variable, which implies our estimation results may be affected by attenuation bias (biasing our estimation results towards zero).

maturing variety of seeds) and livestock (i.e., changing livestock types, the use of feed conservation measures and livestock mobility) adaptation strategies that contribute to reducing risk and exposure to weather shocks – details are provided in Table 1B. Data on adaptation strategies was measured through posing an open-ended question on the adaptation strategies adopted by the household during the past 1 year, and still being used today (Appendix 1). (For the robustness analysis where we consider the implications of a 5 year migration threshold, we count adaptive measures adopted and still used during the past 5 years). Our main dependent variable thus is an index, summing these adaptation strategies.

<< Insert Table 1B here >>

From Table 1A it is clear that the two sub-samples are not "balanced". In general, migrant households are more likely to be headed by a (relatively young) male and are better educated. They are also smaller (reflecting that one household member has moved out). In addition, they are more likely to participate in NGO activities. Importantly, we also document that, on average, migrant households have adopted more adaptive strategies than non-migrant households. However, in light of the many observable and testable differences between migrant and non-migrant households, it is not obvious these differences in terms of adaptation can be attributed to migration status.

Empirical strategy

Since we are interested in examining the effect of migration on the adoption of adaptive measures by source households, we first estimate ordinary least square (OLS) and Tobit models (as the dependent variable is censored at zero):

$$Y_{ij} = \beta_j + \beta_1 X_{ij} + \beta_2 M_{ij} + \varepsilon_{ij}, \qquad (1)$$

where Y_i represents the innovation index for household i, in village j, X_i is a vector of household characteristics, M_i is a dummy taking the value of 1 if the i^{th} household is a migration household (and 0 otherwise), β_j are village fixed effects, and ε_i is the random error variable of the equation. In all model we cluster standard errors at the village level. If migration facilitates the adoption of adaptive measures, then $\beta_2 > 0$. If, in contrast, engaging in migration implies that additional forms of self-protection are redundant, then $\beta_2 < 0$.

Migration status is an endogenous variable in the adoption model (1). The substitution proposition may work both ways (why engage in migration if you can self-protect on the farm?), and omitted variables such as entrepreneurship and curiosity may drive both adoption and migration. To establish causality we need to identify exogenous variation in our migration variable, and estimate a two-stage model. We use a 2SLS model that explains both the determinants of migration and the causal impact of migration on adoption of adaptive strategies(Angrist and Krueger, 2001). The challenge, as always, is to identify suitable instrumental variables Z_i – variables that affect the migration decision of households, but do not affect the adoption decision via any alternative channel (that are not correlated with the error term of the adoption model):

$$Y_{ij} = \beta_j + \beta_1 X_{ij} + \beta_2 M_{ij} + \varepsilon_{ij}, \text{ and} \quad (2)$$

$$M_{ij} = \beta_i + \beta_1 X_{ij} + \beta_2 Z_{ij} + u_{ij}. \quad (3)$$

As instrumental variables we use distance from the household to Nairobi, and an interaction term. This interaction is the product of the sample proportion of migrant households per village and the number of kin members in the family. The intuition for including the distance variable is straightforward as Nairobi is a key destination for migrants, so this variable is a proxy for migration costs. Of course, one may be concerned that this variable also affects adoption via alternative channels. For example, distance to Nairobi could affect the intensity of extension services. However, and importantly, extension services for Samburu region are delivered from Maralal and a branch in Wamba town – not from Nairobi. In addition, one may argue that distance to Nairobi proxies for access to markets, affecting on-farm investments via a profitability channel. However, local (livestock) markets are much more important for our respondents, and we control for these separately in our regressions.

The intuition for the other instrument is perhaps less intuitive. The proportion of migration households in the village captures "migration networks" and, according to cumulative causation theory, should contribute to reducing migration costs and settlement in other areas (e.g.,Massey et al., 1993; Massey and Espinosa, 1997; Munshi, 2003). We assume village-level migration is orthogonal to household-level decisions with respect to the adoption of adaptive measures (an issue to which we return below). To transform the village-level migration variable into a household-level variable (we seek to explain variation in adoption behavior within villages as our models contain village fixed effects), we multiply it by the size of the local kin network, which varies across households. The intuition is that household members with more extensive kin networks are better able to mobilize the resources needed to pay for the costs associated with a migration strategy and send household members out of Samburu county.

To probe whether our instruments are appropriate we first estimate a probit model explaining migration. This enables us to check whether the interaction term and distance to Nairobi significantly correlate with migration. Next, we estimate OLS and Tobit models explaining variation in our adoption index and check that these instruments do not enter significantly (when controlling for migration). Finally, and most importantly, we estimate a 2SLS model and inspect the test statistics. We realize that the over-identification assumption cannot be properly tested so that reservations with respect to the validity of our instrument is likely to remain. For that reason we emphasize that the evidence we produce is suggestive of causal inference, but not more than that. (Follow up work could try to include exogenous variation in migration, for example by subsidizing transport to urban areas for a random subsample of the population–as suggested by Bryan et al. (2013).

Finally, to tentatively probe the welfare effects of migration, we also consider how migration affects consumption. This reduced form approach overcomes problems associated with measuring the full costs of the benefits of adopting a technology. We collected (recall) data on food consumption by the household for a period of one week for frequently consumed items, and two or four weeks for less-frequently–purchased items, and computed a caloric intake per adult equivalent per household, C_{ij}. We then estimate:

$$C_{ij} = \beta_i + \beta_1 M_{ij} + \beta_2 X_{ij} + \varepsilon_{ij} \quad (4)$$

In addition, we perform a number of robustness analyses, including analyses in which we vary the length of the migration interval (from 1 to 5 years), focus on seasonal migration, or use remittances as an explanatory variable.

4. Main Results

Table 2 contains the estimation results of a series of 'naïve' OLS and Tobit models, relating our adoption index to the migration dummy (and covariates). The most parsimonious OLS model in column (1) indicates a positive and significant association between migration and adoption strategies -- on average, migrant households adopt 1.66 more adaptive measures. This is a sizable coefficient, corresponding with no less than 135% of the standard deviation of the adoption index for the full sample, or 75% of its sample mean. In column (2) we control for distance to infrastructure variables. The coefficient of the migration variable is almost unaffected (1.65), and remains significant at the 1% level. Controlling for additional household variables (columns 3 and 4) implies the coefficient shrinks, but again it remains significant at the 1% level. However, these additional co-variates may be endogenous variables in adoption models, so we emphasize the results in columns (3) and (4) should be interpreted with care.

According to the most elaborate OLS model (column 3), other variables that are positively associated with the adoption of adaptive measures are the gender dummy (male-headed households are more likely to adopt, perhaps reflecting easier access to complementary inputs) and plot size (capturing a wealth effect, perhaps, but also reflecting economies of scale associated with certain investments) and access to credit (as it provides the household with additional resources to facilitate self-protection). Note that the share of migrants in the sample does not enter significantly, which we interpret as early evidence that information flows are not the main driver of our results (as information is likely to flow easily across households in areas-of-origin).[8] Supporting our choice of instrumental variables, we find that the two instruments are not associated with adoption (when controlling for migration). Qualitatively similar results are in column (4) based on the tobit model that takes the censored nature of our adoption data into account. In column (5) we focus on a sub-sets of adaptive strategies (pastoral versus non-pastoral innovations)and find that qualitatively similar results ensue.[9] Pastoral innovations are livestock related, and correspond with innovation types 1 and 2 in Table 1B. In contrast, non-pastoral innovations are about cropping, and correspond with innovation types 3 and 4.

<<Insert Table 2, about here>>

Because of simultaneity bias and omitted variables we should be careful not to interpret the associations in Table 2 as causal effects. As mentioned, we use an instrumental variable (IV) model to identify exogenous variation in our migration variable. To further motivate our choice of instruments, we estimate a probit model explaining migrant household status to identify correlates of migration. Multivariate results are reported in Table 3. They

[8] Specifically, if (freely flowing) information is an important channel via which migration affects adoption, then we would expect the adoption variable to not only correlate with migration of (own) household members, but also with average migration status in the village. This, however, is not true according to our data.
[9] We have also explored whether engaging in farming, as a coping strategy, is associated with migration. When estimating a probit model that explains the adoption of cropping, we do not obtain a significant association between farming and migration (the same is true when estimating an iv-probit model).

support our assumption that both the distance to Nairobi and the proportion of migrant households multiplied by the size of the kin network are significantly correlated with migration. As expected, there is a positive association between the interaction term and a negative relation between distance to Nairobi and migration.

<< Insert Table 3 about here >>

Other correlates of migration tend to corroborate results in the literature. Households with high social capital and those with mobile phones are more likely to have a migrant member, and there is a positive (but non-linear) relation between plot size and migration, whilst distances to the roads (tarmac and motorable) have negative impact.

Table 4 presents our 2SLS results. To economize on space we now only report coefficients of interest, but all models have been estimated using a full vector of household and village controls. The first two columns present the results of an analysis of the full dataset. First consider column (1b), which contains the first stage of the model -- explaining migration status of households (now using a linear model, rather than the non-linear model presented in Table 3). Our excluded instruments both enter significantly and the partial F-value associated with the instruments is 27.22 – well exceeding traditional threshold (minimum) values. Moreover, the p-value of the Sargan test equals 0.96, so we cannot reject the assumption that the over-identification condition is satisfied (for whatever that is worth). We therefore start from the premise that our instrumentation strategy is appropriate.

<< Insert Table 4 about here >>

Results of the second stage are reported in column (1a). Predicted migration status enters significantly at the 1% level, and again with a positive sign. As before, the coefficient is large (a Wald test confirms that the coefficient of the 2SLS model is indistinguishable from the OLS coefficient presented in Table 2). Insofar as our instruments are able to identify exogenous variation in migration status, one interpretation of column (1a and b) is that migration is a key determinant of adoption. However, and as mentioned, in light of potential challenges to identification strategies based on cross-section data, it is best to regard our evidence as tentative.

To further probe this result and learn about the causal mechanism linking migration to innovation, we now split the sample into households with and without access to credit. This approach has the drawback that household-level credit use may be an endogenous variable, but allows some tentative exploration of the question whether imperfect capital markets in source areas are a conditioning factor influencing the effect of remittances. We expect remittances to be particularly important when worthwhile investments cannot be financed via credit, so that liquidity constraints are most likely to "bind." There is ample anecdotal evidence of capital market imperfections in the study region, primarily because of high transaction costs (e.g., Little et al. 2001). We find that migration is rather balanced across villages with and without access to credit.[10]

First stage results for the two sub-samples are presented in columns (2b) and (3b). Note that the relevance of the instruments is badly compromised for households with access to credit (partial F value of only 0.7 in column 3b). Hence, these results are only presented for completeness and are possibly severely biased.[11] The 2SLS model performs much better for the (larger) subsample of households who do not use credit. The second stage results for this group are presented in columns (2a), and the most important finding is that migration enters significantly (and the associated coefficient has even increased in size). This is consistent with the hypothesis that migration facilitates adoption for households without access to credit, so that migration (or rather remittances) may help to relax a binding financing constraint.

[10] Specifically, in "credit villages" the number of migrant families is 34, and the number of non-migrant families equals 36. In "no credit villages" the number of migrant families is 251, and the number of non-migrant families is 179.
[11] We have also estimated an OLS model explaining variation in adoption by migration status for households with access to credit, and these results are consistent with the idea that migration is not associated with extra adoption of adaptive measures when households have access to credit. The coefficient for the migration variable is small and far removed from conventional significance thresholds. (not reported but available on request)

We now explore this finding a bit further. While evidence suggests that (capital) market imperfections are to some extent household-specific, we also wish to obtain a village-level proxy of credit access (as this would be more exogenous to household choices). Following Di Falco and Bulte (2013), we develop a rough proxy to distinguish between villages with and without access to credit by defining "credit villages" as those villages where at least one household in our sample used credit during the previous 12 months. In contrast, villages where no respondent used credit are classified as no-credit villages. Splitting the sample this way, the majority of villages (and, hence, households) falls into the latter category. Results for a sample split based on this village level variable are provided in columns (4a) and (5a) (first stage results are available in the on-line appendix A1). We again obtain significant results for no-credit villages only, but we also observe that the first stage results for the sub-sample of credit villages are very bad.

Finally, we use this village-level credit variable to estimate a model that contains an interaction term (migration times access to credit). This allows us to use the full sample, retaining power. Using the pooled data, we use a 2SLS approach and regress our adoption variable on migration, access to credit, the interaction term, and all other household controls. Second stage results are reported in column (6) (first stage results are gain available in the on-line appendix A1, and do not provide cause for concern--partial F's exceed 10 and the excluded instruments are significantly correlated with the endogenous regressors). Migration status enters significantly at the 1% level. As expected, the interaction term enters with a negative sign, implying that access to credit attenuates the effect of migration on adoption. But the interaction term is not significant, so we fail to document strong evidence that the impact of migration on adoption is mediated by credit markets.

5. Robustness Analysis

To probe the robustness of our results, we estimate a series of related models. Results are summarized in Table 5, reporting only the main coefficients (but all models were estimated with a full set of controls). First, we test whether remittances are a channel linking migration to adoption, and replace the binary migration variable in (2) by a continuous remittance variable. Many migrant households were unwilling (or unable) to provide us with an estimate of the amount involved, and these enter as missing observations. Second and first stage results are reported in columns (1a, b) of Table 5, respectively. Predicted remittances enter significantly at the 1% level, and the coefficient again has a positive sign. This suggests remittances may be one channel via which migration may have an impact on adoption. Further analysis (not reported), reveals that these results are driven by households without access to credit.[12]

<< Insert Table 5 about here >>

Next, we report the results of some models where we vary the dependent variable. First, since we are also interested in welfare effects of migration (and adoption), we regress our measure of per capita food consumption on migration status (and controls). Second and first stage results are presented in columns (2a,b). They suggest migration is associated with an increase in calories consumed (significant at the 1% level). Migration matters for both household with and without access to credit (results not shown).[13]

---

[12] In an additional analysis we explore whether remittances are likely to be the only channel affecting adoption. Other potential channels exist, including the obvious one based on enhanced information flows. However, our main analysis is based on *permanent* migration (which obviously limits flows of information) where the great majority of the migrants found an occupation *outside* of agriculture (which obviously limits exposure to useful new farming techniques). The combined coefficients from models with migration and remittances as explanatory variables are not statistically different from zero (p=0.25), which suggests that remittances are the only relevant channel.

[13] As a follow-up analysis we have tried to examine the channels via which migration affects consumption. Specifically, we have estimated a system where our instrumental variables identify exogenous variation in migration. Next, we regress adoption on predicted migration. Finally, we regress consumption on predicted migration and predicted adoption (and controls). We find that both variables enter significantly – see on-line appendix table A2. Our findings suggest that migration affects consumption via two channels: directly and indirectly (via adoption of innovations).

In columns (3a, b) we replace the dependent variable so that, rather than explaining the number of adaptive strategies adopted, we now introduce a binary model capturing whether any innovation was adopted. The reason is that there may be economies of scale in adoption of multiple innovations (via learning, cost-saving complementarities etc.) so that the relation between migration and adoption could be non-linear. Reflecting the binary nature of the dependent variable, we now estimate an IV probit model (and report marginal effects). The associated first stage of the model is contained in column (3b). As is evident, there is, again, a strong relation between (predicted) migration and our generic adoption dummy (column 3a).

In column (4a,b) we focus on seasonal migration, and omit permanent migrants from the sample. We use our standard dependent variable and the same instrumental variables. First stage results are reported in column (4b), as are key test statistics – the instrumentation strategy again appears to "work." The second stage results in column (4a) are comparable to the results for permanent migrants – the quantitative effect of seasonal migration on the adoption of innovations is nearly identical to the effect of permanent migration. Insofar as permanent migration implies a larger annual flow of remittances for the household (facilitating the adoption of more innovations), this may appear surprising. However, perhaps seasonal migrants send back a larger share of their income (during the shorter time they are away). It is also possible that the monetary costs of adoption are modest, and do not require a massive inflow of remittances.[14]

We estimated three more 2SLS models. To economize on space we only report second stage results (in columns 5,6 and 7) and have relegated the first stage results to on-line Appendix A2. First, we examine what happens when we change the one-year threshold to

[14] As an important aside; the channels linking migration to adoption can be different for different types of migration. For example, the technology-information channel may be more relevant for seasonal migrants than for permanent migrants. However, when we compare the coefficients of models based on migration and remittances we cannot reject the hypothesis that remittances are the only channel explaining variation in adoption behavior (*p*-value = 0.60).

define permanent migration, and instead focus on the subsample of households of which a member has migrated out at least five years ago. We also adjust the dependent variable to indicate all adaptive measures adopted within the past 5 years (and still being used today). Results are reported in column (5), and are qualitatively similar as results for the one-year threshold. Second, we split the set of adaptive measures into pastoral and non-pastoral innovations, and find that migration affects both (moreover, the coefficients are statistically indistinguishable; see columns 6 and 7).

<< Insert Table 6 about here >>

Finally, recognizing the various challenges to each individual instrumental variable, we also examine the sensitivity of our results to the inclusion or exclusion of the various excluded instruments. Results are summarized in Table 6 (and first stage results are provided in appendix Table A4). In columns (1-3) we report the key coefficients of the second stages of models explaining adoption by migration for, respectively, the full sample, credit-constrained households, and households with access to credit. We now use only the share of migrant household times kinship variable in the sample as an excluded instrument. Of course this implies we cannot test the over-identification assumption for these models (as the number of excluded instruments equals the number of endogenous variables). In columns (4-6) we do the same, but now only include distance to Nairobi as an instrumental variable. Across the specifications, the second stage results are rather robust. For the whole sample, and for the sub-sample of credit-constrained households, we find that migration facilitates or encourages the adoption of innovations. The same is not robustly true for households with access to credit, but we also find that the first stage results are not satisfactory for this sub-sample of households (as evident from the very low partial F scores).

6. Discussion and Conclusions

Climate change is threatening the livelihoods of herders and farmers in Africa's arid and semi-arid lands. While various innovations are available that reduce household exposure to weather risk, the uptake of such innovations is far from perfect. Enhancing our understanding of the determinants of adoption has emerged as a research priority.

Recent empirical work suggests that family ties may affect adoption decisions. In addition to learning externalities, extended family membership may matter via sharing. For example, focusing on farmers in the Ethiopian horn of Africa, di Falco and Bulte (2013) find an adverse effect of kinship on adoption. More extensive kinship networks are characterized by relatively low investment levels. The reason why family ties may deter adoption is sharing norms within the network that invite free riding, causing under-investment in self-protection.[15] The evidence in this paper points to another, complementary perspective. In addition to potential incentive effects of sharing norms, we document that sharing within families may also facilitate the adoption of innovations (Columns 1a and 2a in Table 4). We offer tentative evidence that remittances of migrant household members may relax local credit constraints (column 1a in Table 5), enabling the uptake of new technologies that involve some switching or investment costs. Specifically, migrant households adopt more adaptive measures (promoting self-protection), especially when the lack access to credit in areas of origin (Column 2a in Table 4). Results for the conditioning effect of credit are mixed, however (presumably because of the small number of households with access to credit), and deserve additional research in the future.

These findings suggest that migration and local innovation are complementary, rather than substitutive mechanisms of self-protection. Households who have at least one member who has migrated are able to overcome barriers to employ agricultural innovations – through using remittances received – thus enhancing their self-protection against climate change re-

[15] For related theory, refer to Alger and Weibull (2010). For other empirical evidence focusing on free riding and compulsory sharing within kinship networks, refer to Baland et al. (2011).

lated shocks. The link between capital and labor markets may be relevant from an academic as well as a policy perspective. Insofar as remittances substitute for lack of access to credit, interventions that seek to promote financial development (i.e., provision of cash) in rural areas may affect the demand for insurance via income-pooling (i.e., via migration), and will thereby affect the flows of labor across the African continent (and perhaps beyond). Similarly, by contributing to the availability of cash in areas of origin and promoting local investments in various forms of capital, remittances may affect the dynamics of local capital markets. Probing these complex interrelations between capital and labor, mediated via family membership and other local institutions, is an urgent priority for future research.

REFERENCES

Adams. Jr., Richard. H., Page, J., 2005. Do international migration and remittances reduce poverty in developing countries? World Development 33, 1645-1669.

Agrawal, A (2010) Local institutions and adaptation to climate change. Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World. Washington DC, World Bank 173-198

Akee, , R., 2010. Who Leaves? Deciphering Immigrant Sel-Selection from a Developing Countru. Economic Development and Cultural Change 58: 323-344

Alger, I. and J. Weibull, 2010. Kinship, Incentives and Evolution. American Economic Review 100, 1725-1758

Baland, J-M., C., Guirkinger, and C. Mali, 2011. Pretending to be Poor: Borrowing to Escape Forced Solidarity in Cameroon. Economic Development and Cultural Change 60, 1-16

Bandiera, O., Rasul, I., 2006. Social networks and technology adoption in northern mozambique. The Economic Journal 116, 869-902.

Barham, B. and S. Boucher, 1998. Migration, Remittances, and Inequality: Estimating the Net Effects of Migration on Income Distribution. Journal of Development Economics 55: 307-331

Beegle, K., J. De Weerdt and S. Dercon, 2011. Migration and Economic Mobility in Tanzania: Evidence from a Tracking Study. Review of Economics and Statistics 93: 1010-1033

Bohra-Mishra, P., Oppenheimer, M., Hsiang, S. M., 2014. Nonlinear Permanent Migration Response to Climatic Variation but Minimal Response to Disaster. Proceeding of the National Academy of Science (PNAS).

Brown, P.H., Bulte, E., Zhang, X., 2011. Positional spending and status seeking in rural China. Journal of Development Economics 96, 139-149.

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., Herrero, M., 2011. Coping with Climate Change and Variability and Adpting to Climate Change in Kenya: Household and Community Strategies and Determinants, Adaptation of smallholder agriculture to climate change in Kenya. International Food Policy Research Institute (IFPRI), Washington.

Bryan, G., S. Chowdhury and A. Mobarak, 2013. Escaping Famine through Seasonal Migration. Working Paper. London School of Economics

Conley, T.G., Udry, C.R., 2010. Learning about a new technology: Pineapple in Ghana. The American Economic Review, 35-69.

De Brauw, A., Rozelle, S., 2008. Migration and household investment in rural China. China Economic Review 19, 320-335.

Di Falco, S. and E. Bulte, 2013. The Impact of Kinship Networks on the Adoption of Risk-Mitigating Strategies in Ethiopia, World Development 43, 100-110

Duflo, E., M. Kremer, and J. Robinson. 2011. Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya. American Economic Review 101, 2350 -2390.

Eriksen, SH, Brown, K, Kelly, PM (2005) The dynamics of vulnerability: locating coping strategies in Kenya and Tanzania. Geographical Journal 171, 287-305.

Feder, G., Just, R.E., Zilberman, D., 1985. Adoption of agricultural innovations in developing countries: A survey. Economic Development and Cultural Change 33, 255-298.

Foster, A.D., Rosenzweig, M.R., 2010. Microeconomics of technology adoption. Annual Review of Economics 2.

Gibson, J. and D. McKenzie (2010). The Development Impact of a Best Practice Seasonal Worker Policy. BREAD Working Paper # 286.

Gibson, J., D. McKenzie and S. Stillman, 2013. Accounting for Selectivity abd Duration-Dependent Heterogeneity when Estimating the Impact of Emigration on Incomes and Poverty in Sending Areas. Economic Development and Cultural Change 61: 247-280

Government of Kenya, 2009. Kenya census 2009: Population and Housing census highlights http://www.planning.go.ke/index. Accessed on 2011-07-06.

Haque, N.U., Kim, S., 1995. Human capital flight: Impact of migration on income and growth. IMF Staff Papers 42, 577-607.

Hojo, M., 2004. Farmer Education and Technology Adoption: The Choice of Education Measures. Discussion Paper 04-06, In Economic And Bussiness Series, March 2004. Japan.

Jolliffe, D., 2002. Whose Education Matters in the Determination of Household Income? Evidence from a Developing Country*. Economic Development and Cultural Change 50, 287-312.

Katz, E., Stark, O., 1986. Labor migration and risk aversion in less developed countries. Journal of labor Economics, 134-149.

Kratli, S., 2009. WooDaaBe herders turn unpredictability into a key resource for animal production. Hamarata 54.

Little, PD, Smith, K, Cellarius, BA, Coppock, DL, Barrett, JC (2001) 'Avoiding disaster: diversification and risk management among East African Herders'. Development and Change 32, 401-33.

Lucas, R.E.B., 1987. Emigration to South Africa's mines. The American Economic Review, 313-330.

Macours, K. and R. Vakis, 2010. Seasonal Migration and early Childhood Development. World Development 38: 857-869

Maitima, J.M., Kariuki, P.C., Mugatha, S.M., Mariene, L.W., 2009. Adapting East African Ecosystem and Productive Systems to Climate Change, Report for the Economics of Climate Change Adaptation in Africa.

Massey, D.S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., Taylor, J.E., 1993. Theories of migration: A review and appraisal. Population and Development Review 19, 431-466.

McKenzie, D., 2012. Learning about Migration through Experiments. CReAM Discussion Paper # 7/12

McLeman, R. and B. Smit, 2006. Migration as an Adaptation to Climate Change. Climatic Change 76, 31-35

Mendola, M., 2008. Migration and technological change in rural households: Complements or substitutes? Journal of Development Economics 85, 150-175.

Mendola, M., 2012. Rural out migration and economic development at origin: A review of the evidence. Journal of International Development 24, 102-122.

Morten, M., 2013. Temporary Migration and Endogenous Risk Sharing in Village India. Working Paper. Stanford University.

Ramin, B.M., McMichael, A.J., 2009. Climate change and health in sub-Saharan Africa: a case-based perspective. EcoHealth 6, 52-57.

Reuveny, M., 2007. Climate Change-Induced Migration and Violent Conflict. Political Geography 26, 656-673

Ritho, C., Mbogoh, S.G., Ng'ang'a, S.I., Muiruri, E.J., Nyangweso, P.M., Kipsat, M.J., Ogada, J.O., Omboto, P.I., Kefa, C., Kubowon, P.C., 2012. Assessment of Farmers' Adaptation to the Effects of Climate Change in Kenya: the Case of Kyuso District. Journal of Economics and Sustainable Development 3, 52-60.

Rozelle, S., Taylor, J.E., DeBrauw, A., 1999. Migration, remittances, and agricultural productivity in China. The American Economic Review 89, 287-291.

Rufino, M., Thornton, P., Ng'ang'a, S., Ianetta, M., Jones, P., van Wijk, M., Herrero, M., 2013. Transitions in agro-pastoralist systems of East Africa: impacts on food security and poverty Agriculture, Ecosystems and Environment 179, 215-230.

Scoones, I., 1992. Coping with drought: Responses of herders and livestock in contrasting savanna environment in Southern Zimbabwe. Human Ecology, Human Ecology. 20, 293-314 20.

Silvestri, S., Bryan, E., Ringler, C., Herrero, M., Okoba, B., 2012. Climate change perception and adaptation of agro-pastoral communities in Kenya. Regional Environmental Change. 12, 791-802, 1-12.

Stark, O. and D. Levhari, 1982. On Migration and Risk in LDCs. Economic Development and Cultural Change 31: 191-196

Stark, O., 1991. The Migration of Labor. Blackwell Oxford.

Taylor, E.J., 1999. The new economics of labour migration and the role of remittances in the migration process. International Migration 37, 63-88.

Thornton, P.K., 2006. Mapping climate vulnerability and poverty in Africa: Report to the Department for International development. Ilri.

Todaro, M., 1980. Internal migration in developing countries: a survey, Population and economic change in developing countries. University of Chicago Press, pp. 361-402.

Woodruff, C., Zenteno, R., 2007. Migration networks and microenterprises in Mexico. Journal of Development Economics 82, 509-528.

Table 1A: Key variables for migrating and non-migrating households

	Migration				No Migration			
Variable	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Household characteristics								
Gender of the household head***	0.85	0.36	0	1	0.66	0.48	0	1
Age of the household head**	47.14	12.47	23	84	50.75	14.16	21	90
Cultivable farm size (in hectares)**	1.02	2.13	0	15	0.47	1.69	0	15.68
Household size*	6.61	2.62	2	19	6.99	2.82	2	19
Financial saving	0.06	0.23	0	1	0.07	0.25	0	1
Access to credit	0.15	0.36	0	1	0.13	0.34	0	1
Years in education***	3.88	5.53	0	16	1.29	3.44	0	16
Activities of NGO's***	0.48	0.50	0	1	0.30	0.45	0	1
Market access variables								
Distance to the motorable road (km)***	1.03	1.38	0.003	9	1.91	3.30	0	24
Distance to the tarmac road (km)***	114.35	22.03	50	155	107.39	32.20	40	190
Distance to the local market (km)***	7.40	8.22	0.03	45	11.18	12.33	0.01	70
Distance to the livestock market (km)	11.68	12.27	8	70	12.53	11.73	0.01	70
Information relating to instruments								
Kinship***	6.13	3.89	1	16	2.37	2.47	0	13
% migrant in a village***	0.48	0.23	0.1	0.8	0.19	0.18	0	0.8
Distance to the Nairobi (km)***	370.13	32.46	300	438	387.45	34.05	320	486
Interaction term (%migrant households _kinship variable)***	23.16	19.30	0	80	5.39	8.05	0	45
Adaptation strategies								
Total adaptation strategies***	2.65	1.22	0	5	2.06	0.92	0	5
n	139				361			

Note: *, ** and*** stand for significant at 10%, 5% and at 1% respectively; NGO's stand for non-governmental organizations; n stands for number of observation

Table 1B: Adaptation strategies in response to climate change during the last 5 years.

Adaptation strategies	Number of households	Percentage (%)
(1) Changed livestock type		
Increased camel and reduced cattle	20	4
Increased herd of goats and reduced cattle	300	60
(2) Introduced feed conservation measures		
Cut and carry of pastures introduced	258	51.6
Fencing patches with grass for use during dry period introduced	57	11.4
Growing of fodder/improved pastures (Napier grass) introduced	9	1.8
(3) Introduced hybrid variety of seed		
Drought tolerant (maize, millet and sorghum)	384	76.8
(4) Introduced fast maturing (short seasoned hybrid variety)		
Fast maturing (short seasoned variety of maize) variety introduced	205	41
(5) Migration (livestock mobility)$^{\phi}$		
Started moving with livestock in search of pastures and water	50	10

NB: the percentage need not to add up to 100% because households may adopt more than one strategy.

$^{\phi}$ To gather data on livestock mobility, we explained the difference between mobility for livestock production and mobility as a coping or adaptation strategy aimed at minimizing losses associated with climate risks and shocks such as drought – the conceptual difference is clear among pastoralist and agro-pastoralist language, but often get confused (or lost) during translation (See Kaufman, 2007 and Dirani et al., 2010 for classic discussion on this).

Table 2. Migration and the adoption of adaptation strategies

	Adaptation Strategy (OLS)	Adaptation Strategy (OLS)	Adaptation Strategy (OLS)	Adaptation Strategy (Tobit)	Adaptation Strategy (Pastoral innovation) (OLS)	Adaptation Strategy (non-pastoral innovation) (OLS)
Migration (*just slightly over 12 months but not more than 15months*)	1.657*** [0.062]	1.654*** [0.063]	1.603*** [0.066]	1.603*** [0.061]	1.026*** [0.121]	0.690*** [0.160]
Remittance			3.34e-07 [1.08e-06]	0.000 [0.000]	0.000 [0.000]	0.000 [0.000]
Gender of the household head			0.114** [0.046]	0.114*** [0.042]	0.089 [0.062]	0.032 [0.078]
Age of the household head			-0.003** [0.002]	-0.003** [0.001]	-0.006** [0.002]	-0.006*** [0.002]
Household size			0.003 [0.008]	0.003 [0.008]	0.006 [0.012]	0.001 [0.013]
Farm size (ha)			0.062** [0.030]	0.062** [0.027]	0.098** [0.045]	0.066 [0.039]
Farm size (ha) squared			-0.099 [0.062]	-0.099* [0.057]	-0.155** [0.061]	-0.169* [0.094]
Total value of livestock			-7.08e-08 [1.13e-07]	-7.08e-08 [1.04e-07]	-0.000 [0.000]	0.000 [0.000]
Total value of livestock squared			1.63e-12 [1.84e-12]	1.63e-12 [1.70e-12]	0.000 [0.000]	-0.000 [0.000]
Years in education			0.007 [0.006]	0.007 [0.006]	0.025** [0.011]	0.022** [0.011]
Financial saving			-0.021 [0.077]	-0.021 [0.071]	-0.199** [0.088]	-0.147* [0.087]
Access to credit			0.167** [0.075]	0.167** [0.069]	0.360*** [0.122]	0.292* [0.159]
Activities of NGO			-0.051 [0.091]	-0.051 [0.084]	-0.081 [0.152]	-0.088 [0.171]
Risk perception			0.026 [0.056]	0.026 [0.052]	0.063 [0.080]	-0.053 [0.075]
Own a mobile			0.009 [0.042]	0.009 [0.038]	0.065 [0.088]	0.162* [0.087]
Trust (CSC)			0.049 [0.055]	0.049 [0.051]	0.057 [0.083]	0.048 [0.082]
Structural social capital (SSC)			-0.066 [0.120]	-0.066 [0.111]	0.299** [0.135]	0.115 [0.144]
Social capital (CSC +SSC)			0.028 [0.042]	0.028 [0.039]	0.126** [0.056]	-0.079 [0.054]
Distance to Motorable road (km)		0.003 [0.005]	-0.001 [0.005]	-0.001 [0.005]	-0.010 [0.007]	0.009 [0.006]
Distance to tarmac road (km)		-0.001 [0.002]	-0.001 [0.002]	-0.001 [0.002]	0.001 [0.004]	-0.003 [0.004]
Distance to local market (km)		-0.002 [0.002]	-0.002 [0.002]	-0.002 [0.002]	-0.001 [0.002]	-0.002 [0.002]
Distance to livestock market (km)		0.001 [0.002]	0.001 [0.002]	0.001 [0.002]	-0.001 [0.002]	-0.005** [0.002]
Kinship	0.037 [0.019]	0.038 [0.019]	0.035 [0.018]	0.035 [0.019]	0.037 [0.029]	0.021 [0.027]
Proportion migrant in a village			-0. 102 [0. 830]	-0. 102 [0. 764]	-0.043 [0.346]	0.319 [0.064]
Distance to Nairobi	-2.14e-06 [1.78e-06]	-2.07e-06 [1.84e-06]	-1.62e-06 [2.55e-06]	-1.62e-06 [2.35e-06]	-0.000 [0.000]	-0.000 [0.001]
Interaction of % migrant per village * kinship	0.003 [0.003]	0.003 [0.003]	0.003 [0.003]	0.003 [0.002]	0.017 [0.014]	0.006 [0.005]
Village dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant/Sigma				0.293 [0.664]		
Constant	0.414 [0.445]	0.430 [0.464]	0.293 [0.720]	0.383 [0.022]***	3.546 [1.072]***	0.570 [0.707]
R Squared	0.83	0.83	0.85		0.65	0.63
Log likelihood				-229.09		
N	500	500	500	500	500	500

Robust standard errors clustered by village level are reported in parentheses, *p<0.10, **p<0.05, ***p<0.01.

Table 3. The determinants of migration (Probit analysis)

	Migration	Margins
Gender of the household head	0.064 [0.200]	0.064 [0.200]
Age of the household head	-0.005 [0.007]	-0.005 [0.007]
Household size	-0.004 [0.035]	-0.004 [0.035]
Farm size (ha)	0.123* [0.072]	0.123* [0.072]
Farm size (ha) squared	-0.225 [0.178]	-0.225 [0.178]
Total value of livestock	-1.92e-06** [8.00e-07]	-1.92e-06** [8.00e-07]
Total value of livestock squared	2.68e-11 [1.95e-11]	2.68e-11 [1.95e-11]
Years in education	0.047* [0.027]	0.047* [0.027]
Financial saving	-0.463 [0.311]	-0.463 [0.311]
Access to credit	0.949*** [0.338]	0.949*** [0.338]
Activities of NGO	-0.167 [0.254]	-0.167 [0.254]
Risk perception	0.446** [0.198]	0.446** [0.198]
Own a mobile	0.110 [0.204]	0.110 [0.204]
Trust (CSC)	0.259 [0.251]	0.259 [0.251]
Structural social capital (SSC)	0.777* [0.400]	0.777* [0.400]
Social capital (CSC +SSC)	0.346** [0.151]	0.346** [0.151]
Distance to Motorable road (km)	-0.098** [0.044]	-0.098** [0.044]
Distance to tarmac road (km)	0.018* [0.010]	0.018* [0.010]
Distance to local market (km)	0.007 [0.006]	0.007 [0.006]
Distance to livestock market (km)	0.003 [0.007]	0.003 [0.007]
Kinship	-0.030 [0.053]	-0.030 [0.053]
Proportion migrant in a village	0.767 [1.079]	0.767 [1.079]
Distance to Nairobi	-2.99e-04** [1.0e-05]	-2.99e-04** [1.0e-05]
Interaction of % migrant per village * kinship	0.087*** [0.011]	0.087*** [0.011]
Village dummies	Yes	Yes
Constant	6.834* [3.777]	6.834* [3.777]
Log likelihood	-187.56	
LR (χ^2) *P value*	155.88 *0.0000*	
Join sign. Plot size[a]:$\chi^2(2)$ Probability> $\chi^2(2)$	5.87 0.05	
Join sign. Plot size[a]:$\chi^2(2)$ Probability> $\chi^2(2)$	7.87 0.006	
N	500	500

Robust standard errors clustered by village are reported in parentheses, *p<0.10, **p<0.05, ***p<0.01, n stands for the number of observation, NGOs stands for non-governmental organizations

[a]Joint significance of plot size per household and plot size owned squared

Table 4. The impact of migration on the adoption of adaptation strategies (2SLS results)

	Adaptation Strategy (1a)	Migrant (1b)	Adaptation Strategy (2a)	Migrant (2b)	Adaptation Strategy (3a)	Migrant (3b)	Adaptation Strategy (4a)	Adaptation Strategy (5a)	Adaptation strategy (6)
Migration	1.848*** [0.174]		1.851*** [0.167]		-0.226 [0.666]		1.770*** [0.186]	0.427 [0.534]	1.742*** [0.246]
Migration*credit									-0.307 [0.730]
Access to credit	0.110 [0.086]	0.231*** [0.071]					0.142 [0.097]	0.453 [0.387]	0.101 [0.069]
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Village control dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kinship	0.037** [0.015]	-0.007 [0.012]	0.035** [0.018]	-0.002 [0.015]	0.018 [0.115]	-0.129 [0.183]	-0.000 [0.030]	-0.054 [0.065]	0.017* [0.010]
Distance to Nairobi		-0.000** [0.000]		-0.000** [0.000]		0.001* [0.001]			
Interaction of % migrant per village * kinship		0.013*** [0.002]		0.013*** [0.002]		0.005** [0.001]			
Constant	-0.116 [0.195]	1.939** [0.818]	-0.161 [0.212]	2.195** [0.913]	1.484 [0.970]	-138.054 [122.860]	-0.058 [0.208]	-113.886** [94.53]	0.075 [0.237]
Sargan test *p-value*		*0.15* *(0.96)*		*0.27* *(0.95)*		1.11 (0.29)			
First stage *(F)* *p-value*		*(2, 49)* *27.22* *0.000*		*(2, 49)* *20.00* *0.000*		(2, 35) 0.73 0.48			
R^2	0.84	0.45	0.84	0.46	0.87	0.88	0.85	0.38	0.81
N	500	500	430	430	70	70	450	50	500

Robust standard errors clustered by village are reported in parentheses, *p<0.10, **p<0.05, ***p<0.01, n = number of observation, NGO's stand for non-governmental organizations. Columns (1a,b) contain the second and first stage of the model explaining migration status of households. Columns (2a,b) contains the second and first stage results of households without credit. Columns (3a,b) contain the second and first stage results of households with credit. Columns 4a and 5a contain the second stage results of the model explaining migration status of households based on sample split based on "village without credit" and in those "with credit". Column (6) shows the second stage result of the model explaining migration status of household using the village level variable but with an interaction term (migration times access to credit).

Table 5 Two stage least squares (2SLS) estimate of the impact of remittance and migration on adoption of adaptation strategies to climate change

	Whole sample (2SLS)		Whole sample (2SLS)		Whole sample (IV probit model)		Seasonal migration (2SLS)		Whole sample (5 years) (2SLS)	Whole sample	Whole sample
	Adaptation strategy (1a)	Remittances (1b)	Energy consumed (2a)	Migrant (2b)	Any innovation adopted 3a)	Migrant (3b)	Adaptation strategy (4a)	Migrant (4b)	Adaptation measures adopted (5)	Non-pastoral innovations (6)	Pastoral innovation (7)
Remittances	4.0e-04*** [8.65e-06]										
Migration			61.294*** [24.528]		1.401*** [0.372]		1.764*** [0.252]		1.860** [0.282]	1.035*** [0.297]	0.782*** [0.243]
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to Nairobi		-4.0e04*** [4.0e06]		-0.001** [0.001]	Yes	-3.0e-4** [0.0001]		-0.001** [0.0001]			
Interaction term (% migrant per village x kinship)		16.837*** [3.812]		0.013 [0.001]	-0.945 [0.590]	0.013*** [0.002]		0.013*** [0.001]			
Village dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.293 [0.566]	181.219*** [43.738]	82.949 [36.571]	0.644 [0.257]	-0.170 [1.078]	0.257* [0.151]	0.603 [0.625]	0.500 [0.339]	1.261*** [0.350]	3.528*** [0.687]	0.872*** [0.250]
		0.77 *(0.67)*		*1.75* *(0.18)*		*1.42* *(0.23)*		*1.88* *(0.17)*			
		(2. 49) *17.83* *0.000*		*(2. 49)* *49.82* *0.000*		*(2. 49)* *22.49* *0.000*		*(2. 49)* *48.01* *0.000*			
R^2	0.27	0.22	0.31	0.32	25	23	0.43	0.21	0.31	0.59	0.27
N	500	500	500	500	500	500	466	466	500	500	500

Robust standard errors clustered by village are reported in parentheses, *p<0.10, **p<0.05, ***p<0.01, n stand for the number of observation, km stands for kilometer, NGO's stand for non-governmental organizations. Column (1a, b) contains the first and second stage results showing that remittances may be one via which migration may have an impact on adoption. Column (2a, b) shows the effects of migration on adoption of adaptation strategies. Column (3a, b) contain the first and second stage results which shows there is a strong relation between predicted migration and our generic adoption dummy. Column (4a) and (5a) contain the results showing the effect of seasonal and permanent migration respectively on the adoption of innovation. Columns (6a, b) and (7a, b) contain the second and first stage results of the model showing that migration matters for the adoption of both pastoral and non-pastoral innovations.

Table 6 Robustness analysis (sets of instruments)

	Instruments: Interaction term (% migrant times kinship)			Instrument: Distance to Nairobi)		
	Whole sample (n=500)	Without credit (n=427)	With credit (n=69)	Whole sample (n=500)	Without credit (n=430)	With credit (n=70)
Migrants	1.914*** [0.077]	1.873*** [0.081]	0.609*** [0.339]	1.799*** [0.480]	1.905*** [0.384]	-0.023 [1.889]
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Village dummies	Yes	Yes	Yes	Yes	Yes	Yes
First stage F-test	F(1,49) = 29.96 p-value = 0.000	F(1,49) = 18.94 p-value = 0.000	F(1,49) = 0.15 p-value = 0.70	F(1, 49) = 16.00 p-value = 0.000	F(1,49) = 17.56 p-value = 0.000	F(1,35) = 0.13 p-value = 0.48
Sargan test:χ2 (2) *Sargan test: p-value*	Exact identifica-tion	Exact identifica-tion	Exact identifica-tion	Exact identifica-tion	Exact identifica-tion	Exact identifica-tion

Robust standard errors clustered by village are reported in parentheses, * significant at 10%, **significant at 5%, ***significant at 1%. Columns 1-3 present robustness results using whole sample, households without credit and households with credit based when using % migrant times kinship as the instrument. Columns 4-6 present robustness results for the whole sample, households without credit and households with credit when using distance to Nairobi as the only instrument. Columns 7-9 present robustness for the whole sample, households without credit and households with credit when using two instruments (i.e., migrant times kinship and average education).

Appendix 1: Extra Tables

Table A1: First stage results of 2SLS models (Table 4).

	Migrant (4b)	Migrant (5b)	Migration*credit (6b)	Migration (6c)
Gender of the household head	0.028 [0.047]	-0.196 [0.510]	-0.001 [0.048]	-0.028 [0.025]
Age of the household head	-0.002 [0.002]	0.010 [0.019]	-0.001 [0.001]	0.001 [0.001]
Household size	-0.000 [0.009]	0.045 [0.030]	-0.000 [0.007]	-0.001 [0.004]
Farm size (ha)	0.026 [0.019]	-0.260 [1.298]	0.017 [0.018]	0.024** [0.009]
Farm size (ha) squared	-0.035 [0.038]	0.373 [37.516]	-0.029 [0.043]	-0.033 [0.022]
Total value of livestock	--3.14e-07** [1.20e-07]	1.06-06 [1.31e-06]	-1.31e-07* [6.71e-08]	-2.27e-07** [1.30e-07]
Total value of livestock squared	2.62e-12 [1.70e-12]	-4.79e-11 [7.19e-11]	1.16e-12 [1.21e-12]	1.56e-12 [2.35e-12]
Years in education	0.009 [0.007]	0.100* [0.058]	0.009* [0.005]	0.002 [0.003]
Financial saving	-0.146 [0.094]	0.198 [0.244]	-0.098 [0.079]	0.042 [0.041]
Access to credit	0.288*** [0.074]	0.495** [0.237]	0.232*** [0.054]	0.044 [0.028]
Activities of NGO	-0.049 [0.082]	0.127 [0.765]	-0.084 [0.069]	-0.019 [0.036]
Risk perception	0.124** [0.053]	0.028 [0.334]	0.091** [0.042]	-0.030 [0.022]
Own a mobile	0.021 [0.053]	-0.155 [0.294]	0.016 [0.046]	-0.010 [0.024]
Trust (CSC)	0.041 [0.055]	0.082 [0.505]	0.006 [0.045]	0.003 [0.023]
Structural social capital (SSC)	0.290*** [0.096]	-0.326 [1.008]	0.176** [0.084]	0.052 [0.044]
Social capital (CSC +SSC)	0.098*** [0.036]	0.133 [0.290]	0.076** [0.030]	0.019 [0.016]
Distance to Motorable road (km)	-0.012 [0.005]**	0.063 [0.116]	-0.017*** [0.007]	-0.000 [0.003]
Distance to tarmac road (km)	0.005* [0.003]	-0.044** [0.018]	0.003*** [0.001]	-0.001 [0.000]
Distance to local market (km)	0.003 [0.002]	0.010 [0.026]	0.0001 [0.002]	-0.001 [0.001]
Distance to livestock market (km)	0.002 [0.002]	-0.013 [0.015]	0.001 [0.002]	-0.001 [0.001]
Kinship	-0.006 [0.014]	-0.217 [0.190]	0.006 [0.008]	-0.003 [0.004]
Village dummies	Yes	Yes	Yes	Yes
Distance to Nairobi	-7.0e-16** [3.43e-06]	-0.0004*** [0.0003]	-2.52e-06** [6.52e-07]	-2.41e-06*** [1.26e-06]
Interaction of % migrant per village * kinship	0.012*** [0.002]	0.018*** [0.006]	0.013*** [0.002]	0.003*** [0.001]
Constant	1.930** [0.881]	8.886** [3.752]	-0.343 [0.288]	-0.661*** [0.149]
Sargan test p-value	*0.41* *(0.83)*	*1.23* *0.48*	*Exactly identified*	*Exactly identified*
First stage	*(2, 43)*	*(2,35)*	*(2, 49)*	*(2, 49)*

(F)	*19.20*	*0.71*	28.34	11.99
p-value	*0.000*	*0.49*	0.000	0.000
R^2	0.46	0.23	0.37	0.38
N	450	50	500	500

Robust standard errors clustered by village are reported in parentheses, **p*<0.10, ***p*<0.05, ****p*<0.01, n stand for the number of observation, km stands for kilometer, NGO's stand for non-governmental organizations. Columns (4b) and (5b) contain the first stage results of the model explaining migration status of households based on sample split based on "village without credit" and in those "with credit". Columns (6b,c) contain the first stage results of the 2SLS when we regress our adoption variable on migration, access to credit, the interaction term, and all other household controls using the whole sample

Table A2: The direct and indirect effects of migration on consumption

	Energy consumed	Adaptation strategies	Migrant
Migration	74.671*** [22.758]	2.057*** [0.107]	
Adaptation strategies	14.256** [4.66]		
Household controls	Yes	Yes	Yes
Village control	Yes	Yes	Yes
Distance to Nairobi			-0.002*** [0.001]
Interaction term (% migrant per village * Kinship)			0.013*** [0.001]
Constant	-8.505 [40.166]	-0.169 [0.189]	0.739*** [0.240]
N	500	500	500

Robust standard errors clustered by village are reported in parentheses, **p*<0.10, ***p*<0.05, ****p*<0.01

Table A3 First stage results of 2SLS models (Table 5)

	Whole sample (5 year interval) Migrant	Non-pastoral innovations Migrant	Pastoral innovations Migrant
Gender of the household head	0.001 [0.047]	-0.009 [0.044]	-0.009 [0.044]
Age of the household head	-0.002 [0.001]	-0.001 [0.002]	-0.001 [0.002]
Household size	-0.003 [0.007]	-0.001 [0.007]	-0.001 [0.007]
Farm size (ha)	0.017 [0.017]	0.028* [0.016]	0.028* [0.016]
Farm size (ha) squared	-0.036 [0.027]	-0.042 [0.037]	-0.042 [0.037]
Total value of livestock	-0.0007 [0.0005]	--3.12e-07** [1.16e-07]	--3.12e-07** [1.16e-07]
Total value of livestock squared	0.134 [0.085]	2.16e-12 [1.59e-12]	2.16e-12 [1.59e-12]
Financial saving	0.059 [0.055]	-0.083 [0.085]	-0.083 [0.085]
Access to credit	0.133** [0.068]	0.225*** [0.071]	0.225*** [0.071]
Activities of NGO	-0.072 [0.051]	-0.025 [0.070]	-0.025 [0.070]
Risk perception	0.049** [0.021]	0.102** [0.046]	0.102** [0.046]
Own a mobile	0.047 [0.049]	0.036 [0.044]	0.036 [0.044]
Trust (CSC)	0.022 [0.050]	0.045 [0.048]	0.045 [0.048]
Structural social capital (SSC)	0.178** [0.076]	0.210** [0.087]	0.210** [0.087]
Social capital (CSC + SSC)	0.076*** [0.026]	-0.083*** [0.030]	-0.083*** [0.030]
Distance to Motorable road (km)	0.016*** [0.005]	-0.011** [0.005]	-0.011** [0.005]
Distance to tarmac road (km)	0.004*** [0.001]	0.003 [0.003]	0.003 [0.003]
Distance to local market (km)	-0.007* [0.004]	0.002 [0.001]	0.002 [0.001]
Distance to livestock market (km)	0.002 [0.001]	0.001 [0.002]	0.001 [0.002]
Kinship	0.003 [0.010]	-0.007 [0.012]	-0.007 [0.012]
Distance to Nairobi	0.0003** [0.0001]	-0.004*** [0.001]	-0.004*** [0.001]
Interaction (% migrant per village * Kinship)	0.013*** [0.002]	0.012*** [0.002]	0.012*** [0.002]
Village dummies	Yes	Yes	Yes
Constant	0.257 [0.151]*	1.773*** [0.432]	1.773*** [0.432]
Sargan test *p valeu*	*5.44* *(0.215)*	*1.23* *(0.26)*	*0.188* *(0.66)*
First stage *(F)* *p-value*	*(2.49)* *20.87* *0.000*	*(2.49)* *36.17* *0.000*	*(2.49)* *36.17* *0.000*
R^2	0.32	0.48	0.48
N	500	500	500

Robust standard errors clustered by village are reported in parentheses, *p<0.10, **p<0.05, ***p<0.01, n stand for the number of observation, km stands for kilometer, NGO's stand for non-governmental organizations. HH stands for households. Columns 1 contains the first stage results of the model showing that migration matters for the adoption for the whole sample. Columns (2) and (3) contain the first stage results of the model showing that migration matters for the adoption of both pastoral and non-pastoral innovations

Table A4: First stage results for 2SLS models (Table 6)

	Set of instruments = 1 (interaction term of % of migrant in a village * kinship)			Set of instruments = distance to Nairobi		
	Migration (1b)	Migration (2b)	Migration (3b)	Migration (4b)	Migration (5b)	Migration (6b)
Gender of the household head	-0.047 [0.050]	-0.031 [0.055]	-0.233 [0.417]	0.003 [0.047]	0.030 [0.057]	-0.277 [0.461]
Age of the household head	0.009 [0.010]	0.010 [0.010]	0.097 [0.129]	-0.001 [0.002]	-0.000 [0.002]	0.002 [0.017]
Household size	-0.008 [0.008]	-0.013 [0.010]	0.016 [0.051]	-0.005 [0.008]	-0.010 [0.009]	0.037 [0.029]
Farm size (ha)	0.015 [0.020]	0.006 [0.024]	-0.463 [0.466]	0.012 [0.016]	0.005 [0.022]	-0.948 [1.391]
Farm size (ha) squared	-0.059 [0.035]	-0.045 [0.041]	9.371 [14.276]	-0.010 [0.042]	0.005 [0.045]	19.353 [39.045]
Total value of livestock	-3.47e-07 [1.20e-07]	1.47e-06 [1.93e-06]	2.30e-07 [8.03e-07]	-3.54e-7** [1.21e-07]	-0.000* [0.000]	4.97e-08 [1.19e-06]
Total value of livestock squared	-2.84e-12 [1.67e-12]	-1.67e-10 [2.19e-10]	-3.21e-11 [4.89e-11]	2.88e-12 [1.67e-12]	0.000 [0.000]	0.000 [0.000]
Years in education	0.015* [0.008]	0.015* [0.009]	0.034 [0.052]	0.012* [0.006]	0.013* [0.007]	0.093 [0.064]
Financial saving	-0.097 [0.093]	-0.231* [0.130]	-0.011 [0.481]	-0.121 [0.092]	-0.285** [0.131]	0.136 [0.277]
Access to credit	0.023** [0.006]			0.266*** [0.071]		
Activities of NGO	-0.017 [0.105]	0.033 [0.125]	-0.137 [0.552]	-0.060 [0.081]	0.004 [0.100]	0.521 [0.924]
Risk perception	0.116** [0.046]	0.107* [0.054]	0.597 [0.481]	0.106** [0.046]	0.093* [0.054]	0.172 [0.369]
Own a mobile	0.067 [0.058]	0.065 [0.060]	-0.241 [0.305]	0.014 [0.052]	-0.005 [0.056]	-0.211 [0.321]
Trust (CSC)	0.053 [0.054]	0.067 [0.058]	-0.053 [0.418]	0.048 [0.048]	0.082 [0.053]	0.112 [0.458]
Structural social capital (SSC)	0.158* [0.093]	0.176* [0.103]	0.867 [0.750]	0.250*** [0.091]	0.296*** [0.103]	0.111 [0.838]
Social capital (CSC +SSC)	-0.080** [0.037]	-0.087** [0.041]	-0.232 [0.313]	-0.084** [0.036]	-0.101** [0.039]	0.016 [0.269]
Distance to Motorable road (km)	-0.012** [0.005]	-0.010** [0.005]	0.159 [0.122]	-0.013** [0.005]	-0.011** [0.005]	0.096 [0.105]
Distance to tarmac road (km)	0.004 [0.003]	0.005 [0.003]	-0.035** [0.016]	0.004 [0.003]	0.005* [0.003]	-0.040** [0.016]
Distance to local market (km)	0.002 [0.002]	0.002 [0.003]	0.017 [0.031]	0.002 [0.002]	0.002 [0.002]	0.014 [0.025]
Distance to livestock market (km)	0.002 [0.002]	0.003 [0.002]	-0.007 [0.014]	0.002 [0.002]	0.002 [0.002]	-0.011 [0.014]
Village dummies	Yes	Yes	Yes	Yes	Yes	Yes
Distance to Nairobi				-8.74e-06** [3.17e-06]	-5.0e-05** [3.79e-06]	-7.0e-05** [2.0e-07]
Interaction term (% migrant per village * Kinship)	0.006*** [0.001]	0.006*** [0.001]	0.005** [0.001]			
_cons	-0.130 [0.404]	-0.223 [0.434]	-0.520 [2.126]	-0.114 [0.189]	-0.207 [0.212]	1.606 [2.212]
First stage F-test	(1,49) 26.96 0.000	(1,49) 18.94 0.000	(1,35) 0.15 0.70	(1,49) 16.00 0.000	(1,49) 17.56 0.000	(1,35) 0.13 0.60
Sargan test:χ2 (2) *Sargan test: p-value*	Exact Identification	Exact Identification	Exact Identification	Exact Identification	Exact Identification	Exact Identification
R^2	0.31	0.33	0.87	0.38	0.41	0.90
N	500	430	70	495	426	69

Appendix 1: A protocol used during focus group discussions.

Each focus group discussion was done with the aim of understanding social realities, and for the purpose of supplementing the in-depth quantitative interview data in explaining changes in social phenomenon

Introduction and consent by main respondent

> Before the beginning of the focus group discussion the researcher read out the following paragraph to ensure that the respondent understands before asking for consent.
>
> "Good morning/afternoon. We are coming from (International Livestock Research Institute (ILRI) and Wageningen University) with permission from the local government. We are conducting a survey looking at farming practices and how they change over time. We would like to ask you some questions that should take no more than one to one and half hours of your time. We would like to share some of this information widely in order that more people understand how food is grown and used in this region and the issues that you face regarding crop and livestock production and soil, water and land management.
>
> Your name will not appear in any data that is made publicly available. The information you provide will be used purely for research purposes; your answers will not affect any benefits or subsidies you may receive now or in the future. Do you consent to be part of this study? You may withdraw from the study at any time and if there are questions that you would prefer not to answer then we respect your right not to answer them.

1. Has consent been given? [___] 1=Yes, 0=No
2. The names of the meeting focus group discussion participants were as follows……………
3. I would now like you to tell me a bit of general history of this area in terms of how long this village has been in existence, how it started, who determine the size of the village, where to set it up and the changes observed on village set up over the last 20 years.
4. I would like now you tell me about the main livelihood resources that households in this area depends on?
5. For the mentioned livelihood resources (i.e., crop and farm animals) how the households have in this village have been managing them over the last 20 years. ***[If the respondent is obviously too young to have been farming over the last 20years, they could talk about what their father did over the last 20 years]***
6. Now I would like to hear about the important changes that have taken place in this area during the last 20 years?
7. Among those changes that you've mentioned, I would now like to discuss specific ones that have affected your livelihood resources the most.
8. I would now like you to tell me in general how households in your village cope[16] and adapt[17] to the negative effects impacted on your livelihood resources by changes

[16] Coping strategies was explained as the use of endowment and entitlement as physical or social capital by the households to achieve desired goals during and immediately after a shock (e.g., Agrawal, 2010).

[17] Adaptation strategies were explained as a long term process and involve action and adjustment that are undertaken to maintain household ability to deal with shocks induced by the current and future expected changes (e.g., Eriksen *et al.* 2005)

you've mentioned and how long you've been practicing it. ***[If the respondent is young, they could talk about what their households do to overcome the negative effects associated with the mentioned changes]***

NB: With regard to question 8 because many of the respondent did not adapt the meaning of the two terms "adaptation" and "coping", the researcher took time to explain to respondents during the focus group discussion (prior to the household surveys) the difference between coping and adaptation strategies

9. I would now like you to tell me whether there are some households who do well than other in terms of adapting to the mentioned changes, and what distinguishes them from those who are not able to adapt.