Determinants of Rural Household Choice of Income Dependency Strategies in Eastern Mau, Kenya

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Abstract

The rural households living in the forest fringes of Eastern Mau have become poor over the last five decades due to constraints related to socio-economic and demographic characteristics, low holding asset and contextual factors. As a result, rural households have been unable to make optimal decisions to pursue more remunerative income dependency strategies. These shortcomings are the causes of household regular and forest-based income underperformances. In this paper, we examine the factors that influence the rural household choice of income dependency strategies. Primary data in the study area were collected purposively selected from six-administrative locations that straddle Molo and Njoro sub-Counties. Rural household respondents were those living in forest margins located in a four-kilometer radius away from the forest protected areas. Semi-structured questionnaires survey instruments and interviews were used to collect the data. The main objective of the study was to determine the factors that impede rural households from making optimal choices of income dependency strategies. Household income dependency strategies, like on-farm income, off-farm income, mixed-income, transfer income and forest-based income. A multinomial logistic regression model was used to identify the predictor variables that influence the household choice of income dependency strategies. The variables of the model are household socio-demographics, asset holdings and contextual factors. In the analysis, the model used estimated coefficients, log-odd ratios, or odds-ratios and marginal effects to reveal the thirteen out of fifteen measured indicator variables. These predictor variables of the model influenced the choice of household income dependency strategies. The results of the analysis of the multinomial model show the likelihood ratio (LR) of the multinomial logit model analysis based on Chi-square tests show significance at the 1% level of significance (LR Chi^2 (60) = 1680.04, Prob > Chi^2 = 0.0000). Equally, the analysis of estimated coefficients, odd-ratios and marginal effects demonstrate that at least one of the predictor variables has a significant influence on the response variables. This study recommends that state-actor policymakers should invest in the embedment of household livelihood outcomes into efficient conservation and management of forest ecosystem resources. This strategy ensures that there is an increase in regular household on-farm income activities. Also, this will increase total household income which reduces household poverty and over-dependence on forest ecosystem resources. The reduced dependence on forest ecosystem resources reduces its degradation and loss of biodiversity in the long term.

Keywords: forest-based-income, socio-demographics, livelihoods

INTRODUCTION

Globally, in the last five decades, rural households living in forest peripheries of tropical countries live below the poverty line (Kleinshmit et al., 2015; Larsen et al., 2015; Vira et al., 2015). Equally, the countries of sub-Sahara Africa, like Kenya, have rural households living in abject poverty. The underlying causes of rural household poverty are less understood.

Rural households have depended on forest resources since time immemorial and have not been able to find a pathway out of poverty. This phenomenon is not researched and is seldom understood. Rural households primarily depend on on-farm income activities and less on forest-based (Asfaw, Lemenih, Kassa, & Ewnetu, 2013; Dolisca, Carter, McDaniel, Shannon, & Jolly, 2006). During these past five decades, on-farm income activities have been dwindling and so have been forest-based income sources. Household socio-economic and demographic characteristics and asset holdings and endowments coupled with contextual factors that influence the underperformance of both regular household on-farm income and forest-based income dependency activities (Ouedraogo & Ferrari, 2015; Reardon, Berdegué, Barrett, & Stamoulis, 2007). The degradation of forest ecosystem resources causes a decline in forest-based income. These are some of the reasons why rural households in Eastern Mau cannot find a pathway out of poverty without the intervention of state-actors. Rural household poverty and the degradation of forest ecosystem resources. This phenomenon and the factors that influence the household choice of income dependency strategies are not yet understood. The inability of rural households to find a pathway out of poverty is related to the factors that influence the rural household choice of income dependency strategies (Cavendish, 2000a; Maloma, 2016; Soltani, Angelsen, Eid, Naieni, & Shamekhi, 2012).

The objective of this study is to highlight the underlying factors that influence the rural household choice of income dependency strategies. Specifically, most rural households in Eastern Mau, live below the poverty line because they are constrained by these factors that impede them from pursuing more remunerative income strategies. These factors include socioeconomic and demographic characteristics. These include, for example, household size, age of household head, number of household members who are employed or employable, the household head highest level of education, gender and ethnicity. The other factors include accessibility to loans and financial credit and household membership in social groupings. The other is household asset holdings that include ownership of livestock herd, productive agricultural equipment, agricultural land and percentage of land under irrigation. The contextual factors which are external to a household also act as impediments. These factors include state-actor governance structures and policies, for example, development in physical infrastructure, like road networks. The other includes commodity market trends and the effect of climate-changes, which causes vulnerabilities. Studies (Cavendish, 2000b; Ebenezer & Abbyssinia, 2018; Megbowon, 2018) show that poverty in most developing countries of the tropics exacerbates poor state-actor driven structural governance and policies. Equally, studies (Barrett, 2005; Berhanu, Colman, & Fayissa, 2007; Bryceson, 1999; Córdova, Wunder, Smith-Hall, & Börner, 2013; Illukpitiya & Yanagida, 2008; Rudin & Morgan, 2006; Valdivia, Dunn, & Jetté, 1996) have shown that these characteristics and contextual factors conspire to make rural households to be vulnerable to food insecurity and poverty.

A study by Nielsen et al. (2013) used a model based on household income activity approach to identify and analyze these factors that constrain the rural household choice of income dependency strategies. Equally, studies (Abdulai & CroleRees, 2001; Reardon et al., 2007) show that most rural households depend on on-farm income activities for their economic mainstay. The study shows that on-farm income activities contribute more than two-thirds of the total household income. Hence, state-actor policies should focus on programmes that improve the performance of household on-farm income activities if it has to alleviate household poverty. Some of the state-actor programme activities that increase the performance of on-farm income activities include technological innovations (Awojobi, 2011; Keenan et al., 2015). For example, investment in agricultural extension services that increase agricultural productivity. The state-actor driven agricultural extension services

include improving agricultural productivity using crop irrigation technology to augment rain-fed crop production. The other recent technological innovations in sub-Sahara Africa include the introduction of farm insurance, contract farming and improved commodity handling. The post-harvest handling technology includes sorting, drying, semi-processing and storage of harvested farm produce (Barnett, Barrett, & Skees, 2008; Barrett, 2005; Barrett & Carter, 2013; Ellis, 2000; Ellis & Freeman, 2004). Additionally, agricultural extension services are dove-tailed with efficient conservation and management of forest ecosystem resources. This two-pronged strategy increases rural household on-farm income activities which concomitantly reduces rural household dependence on forest ecosystem resources. The increase in on-farm income activities effectively reduces the degradation of forest ecosystem resource degradation (Larsen et al., 2015; Lyatuu, 2015; Nguyen, Do, Bühler, Hartje, & Grote, 2015; Porro, Lopez-Feldman, & Vela-Alvarado, 2015). This study, therefore, highlights the inter-relationship between reduced rural household poverty because of increased total household income and reduced dependence on forest ecosystem resources. However, studies (Carney, 1998; Duffield, 2012; Gibson, Ostrom, & Ahn, 2000; Jansen, Pender, Damon, Wielemaker, & Schipper, 2006; Lamsal, Pant, Kumar, & Atreya, 2015; Scoones, 2009; Solesbury, 2003) show a decrease in total household income because of underperforming on-farm income activities, is because of these factors that constraint the choice of rural households. The underperformance of on-farm income activities in sub-Sahara African is attributed to the contextual factors, for example, climate-change-induced weather fluctuations (Dokken & Angelsen, 2015). Most households in these countries face high-income risks because of under-performing on-farm income activities which cause income shortfalls and a drop in total household income. The climate-change effects cause changes in rainfall patterns that lead to floods or droughts and crop failure in a rain-fed agricultural production. In this context, studies (Nguyen et al., 2015; Porro et al., 2015) show that rural households who fall in the poorest income quintiles are mostly affected by climate-changes. Also, studies (Abdulai & CroleRees, 2001; Barrett & Carter, 2013; Chinn, 1979; Dolisca et al., 2006; Maloma, 2016; Narain, Gupta, & van't Veld, 2008) show state-actor supported technological innovations in most tropical countries have climate-change mitigating effects, like reducing crop failures and income shortfalls.

The findings from this paper will be significant in informing state-actors policymakers to embed rural household livelihood improvements in mitigating contextual factors that affect the household choice of income dependency strategies. These include factors that improve on-farm income activities and increases total household income hence reducing over-reliance on forest ecosystem resources. Results of this study will lead to state-actor policy changes which reduce rural household and simultaneously reduces degradation of forest ecosystem Studies (Andres, Mir, van den Bergh, Ring, & Verburg, 2012; Booysen, Van Der Berg, Burger, Von Maltitz, & Du Rand, 2008; Hogarth, Belcher, Campbell, & Stacey, 2013; Jagger, Luckert, Banana, & Bahati, 2012) show this approach as a win-win strategy. The results of this paper, therefore, are useful in illuminating our understanding of the factors that determine the household choice of income dependency strategies. It also provides knowledge that bridges the existing gaps in the literature on the link between forest ecosystem degradation and forest-fringe household poverty. The remainder part of this paper is organized as follows: Section 2 covers the research methodology, which specifically deals with study area and research design. Also, the section provides a brief account of the recent cited literature on the nexus between efficient conservation and management of forest ecosystem resources and alleviation of household poverty. Section 3 deals with research results and discussions. Section 4 deals with study conclusions and recommendations.

METHODOLOGY

Study Area

Eastern Mau Forest Reserve is about 190 km North-West of Nairobi and lies on a 35°58'00" E and 00°32'00" S of the equator. The study area comprises the remaining 22 contiguous forest reserves of the greater Mau Hills Forest Complex. The study area comprised six administrative sub-locations located in Molo and Njoro sub-Counties of Nakuru County Figure 1. This study area was purposively selected because of its demographic stability in the past 12 months. Equally, the area has an altitude range of between 1100m above mean sea level at the lowlands and 2800m above mean sea level at the highlands. The highest mountain summit of Eastern Mau averages 5800m above mean sea level. These altitude ranges make Eastern Mau one of the largest watersheds of Mau Hills Forest Complex which is rich in forest ecosystem products. Currently, Kenya's forest cover stands at approximately 6.99% of the total landmass. The government policymakers are planning to expand the area to 10% by 2030 (KNBS, 2010). The Eastern Mau forest reserve has high species richness and endemism that comprises small and mega terrestrial biodiversity. Forest-fringe poor rural households living in the forest-peripheral areas of Eastern Mau utilize forest ecosystem products to sustain their livelihoods. Conversely, rural households living in forest-fringes of Eastern Mau forest reserve also benefit from excellent microclimatic conditions which favour farming activities. On-farm income activities are the economic mainstay of Eastern Mau forest-peripheral communities.

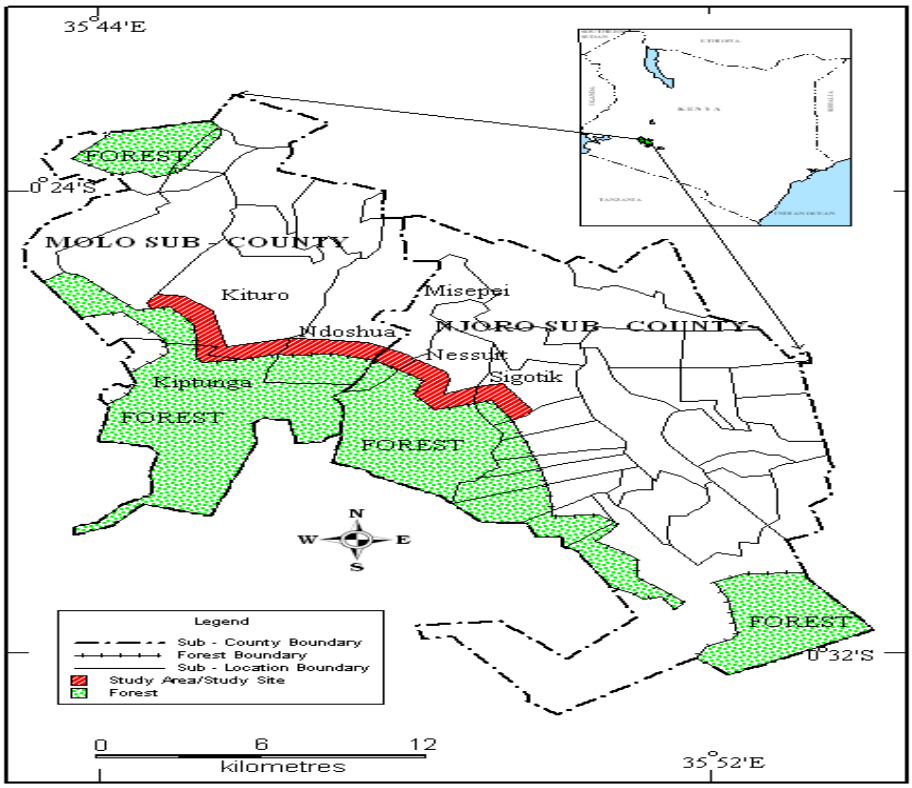

Figure 1: Map of Study Area showing sub-Location in Eastern MauResearch Design

The reconnaissance survey was done to understand the topography of the study area before sampling could commence. The reconnaissance survey commenced in June 2011 and ended

in July 2011. The pre-testing of the questionnaires was done between August to December 2011. The collection of data commenced in earnest as from January 2012 and ended in June 2013. Meanwhile, the representative sample size was determined using a multi-stage cluster sampling formula (Bassioni, Price, & Hassan, 2003; Grandval & Vergnaud, 2006).

A representative sample size (n=450) was determined using a multi-stage cluster sampling formula adapted from (Bassioni, Price, & Hassan, 2003; Grandval & Vergnaud, 2006; Mouakhar & Tellier, 2013). The first stage was to delineate households living within a four-kilometer radius from the forest protected area. These were households living in the six sub-locations that were purposively selected as study areas. The second stage was to select using stratified random sampling method five villages in the six sub-locations. The method takes into consideration the distribution of survey villages along with the four-kilometer forest band. This stratification method also put into consideration the variations across the six sub-locations in the study area (n=30 villages) as shown in Figure 1.

The location of each village was checked to ensure sufficient geographic distribution along with the forest band. A list of rural households residing in each village of the six sub-locations was compiled. Key informants and village leaders did the village register. Sixty households were randomly selected from the thirty villages. The third stage was to enumerate households living in all the 30 identified villages. A total of 1,800 (sample frame) households were enumerated in the six villages. The fourth stage was to determine a sampling fraction to guide in systematic random sampling. A sampling fraction was computed by dividing the representative sample by the sample frame, which gave (0.25 or 1/4) as the fraction (450/1,800). In a multi-stage random sampling procedure, all rural households in the sample area get a fair and equal chance of being sampled. A systematic random sampling procedure was performed. The counting was commenced from a predetermined commencement point on the sample frame. This started with systematically The counting of four households systematically commenced from the commencement point. The 5^{th} household was assigned a random number #1 then interviewed. The next four households were counted and the 10^{th} household was assigned a random number #2 then interviewed. The process continued until all the 1,800 households were counted. The last household to be counted and interviewed was assigned a random number #450. These procedures show that a representative sample of 450 households was obtained from a sample frame of 1,800 households. This representative sample (n=450) represents 25% of the sample frame.

Factors that Affect Sustainable Household Income Dependency Strategies

A conceptual framework of sustainable household income dependency strategies shows the effects of household socio-demographics, household asset holdings and contextual factors on household income dependency strategies (DFID (1999) and (Ellis, 2000; Reardon & Vosti, 1995; Scoones, 1998). The predictor variables are independent variables which influence the response variables or dependent variables. These are the clustered household income dependency strategies like on-farm income, off-farm income, mixed-income, transfer income and forest-based income. A sustainable household livelihood framework model shows the relationships between the predictor variables and the response variables. The socio-demographic variables were considered as continuous or dummy variables, for example, household size, age of household head, number of members who are working, the gender of household head, highest education level of household head and ethnicity of the household head. Household asset holdings included agricultural land size, percentage of land under irrigation, number of livestock herd, ownership of productive agricultural equipment, household savings, accessibility to loans and membership in social network groups. Forest-based income in the multinomial logistic regression analysis is held constant

as other diversified income dependency strategies are varied to see the responses of the outcome. Studies from (Ellis & Freeman, 2004; M Fisher, 2009; Mamo, Sjaastad, & Vedeld, 2007; Narain et al., 2008; Nielsen, Rayamajhi, Uberhuaga, Meilby, & Smith-Hall, 2013) show forest-based income has both poverty alleviating and income equalizing effects on poor rural households. Other studies by (Ellis, 2000) show that rural households attempt to maximize and diversify income dependency strategies. However, contextual factors are usually conditions that go beyond the direct control of rural households and they affect income performance (Angelsen et al., 2014; Babulo et al., 2008; Monica Fisher, 2004).

Measuring Factors that Influence Household Choice of Income Dependency Strategies

This study used a multinomial logistic regression model to analyze a set of predictor or explanatory or independent variables that affect the dependent or outcome or response variables. The explanatory power of the logistic regression model will show the factors that determine the response outcomes (Walelign, Pouliot, Larsen, & Smith-Hall, 2017). The measurement model uses a probability approach to analyze the odd-ratios or probabilities that a rural household will choose a particular income dependency strategy given the prevailing conditions. (Walelign et al., 2017) in his findings shows that predictor variables, including contextual factors, constituting some of the entry barriers to more lucrative income dependency strategies when forest-based income is held constant, given all other factors. The analytical model as adapted from (Walelign, 2016; Walelign et al., 2017) has been presented mathematically as:

$$\text{Prob}\left(X_i = q \mid r_i\right) = \frac{e^{\beta^1 q^r qi}}{1+\sum_{p=1}^{r} e^{\beta^1 p^x qi}}$$

.....Equation (1)

Where $q = 0,1,2,...,q; i = 1,2,3,...,n \; and \; \beta_0 = 0$, where β_{qi}^1 are vectors of coefficients r_i which are associated vectors of explanatory variables. The multinomial logit model is used in this study to show the effects of independent variables on log-odds ratios. This is represented mathematically as:

$$\ln\left[\frac{s_{iq}}{s_{ip}}\right] = r_i^{'}\beta_j \; if \; p = 0$$

.....Equation (2)

Where β_j indicates the change in log-ratio between the probability of the choice of income dependency strategy j and the probability of the choice of livelihood strategy k (forest-based income) which is the base group, given each unit change of x_i according to (Nielsen *et al.*, 2013).

However, the odd-ratios are given by $\frac{s_{iq}}{s_{ip}}$ does not depend on the other household income dependency choices.

However, the analytical model by Leach, Mearns, & Scoones, 1999; Scoones, 1998, 2009) shows household income dependency strategy choices were determined by three predictors, socio-demographic, household asset-holdings and contextual variables. Equally, studies by Babulo et al., 2008, p. 20; Walelign, 2016) show the existence of endogenous interdependence among rural household asset holdings variables and livelihood outcomes

(poverty alleviation and reduction of income inequality). This implies that rural household livelihood outcomes are generated by chosen household income dependency strategies which could in turn endogenously affect rural household asset holdings (Babulo et al., 2008; Dasgupta, Deichmann, Meisner, & Wheeler, 2003). Rural household diversified income strategies were analyzed as determinants with a focus on forest-based income as a base. The errors of endogeneity were eliminated by using indicators of variable according to Babulo et al., 2009; Raes, Loft, Le Coq, Van Huylenbroeck, & Van Damme, 2016; Xu et al., 2015). In this study, predetermined independent variables were selected to ensure that they were truly exogenous before conducting a multicollinearity test.

RESULTS AND DISCUSSIONS

The results of the multinomial logistic regression model show that thirteen out of fifteen indicator variables of the model influence the household choice of income dependency strategies. The variable indicators that did not have any effect on the household choice of income dependency strategies include household gender and percentage of irrigated crop production lands.

Results of the Model on Household Socio-Demographic Variables

The results of the multinomial logit model identified the predictor variables and the response variables as presented in Table 2. Results show household size (HH_SIZE) has a significant and negative influence on the likelihood of a household choosing off-farm income, mixed-income and transfers income strategy choices. This implies that rural households with more family members are more likely to adopt on-farm income and forest-based income strategy choices. The odd ratios of 0.897, 0.886, and 0.817 are for off-farm income, mixed-income and transfer income strategy choices, respectively. These ratios indicate that given an additional member in the household size, the relative probabilities or relative odds of being in the three income strategies are from 1.11 to 1.12 (1/0.897 to 1/0.817) times lower when other variables in the model are held constant. The marginal effects of the household size effect on the household choice are minimal for off-farm income, mixed-income and transfer income are (-0.015, -0.013 and -0.016, respectively). Marginal effects are calculated at the mean values and have little meaning for discrete values (Welsh & Poe, 1998). The marginal effects of these results indicate that an additional member of a household reduces the likelihood of the household being in the off-farm income, mixed-income and transfers income by 1.5%, 1.3% and 1.6%, respectively, when all other variables in the model are held constant. This finding is expected in theory and results from Babulo et al. (2008) which shows the more members a household has, the more likely they will pursue labour-intensive income strategies, for example, on-farm income and forest-based income strategies. The highest level of education of household head (EDU_HEAD) has been shown to have a positive and significant influence on the likelihood of a household to choose any three income dependency strategy choices. The odds ratios reveal the odds of a household head engaging in off-farm income, mixed-income and transfer income strategy choices as 1.704, 2.622 and 2.104 times, respectively higher than for households who have a low level of education. This means household heads that have a high level of education are more likely to participate in the three household income strategies, off-farm income, mixed-income and transfers income. This means households with high level of education are likely to have better skills and knowledge. This provides households with a better capacity to get employed in well-being jobs and to engage in more remunerative income activities. For example, engaging in business activities which are non-farm and non-wage businesses. Besides, highly educated household heads are more likely to engage in broader social connections. This makes them be employed in both private and public institutions.

The results further show the household head that is of working age (HH_WORKING AGE) has mixed effects on household choice of income dependency strategies. It shows age has a significant and positive influence on the household choice of income dependency strategy at the 1% level of significance. This means it has a positive influence on the probability of households choosing off-farm income and mixed-income dependency strategies. Also, it shows that it has a negative influence on the likelihood of a household choosing transfers income dependency strategy. This means households with more labour are more likely to belong to off-farm and mixed-income dependency and are less likely to engage in transfers income dependency strategy relative to forest-based income dependency strategy.

Conversely, if a household has one additional worker (HH_WOEKING) in the working category, the likelihood for the household to engage in off-farm income and mixed-income dependency strategy choices increases by 8.8% and 1.6%, respectively. Equally, the likelihood for the household to pursue transfers income dependency strategy declines by 4.5%. Results reveal that a household with more labour is more likely to be in off-farm income and mixed-income dependency strategies relative to the forest-based income dependency strategies. These results are in agreement with theory and findings by (Adhikari, Di Falco, & Lovett, 2004; Kumar, 2019) which shows the more households have labour, the more they are like to release other labour to go into wage and salary employment and mixed-income business that are less labour-intensive. Rural households in Eastern Mau have fragmented farmlands a phenomenon that has reduced the productivity of household on-farm income activities. In these circumstances, rural household farming activities are small-scale hence have low-return on investment. It is for this reason that on-farm income activities have a marginal increase in forest-based income that is relatively small even when the number of workers engaging in the activities increases. Equally, due to the shrinking rural economy, most wage-incomes derived from on-farm income activities are earned by many household workers which are a minimum wage. This means the younger workforce tends to seek higher return income employment opportunities outside the farms. This is mainly because they are more educated than the older workforce. This leaves the older workforce to work on the farms for little pay since most of them have a low level of education. The socio-demographic characteristics include household ethnicity (HH-_ETHNICITY) of a household head that has effects on household choice of income dependency strategy. The results of the analysis show the majority of households from the dominant ethnic group engaged in more remunerative income activities. The odds ratios of this variable are high, especially for mixed-income dependency strategies. This result reveals the relative probability of a household choosing mixed-income dependency strategy is for the Kalenjin ethnic group to be 13.78 times higher than for the minority ethnic groups. Similarly, the odd-ratios or the odds that a Kalenjin household head will engage in on-farm income, off-income and transfer income dependency strategies are 2.68, 2.14, and 2.79 times higher, respectively than the minority ethnic groups.

Results of the Model on Household Socioeconomic Variables

Results of the model on household socio-economic indicators or the influence of financial capital are shown to have an effect on the likelihood of household choice of income dependency strategies. The effect of the influence on households is measured by two indicator variables. These are household accessibility to credit facilities or loans (HH_LOAN) and the amount of household savings (HH_SAVINGS). These two variables have a significant influence on household decision to pursue mixed-income and transfer income dependency strategies. Specifically, results show household income savings have a negative influence on the likelihood that a household decides to pursue a transfer income dependency strategy. This savings variable indicator shows rural households with income savings are less likely to engage in a transfer income dependency strategy. The odds-ratio of

0.865 indicates that the relative probability of a household having income savings pursuing transfer income dependency strategy is 1.16 (1/0.865) times lower than those without income savings. The explanation to this is that rural households engaging in forest ecosystem resources or deriving forest-based income require financial capital to buy the required farm inputs for on-farm income activities. The financial ability is, therefore, required to support the extraction of forest ecosystem resources. This provide rural households with the motivation to save and accumulate their capital assets. This finding is contrary to the results by (Walelign et al., 2017), which show households with income savings to be less likely to engage in on-farm income activities and extraction of forest ecosystem resources.

Results on household accessibility to financial credit or loans, the model shows households who access loans were more likely to pursue two household income dependency strategies. Again, this confirms that household accessibility to financial credit allows them to pursue more remunerative or lucrative income-generating activities. This is because most income-generating activities require an initial financial capital outlay. For example, small business start-ups require finances to incubate the business. The effect of this financial indicator variable on the household choice of income dependency strategy is in line with theory and studies by (Soltani et al., 2012; Walelign, 2016) which shows rural households with access to credit are more likely to pursue more lucrative or more remunerative income dependency strategies. The mixed-income activities or activities that are non-wage and non-farm are income-generating activities that are not labour-intensive and do not require land and equipment. The mixed income activities deal with business enterprises like premise and land rentals. The other activities are asset selling and buying or brokerage. These income-generating activities are not affected by land scarcity, shortage of inputs or rainfall fluctuations. This findings are in agreement with the results and theory by (Gecho, Ayele, Lemma, & Alemu, 2014) which shows the economic mainstay of rural household is on-farm income. It further shows the primary income sources are sustained by mixed-income generating activities which are less affected by weather fluctuations.

Results of the Model on Household Agricultural Land Variables

The household land size (HH_AGRIC_lAND) owned by a household and the percentage of irrigated farmland (IRRI_LAND) were included in the model. These variables were used to examine the influence of the size of land resource on household choice of income dependency strategy. The size of land owned by households as an indicator shows the variable has a significant influence at the 1% level. Results presented in Table 1 show that when holding all other variables constant, an additional hectare of agricultural land to a household reduces the likelihood of the household being in the off-farm income dependency strategy as indicated by the marginal effect decrease by 18.5%. The household likelihood of pursuing a mixed-income dependency strategy is indicated by marginal effects decrease by 10.9%. These results are in line with theory and findings by (Babulo et al., 2008; Jansen et al., 2006; Xu et al., 2015) which shows the size of agricultural land as a key factor in household on-farm income production, especially the crop production. Equally, results reveal that the larger the household agricultural land, the higher their capacity to increase agricultural production. This also has the potential of increasing total household income. Subsequently, an increase in total household income is equivalent to improved household livelihood outcomes. For example, alleviation of poverty and reduction of income inequality is reduced by increased total household income. Also, the improved performance of regular household income, for example, on-farm income, dissuades rural households from over-exploiting forest ecosystem resources. This means the households are less likely to engage in the foraging of forest ecosystem products. In addition, the more agricultural land a household owns the more labour they require to work on the land. This means the family

members are less likely to migrate to other towns outside their rural areas in search of jobs. Thus, rural household dependence on on-farm income is far greater than any other income sources. Finally, forest-fringe rural households in Eastern Mau are still characterized by low levels of education and so they have low financial capital endowments.

Results of the Model on Agricultural Equipment and Livestock Variables

The indicators of household asset holdings include farm asset like ownership of productive agricultural equipment, tools and machines (HH_PROD_EQUIP). Results of the model show that ownership of agricultural tools, machinery and equipment significantly and negatively influences the likelihood that household chooses all the four income dependency strategies relative to forest-based income dependency strategy. Equally, the odd-ratios displayed in Table 1 imply that the odds for households who own agricultural production equipment are in on-farm income, off-farm income, mixed-income and transfers income strategies which are 3.14 (1/0.318); 1.85 (1/0.541); 2.2 (1/0.453) and 2.1 (1/0.478) times, respectively lower than the households without the productive equipment. The households who own agricultural productive equipment are shown to increases their scale of agricultural production and economies of scale. This means households owning productive equipment are less likely to engage in forest-based income dependency strategies. The other household asset is the ownership of livestock herds (HH_LIVES). The model shows household ownership of livestock herd to have great impacts on household performance of regular on-farm income. This is revealed by the marginal effects that imply the odds of households who own livestock herds are in on-farm income, off-farm income, mixed-income and transfers income dependency strategies. These are 4.5%, 0.8%, 0.5% and 0.3% times, respectively lower than those without livestock herds. These results reveal the likelihood of household owning agricultural productive equipment and livestock herd to increases their economies of scale of agricultural production. Conversely, household ownership of productive assets like agricultural equipment, agricultural land and livestock is bound to increases on-farm income productivity. This increases total household income and reduces household dependence on forest ecosystem resources.

Results of the Model on Contextual Variables

The influence of contextual variables on household choice of income dependency strategies is revealed by household experience of unexpected shocks (UNEX_SHOCK) caused by income shortfalls that come as a results weather fluctuations. The shock variable indicator is shown in the model to have a positive and significant effect at the 1% level. This shows the unexpected shocks and poor infrastructure have an effect on household likelihood to pursue transfers income dependency strategy. These results mean that rural households who experience unexpected losses from shocks were more likely to be in the transfer income dependency strategy when compared to those who have never faced any losses from unexpected shocks. The possible reason for the causes of these shocks is attributed to income shortfalls due to disasters caused by climate-change-induced weather fluctuations. These are manifested by changes in rainfall patterns which cause extremities like droughts and floods. These disasters cause failures in crop and livestock production resulting in production yield gaps. These causes food shortages and income shortfalls resulting household unexpected shocks. The losses force rural households to re-allocate their resources into more defensive income strategies. For example, a study (Van den Berg, 2010) reveal that poor rural households in Nicaragua experienced climate-change driven weather disasters caused by hurricanes. These disasters have over the years hardened rural households to pursue more defensive income strategies for their survival. These included divesting away from on-farm income activities and investing in other income generating activities that are less dependent on weather patterns.

Table 1: Results of Analysis of Multinomial Logistic Regression Model

	Cluster 1			Cluster 2			Cluster 3			Cluster 4		
	On-farm Income Dependency			Off-Farm Income Dependency			Mixed-income dependency			Transfers Income Dependency		
Variables	Coeff.	Odd-ratios	ME	Coeff.	Odd-ratios	ME.	Coeff.	Odd ratios	ME.	Coeff.	Odd ratios	ME.
HH_SIZE	0.147	0.893 (0.0662)	0.186	-0.113	0.897*** (0.0360)	-0.015	-0.121	0.886*** (0.0641)	-0.132	-0.202	0.817*** (0.00442)	-0.164
EDU_HEAD	0.533	1.019* (0.330)		0.482	1.704*** (0.246)		0.484	2.622*** (0.0641)	0.015	0.432	1.914** (0.00442)	0.024
HH_AGE	0.011	0.989 (0.00640)	-0.002	-0.011	1.989* (0.00432)	-0.001	0.021	1.622*** (0.389)	0.002	0.023	1.104*** (0.388)	0.006
WORKING_HHM	0.230	1.258 (0.0890)	0.096	0.390	1.477*** (0.0970)	0.088	0.079	1.132*** (0.0984)	0.016	-0.153	0.654*** (0.0585)	-0.045
HH_GENDER	0.230	1.258 (0.0989)		-0.175	0.840 (0.130)		0.096	1.100 (0.0982)	-0.003	-0.188	0.829 (0.583)	-0.041
HH_ETHNICITY	2.752	2.683*** (4.263)	0.128	1.112	2.141*** (0.388)		1.341	13.786*** (0.186)		1.034	2.789*** (0.159)	
AGRI_LAND	-0.584	0.507 (0.0558)	-0.175	-0.676	0.559*** (0.0317)	-0.185	-0.255	0.908*** (0.827)	-0.109	1.062	0.892 (0.494)	0.005
IRRI_LAND	0.000	1.000 (0.00230)	0.000	0.001	1.001 (0.00157)	0.000	-0.020	0.980 (0.0468)	0.018	-0.063	0.939 (0.0441)	0.030
HH_LIVESK	-0.026	0.670*** (0.0278)	-0.045	-0.261	0.543*** (0.0460)	-0.008	-0.022	0.165*** (0.00264)	-0.005	-0.013	0.761*** (0.0354)	-0.003
AGR_PROD_EQP	-1.146	0.318*** (0.0546)		-0.588	0.541*** (0.0597)		-0.205	0.453*** (0.0551)		-0.129	0.478*** (0.0354)	
HH_LOAN	-0.308	1.361 (0.211)		0.112	0.894 (0.0946)		-0.801	0.449*** (0.0858)		0.677	0.508*** (0.0721)	
HH_SAVING	0.228	1.256 (0.266)		0.114	1.121 (0.158)		-0.278	0.758 (0.143)		-0.321	0.865*** (0.191)	

SOC_NETWORK	0.326	1.385		0.502	1.542***		0.462	1.588		0.345	1.628***	
		(0.316)			(0.248)			(0.447)			(0.122)	
UNEX_SHOCK	-0.056	0.945		-0.120	0.887		0.369	1.446		0.485	1.624***	
		(0.152)			(0.0968)			(0.397)			(0.341)	
DIS_ACC_ROAD	-0.021	0.931***	-0.003	-0.027	0.973**	-0.000	-0.047	0.865***	-0.002	-0.065	0.973***	-0.004
		(0.00958)			(0.0279)			(0.0246)			(0.0179)	
Constant	-0.454	0.650*		-3.599	0.0450***		-0.326	0.0234***		-2.143	0.0432***	
		(0.149)			(0.0243)			(0.0126)			(0.0213)	

Source: Survey Data 2013

Observations = 450; Log Likelihood = -3,314.81; LR $Chi^2(6)$ = 1,580.08; Prob > Chi^2 =0.0000

*p<0.1, **p<0.05, *** p<0.01

Table 2: Distribution of Total Household Income across Household Clusters

Income Activities	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Total Sample
Crop	74.65	40.94	26.17	24.92	37.15
Livestock	25.83	22.85	26.96	26.19	25.45
Wages/salary	27.17	25.72	19.54	9.53	20.49
Asset selling	2.05	3.09	8.27	2.13	3.34
Rental/hiring	1.19	2.16	2.84	3.68	2.05
Non-farm/non-wage	2.51	2.61	7.36	3.04	3.77
Transfers income	4.59	3.71	4.33	13.85	5.80
Forest resources	9.87	8.51	7.79	8.69	11.60
Other incomes	0.63	0.09	0.23	0.41	0.35
Total					100

The other contextual variable is measured by physical infrastructure development in the rural economy. The distance travelled by rural household (DIS_ACCESS_ROAD) to reach the nearest all-weather road is a proxy of rural economic development. This variable indicator in the model is shown to have a positive and significant effect at the 1% level. The unexpected shocks and distance to the nearest all-weather roads are indicator variables that are shown to have an influence on household choice of income dependency strategies. The model shows the variables have a significant influence on household choice to pursue transfers and all other income dependency strategies. Distance to the nearest all-weather road is used as a proxy for remoteness by many environmental economists (Belcher, Achdiawan, & Dewi, 2015). A study by (Stifel & Christiaensen, 2007) shows remoteness of a rural set up increases household spatial transaction costs. It affects the degree of household to access markets which, in turn, influences household decision to choose an income dependency strategy. However, the marginal effect of the distance indicator variable on the choice of household income dependency strategy is quite small. For example, the addition of one kilometer to the distance to be traveled by a household to reach the nearest all-weather road reduces the likelihood of a household of being in all the four income dependency strategies. The marginal effect on-farm income, mixed-income and transfers income reduces by 0.3%. When the distances to various destination points in the rural economy were to be reduced, rural households would easily travel to seek employment, buy goods like farm inputs, reach markets of farm produce easily and thus reduce spatial transaction costs. Road accessibility makes households to access more opportunities and to participate in more lucrative income-generating activities. The finding is consistent with theory and studies (Babulo et al., 2008; Xu et al., 2015) which shows rural household dependence on agricultural activities among rural households in remote areas in Ethiopia and China. Equally, rural households in far-flung rural areas were more likely to engage in on-farm or agricultural income production activities. A study in China by Xu et al. (2015) show household dependence on agriculture were found living in more remote areas.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The results of multinomial logistic regression model in this study shows that thirteen out of fifteen indicator variables of the model have an influence on household choice of income dependency strategies. These variable indicators have been shown to have a high likelihood ratio (LR). This indicates that at least one of the predictor variables has a significant influence on the response variable.

Also, the results of the study show that on-farm income activities which are derived from crop and livestock production constitute 62.6% of total household income. This result shows on-farm income activities if enhanced could reduce household income shortfall and poverty. It will also reduce household over-dependence on forest ecosystem resources which causes degradation and loss of biodiversity.

In addition, the results of the study reveal that efficient conservation and management of forest ecosystem resources when embedded in household livelihood improvement will expand household choices of income dependency strategies.

Recommendations

It is recommended to state-actor policymakers should focus on technological innovations for improved agricultural productivity. This includes improving performance of regular household on-farm income activities. Some of the innovations include improvement in agricultural extension services. These are on-farm services that include use of agricultural

equipment, investment in modern livestock production and provision of financial credit or loans to enhance farmers' working capital.

Further, state-actors should invest in improving physical infrastructure like road network which reduces the distance to be travelled to reach mixed-income roads. Reduced distances reduce spatial costs to households who are located in far-flung remote areas. They travel when transporting farm commodities and to access social amenities.

Also, state-actors should also invest in the diversification of income generating activities. For example, supporting programmes that allows households to divest into small business start-ups, that include, non-farm and non-wage business activities. These activities reduce household exposure to risks related to income shortfall due to crop failure caused by rain-fed agricultural production. The diversification of income activity programmes is a mitigation strategy against disasters of climate-change-induced rainfall fluctuations.

Equally, state-actors should embed household livelihood sustainability into efficient conservation and management of forest-ecosystem resources. For example, the improved on-farm income activities, increases total household income which alleviates household poverty. Reduced rural household poverty reduces over-exploitation of forest products which in the long term causes degradation and loss of biodiversity.

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