Evaluation of the Factors Associated with Shift from Pastoral to Agro-pastoral Farming Systems in Trans-Mara West District of Narok County-Kenya

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Abstract: The Kenyan Government in partnership with the private sector has set up co-operative societies for marketing livestock and livestock products in Narok County. These co-operatives are supposed to trigger extensive expansion in livestock production. Despite perceived steady incomes, high turnover and ready market for livestock, the pastoral Maasai community is shifting from pastoralism to agro-pastoralism. This community is strongly traditional with much cultural and economic attachment to livestock. The shift brings to question the underlying drives which are not well understood. The drives are diverse, but little is known about their contribution to the engaged shift. The objective of this study was to determine the factors associated with the shift. Stratified proportionate random sampling procedure was used to get the appropriate sample. Data were collected from a sample of 130 households through interview schedule. Heckman two-step model was used to determine the factors associated with the shift. The findings indicated that household decision to shift was enhanced by more frequent group meetings and farmer trainings, declining land sizes, longer distance to watering points, shorter distance to market and more income from off-farm sources of incomes. The agro-pastorals choice to allocate higher proportion of land for crop production compared to livestock production was enhanced by more distance to watering points, low off-farm incomes, private land ownership, larger family, male dominance, more extension services, shorter distance to the market, less years of crop farming and little interaction with the neighbors. Whereas some households shifted out of necessity, others shifted by choice.

Keywords: Co-operatives, decision, determinants, household, maasai community

INTRODUCTION

There are over 200 million pastoralists in the world. In Kenya almost 8 million people who depend on livestock and dry land agriculture reside in Arid and Semi Arid areas (ASALS). The ASALS are characterised by high rainfall variability and recurring droughts which impact on rangeland productivity (Fratkin, 2001; Adeel and Uriel, 2005; Ellis, 1998).

In some ASALS, where rangelands receive reliable rainfall pattern which can support crop production, pastoral households have responded by introducing commercial crop production. Consequently, the response has been associated with gradual shift from pastoral livelihoods to agro-pastoral land use systems (Gumbo and Maitima, 2007; Mwang’ombe et al., 2009). In TransMara West of Narok County, the pastoral Maasai community is not exceptional. This community has a strong cultural attachment to livestock keeping, but currently a paradigm shift has been observed from pastoralism to agro-pastoralism, which pauses curiosity to the researcher (Mochabo et al., 2006).

In the county, integration of crops and livestock systems is on the increase, but the drives behind these land use system are not well understood. Increased conversion of fertile range lands to commercial cultivation in Trans-Mara West district has led to competition for land resource between livestock and crops. Remaining rangelands are themselves increasingly privatized through sub-division and allocation of rights for ranching and farming enterprises. Moreover, high rates of population growth and in-migration have added to both real and perceived pressures on pastoral lands (Coast et al., 2001, 2006; Tangu, 2004; Akinwumi et al., 1996). Land ownership remains communal in pastoral land use, unlike in agro-pastoral land use where, land ownership is private, which may be used for ranching and crop enterprises.

Access to extensive public land, offering potential for grazing and water resources is key in pastoral production system since it promotes pastoral mobility. Policies not in line with pastoral mobility increases pastoral vulnerability to drought and loss of livestock.
assets, which pose threat to sustainability of pastoral-based livelihoods (Coast et al., 2006; Mwangi, 2005).

Faced with such threats, many pastoral communities have responded with diversification of livelihoods to agro-pastoralism (Binsbergen and Watson, 2008; Galvin, 2009; Freeman et al., 2008). To mitigate some sustainability threats to pastoral livelihoods, the Kenyan government in partnership with the private sector promoted integration of pastoral economy into market economy. This has been through setting up of co-operative societies in TransMara West district to open ready market for livestock and livestock products trading in order to accommodate financial and social capital. This development strategy has however not been able to support sustainable pastoralism, evidenced by ongoing gradual shift to agro-pastoral based livelihoods (Morton and Meadows, 2000; Mochabo et al., 2006). The drives behind the shift are many but the contribution of the key determinants to the shift has not been well understood. Therefore, the study sought to evaluate the factors associated with the shift from pastoral to agro-pastoral based livelihoods, so as to enhance better understanding of the household decision making process.

**MATERIALS AND METHODS**

**Study area:** The study was conducted in TransMara West District of Narok County, Kenya between June and August, 2011. The district lies on the south-western part of Rift Valley Province between Latitude 0° 50’ and 1° 50’ South and Longitude 34° 35’ and 35° 14’.

The topography of TransMara West district comprises three major categories:- the highlands which lie between 2,200 and 2,500 m above sea level, the plateau which rises from 1524 to 2200 m above sea level and the lowland which lie below 1524 m above sea level.

The lawland receives 1000 mm of rainfall/year.

The district has seven divisions covering an area of about 2,846.40 km² with an estimated population of 170,591 (1999 census), growing at a rate of 2.23% and has a population density of 60 people/km² (MOFAP, 1999) with an estimated poverty index of about 40% (MOFAP, 1999). The study area is estimated to have 14517 households (in the eight locations of interest) with an average household size of 5 people (MOFAP, 1999). Settlement patterns in the district correspond to land use, land tenure and urbanization. Settlement is sparse where large stocks of livestock are reared, but comparatively denser in areas where crop farming is practiced and small stocks of livestock reared.

**Sampling design:** The study used stratified proportionate random sampling procedure. Within TransMara district, the divisions were stratified according to agro-ecological zones. Kirindoni and Lolgorian divisions were selected because of having prominent pastoral and agro-pastoral farming households within the same agro-ecological zone. Eight locations among the two divisions were randomly selected. The locations were further stratified into two namely: -pure pastoralism and a mixture of pure pastoralism and agro-pastoralism. Lastly, random selection of the respondents within the locations was made proportionate to the population of each location to obtain the required sample size. The needed proportionate sample in a location was computed from the households in a location divided by sum of all households in eight locations them multiplied by the needed sample estimate of 130 households.

**Data collection:** Data collection used interview schedule. Both large scale and small scale farmers were contacted. Secondary data such as the number of households in the area and the total population per location was collected from the Divisional and District Agricultural extension offices and the District development office in TransMara West district.

Data requirements for analysis of the factors included: -household characteristics (Age, family size, off-farm sources of incomes, gender and education level), institutional factors (land tenure system, access to credit, group meetings), physical factors (distance to market and watering points, asset owned) and farm factors (herd size, farm size).

**Specification of the empirical model:** Literature is rich on quantification of income diversification using econometric models such as censored Tobit model (Karugia et al., 2006), OLS (Babatunde and Qaim, 2007), Generalized linear regression analysis (BurnSilver et al., 2009) and Multinomial logit.

Heckman two stage and double hurdle models (Matishe and Young, 2004; Lansink et al., 2000) have been used to determine the factors influencing ones decision to participate in diversification and the extent of participation. However, in this study a Heckman two- step model was used. This is because the model works well when normality assumption is upheld; moreover, it provides guidance on which variables to be included in the first and second steps respectively (Obayelu et al., 2009). The two step procedure was chosen for estimation so as to correct the sample selectivity bias as per Heckman (1979). Both participation and extent equations were estimated simultaneously. The variables included in the model were age, farmer training, gender, off-farm income, education level, herd size, individual land tenure, frequency of group meetings, distance to market, extension services, household size, land size, distance to watering points, experience in crop farming, of
neighbour influence and credit access. Marginal effects of variables were arrived at after post estimation of selection equation. The marginal effects were used for interpretation, since coefficients of both selection equation and outcome have no direct interpretation. The reason is that they are just values that maximize the likelihood function. Marginal effects have direct interpretation (Heckman, 1979). Therefore, this objective was modeled as two separate decisions:

- Whether or not to shift to agro-pastoralism
- The extent of the shift

The reason for separation was that these decisions are twofold. First, due to social or psychological drives, the individual may prefer not to engage in agro-pastoralism. Second, an individual may be a potential diversifier but for certain levels of relevant variables, decide not to diversify. The former represents abstention, the latter a corner solution. Heckman (1979) proposed a two-step procedure which only involves the estimation of a standard probit and a linear regression model. The two equations for the two steps were specified as follows:

**Selection equation (probit):**

\[
\text{Participation decision} = \beta_0 + \beta_1 \ast (\text{agehh}) + \beta_2 \ast (\text{off-farminc}) + \beta_3 \ast (\text{educlevel}) + \beta_4 \ast (\text{totherd}) + \beta_5 \ast (\text{hectha}) + \beta_6 \ast (\text{oment}) + \beta_7 \ast (\text{freqmeet}) + \beta_8 \ast (\text{distmk}) + \beta_9 \ast (\text{noconst}) + \beta_{10} \ast (\text{farmsize}) + \beta_{11} \ast (\text{distwater}) + \beta_{12} \ast (\text{crdtaces}) + \beta_{13} \ast (\text{trainim}) + \beta_{14} \ast (\text{genderhh}) + \beta_{15} \ast (\text{ninfl}) + \beta_{16} \ast (\text{cropfay}) + \ldots + \epsilon_1
\]

**Outcome equation (simple OLS):**

\[
\text{Proportion of land allocated to crop production} = \beta_0 + \beta_1 \ast (\text{agehh}) + \beta_2 \ast (\text{off-farminc}) + \beta_3 \ast \ldots + \epsilon_2
\]
Table 2: Heckman two-step selection equation results for dependent variable—participation in the shift from pastoral to agro-pastoral farming

| Variables    | Coefficient | S.E.  | p>|z|  | Marginal effects dy/dx |
|--------------|-------------|-------|------|-----------------------|
| agehh        | 0.001       | 0.011 | 0.921| -0.000                |
| crdtaces     | 0.439       | 0.278 | 0.115| 0.159                 |
| off-farminc  | -0.752      | 0.307 | 0.014**| -0.259               |
| farmsize     | -0.008      | 0.004 | 0.041**| 0.003                 |
| educlevel    | 0.201       | 0.179 | 0.261 | 0.068                 |
| ownd         | 0.475       | 0.373 | 0.023 | 0.014                 |
| totherd      | -0.060      | 0.062 | 0.016 | 0.009                 |
| freqnet      | 0.248       | 0.114 | 0.030**| 0.087                 |
| dstmkt       | -0.308      | 0.120 | 0.010**| -0.113               |
| noconta      | 0.169       | 0.130 | 0.196 | 0.060                 |
| hhsiz        | 0.085       | 0.062 | 0.171 | 0.030                 |
| dstwater     | 0.677       | 0.221 | 0.002* | 0.243                 |
| traintim     | 0.289       | 0.154 | 0.061***| 0.105                |
| genderhh     | -0.154      | 0.452 | 0.074 | -0.054               |

dy/dx: Marginal effects; *: Means significant at 10%; **: Significant at 5%; ***: Significant at 1%

Table 3: Heckman two-step outcome equation results (OLS results)

| Variables    | Coefficient | S.E.  | p>|z|  | Marginal effects dy/dx |
|--------------|-------------|-------|------|-----------------------|
| agehh        | -0.000      | 0.002 | 0.978 | -0.000                |
| cropfayr     | -0.058      | 0.026 | 0.027**| -0.059               |
| crdtaces     | 0.037       | 0.041 | 0.358 | 0.038                 |
| off-farminc  | -0.093      | 0.056 | 0.099***| -0.093               |
| farmsize     | -0.000      | 0.000 | 0.984 | -0.000                |
| educlevel    | 0.014       | 0.024 | 0.547 | 0.015                 |
| ownd         | 0.120       | 0.051 | 0.020**| 0.121                 |
| totherd      | -0.000      | 0.000 | 0.739 | -0.000                |
| freqnet      | -0.018      | 0.016 | 0.255 | -0.018                |
| dstmkt       | -0.071      | 0.024 | 0.004* | -0.071               |
| noconta      | 0.077       | 0.019 | 0.000* | 0.077                 |
| hhsiz        | 0.016       | 0.009 | 0.064***| 0.017                |
| dstwater     | 0.082       | 0.035 | 0.020**| 0.082                 |
| ninfl        | -0.121      | 0.037 | 0.001* | -0.122               |
| traintim     | 0.017       | 0.022 | 0.437 | 0.018                 |
| genderhh     | 0.225       | 0.084 | 0.007* | 0.226                 |

dy/dx: Marginal effects; *: Means significant at 10%; **: Significance at 5%; ***: Significance at 1%

Declining land sizes increased the shift to agro-pastoral farming by 0.8%, implying that farmers with less land sizes could shift to agro-pastoral farming as compared to those with more land sizes. The reason could be that, farmers could not achieve self-sufficiency through livestock production alone so as a response they tended to diversify to crop production so as to provide a variety of food for their families (Liyanage, 2006; Adewumi et al., 2009). An increase in time taken to reach the nearest market decreased the shift to agro-pastoral farming by 30.8%. The result was consistent with findings from previous agricultural market studies such as (Abele et al., 2009). The finding reinforces the argument that poor market access for households located further from the water points were more likely to shift to agro-pastoralism than those living closer to the water sources. The reason is that near water sources, natural salt licks are found (Ndumu et al., 2008; Galvin, 1992) which promotes the health of the animals, thus most pastoralists prefer grazing their livestock near water sources. Moreover, availability of salt licks saves farmers the cost of buying mineral licks for their livestock (Karbo, 2007).

Training of the household head was also significant with a positive sign. Almost 29% of the observed variation in the shift from pastoral to agro-pastoral farming could be explained by the number of trainings. An additional training session of the household head increased participation by 29%. Moreover, frequency of group meetings showed up as significant and positive in terms of explaining variation in the shift across farmers, increasing the explanatory power of the model to 25%.
Frequent meetings enhance access and exchange of new ideas and knowledge. Both household training and frequent group meetings increased participation in the shift since well educated farmers tend to be more receptive to new technologies (Kosgey et al., 2004; Kariuki et al., 2007).

Table 3 shows the results of Heckman two-step outcome equation. The extent of the shift was determined as the proportion of land allocated to crop production divided by total farm/land size. Variables determined to have significant association with the extent of the shift included: experience in crop production, other sources of income, land ownership with title deeds, household size, gender, neighbor influence, extension services, distance to the market, distance to the watering points and farmer training.

Years of crop farming experience had a significant negative effect on proportion of land allocated to crop cultivation. The intensity of crop production decreased by about 6% for every extra year of farming experience a household gained. The reason could be that, as one grows old the energy to work on the farm declines since crop farming is labor intensive (Adewumi et al., 2009). Also, it might happen that due to strong cultural attachment to livestock in the area, over time older farmers revert back to livestock production (Akinwumi et al., 1996). Research by Kristjanson et al. (2002) showed that diversification into cropping appeared to be a quite tenuous option, with many households not getting a harvest even in a year considered to be a ‘good rainfall year’. Similarly, there is a possibility of farmers reverting back to pastoral production over time if returns from crop farming are low.

Income from off-farm sources significantly and negatively affected the proportion of land allocated to crop production. As incomes from off-farm sources increase, the proportion of land allocated to crop production decreases by about 9%. This result differs from what Lynne (2010) observed. The difference in observations could be attributed to the fact that as income increases, farmers can be able to use the money in buying a variety of foods rather than growing the crops. Pastoralists are known to sell livestock so as to buy food, clothing, pay medical bills and even school fees and in response they tend to adopt crop farming to supplement livestock incomes. Therefore, with increase in other sources of incomes, sell of livestock is limited and by so doing livestock units tend to increase. Over time, most farmers would have more livestock, implying more land will be allocated to livestock production compared to crop production (Boone et al., 2003; Markakis, 2004; Bebe et al., 2002; Deluca et al., 2010).

Land ownership with title deed showed up as positive and significant, along with household size. So, larger household sizes together with land title deeds appear to have an advantage when it comes to the proportion of land allocated to crop production. Private land ownership with title deeds gives farmers a right to use the land (security of tenure) thus creates an incentive for the farmers to make necessary investments in their land which are long term and even riskier (Rana et al., 2000).

A larger household size increased the probability of allocating more land share to crop production by 2%. Larger household sizes have been found to be associated with extra expenses (food, school fees and medical bills), thus households will allocate more land for crop production so as to cater for such expenses instead of selling livestock. Also due to change in dietary habits (from milk and blood) more land is allocated to crop production so as to get a variety of foods (Markakis, 2004; Deluca et al., 2010).

Extension service was measured by the number of household head contacts with extension officers and it proved significant with a positive sign. It was realized that 8% of the observed variation in the extent of the shift from pastoralism to agro-pastoralism could be explained by the number of contacts. An additional visit of the household head by the officers increased the extent by 8%. Extension agents supply farmers with important information and skills on production, management and even marketing. The availability of relevant and adequate information reduces the risk associated with crop production. The reduction in the risk therefore provides an incentive to the farmers to expand production of a particular crop. According to Alakpa and Onemolease (2009), farmers in contact with extension agents are two times more likely to increase adoption of crop-related innovations than those with no contact.

Distance to the market significantly and negatively affected the proportion of land allocated for crop production. An increase in time taken to reach the nearest market reduced the probability of allocating more land for crop production by 7%. This implies that increased distance to the market favors pastoralism in the area. This would be attributed to the fact that by moving further from town, a household is able to occupy less crowded pastures for livestock and there is much space for resting of livestock (during the day for lactating livestock and at night for non-lactating ones) (Doss and McPeak, 2005).

Distance to the nearest water source was significant and positively correlated with extent of the shift. Increase in time taken to reach the nearest watering point say by one hour increased the proportion of land allocated for crop production by 8%. Research by Herrero et al. (2006) has shown that households located closer to water points earn more returns from livestock as compared to households further from watering points. Thus, it might happen that households located further from water sources get demotivated by little returns (less milk, blood and little income from sales)
from livestock and in response they allocate more land for crop production. In addition, following the Kenyan government decision to privatize land in the area, it is difficult to access water given that already other farmers have fenced their land (Mwang’ombe et al., 2009; Griffiths, 2007; Semambo et al., 2009).

Gender of the head of the household had a significant impact on the proportion of land allocated to crops positively. There was a lower likelihood for female-headed households to allocate land for crop production compared to male-headed households (Deluca et al., 2010). The results indicated that if the household head is a male the probability of allocating more land for crop production increased by 22.58%. A plausible explanation for this could be that female headed households are resource constrained given that they do not own critical resources such as land and livestock. Moreover, they have no power to make decisions on resource use as noted by WIBD (2005).

Influence from the neighborhood significantly and negatively affected the extent of the shift. As farmers interacted more with their neighbors, the probability of allocating more land for crop production declined by 12.17%. In this context, the neighborhood comprised of other communities found in the area such as the Kisii, Luo and the Kipsigis. On the other hand, the Maasai themselves formed part of the neighborhood based on different Maasai clans. So, depending on who formed the neighborhood, farmers could decide to allocate more or less land towards crop production. A plausible explanation for this result is that the Maasai community has a long time history in livestock production. Besides, they have a strong cultural attachment to livestock (Mageka and Osero, 2007; WISP, 2008) hence they were likely to allocate much land to livestock production as compared to crop production. Langyintuo and Mulugetta (2005) argues that as farmers interact more with their neighbors and outside world, they become more able to assess the relevance of new technologies and ideas thus they exercise a choice.

CONCLUSION AND RECOMMENDATIONS

From the study, households would be better off with the shift from pastoral to agro-pastoral livelihoods, given that the shift was enhanced by more frequent group meetings and farmer trainings, shorter distance to market and more income from off-farm sources of incomes. Declining land sizes and longer distance to watering points forms the rationale of the observed behavior changes among households.

The agro-pastorals choice to allocate higher proportion of land for crop production compared to livestock production was enhanced by more distance to watering points, low off-farm incomes, private land ownership, larger family, male dominance, more extension services, shorter distance to the market, less years of crop farming and little interaction with the neighbors.

Distance to watering points was found to be key in influencing the shift, however, as much as most farmers have shifted, still culture inhibits complete exit from pastoralism, thus there’s need for a policy to address water problems in the area (given that farmers took 1-2 h before they could reach the nearest water source), through targeted training programs that will enhance the knowledge of farmers on water harvesting technology. Moreover, the Government should drill more boreholes in strategic points to assist households during the dry season.

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