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Potential Impact of Climate Change on Resilience and Livelihoods in Mixed Crop-Livestock Systems

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Mixed crop-livestock systems cover over one million square kilometers of farmland and support the livelihoods of millions of poor people in arid and semi-arid areas of Africa. The scant and highly variable rainfall that is characteristic of these areas leads to frequent crop failures, typically one out of every six growing seasons. Many local households face a wide array of problems including poverty, food insecurity, and inadequate diets – all of which stand to be seriously exacerbated by the effects of climate change. A variety of projected climatological scenarios forecast that these areas will become drier, making crop production even riskier than it is at present. This note describes the possible climate-induced livelihood transitions in mixed crop-livestock systems using East Africa as a case study. The findings reported are based on three exercises. The first was the mapping of potential hotspots of climate-induced changes using high resolution geospatial methods. The second exercise entailed household-level and key informant surveys to determine the evolution of livelihood patterns in 12 districts in Kenya, Tanzania, and Uganda (Table 1). The third applied the Decision Support System for Agrotechnology Transfer cropping systems model to assess the potential impact of climate change on food security and poverty levels.

EVOLUTION OF MIXED-CROP LIVESTOCK FARMING SYSTEMS AND ADAPTATION STRATEGIES

The evolution of farming systems in East Africa is conditioned by a variety of powerful social and cultural processes. Prominent among these has been an expansion in the area in which crops are cultivated, and in the number

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TABLE 1. SOME CHARACTERISTICS OF THE STUDIED DISTRICTS

District	Country	Population density (persons km^{-2})	Annual rainfall (mm)	Length of growing period (days)	Cropland (%)	Pasture (%)
Kwale	Kenya	19	787	179	15	48
Baringo	Kenya	15	658	134	10	85
Samburu	Kenya	1	523	85	18	57
Machakos	Kenya	498	1205	159	13	49
Kajiado	Kenya	21	655	146	24	0
West Pokot	Kenya	17	717	139	34	65
North Pokot	Kenya	22	935	196	74	26
Kishapu	Tanzania	24	875	168	19	35
Singida	Tanzania	28	827	139	2	98
Mbarara	Uganda	15	898	211	67	0
Nebbi	Uganda	55	1058	210	64	36
Masaka	Uganda	294	1061	217	88	0

of households engaged in crop production over the last 30 to 40 years. This has included expansion into highly marginal areas with 700 mm or less annual rainfall. In all but four of the twelve districts studied, cropping has been introduced only in the last 50 years. Maize predominates, but some householders are increasing their crop and diet diversity, particularly in locations with higher annual rainfall, and are willing to try drought-tolerant crops such as millet, sorghum, and cassava.

Food security is positively correlated with rainfall. In seven of the twelve districts, all with annual rainfall higher than 800 mm, households were self-sufficient in securing adequate dietary energy from food production. The districts with high food insecurity were also those in which a large proportion of households receive food aid several times each year. Food insecurity was common in all districts with an annual rainfall of 800 mm or less, and assumed critical levels in those districts with less than 700 mm of rainfall. Adaptation strategies varied across districts. Some householders in the low rainfall districts undertook to diversify their income sources through crop production. Others who were already engaged in farming sought to intensify crop-livestock systems with a variety of crops and intercropping. Opportunistic income generation is an important strategy, reflecting the flexibility that many households show in adapting to their environment (Figure 1).

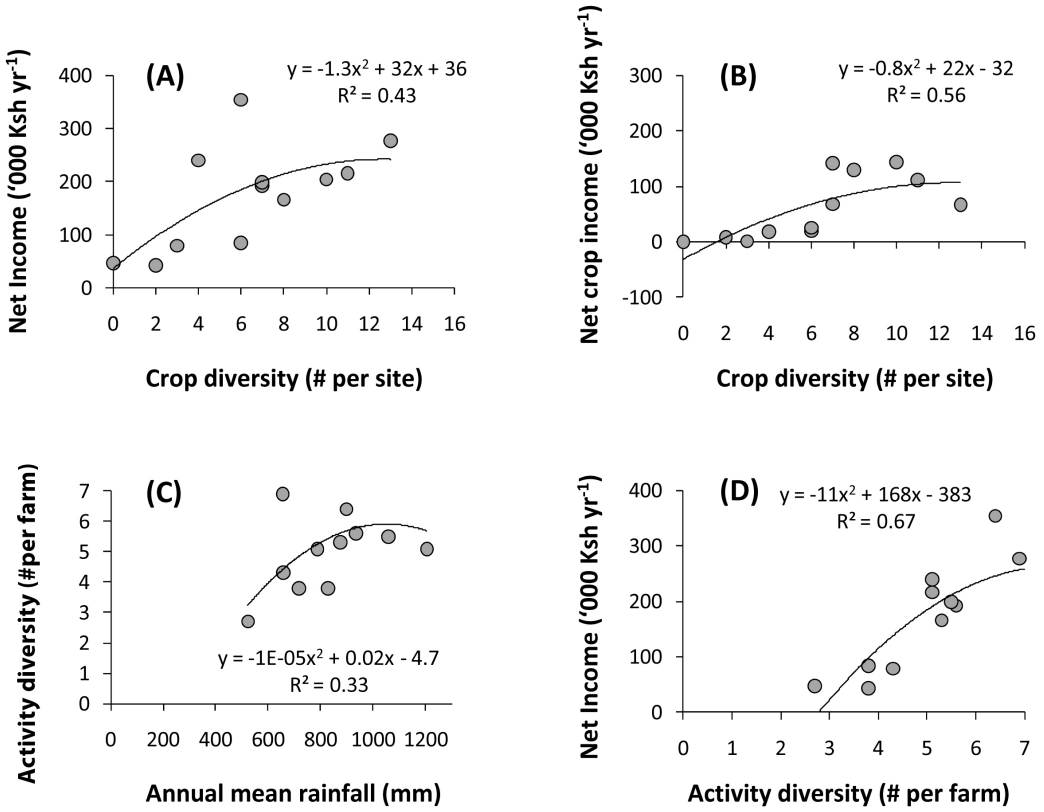
Water was ranked as the most important concern by respondents in all 12 districts, both for human consumption and for livestock, and to a lesser extent for crop production. About 48 percent of respondents expressed concern over not having enough drinking water and 48 percent over not having enough water for livestock. 16 percent expressed concern over not having enough water with which to cultivate crops. In 10 of the 12 districts, households were concerned about not having enough food for the family (38 percent of the respondents), while in seven of the 12 districts household were concerned about not having enough pastures for the livestock (28 percent of the respondents).

Searching for water is a primary coping strategy, and drilling boreholes has emerged as an important means of adaptation. Households cope with food shortages by buying food or relying on food aid, as well as by reducing consumption. Adaptation strategies against food deficits vary across the rainfall gradient: in the low rainfall districts, households mentioned income diversification, expansion of cropping, diversification of crops, and increasing herd sizes. In the higher rainfall districts, households mentioned increasing the storage of food, planting drought resistant cultivars, and intercropping. Households respond to the lack of pastures for livestock by increasing livestock mobility. In some of the districts, households mentioned conservation of feeds, use of irrigation, and use of drought-tolerant grasses as adaptation strategies.

PROJECTED IMPACTS OF CLIMATE CHANGE ON FOOD SECURITY AND POVERTY

Model results indicate that the effects of climate change are dependent on crop and on location. Maize, which is the preferred crop, generally does not do very well under current conditions in

Figure 1: Relationship between: A) Number Of Crops Cultivated And Net Household Income; B) Number of Crops Cultivated and Net Cropping Income; and C) Number of Activities Per Farm and Annual Rainfall; and D) Number of Activities Per Farm and Net Income



terms of yields. Nor is maize well-suited to the conditions which are likely to emerge as the result of climate change – conditions that will markedly increase the probability of crop failure. More positively, projections about the effects of climate change suggest that in some places opportunities may emerge for households to diversify and intensify cropping, and possibly expand into places where cultivation is not currently possible. In other places, particularly in low rainfall areas, households are likely to experience increased food insecurity and higher poverty rates in the future. However, the model indicated considerable variability in income, food security and self-sufficiency between households within the same districts. This implies that some proportion of the households may be successful in adapting to climate change and taking advantage of new opportunities that may present themselves in the changing landscape.

While the effects of climate changes in East Africa are diverse, there may be areas which benefit from climate change and may not need to shift from their current maize-based cultivation systems. Others would need to shift to include more cassava and sorghum in their cropping portfolio. Dryland cropping with its associated lower yields and higher production costs, is estimated to have negative impacts on farm profits, although diversification involving drought-tolerant crops may help smooth the inter-annual income variability that can arise because of market price variability. Increased livestock numbers might be a mechanism for enhancing food security, if households would treat livestock as an enterprise, as they do crops. It should be noted that there is some uncertainty among climate models as to the direction of change in rainfall amounts in East Africa in the coming decades, and so simulated production changes into the future should be interpreted with caution.

POLICY IMPLICATIONS

Some policies that can strategically address climate-induced livelihood transitions in mixed-crop livestock systems are discussed below.

Extension support to successfully innovate in cropping, particularly in the locations where cropping is a relatively new activity.

Drought-tolerant crops are likely to be an important component of future farming systems. Although many households have some knowledge about them, few cultivate them. Millet, sorghum and cassava are grown in six, five and three districts only, respectively, and by relatively few households.

Crop breeding to improve nutrition security. The diets of many people in the region that are built around maize are largely protein deficient, and reliance on maize for regional food security may be increasingly risky in view of its susceptibility to climate change impacts. In addition to crop breeding, addressing seed distribution systems for drought-tolerant crops: sorghum, millet, cassava, and legumes will be important. Knowledge transfer on how to effectively cultivate these less familiar, non-traditional crops should also include instruction on how to add value to these food crops through cooking, processing, and marketing.

Support households in drier locations with safety nets and infrastructural services. These include roads, water, crops and livestock input services. Together, these will reduce their vulnerability and potentially trigger certain tipping points for achieving food security and proportionately greater self-sufficiency.

Develop and disseminate better short-and medium-term weather forecasting. Improved forecasting is required to help households in wetter regions better manage risks and increasing cropping diversity or intensification of livestock production. The weather forecasting tool should be utilized together with crop and livestock insurance schemes and market development for reaching growing urban and peri-urban populations.

Photo: Curt Carnemark

This *Note* was written by Ademola Braimoh, Nancy Morgan, and François Le Gall, and edited by Gunnar Larson. The *Note* is based on the report of a World Bank–commissioned study, *Genesis Reversed: Climate Change Impacts on Agriculture and Livelihoods in Mixed Crop-Livestock Systems of East Africa* by the International Livestock Research Institute (ILRI) in Nairobi, Kenya.