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Croppers to livestock keepers: livelihood transitions to 2050 in Africa due to climate change

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ABSTRACT

The impacts of climate change are expected to be generally detrimental for agriculture in many parts of Africa. Overall, warming and drying may reduce crop yields by 10–20% to 2050, but there are places where losses are likely to be much more severe. Increasing frequencies of heat stress, drought and flooding events will result in yet further deleterious effects on crop and livestock productivity. There will be places in the coming decades where the livelihood strategies of rural people may need to change, to preserve food security and provide income-generating options. These are likely to include areas of Africa that are already marginal for crop production; as these become increasingly marginal, then livestock may provide an alternative to cropping. We carried out some analysis to identify areas in sub-Saharan Africa where such transitions might occur. For the currently cropped areas (which already include the highland areas where cropping intensity may increase in the future), we estimated probabilities of failed seasons for current climate conditions, and compared these with estimates obtained for future climate conditions in 2050, using downscaled climate model output for a higher and a lower greenhouse-gas emission scenario. Transition zones can be identified where the increased probabilities of failed seasons may induce shifts from cropping to increased dependence on livestock. These zones are characterised in terms of existing agricultural system, current livestock densities, and levels of poverty. The analysis provides further evidence that climate change impacts in the marginal cropping lands may be severe, where poverty rates are already high. Results also suggest that those likely to be more affected are already more poor, on average. We discuss the implications of these results in a research-for-development targeting context that is likely to see the poor disproportionately and negatively affected by climate change.

1. Introduction

Agricultural systems in developing countries are changing rapidly in response to a variety of drivers. Globally, human population is expected to increase from more than 6.5 billion today to nearly 9.2 billion by 2050 (UNPP, 2008). About 1 billion of this increase will occur in Africa. At the same time, rapid urbanisation is expected to continue in developing countries. By the end of 2008, more than half the global human population (3.3 billion) will be living in urban areas. By 2030, this number will have increased to almost 5 billion: the next few decades will see unprecedented urban growth particularly in Africa and Asia (UNFPA, 2008). Furthermore, the global demand for livestock products will continue to increase significantly in the coming decades (Delgado et al., 1999), driven by urbanisation, population growth and income

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increases. This increased demand is largely based in developing countries (Delgado, 2005). The trends in demand will be for both increased quantity, especially as incomes rise from USD 2 to 10 per day, and for increasing quality, particularly among urban consumers who purchase livestock products from supermarkets (Thornton et al., 2007).

In addition to all this, the climate is changing. Recent climate model projections suggest an increase in global average surface temperature of between 1.8 and 4.0 °C to 2100, the range depending largely on the scale of fossil-fuel burning between now and then and on the different models used (IPCC, 2007). At mid- to high latitudes, crop productivity may increase slightly for local mean temperature increases of up to 1–3 °C, depending on the crop, while at lower latitudes, crop productivity is projected to decreases for even relatively small local temperature increases (1–2 °C) (IPCC, 2007). In the tropics and subtropics in general, crop yields may fall by 10–20% to 2050 because of warming and drying, but there are places where yield losses may be much more severe (Jones and Thornton, 2003). In addition to these longer-term changes in climate, shorter-term changes are also anticipated. For example, there will be changes in the frequency and severity of extreme climate events, and these will have significant consequences for livelihoods, natural resources, food production, and food security. Increasing frequencies of heat stress, drought and flooding events are likely, and these will undoubtedly have adverse effects on crop and livestock productivity over and above the impacts due to changes in mean variables alone (IPCC, 2007).

Taking these drivers together, the trajectory of agricultural systems in the coming decades in different places may be difficult to foresee in much detail, but they will certainly be extremely dynamic. On the one hand, the increased demand for crop and livestock products is going to have to be met from somewhere, and one development challenge is to maximize the benefits to the poor in this demand-led income opportunity. The poor will be able to play a greater role in some livestock production and market chain systems than others. Smallholders are major players in the dairy sector, for example – indeed, almost all the meat and milk in Africa is produced in agro-pastoral and mixed systems (de Haan et al., 1997) – while industrial systems are the major actors in the rapidly growing poultry market. On the other hand, climate and other global change drivers may make it difficult for smallholders to take advantage of the demand-led income opportunities that will arise. The impacts of climate change on agricultural systems are likely to be highly heterogeneous, both spatially and temporally. Some places in the highlands of sub-Saharan Africa (SSA) may see improvements in conditions for crop growth as a result of increasing temperatures and rainfall amounts, and there may be opportunities for smallholders to intensify and/or diversify production in these areas. There are other places where the changing climate means that the livelihood strategies of rural people will have to change, to preserve food security and provide income-generating options. These are likely to include areas of Africa that are already marginal for crop production. As these become increasingly marginal, then livestock may provide an alternative to cropping. In many of the semiarid systems in sub-Saharan Africa, livestock production enables farmers to diversify incomes, helping to reduce income variability—indeed, livestock are a crucial coping mechanism for poor and vulnerable people in variable environments (LID, 1999).

Given the heterogeneity of the likely impacts of climate change and of households' ability to deal with it, there is a need for detailed information on the impacts on agricultural systems, so that effective adaptation options can be appropriately targeted. In this paper, we summarise some existing broad-scale analysis that quantified possible changes in indicator crop yields and length of growing periods in Africa. We build on this work in an attempt to locate ''transition zones'' where climate shifts between now and 2050 may make cropping increasingly risky, and where by extension livestock keeping may increase in importance as a livelihood strategy. We characterise these transition zones in terms of their human and animal populations and poverty rates, using appropriate proxies. Results of the analysis are discussed in terms of their implications for the targeting of adaptation options for poverty alleviation. We conclude by highlighting some methodological and information gaps that, once filled, could increase our effectiveness in pro-poor targeting.

2. Methods

In previous work we have carried out broad-scale analyses at the continental level that quantify possible changes in the length of the growing period and in indicator crop yields in the coming decades under a range of different scenarios, to help identify people who are likely to be particularly vulnerable to such changes. Prospective changes in the length of growing period (LGP) for Africa were projected to 2050 for a variety of combinations of General Circulation Model (GCM) and greenhouse-gas (GHG) emission scenarios in Thornton et al. (2006). These ''hotspots'' of LGP change were then used in conjunction with indicators of current vulnerability to identify agricultural systems that could be considered highly vulnerable in the future, to assist in priority setting and allocating research resources. In Jones and Thornton (2003), we demonstrated possible impacts on maize production in Africa and Latin America to 2055, using high-resolution methods to generate characteristic daily weather data for driving a detailed simulation model of the maize crop. Those results indicated an overall reduction of 10–20% in maize production to 2055, equivalent to losses of $2 billion per year. However, the aggregate results hide enormous variability, and Jones and Thornton (2003) identified three major types of (simulated) response of the maize crop to climate change:

1. Crop yields decrease, but to an extent that can be handled by breeding and agronomy. The history of breeding and agronomic research would suggest that, depending on circumstances and the crops involved, yield losses of 25–40% could potentially be dealt with in this way without great difficulty. For example, there have been periods during the history of maize breeding in East and southern Africa when yield growth rates have been sustained at nearly 5% per year over several years (Smale and Jayne, 2003).