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Climate change and indicators of probable shifts in the consumption portfolios of dryland farmers in Sub-Saharan Africa: Implications for policy

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A B S T R A C T

Several studies estimate the immediate impact of climate change on agricultural societies in terms of changes in crop yields or farm income, though few studies concentrate on the immediate secondary consequences of climate change. This synthetic analysis uses a set of indicators to assess the repercussions of predicted income reductions resulting from climate change on food consumption, nutrition, health expenditure, education, and recreation in Zimbabwe, Cameroon, South Africa and Ethiopia. We also assess the potential decline in human development potential among smallholder dryland farmers in these sub-Saharan African countries. In contrast to previous efforts, the current study directly integrates the uncertainties in estimations of income changes and secondary consequences through a weighting scheme. The results reveal moderate to high levels of secondary impacts which could lead to increased vulnerability to diseases, susceptibility to nutritional disorders, deprivation of educational opportunities, and ultimately to a reduction in human and societal development potential among the considered nations. The article concludes by proposing a portfolio of policy options for ameliorating the secondary impacts of climate change in these sub-Saharan African countries.

1. Climate impact assessments

The anticipated effects of climate change on dryland agriculture in Sub-Saharan Africa (SSA) tends to be higher compared to other regions of the world, due largely to the higher baseline temperatures, and lower precipitation rates than found elsewhere in the globe (O'Brien and Leichenko, 2000; Kurukulasuriya et al., 2006; Kotir, 2011; Müller et al., 2011). Given the projected increased variability in precipitation and rising temperatures, considerable adverse impacts on farm production are expected (e.g., Parry et al., 2004; Schlenker and Lobell, 2010), which will in turn affect the viability of dryland agriculture (Mendelsohn, 2008; Seo, 2010). This situation is compounded by the limited adaptive ability of many dryland farmers that stems from their dependence on precipitation, low-income, lack of alternative livelihood options, relative absence of safety nets (e.g.: weather insurance) and poor institutional resources necessary to hedge against climate change (Thomas et al., 2007). Adaptation is nonetheless not elusive; many examples where communities are adapting to the current and anticipated effects of climate change have been documented (Gbetibouo and Hassan, 2005; Thornton et al., 2010), although such efforts may not prevent a reduction in household income derived from agricultural pursuits (Kurukulasuriya and Mendelsohn, 2008).

Barrios et al. (2008) showed that compared to other developing regions, changes in climate as measured from the 1960s can account for a large proportion of the production deficit in SSA. The prevailing climate, specifically the quantity and timing of precipitation, plays a leading role in influencing regional agricultural output and poverty levels. For these reasons, it is critical to understand the influence that climate change may have on dryland agriculture in SSA. A handful of approaches (statistical, econometric, and process based) are available, each of which quantifies the impacts of climate change on rainfed agriculture in SSA in terms of changes in crop yields and resulting farm income, given projections based on futuristic climatic scenarios. Most statistical and process based models predict yield changes. Ricardian analysis by contrast

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predicts potential changes in household income resulting from the impact on agricultural production (Mendelsohn, 2008). The use of spatial analogues [spatial climatic analogues are those with a current climate resembling the expected future climate of a given site or region (Vermeulen et al., 2012)], which underlie the Ricardian approach, is intuitively appealing. This analogy enables the quantification of temporal changes in income for farming households due to climatic shifts, using a cross section of data of relevant variables. Assuming that farmers of a given region have to the best of their abilities adapted to prevailing climatic conditions, the Ricardian approach also accounts for local adaptive measures, viz. modifying the crops or cultivars grown, adjusting planting dates, or utilizing other changes in agronomic management (Deressa, 2007).

Irrespective of the approach utilized to study the potential impacts of climate change, it is important to utilize the information generated to develop policy measures that may assist dryland smallholders in adapting to the changing climate. In this paper, we briefly discuss some of the policy measures already suggested to improve the adaptive capacity of dryland farmers in SSA. Most policies suggested in the literature focus on mitigating the primary impacts of climate change, i.e. reduced crop yields and resulting food and/or income deficits. Conversely, few studies focus on secondary impacts, resulting in a knowledge gap with respect to the expected impacts on longer-term food consumption, nutrition, health expenditure, and education in SSA. We respond to this problem by analyzing the anticipated secondary impacts of climate change among dryland farmers of selected Sub-Saharan African countries using a set of indicators. By doing so, we provide new insight on critically important policy options to be considered in preparing for the projected impacts of climate change for smallholder dryland farming communities in SSA. Excepting computable general equilibrium models, or CGEs (e.g.: Calzadilla et al., 2013) that analyze welfare impacts from climatic changes, there are few studies that look beyond the impacts on yield or income changes due to climate change in Sub-Saharan Africa. Given the limitations of using CGE models in African context, developing a set of relevant indicators to assess the secondary impacts resulting from climate changes is critical in developing informed policy assessments and options.

1.1. Policy suggestions so far

The major policy suggestions from previous studies on climate change adaptation in SSA are reviewed below. In this paper, we selected dryland (rainfed) smallholder agriculture in countries spanning West/Central Africa (Cameroon), Southern Africa (Zimbabwe, South Africa), and the Horn of Africa (Ethiopia). Collier et al. (2008) suggests that where negative climate change impacts are anticipated, three types of adaptive policy options are possible, including (1) altering farm management in response to the effects of climate change (for example, use of irrigation or changing crop choice), (2) sectoral shifts in employment, for example stepping out of subsistence farming and moving into wage labor, or (3) relocation (e.g. migration from rural areas and increased urbanization). However, Collier et al. (2008) caution that relocation may not be an attractive option in SSA because of political restrictions, strong ethnic identities that may cause clashes following relocation, and problems with land tenure arrangements. The potential for stepping out of agriculture and into another sector is also limited by the restricted absorption capacity of alternative employment sectors. The slower growth of the non-agricultural and industrial sector also poses problems; as such, it cannot be expected that these sectors can absorb an influx of former farmers with ease.

The remaining option is to encourage farmers to modify their crop management techniques, which is the major focus of most studies focused on rural adaptation to climate change in SSA (Stringer et al., 2009). In dryland agriculture, some technical and agronomic suggestions include improved agricultural water management (installation of irrigation, use of mulching, water run-off harvesting, check-dams, some forms of conservation agriculture, contour bunds, increased application of organic materials to the soil, and other means to improve water infiltration and soil moisture storage), adjustment in farm or crop management strategies, for example shifting planting dates to better coincide with rainfall or to escape heat stress, or the use of drought tolerant or less water consumptive crops and cultivars, etc. (Below et al., 2012; Knox et al., 2012; Amjath-Babu et al., 2016). Several of these suggestions have been backed by crop modeling efforts (Jones and Thornton, 2003). Other options include agroforestry, crop diversification, or integration of new enterprises to hedge against risk, for example integrated crop-livestock and biologically diverse farming systems (Stringer et al., 2009; Palm et al., 2010). Conversely, irrigation is widely acknowledged as a 'best-bet' strategy to avoid the negative effects of climate change, although the cost of investment in sufficiently large irrigation schemes is usually prohibitive, not to mention the social and managerial complexities of their operation, especially where collective action may be required to optimize water allocation and use (Collier et al., 2008; Krupnik et al., 2012).

Other more drastic options to buffer agriculture against climate change include extensification of cultivation and liquidation of livestock and other assets to purchase food (Cooper et al., 2008), although both options have negative consequences, for example biodiversity loss and the undermining of household income security (Tilman et al., 2011; Tittonell, 2013). Moreover, implementation of these approaches may encounter physical, social, institutional and economic obstacles. In South Africa and Ethiopia, for example, major hurdles to adaptation include a lack of credit access, dearth of land for expanding cultivation (especially in population dense areas), a scarcity of water for irrigation, and insufficient information and knowledge among farmers and policy makers alike regarding viable adaptation strategies (Bryan et al., 2009). Other studies propose agricultural risk management options (e.g., weather forecasting and climatic information services) and safety net mechanisms such as crop and weather index insurance. However, the latter is typically more suitable to buffer against climatic variability and weather shocks, rather than longer-term shifts in climate (Vermeulen et al., 2012).

Given the general lack of success of implementing policy aimed at higher-yielding crop management practices and varieties in much of SSA (Kates, 2000; Maddison, 2007), constraints may also be encountered in the similarly complex task of encouraging uptake of climate change adaptation policies. The high rates of poverty, poor market and transport networks are some of the myriad factors that slow agricultural technology adoption in SSA (Dinar et al., 2008; Amjath-Babu et al., 2016). It is also reported that older farmers are less willing to experiment with new technologies (Shiferaw and Holden, 1998). For example, use of heat tolerant varieties (Tingem and Rivington, 2009) and use of irrigation are not yet widely practiced in SSA (Kurukulasuriya et al., 2006; Lobell et al., 2008; Calzadilla et al., 2013). But most importantly, the major adaptation options suggested above are for the most part aimed at preventing more near-term adverse impacts of climate change on crop productivity or farm income. As such, adaptation to the secondary and potentially chronic effects of climate change – for example health and education impacts on farming communities resulting from reduced yields and farm income – and on societal development, are given less emphasis.

In this paper, we address these secondary impacts of climate change on dryland agricultural communities in SSA, by assessing how reduced income stemming from climate variability might affect food consumption, the enrollment of children in educational programs, and human health. We identify potential policy options