Investigating the Sensitivity of Household Food Security to Agriculture-related Shocks and the Implication of Informal Social Capital and Natural Resource Capital: The Case of Rural Households in Mpumalanga, South Africa

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ERSA working paper 470

October 2014

Economic Research Southern Africa (ERSA) is a research programme funded by the National Treasury of South Africa.

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October 6, 2014

Abstract

Resource-poor rural South Africa is characterised by high human densities due to the historic settlement patterns imposed by apartheid, high levels of poverty, under-developed markets and substantially high food insecurity. This chronic food insecurity combined with climate and weather variability has led to the adoption of less conventional adaptation methods in resource-poor rural settings. This paper examines the impact of agriculture-related shocks on the consumption patterns of rural households. In our assessment we are particularly interested in the interplay between social capital (both formal and informal), natural resource capital and agriculture-related shocks. We use three years of data from a relatively new and unique panel of households from rural Mpumalanga Province South Africa who rely on small-scale homestead farming Overall we make two key observations. First, the agriculture-related shocks (i.e. crop failure from poor rainfall and hailstorm) reduce households' food availability and thus consumption. Second, natural resource capital (e.g. bushmeat, edible wild fruits, vegetables and insects) and informal social capital (ability to ask for food assistance from neighbours, friends and relatives) somewhat counteracts this reduction and sustains households dietary requirements In general, our findings suggest the promotion of informal social capital and natural resource capital as they are easier, cheaper and more accessible coping strategies, in comparison to other

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more technical and capital-intensive strategies such as insurance, which remain unaffordable in most rural parts of sub-Saharan Africa However, a lingering concern centers on the sustainability of these adaptation strategies.

1 Introduction

Unfortunately, South Africa, the second largest economy in Africa, recently released a national report[1], coinciding with the 2014 World Hunger Day[2], showing that only 46% of South Africans are food secure and that 26% experience full-blown hunger (Shisana *et al.*, 2014). Further to this, the current literature asserts that variability in weather and climatic conditions in South Africa, like elsewhere in the sub-Saharan Africa region, are expected to have considerable adverse impacts on the livelihoods of small-scale subsistence farming households (Kochar, 1995; Mirza, 2003; Christiansen and Subbarao, 2005; Dercon and Krishnan, 2007; DEA, 2011). This is also unfortunate because there are approximately 1.3 million small-scale farming units in South Africa, and it is estimate that 70% of South Africa's poorest households reside in these areas and are said to be food self-reliant (DEA, 2011).

The rural farming households are particularly vulnerable because they are mostly dependent on rain-fed agriculture and have low adaptive capacity due to low economic resources (IPPC, 2007; Shields and Fletcher 2013). The vulnerability of rural farming households is further worsened by the fact that rural South Africa is mainly characterised by high human densities due to the historic settlement patterns imposed by apartheid, high levels of poverty and underdeveloped labour markets[3] (DEA, 2011). Even more unfortunate, the majority of the food insecure South Africans reside in resource-poor rural South Africa (Shisana *et al.*, 2014), hence any weather-related shocks are likely to translate into even more severe food insecurities (FAO, 2008; Nhemachena *et al.,* 2010; Nelson *et al.*, 2010; Shields and Fletcher 2013). It is no surprise that one of the national policy concerns is to tackle food insecurities in the era of climate change (DEA, 2011).

This paper contributes to the growing literature on the impact of agriculture-related shocks on small-scale subsistence farming households' consumption pat-

[1] The report is based on the first South Africa National Health and Nutrition Examination Survey (SANHANES-1) conducted by the Human Science Research Council (HSRC). The survey is expected to occur periodically and report on the health and nutritional status of South Africans.

[2] According to the World Hunger and Poverty Facts and Statistics report, there is an increase in the level of hunger in Africa, with one in every four Africans suffering from hunger. One of the reasons for this increment is climate change.

[3] As a result there is high reliance on government grants, remittances and other forms of subsistence activities, such as natural resources (e.g. wild fruits, vegetables and bushmeat for food or twigs and reeds for making brooms and baskets) and small-scale farming amongst the rural South African populations. This is mainly to meet basic dietary needs and generate income for other household requirements (Shackleton and Shackleton, 2004; Reid and Vogel, 2006; Hunter *et al.*, 2009; Twine and Hunter, 2011; DEA, 2011).

terns (see, e.g. Kochar 1995; Dercon and Krishnan 2000; Dercon 2004; Mogues 2004; Christiaensen and Subbarao 2005; Mogues, 2006; Di Falco and Bulte, 2009; Oshbar *et al.*, 2010; Porter 2011; Dillon, 2012; Dinkleman, 2013; Tibesigwa *et al.*, 2014). The assessment is based on a unique panel spanning three years (2010-2012) from the Agincourt Health and Demographic Surveillance System (AHDSS) site in rural Mpumalanga, South Africa[4]. The panel consists of rural households whose main sources of dietary needs are small-scale subsistence farming and natural resources such as edible wild fruits, vegetables and insects, while food purchasing (i.e. groceries of basic food necessities, e.g. maize meal, cooking oil, salt) although practiced, is less common. In our assessment we are particularly interested in the interplay between social capital, natural resource capital and agriculture-related shocks. Thus we explore the hypothesis that the shocks are likely to have a lower impact in the presence of social capital and/or natural resource capital, especially given that several studies suggest that they are pivotal coping strategies in rural South Africa (e.g. Reid and Vogel, 2006; Hunter *et al.*, 2007; Kashula, 2008).

In addition we depart from and build upon previous related studies in several ways. First, we use caloric and monetary consumption measures as outcomes on the premise that monetary values are likely to introduce bias since small-scale subsistence farmers are more likely to sell in informal markets (e.g. streets or open markets) where price negotiation is likely to be prevalent. Second, unlike the current studies that use endogenous shocks (e.g. crop failure from pests or diseases) and treat such shocks as exogenous regressors, we use agriculture-related shocks caused by weather-related crop failure (poor rainfall or hail storms), hence providing a more exogenous measure. In section 4, we test this assertion. In addition, we do not only measure whether households experience the shocks but also capture the magnitude of the shocks. That is, households were asked to mention how much crop loss they experienced and the responses included, 'none', 'a little', 'some', 'most' and 'all', which in essence captures the size of the shock, thus allowing us to measure whether there is any variation in the impact of these shocks. Third, we control for the likely self-reported error from recall bias by using an alternative binary variable, where one represents a household that has experienced crop failure and zero otherwise.

Lastly we use a new study area and panel in our assessment - the rural Bushbuckridge in the Mpumalanga Province of South Africa. Thus the analysis offers new insights from an unexplored area whose population is characterised by substantially high food insecurity, and by dependence on natural resources and agriculture for rural livelihoods (Reid and Vogel, 2006; Hunter *et al.*, 2007). In general the results indicate that agriculture-related shocks have a negative

[4]The SUCSES panel study (Sustainability in Communal Socio-Ecological Systems) is nested within this well-established Agincourt Health and Demographic Surveillance System, managed by the University of the Witwatersrand. The field site is located in a former 'homeland' region of rural South Africa. Detailed information on household livelihoods, including capital, activities, shocks and food security, in collected annually in this panel of 590 households. Thus the data allows us to investigate the dynamic interaction between the environment, human well-being as well as rural livelihood.

and significant impact on household consumption and that informal social capital, the ability to receive assistance from neighbours, friends and relatives, are pivotal in cushioning the most vulnerable households against the shocks. We also observe that the use of natural resources somewhat relieves the impact of such shocks Quite surprisingly we observe that formal social capital (membership in an association) is significant amongst the least vulnerable, i.e., those who lost a small portion of their crops. Important, various robustness checks yielded satisfactory results and provided consistent findings. Overall, our results suggest that informal social capital and natural resource capital can be utilised to facilitate various measures to improve the adaptive capacity of poor rural households, thereby making them less vulnerable to shocks and stresses.The remainder of this paper is organised as follows: the subsequent section contains the body of selected literature relevant to this study, while section 3 presents a detailed description of the data and study area, including the definition of variables and the estimation strategy. Thereafter section 4 presents the descriptive and empirical analysis and the final section provides a conclusion, policy considerations and areas that require further exploration.

2 Agriculture-related Shocks, Household Responses and Related Emprical Studies

Sub-Saharan Africa remains vulnerable to chronic food insecurity (IPPC, 2007; Hunter *et al.*, 2009; Kotir, 2011). The World Bank defines food security as 'access by all at all times to enough food for an active, healthy life' (World Bank 1986: p.1). This is further exacerbated by the fact that almost 70% of sub-Saharan Africans depend on rain-fed small-scale farming. Hence any weather-related irregularities are likely to have adverse effects on the food security of many households in the region (Hansen *et al.* 2004; Ellis and Freeman 2004; Hellmuth *et al.*, 2007; Kotir, 2011). To cushion against such negative weather events households in turn adopt various methods to boost their dietary or income needs.

The availability of local natural capital such as wild foods (e.g. bushmeat, edible insects, wild fruits and vegetables), fuelwood, and materials for crafts, which are often freely available in rural sub-Saharan Africa plays an important role in buffering households from food or income shortages (Shackleton *et al.*, 1998; Hansen 1998; Hunter *et al.*, 2007; Kashula, 2008; McGarry *et al.*, 2009). For instance, it is estimated that approximately 32% of meals in Tanzania, Niger, Ethiopia, South Africa and Swaziland are sourced from natural capital (Kashula, 2008). A study by Twine *et al.*, (2003) found that on average, rural households in Limpopo Province of South African households use approximately R3959 worth of local natural resources annually, and that the value was highest in povertystricken villages. Evidence from another study by Hunter *et al.*, (2007) has shown *marula* (local fruit), *guxe* (one of 41 species of local wild vegetables) and other wild fruits to be important sources of food and income among rural households in South Africa. In particular the rural households eat the raw *marula* fruit or cook the *marula* nut together with wild herbs and relish and this is then eaten as a meal. An alternative menu for these households is *guxe* eaten together with maize (a staple food in the region). Apparently, *guxe* plants are an ideal staple food as well due to their drought resistant property. Likewise, Reid and Vogel (2006) found that in the rural KwaZulu Natal region of South Africa women use local grasses, reeds and beads to make crafts, brooms or mats to generate income, thereby decreasing their vulnerability to crop failure. Thus in general the role of natural capital in improving food security amongst households in rural resource-poor settings cannot be over-emphasised.

Social capital also plays an important role in food security (Misselhorn, 2009). Although a subject of much debate, social capital can generally be defined as the 'attributes of social relations from which members of formal or informal social networks may derive economic benefits and is often linked to trust, reciprocity and exchange within a community' (Gilbert and McLeman, 2010: p.15). Formal social capital, as the name suggests, is more formally organised with a management structure and membership dues. Informal social capital, on the other hand, refers to a group or network of people who come together for a common good (Putman, 2001; Pichler and Wallace, 200). In developed countries these structures are more formal in nature. In contrast, in developing regions such as sub-Saharan Africa where communities are more integrated both formal and informal structures exist, with the latter however being more prevalent[5]. Such strong social cohesion enables communities to exchange resources in the form of credit or gifts, thus enabling vulnerable households to manage shocks or stresses (Misselhorn, 2009; Lippman *et al.*, 2013). For example, Deressa *et al.*, (2009) observes that social capital, such as having relatives in close proximity and farmer-to-farmer extension enhances household's adaptation. In support of Deressa *et al.*, (2009), Oshbar *et al.*, (2010) stress the importance of collective action and building of social capital as an adaptation tool within communities. Echoing a similar view Tesso *et al.*, (2012) state that households' participation in local institutions and having relatives in the same area contribute to the resilience of vulnerable households.

This suggests that household's experiences of shocks are likely to vary depending on the availability of natural capital or social capital[6]. As alluded to earlier this paper investigates the impact of agriculture-related shocks on small-scale rural farming households' consumption patterns, with a particular focus on the role of natural and social capital. In this section we provide a literature review of previous studies and highlight our contribution to the current literature. Kochar (1995) in investigating the impact of crop income shocks on household

[5]For more details see Putman (2001) who provides a good overview of social capital in general, while Pichler and Wallace (2007) gives an overview of Europe and Meagher (2005) concentrates more on Africa.

[6]Please note that here we do not attempt to exhaust all the available coping strategies, but rather highlight those that are relevant to our study. There are other forms coping mechanism that are currently being utilised. For example, asset holding and labour participation have been found to be good sources of insurance for rural poor households in times of shocks and stresses.

consumption (wage income and borrowing) in India found that households are able to mitigate against the negative shocks by increasing their participation in labour markets. Importantly, small (less than 500 rupees) negative crop shocks had a positive and significant effect which is unexpected, while larger (more than or equal to 500 rupees) negative shocks appeared to be insignificant.

Dercon and Krishnan (2000) provide further evidence using a panel of households in rural Ethiopia. The authors found that the consumption patterns (food and non-food consumption in monetary values) were affected by agriculture-related shocks (crop failure from climate, pest, diseases and illnesses) and rainfall shocks. In addition the authors found food aid initiatives to have relatively marginal effect on relieving households from shocks. Along similar lines, Carter and Maluccio (2002) used a household panel to examine the effects of shocks on child nutritional status (height for age Z-score of a child) in the KwaZulu Natal region of South Africa. Similar analysis can be found in the studies by Yamano *et al.*, (2005); Akresh *et al.*, (2011) and Dillon (2012). Slightly different from the aforementioned studies, Mogues (2004) measures the relationship between livestock assets, environmental shocks and social capital in north-east of Ethiopia. In another empirical investigation by Dercon (2004) using a panel of households from rural villages in Ethiopia, the study found that rainfall shocks, agriculture-related shocks (crop damages from frost, animal trampling, weed and plant diseases) and livestock suffering index (lack of water or fodder) have adverse effects on consumption (in monetary and caloric values).

On the other hand, Christiaensen and Subbarao (2005) use repeated cross-sectional data from households in the same community in Kenya. The authors conclude that households that experienced rainfall shocks were more vulnerable, especially those in arid areas, and that illness shock had non-negligible effects on consumption (food expenditure per adult). In a similar manner, Salvatori and Chavas (2008) measured the effects of rainfall shocks on agro-ecosystems productivity in southern Italy. In a similar spirit, Di Falco and Bulte (2009) measured the effects of weather shocks and the role of social capital (kinship networks) in adaptation to climate change in rural Ethiopia. Similarly, Porter (2011) measured the effects of rainfall shock and agriculture-related shocks (crop failure due to illness and crop pests) on consumption (household consumption in monetary values) in rural Ethiopia. Porter (2011) finds the rainfall shock to be negatively related to consumption. However, agriculture-related shocks have a positive relationship with consumption which is unexpected. The authors attribute this to the bias in self-reporting shocks or in the definition of the outcome variable which did not include consumption from gifts of food.

Complementing and building from the above mentioned studies the current study investigates the impact of agriculture-related shocks on consumption patterns among rural households. As previously stated we use a unique panel from the Bushbuckridge (former Bantustans or *homelands*) region in Mpumalanga Province South Africa. The panel covers three years and contains information that offers valuable insights into the human-environment relationships. A greater percentage of households in this area rely on rain-fed homestead farming and natural resources as part of their livelihoods (Shackleton and Shackleton, 2004; Twine and Hunter, 2011). The region represents a typical rural setting in South Africa, characterised by poverty, high dependence on remittances and migrant labour, high human density and limited formal labour markets (Hunter *et al.*, 2009; Twine and Hunter, 2011). In synthesising the above review of current empirical studies we observe that there appear to be mixed results. While some studies have found the effect of household shocks to be negative and significant, as expected, other studies have found the results to be insignificant, and others have had positive and significant results. This variation in results can be attributed to various factors, in an attempt to explain the likely causes of this variation we also highlight our contribution to the current studies.

First, while rainfall shock is a strictly exogenous measure, agriculture-related shocks from crop failure may either be exogenous or endogenous. Crop failure is likely to be exogenous if it is weather-related, for example, poor rainfall, hailstorms, floods or frost. However crop failure is likely to be endogenous if the source is from pests or diseases as this is likely to be correlated with the effort one exerts on the farm. That is, if a household invests more effort by using more labour, pesticides or herbicides then they are likely to experience minimal crop failure in comparison to a household that invests less effort. In the current study weather-related crop failure is an agriculture-related shocks, and as such this is likely to be an exogenous measure. This assertion is tested in section 4. Second, we recognise the short-fall in self-reported variables which may be biased as a result of the recall error as it is easier for a more vulnerable household to remember how much crop they lost than for a household that is less vulnerable. Accordingly, we use an alternative binary regressor, represented by one if crop failure was experienced and zero otherwise.

Third, in general, small-scale farming households often sell their products in informal markets (e.g. streets or open markets) where buyers and sellers engage in price negotiation. Because of this negotiation process there is likely to be a very high degree of variation in prices in these informal markets. Thus using monetary values is likely to introduce measurement error in the variable and to bias the estimation results. Accordingly in the current study we use caloric and monetary consumption measures. Third, some of the past empirical models are likely to be influenced by unobservables due to being cross-sectional in nature. We control for unobservable heterogeneity by using panel data methods.

3 Empirical strategy

3.1 *Econometric Model*

As previously stated, the current study measures the impact of agriculture-related shocks on consumption patterns of rural households. In describing the empirical model and the variables used for estimation, we follow the current literature and define a consumption function as depicted by equation (1)

$$y_{it} = f(S_{it}, \mathbf{X}_{it}) + y_i + \varepsilon_{it} \tag{1}$$

where y_{it} is per capita consumption belonging to household i at time t, S_{it} is a categorical variable capturing a negative agricultural-related shock experienced by household i at time t, $\mathbf{X}_{it}$ are household characteristics (education and age of the head of the household, size of the household, household income, informal and formal social capital). Lastly, y_{it} is the unobservable household-level heterogeneity, which captures the time-invariant effects, while ε_{it} is the random error term

3.2 Study Area, Data and Definition of variables

This study uses the first three years (2010-2012) of a panel study from the AHDSS field-site located in Bushbuckridge local municpality in the Mpumalanga province of South Africa. The field-site covers 27 villages with a population of 87,000 inhabitants (Collinson *et al.*, 2002; Twine and Hunter, 2011). The area described is a former homeland or Bantustan region, and is characterised by high human density; poverty; undeveloped labour markets; high dependence on subsistence farming; frequent use of natural capital; high migrant labour (to work in commercial farms and towns across the country) and high dependence on remittances (Tollman *et al.*, 1999; Collinson *et al.*, 2002; Twine and Hunter, 2011). The panel is derived from the Sustainability in Communal Socio-Ecological Systems (SUCSES) project, which investigates the relationship between rural livelihoods, the environment, and human well-being in a communal tenure system. A detailed questionnaire collected diverse and rich information on livelihood capital (financial, physical, social, human and natural), activities (on-farm and off-farm economic activities, migration, and natural resource harvesting) and well-being outcomes (health, food and nutrition and heights and weights of children). A total of nine villages were surveyed: Agincourt, Cunningmore B, Huntington, Ireagh A, Ireagh B, Justicia, Kildare, Lillydale B, and Xanthia. The panel consists of 590 households, which is approximately 8% of the total households in each village. The location and the geographical boundary of the field-site is depicted in Figure 1. The current study is based on an uneven panel of 1528 observations, with approximately 500 households per wave.

While we are interested in the impact of agriculture-related shocks it is important to get a comprehensive measure of all food sources accessed by the household. Accordingly, we use three consumption outcomes: consumption from crop farming only, consumption from crop farming and natural resources gathered from the local environment and lastly we combine consumption from crop farming and natural resources with groceries (i.e. food purchases). We use both caloric and monetary measures to obtain these consumption outcomes. Our first measure, monthly caloric consumption per capita from crop farming is derived by adding together the calorie content of all crops harvested This is then divided by the household size (number of household members). In this conversion we use the Food and Agriculture Organisation (FAO) conversion tables[7]

[7] An example will clarify our approach. According to the FAO conversion tables 100g of

(see Latham, 1997).The second measure is monthly caloric consumption per capita from crop farming and natural resources. The measure extends the previous measure by including household consumption of natural resources. These natural resources include wild fruits, wild vegetables, edible insects, fish from local rivers and bushmeat obtained from the local environment. Our third and final outcome is monthly monetary consumption per capita from crop farming, natural resources and groceries (food purchased) Thus unlike the previous measures which capture partial household consumption, this measure portrays a more comprehensive picture of household consumption. Also, unlike the previous measures, here, we include the total monthly expenditure on food purchased (groceries) and produced (farming and natural resources), we then divide by the total number of household members.

We favour caloric measures over monetary measures of consumption, because caloric measures reduces the bias associated with monetary measures. This follows from my earlier example on small-scale farmers and price negotiation. Thus using monetary values (as opposed to caloric values) are likely to introduce measurement error. We anticipate that this bias is likely to decrease with increases in farm size. Furthermore, even if one uses self-reported monetary values, it is unlikely that the households will recall the prices of their products due to the likely high price variation over time. A similar argument holds for monetary expenditure measures. First, households with higher incomes are likely to consume from formal markets while those with lower income consume from informal markets. Second and as before, even if one uses monetary values self-reported by the households it is unlikely that they will recall the prices of their household food expenditure. This recall bias is likely to be skewed towards those who purchase in the informal markets in comparison to those who purchase in the formal markets.

The main regressor is agriculture-related shocks defined as crop failure from poor rainfall and hailstorms. This information was obtained from the following question, "How much crop loss did you experience in the last season as a result of rainfall/hailstorm". The responses include, 'none', 'a little', 'some', 'most' and 'all'. Like all self-reported variables, our regressor is likely to be prone to measurement error (see Carter and Maluccio, 2002; Carter and Maluccio, 2003). Measurement error becomes harmful if it is systematic (Greene 2002). We expect the error to be systematic since it is easier for a more vulnerable household (e.g. a household with a small garden or fewer alternative food sources) to remember the amount of crops they lost than for a less vulnerable household. Our strategy to overcome this bias is to use an alternative binary variable where one represents a household that has experienced crop failure and zero otherwise.

We add various household characteristics, following the current literature. These include education and age of the head of the household. The size of the household which captures the total number of household members is also

pumpkins, one of the main crops in the area, contains 26 calories (kcal). Hence a household that harvests 2000g (2kg) of pumpkins will earn a total of 52000kcal for the household. This process is repeated for each crop produced by the household, thereafter we add all calories and divide by the total number of household members.

included. We account for different household income sources: labour income, agriculture income and natural resource income (firewood, wild fruits and vegetables, edible insects, fish from local rivers, bushmeat and medicinal plants)[8] by means of dummy variables represented by 1 if the household receives the income and 0 otherwise. It is reasonable to assume that in the event of agricultural-related shocks, households with multiple sources of income are less impacted and more able to adapt than households whose livelihoods entirely depend on farming (see Kochar, 1995; Christiansen and Subbarao 2005; Birhanu and Zeller, 2009; Porter, 2011). We also include social capital (informal and formal). It is expected that social capital will enable households to cope with stresses and shocks (see Misselhorn, 2009;Deressa *et al.*, 2009; Oshbar *et al.*, 2010; Cavatassi *et a*l., 2011;Tesso *et al.*, 2012). Following Pichler and Wallace, (2007) we define formal social capital as "participation in formally constituted organisations and activities" (Pichler and Wallace, 2007: p. 423). The term formal is attached because of existing structures that register them asorganisations or associations This is aligned with the literature on democracy and civil society, e.g. social clubs, churches or clubs (Pichler and Wallace, 2007). Accordingly, our measure of formal social capital is households' having membership in the following associations: farmers' association, grocery stokvel and business association. Grocery stokvel is the most common type formal social capital in our data. In contrast, informal social capital, which is more aligned with social network literature, is "the density, strength (i.e. the extent to which people give or provide services of different kinds) and extensiveness of social networks with colleagues, friends and neighbours" (Pichler and Wallace, 2007: p. 427). Our measure of informal social capital is the ability of households to ask for assistance from relatives, neighbours or friends in matters related to household needs (e.g. food, money, transport, fuel, child and elderly care, clothes and uniforms) in times of household stresses. Our current data shows that food is the most prevalent type of assistance that these rural households receive from their informal networks. Hence, unlike formal social capital, informal social capital here refers to exchange of food and other household necessities and somewhat lacks functioning structures[9].

[8] Specifically, this includes selling the following resources: firewood, *morotso* (furniture made from collected wood), wooden carvings, poles, *nsango* (reed mats), *timongo* (marula nuts), marula beer, wild fruits, e.g., *nkhanyi, makwakwa, masala* and *tintoma*, *nkwakwa* (dried monkey orange), wild vegetables - *guxe, nkaka, bangala*, edible insects, e.g., *grasshoppers, masonja* , thatching grass, *nkukulu wa le handle* (twig hand brooms), *nkukulu wa le indlwini* (grass hand brooms), and medicinal plants.

[9] For a comprehensive review of social capital (informal and formal) see Wallace and Pichler, (2009); Lovell, (2009 and Bhandari and Yasunobu (2009)

4 Results

4.1 *Data Description*

Table 1 shows the descriptive statistics. We find 53 as the average age of the heads of households. We also observe that the average household contains 8 household members (both permanent and migrants). The descriptive statistics also reveal that 57% income, 12% income from selling natural resources(firewood, wild fruits and vegetables, edible insects, fish from local rivers, bushmeat and local medicinal plants). Additionally, Table 1 indicates that, on average, most households have experienced *agriculture-related shock*s. We find that 45.3% formal social capital and that 60.3% assistance from close friends, relatives and neighbours. Lastly, 51.9% given some form of assistance to other households.

Further exploration of the data reveals that the majority of the households keep the agricultural output for their own consumption, with just 4.5% the households selling the crops they harvest. This supports current literature that states that small-scale farming in sub-Saharan Africa is often subsistence in nature, where the main reason for participating in farming is to supplement dietary needs. This also explains the low number of households with agriculture related income in the descriptive statistics (Table 1). Table 2 shows the distribution of household' experience of the agriculture-related shocks. Table 2 shows that almost 78.1% households have experienced such shocks, with the majority of them (31.5% having lost'most' of their crops in the $2010 - 2012$ period. Note that crop loss from poor rainfall (64.5% storm (10.9%).

Table A.1 in Appendix A shows food security statistics from the Food and Agriculture Organisation (FAO). The table includes statistics of, the only available, sub-Saharan African countries: Chad, Côte d'Ivoire, Ghana, Kenya, Malawi, Mozambique, Niger, Sudan, Togo, Uganda and Zambia. We compare our outcome variables to the FAO statistics of the aforementioned countries. Our data shows that the average food consumption, in monetary value, is US$1.26 per capita per day. This is, somewhat, consistent with FAO statistics, from other parts of sub-Saharan Africa, which reveal a range between US$0.05 -1.62 amongst individuals in the low income percentiles and US$0.09 - 3.04 for those in the middle income percentiles. We compare with the poor and middle income individuals because this is likely to be similar to the individuals in our data. Further, our data shows that, the average food consumption, using caloric values, from crop farming alone and crop farming together with natural resources is 452.1 kcal and 567.8 kcal per capita per day respectively. These values also fall within the range of FAO statistics, when we compare with the share of dietary energy from own food production in Table A.1. In particular, the statistics from FAO show that the caloric consumption from the production of own food ranges between 188.1 - 1485.2 kcal for low income percentiles and 139.4 - 1572.0 kcal for middle income percentiles[10].

[10] The FAO statistics also show the total dietary energy consumption which is an aggregation of energy from (i) purchased food, (ii) own production, and (iii) other sources. Here, we observe

4.2 *Regression Results*

Household Consumption and Agriculture-related Shocks

Table 3 reports the baseline results, where we begin by analysing the effect of agriculture-related shocks on different per capita household consumption measures. Note that the Hausman test rejects the null hypothesis of the regressors being correlated with the error term, hence we only report the fixed-effects models. In Panel A (Column 1-3), we include agriculture-related shocks but suppress household characteristics. In specific, Column 1 uses consumption from crop farming as the outcome and agriculture-related shocks as the only regressor, while Column 2 reports estimates for our second outcome:caloric intake from crop farming combined with natural resources. Finally, Column 3 shows estimates from consuming crops, natural resources and groceries. Overall, and most importantly, we observe qualitatively similar results: agriculture-related shocks are negatively associated with all the per capita household consumption measures. In particular, the expected percentage decrease in caloric intake, from households who did not lose any crop to those who 'lost most of their crops' is about 33.9% who'lost all their crops'. Moving to Column 2, the percentage is 34.0% and 72.1% respectively, while in Column 3 we will expect a percentage decrease of 21.3% and 47.8% respectively in per capita houshold consumption.

The negative relationship suggests that the shocks lead to a reduction in caloric intake for each of the household members. This result is in line with our expectation and is broadly consistent with previous studies that have observed decrease in household welfare after experiencing a negative shock (e.g. Dercon, 2004; Porter, 2011). Also important, we observe the magnitude of the shock to matter as the coefficients are negative and significant, at 1% level, amongst households who lost 'most' and 'all' of their crops and insignificant among those who lost 'a little' and 'some' of their crops. Consumption is therefore likely to be lower amongst these households in comparison to those who did not lose any crops. This suggests that the shocks affect the most vulnerable households.

More important, the size of the coefficients reduce as we move from Column 1 to Column 3, i.e., when we include consumption from natural resources (Column 2) and groceries (Column 3). This suggests that the shocks have stronger impact when we consider caloric intake from crop farming only (an activities mainly engaged to fulfil household dietary requirements in this rural setting), and this impact wears out once we include consumption from natural resources and groceries. This indicates that households' consumption of natural resources is somewhat a buffer against agriculture-related shocks, and that food purchases, although seldom practiced, provide an additional buffer against these shocks. Our results are consistent with studies in other parts of sub-Saharan Africa where natural resources have been identified as a key strategy in increasing the livelihood viability of households in resource-poor rural settings (see, e.g.,

that amongst those in the poorest percentiles the caloric consumption ranges between 1251.7 and 1765.2 kcal, while in the medium percentile this range is between 2036.7 and 2418.6 kcal. See Table A.1. Note that, due to data limitation, we are unable to show these values from our data, because we cannot observe caloric values from groceries and livestock farming.

Amolo, 2010). Further, our finding supports studies in other settings as well: natural resources have been found to be useful in areas with limited economic opportunities and high prevalence of HIV/AIDS (see, e.g., Twine and Hunter, 2008). An advantage of natural resources (i.e. local/indigenous fruits and vegetables), is that they are freely available in rural areas. Another advantage is that they (e.g. guze) are more resilient to weather variability in comparison to crop farming Hunter *et al.*, 2007). Sadly, however, the use of natural resource capital as an adaptation method, to some extent, is unlikely to be sustainable. Here we are concerned about natural resource capital depletion. More so, climate and weather variability are expected to continue into the future, a practical response from the small scale-subsistence farming households, particularly in resource-poor rural settings, will be to increase natural resource dependence.

According to (IPPC, 2001) "adaptation to climate change is a process by which strategies to moderate, cope with and take advantage of the consequences of climate events are developed and implemented' Burton, 2005: p.185). However, adaptation efforts have somewhat neglected sustainable development, especially when addressing the most food insecure and vulnerable populations (Eriksen *et a*l., 2011). It is particularly important to associate adaptation with sustainability. Here, sustainable adaptation is defined as "adaptation that contributes to socially and environmentally sustainable development pathways, including both social justice and environmental integrity' (Eriksen *et al.*, 2011: p.8). The highest priority therefore, in resource-poor settings, is a win-win policy design that successfully links natural resource capital adaptation with sustainability. This is however, unfortunately, easier said than done, and has indeed proven to be a challenge in the current policy-making process (Burton, 2005)

In Panel B (Column 4-6) we proceed to run the same regressions, but here, we introduce household characteristics. The agriculture-related shocks estimate in Panel B mirrors those we found in Panel A. In addition, and as expected, Panel B shows that theconsumption levels decrease with increment in household size. This is evident in the negative and significant household size coefficient. Also, it is apparent that the age of the head of the household has a non-linear relationship with household caloric intake. Panel B further shows positive and significant coefficients on the household income sources (labour, agriculture and natural resources). This indicates that households who receive income from participating in the labour markets are more likely to have higher consumption. Also households with some income from agriculture activities or from selling natural resources are also more likely to have higher consumption levels. In summary, in this section we uncovered two key observations: First the agriculture-related shocks reduce the consumption levels, and hurts, the most vulnerable households. Second, having additional consumption from natural resources and groceries somewhat minimises the effects of the shocks.

Household Consumption, Agriculture-related Shocks, Formal and Informal Social Capital

In the previous section we found that the agriculture related shock affects the most vulnerable and that natural resources and additional food purchases act as a buffer against the shocks. Here, we introduce social capital. Our data contains detailed information on social capital: formal and informal. In addition, we are able todifferentiate between informal social capita-receive, which is the ability to receive assistance and informal social capital-give as the ability of households to give assistance. Our data shows that 51.8% of the households have given some form of assistance, while 60.3% have received some form of assistance. Figure 2 shows the distribution of the informal social capital by household income quintiles, while Figure 3 shows distribution of formal social capital. While the distribution of the formal social capital in Figure 2 is apparent – higher amongst the higher income households, the distribution of the informal social capital is however somewhat stable – i.e. we observe the giving and receiving of informal social capital across all income levels.

We proceed to extend the baseline analysis in Table 3, by re-estimating the regressions and including the different measures of social capital as regressors. The results are reported in Table 4. Here, qualitatively similar pattern, to Table 3, continues to be observed. In addition to the similarity with our baseline results, here, we find both informal and formal social capital to be insignificant, suggesting that they do not have any direct effect on caloric intake.

Continuing with social capital, Panel B introduces the interaction effects. In general, the results in Panel B echo the previous panel, with only two key differences: the shocks coefficients are smaller (in comparison to Panel A) and, although the coefficients of formal and informal social capital remain insignificant, the interaction coefficients are significant. On the whole, Panel B shows some interesting results. First, we observe that informal social capital is more effective among the most vulnerable households, i.e., those that lost the majority of the agriculture products. This is evident in the shock to informal social capital-receive interaction coefficient which is positive and significant amongst those who lost 'al' their crops. This indicates that the effects of the shocks are lessened, amongst the most vulnerable, when households receive assistance (informal social capital), which in turn increases their consumption levels. Stated differently, this suggests that in times of stresses and shocks, when consumption is low, the transfer of food becomes a lifeline for the most vulnerable households. Second, there appears to be a trade-off between giving and receiving assistance. That is, although we observe that consumption increases when a household receives assistance, we find that, when assistance is offered to other households, this reduces consumption. This is shown by the shock to informal social capital-give interaction coefficient which is negative and significant amongst those who lost'al' of their crops.

Third, and related to the above observation, there appear to be some entangled mechanisms, perhaps pointing to something even beyond a trade-off, to cultural or familiar expectations/pressure, such that households feel obligated to offer assistance even when they themselves are being assisted.The interaction between households that have lost most of their crops due to a climate related shock and receiving assistance has a positive effect on caloric intake, whereas for similar households being involved in giving assistance to other households significantly lowers caloric intake. This emphasizes the heightened vulnerability of such households having lost a large portion of their normal caloric intake, but also the important role of social ties either buffering caloric-poor households against agricultural shocks or placing further strain on the resources of the household, depending on the direction of caloric exchange. A potential explanation for this finding is the set-up in rural communities. Rural communities are characterised by close ties (Hofferth and Iceland, 1998), and according to Coleman (1988), these ties consist of strong interpersonal relationships, with mutual obligations, expectations and reciprocity. The observed giving and receiving of assistance is also somewhat consistent with current literature. For example, a study by Hofferth and Iceland (1998) investigated the type, prevalence and extent of social exchanges and found that receiving and giving assistance is more common in rural than in urban areas. Also,Goudge *et al.*, (2009)'s qualitative study reported the following verbatim finding: 'When I cannot get enough money to buy food it is difficult to go out and borrow because I know I will not be able to repay the money on time. I do go to the neighbours to borrow, say, mielie meal, but only to find that they are also running low which makes it difficult, but at times people do give without expecting me to return it' (Goudge *et al.*, 2009: p. 246).

Fourth, in Column 5 and 6 we find that giving assistance no longer reduces consumption, as shown by the insignificant shock to informal social capital-give interaction coefficients. Taken together, this suggests that having additional food from natural resources (Column 5) and groceries (Column 6) has a somewhat cushioning effect against not only the shocks but in food transfers (i.e. social capital-give) as well. Fifth, surprisingly, the formal social capital (membership in an association) becomes significant among the less vulnerable, i.e., those who lost a little of the crops. This is somewhat of a puzzle in that formal social capital is effective amongst the less vulnerable and ineffective among the most vulnerable. A plausible explanation is that this observation may be driven by the fact that households with more economic resources, who are likely to be less vulnerable, are more likely to afford membership fees and other requirements associated with being a member to a formal association. On the other hand, the most vulnerable, who are likely to have lower economic resources, are more likely to be excluded as a result of membership requirements. Nonetheless, formal social capital has been found to be significant in other settings. For example, Deressa *et a*l., (2009) and Cavatassi *et al.*, (2011) found formal social capital (farmers' associations, networks for seed exchange) to be significant in predicting farmers' adaptation decisions (soil conservation, crop varieties, planting trees, changing planting date, irrigation, no adaptation). Similarly, social capital has been linked with increased food security (see, e.g., Misselhorm, 2009)

4.3 *Robustness Check*

Before we conclude, it is important to investigate whether our results remain consistent after we address potential estimation pitfalls. To this effect, in addition to testing the response of different consumption measures in the previous section, this section first tests whether measurement error in self-reported agriculture-related shocks influence our results. Second, we test whether the results will hold after we introduce household income, which is likely to be endogenous, as a control. Third, we test our assertion of exogeneity of the agriculture-related shocks.

Measurement error in reported agriculture-related shocks

As previously explained, the agriculture-related shocks regressor is likely to face measurement error (Carter and Maluccio, 2002; Carter and Maluccio, 2003), and this is harmful (Greene 2002) because the error is likely to be systematic. We say it is systematic because the error is likely to vary by household vulnerability. For instance, a vulnerable household with a small garden is more likely to remember how much crop they lost than a less vulnerable household with many alternative food sources. We curb this bias by using a binary measur. This binary regressor takes the value of one if the household has experienced the shock and zero otherwise. Table 5 re-estimates the regressions using a binary agriculture-related shock. Our coefficient of interest shows that households who have experienced the shock are likely to have less consumption, which is consistent with our previous finding

Adding Household Income as an Additional Control

Thus far, the estimations have included sources of income dummies as controls and have omitted household income. This is because introducing household income brings with it endogeneity. Here we measure whether our results will be consistent once we include household income as an additional control. Our assertion that household income is likely to be endogenous emanates from past empirical studies. A potential source of endogeneity is reverse causality between income and the consumption outcome, in that income enters a consumption function, and in like manner, consumption enters an income function through nutrition/health; for example, a healthier/more nourished person is more likely to earn more income. We use lagged income value as an instrument to mute the endogeneity in the income regressor.

Table 6 presents the results from the fixed-effects IV (FE2SLS) model. After controlling for household income, in Table 6, the coefficient s of the agriculture-related shocks amongst those who lost 'most' of their crops remain robust in sign and significance. We also observe a statistically significant sign on the coefficient of those who lost 'al' of their crops (Panel A; however, once we introduce the interaction effects in Panel B, this significance disappears. Of special interest, in Table 6, is the household income coefficient, which is not statistically different from zero across the various consumption measures. This is somewhat surprising. Speculatively, this may suggest that household income is mainly budgeted for non-food consumption (e.g. school fees, transport and other essentials) rather than food consumption, while other household activities such as farming and gathering of natural resources cater for food consumption.

Nonetheless, the inclusion of household income shields against potential omitted variable bias, and still provides consistent results. A valid concern, however, is our choice of IV. Admittedly, lagged income value is unlikely to be a perfect IV. A priori, it is reasonable to suspect that the previous year's (t-1) income is likely to affect this year's (t) consumption, which implies correlation with the error term. One potential channel is farm management effects. Specifically, some households are more likely to manage their farms better than others. If this happens in year t-1, for instance, such that the households use income to purchase extensions e.g. fertilisers, pesticides or labour to boost garden yields, these effects (boost in yields) are likely to be faced not only in year t-1 but in year t as well. This may be through improved soil capability over time or even left over extensions (from year t-1) used in year t.

To investigate this premise, we use the t-test and compare differences in mean agriculture output (consumption) in year t between those who purchased and those who did not purchase extensions (fertilisers, pesticides, herbicides, ploughing, implements and labour) in year t-1. If the premise holds, then our expectation is that the agriculture output of households who purchase extensions would be higher than those who do not purchase extensions. Consistent with our expectations, the results of the t-test revealed that households who use extensions had significantly higher crop yield $(94,477.2 \pm\ 7650.8)$ $kcal$ compared to those who did not use any extensions $(66,637.9 \pm\ 6210.3)$; $t(1034) = -2.7031, p = 0.0070$. This statistically significant difference provides suggestive evidence that the lagged income value is likely to be correlated with the error term.

Debunking exogenous agriculture-related shocks - adaptation effects?

So far, we have asserted that our agriculture-related shocks from weather-related crop failure are somewhat more exogenous in comparison to crop failure from pests or diseases. Here we probe this assertion. A concern is that, to some extent, it is plausible for households to cushion themselves against weather-related crop failure through adaptation. For example, in the presence of poor rainfall, households may opt to water/irrigate their gardens to reduce crop failure. Adaption is more likely to be present in higher-income and/or more-knowledgeable households (i.e. those with awareness of weather variability and adaptation methods) in comparison to lower-income/or less-knowledgeable households. Indeed, studies have found adaptation to be correlated with income and knowledge (e.g. Knowler and Bradshaw, 2007; Deressa et al., 2009).

In testing this, first, we investigate whether the agriculture-related shocks systematically differ by income levels. If we find systematic differences, it would suggest that observable household characteristics, such as income, affect the shocks. Second, we include agriculture-related shockst+1 as an additional regressor conditional on the current shocks (agriculture-related shocks). The expectation is that we should not find significant coefficients on the agriculture-related shockst+1 (Duryea et al., 2007; Dinkelman et al., 2008). If this holds, it would be some indication that the agriculture-related shocks are not prone to some unobserved household influence (e.g. knowledge).

To that effect, Table 7 shows the distribution of the agriculture-related shocks (1 if the shock was experienced and 0 otherwise) by 2010 household income quartiles. Fortunately, the shocks are not systematic, suggesting that lower-income households are not more prone to the shocks than higher-income households. In Table 8 we re-estimate regressions but introduce agriculture-related shockst+1 as an additional regressor using a 2SLS model. Consistent with our expectation, the coefficient of agriculture-related shockst+1 is statistically insignificant across the three consumption outcomes, providing some evidence that the significant effects of agriculture-related shocks is unlikely to be due to unobservable influence.

5 Conclusion

Climate variability is likely to become more frequent, resulting in increased weather-related events such as poor rainfall, floods or storms. Most rural households are already food insecure and depend on rain-fed homestead farming; hence, any weather-related event is likely to heighten food insecurity. The current paper investigates the impact of agriculture-related shocks (crop failure from poor rainfall and hail storms) on rural household consumption patterns, in an attempt to discover coping mechanisms that currently exist. In doing so, we use the SUCSES panel, which gathered information from small-scale subsistence farming households in rural Mpumalanga, South Africa. We test three consumption outcomes which capture essential but different consumption measures. We use an exogenous measure of agriculture-related shocks which is categorical in nature and includes 'none', 'a little', 'some', 'most' and 'all', which in essence also captures the size of the shock. We also measure the interplay between the shocks and formal and informal social capital.

We observe three key findings. First, the magnitude of the shock matters, in that households that lost all or most of their harvest are likely to consume significantly less. Second, although there appears to be no evidence of direct effects of informal social capital and formal social capital on consumption, the significant interaction effects show that receiving assistance has a cushioning effect on the consumption level of the most vulnerable, while giving assistance has the opposite effect also among the most vulnerable. Third, apart from informal social capital, the use of natural resources also reduces the negative effects of the shock. Surprisingly, we find formal social capital to be significant amongst the least vulnerable (i.e. with minimum crop loss).

In general, findings from this study show that crop production, which is the mainstay of the majority of households in sub-Saharan Africa is under threat from poor rainfall. While this issue has been previously investigated, the major concern of this study was the adaptive strategies that are effective in reducing the negative effects of shocks. Periodic fluctuations in rainfall are not new to a vast majority in rural sub-Saharan Africa. Our findings suggest that one way of improving the adaptive capacity of the rural poor is to strengthen social and natural resource capital, as they could provide easier, cheaper and more accessible alternative to household coping strategy, in comparison to other, more technical and capital intensive strategies, such as insurance. Yet, little is being done in most parts of sub-Saharan African countries to capture, utilise and promote these opportunities.

Currently, this untapped coping strategy is effectively being utilised among people living with HIV/AIDS, especially in resource- limited regions like those of sub-Saharan Africa (see Goudge *et al.*, 2009a; Goudge *et al.*, 2009b; Lippmanted *et al.*, 2013). Their effectiveness has led to various interventions such as'treatment buddie', while the more formal structures include community-home-based-care targeted at improving treatment response and coping mechanisms. Such valuable lessons can be drawn and adopted in the current context: household vulnerability to agriculture-related shocks. This is especially true since there is recognition in the current literature that climate variability is likely to continue, which implies that weather-related crop failure is more likely to be a common occurrence. In the current rural setting, which is characterised by poverty, insurance is unlikely to be a short-term solution, thus calling for the promotion of more informal methods readily available in resource-poor settings.A remaining concern centers on the sustainability of these less conventional adaptation strategies currently utilised by rural households. While informal social capital is, somewhat, more of a sustainable adaptation strategy, sadly, however, the use of natural resource capital, to some extent, is unlikely to be sustainable. Our concern here is natural resource depletion. This calls for a win-win policy intervention that can successfully link natural resource capital adaptation strategies with sustainability. On the other hand, with the informal social capital we are concerned with the likely negative effects on the most vulnerable households, i.e., their welfare and the trade-off between giving and receiving assistance. Since a plausible driver for this trade-off is the culture of strong ties and interpersonal relationships in rural communities, to achieve sustainability, policy designs will benefit by targeting the existing relationships.

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Table 1: Summary Statistics

Variables	Mean	Std. Dev.
Log kcal consumption (crops) per capita	8.727	1.415
Log kcal consumption (crops, natural resources) per capita	8.935	1.287
Log monetary consumption (crops, natural resources and groceries) per capita	5.464	0.886
Agricultural related shock[1]	1.566	1.271
Informal social capital	0.603	0.489
Formal social capital	0.446	0.497
Age	53.311	13.751
Household size	8.083	3.985
Agriculture income source	0.120	0.325
Natural Resource income source	0.115	0.319
Trade income source	0.576	0.494

[1]Agricultural related shock: 0 is 'none' of the crops were destroyed, 1 is 'a little' of the crops were destroyed, 2 is 'some' of the crops were destroyed, 3 is 'most' of crops were destroyed, 4 is 'all' of the crops were destroyed.

Table 2: Percentage of Households who have Experienced Agriculture-related Shocks

	Pooled	2010	2011	2012
• 'None' of the crops were lost to poor rainfall or hail storm	31.9	37.2	40.0	17.8
• 'A Little' of the crops were lost to poor rainfall or hailstorm	14.6	13.4	17.8	12.6
• 'Some' of the crops were lost to poor rainfall or hailstorm	19.3	19.2	18.7	19.9
• 'Most' of the crops were lost to poor rainfall or hailstorm	31.5	28.2	22.8	44.2
• 'All' of the crops were lost to poor rainfall or hailstorm	2.8	2.1	0.7	5.6

Table 3: Impact of Negative Agriculture-related Shocks on Household Consumption

	Panel A Without Household Characteristics			Panel B With Household Characteristics		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)
Shock, lost a little crop	0.132	0.0559	0.0599	0.152	0.0730	0.0739
	(0.104)	(0.0858)	(0.0605)	(0.104)	(0.0845)	(0.0581)
Shock, lost some crops	0.0136	-0.0497	-0.0645	0.0254	-0.0470	-0.0642
	(0.0992)	(0.0773)	(0.0607)	(0.0985)	(0.0764)	(0.0581)
Shock, lost most of the crops	-0.414***	-0.416***	-0.239***	-0.388***	-0.395***	-0.222***
	(0.0848)	(0.0730)	(0.0559)	(0.0866)	(0.0721)	(0.0541)
Shock, lost all of the crops	-1.448***	-1.278***	-0.649***	-1.398***	-1.251***	-0.632***
	(0.364)	(0.295)	(0.193)	(0.370)	(0.297)	(0.187)
Head of household age				0.169***	0.119***	0.103***
				(0.0562)	(0.0420)	(0.0234)
Head of household age^2				-0.00171***	-0.00122***	-0.000993***
				(0.000521)	(0.000368)	(0.000205)
Number of household members				-0.884***	-0.984***	-0.835***
				(0.245)	(0.174)	(0.134)
Income source: agriculture				0.238*	0.254***	0.246***
				(0.126)	(0.0978)	(0.0749)
Income source: natural resource				0.158	0.191**	0.0746
				(0.105)	(0.0915)	(0.0818)
Income source: labour				0.186**	0.152**	0.145***
				(0.0807)	(0.0632)	(0.0461)
Constant	8.823***	9.178***	5.630***	6.546***	8.342***	4.654***
	(0.0518)	(0.0416)	(0.0317)	(1.449)	(1.141)	(0.635)
Observations	1,536	1,536	1,536	1,536	1,536	1,536
R-squared	0.053	0.066	0.038	0.092	0.123	0.108
Number of observations	581	581	581	581	581	581

Ŏ Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Ŏ Reference category for shock (crop failure) is none

Table 4: Impact of Negative Agriculture-related Shocks & Social Capital on Household Consumption

	Panel A Without Interactions			Panel B With Interactions		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)
Shock, lost a little crop	**0.139**	**0.104**	**0.0825**	**0.00927**	**-0.00477**	**-0.0697**
	(0.106)	**(0.0939)**	**(0.0590)**	**(0.184)**	**(0.149)**	**(0.0989)**
Shock, lost some crops	**-0.0178**	**-0.0856**	**-0.0806**	**0.158**	**0.00220**	**-0.0367**
	(0.0962)	**(0.0872)**	**(0.0595)**	**(0.174)**	**(0.168)**	**(0.0979)**
Shock, lost most of the crops	**-0.432*****	**-0.419*****	**-0.234*****	**-0.331****	**-0.290****	**-0.258*****
	(0.0841)	**(0.0815)**	**(0.0547)**	**(0.151)**	**(0.144)**	**(0.0902)**
Shock, lost all of the crops	**-1.433*****	**-1.118*****	**-0.624*****	**-0.615**	**-0.748***	**-0.618**
	(0.375)	**(0.368)**	**(0.184)**	**(0.431)**	**(0.395)**	**(0.377)**
Informal social capital, receive	0.0201	-0.0811	0.00330	-0.0709	-0.141	-0.0527
	(0.107)	(0.0950)	(0.0674)	(0.215)	(0.177)	(0.114)
Shock, a little*Informal social capital, receive				0.335	0.370	0.366
				(0.325)	(0.295)	(0.234)
Shock, some*Informal social capital, receive				0.000673	0.215	0.0781
				(0.288)	(0.255)	(0.183)
Shock, most*Informal social capital, receive				0.0662	-0.145	-0.0111
				(0.273)	(0.272)	(0.151)
Shock, all*Informal social capital, receive				4.244***	2.799***	0.403*
				(0.745)	(0.771)	(0.226)
Informal social capital, give	0.0431	0.0851	0.0657	0.251	0.246	0.0876
	(0.0758)	(0.0811)	(0.0425)	(0.153)	(0.153)	(0.0801)
Shock, a little*Informal social capital, give				-0.162	-0.228	0.0536
				(0.232)	(0.205)	(0.128)
Shock, some*Informal social capital, give				-0.352*	-0.253	-0.108
				(0.205)	(0.182)	(0.120)
Shock, most*Informal social capital, give				-0.302	-0.213	-0.0166
				(0.199)	(0.179)	(0.111)
Shock, all*Informal social capital, give				-1.445**	-0.424	0.0311
				(0.628)	(0.646)	(0.420)
Formal social capital	-0.00915	-0.0662	-0.0135	-0.112	-0.138	-0.0736
	(0.0727)	(0.0610)	(0.0435)	(0.129)	(0.117)	(0.0801)
Shock, a little* Formal social capital				0.415**	0.438**	0.226*
				(0.207)	(0.192)	(0.124)
Shock, some* Formal social capital				0.0372	0.0584	0.0117
				(0.202)	(0.174)	(0.126)
Shock, most* Formal social capital				0.0870	-0.0116	0.0789
				(0.185)	(0.170)	(0.104)
Shock, all* Formal social capital				-0.771	-1.283	-0.330
				(0.760)	(0.818)	(0.272)
Head of household age	0.155***	0.141***	0.115***	0.160***	0.146***	0.115***
	(0.0571)	(0.0452)	(0.0252)	(0.0568)	(0.0452)	(0.0260)
Head of household age^2	-0.00159***	-0.00138***	-0.00108***	-0.00162***	-0.00142***	-0.00108***
	(0.000512)	(0.000392)	(0.000218)	(0.000505)	(0.000387)	(0.000223)
Number of household members	-0.891***	-1.107***	-0.860***	-0.855***	-1.084***	-0.855***
	(0.248)	(0.184)	(0.139)	(0.252)	(0.187)	(0.141)
Income source: agriculture	0.289**	0.401***	0.243***	0.286**	0.409***	0.248***
	(0.124)	(0.151)	(0.0777)	(0.123)	(0.150)	(0.0771)
Income source: natural resource	0.158	0.156*	0.0695	0.183*	0.169*	0.0680
	(0.106)	(0.0930)	(0.0835)	(0.109)	(0.0960)	(0.0828)
Income source: labour	0.158*	0.114	0.130***	0.152*	0.116	0.132***
	(0.0808)	(0.0817)	(0.0478)	(0.0798)	(0.0835)	(0.0487)
Constant	7.029***	7.843***	4.329***	6.712***	7.551***	4.318***
	(1.484)	(1.236)	(0.684)	(1.506)	(1.278)	(0.720)
Observations	1,536	1,536	1,536	1,536	1,536	1,536
R-squared	0.100	0.103	0.113	0.118	0.118	0.121
Number of observations	581	581	581	581	581	581

Ǒ Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Ǒ Reference category for shock (crop failure) is none

Table 5: Impact of Negative Agricultural Related Shock using Binary shock regressor

	Panel A Without Interactions			Panel B With Interactions		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)
Shock, Crop failure	**-0.191****	**-0.207*****	**-0.118****	**-0.132**	**-0.158**	**-0.162****
	(0.0775)	**(0.0705)**	**(0.0456)**	**(0.133)**	**(0.127)**	**(0.0765)**
Informal social capital, receive	0.0134	-0.0903	-0.00267	-0.128	-0.197	-0.0917
	(0.110)	(0.0989)	(0.0682)	(0.213)	(0.175)	(0.119)
Shock*Informal social capital, receive				0.181	0.137	0.115
				(0.245)	(0.206)	(0.147)
Informal social capital, give	0.0168	0.0619	0.0518	0.229	0.222	0.0738
	(0.0766)	(0.0816)	(0.0427)	(0.154)	(0.155)	(0.0806)
Shock*Informal social capital, give				-0.303*	-0.229	-0.0280
				(0.172)	(0.153)	(0.0952)
Formal social capital	0.0356	-0.0273	0.0107	-0.117	-0.135	-0.0698
	(0.0735)	(0.0624)	(0.0430)	(0.132)	(0.120)	(0.0802)
Shock* Formal social capital				0.193	0.135	0.112
				(0.160)	(0.143)	(0.0923)
Head of household - age	0.144**	0.131***	0.111***	0.142**	0.130***	0.107***
	(0.0588)	(0.0465)	(0.0249)	(0.0585)	(0.0469)	(0.0253)
Head of household - age2	-0.00151***	-0.00131***	-0.00105***	-0.00149***	-0.00130***	-0.00102***
	(0.000528)	(0.000403)	(0.000216)	(0.000525)	(0.000405)	(0.000219)
Number of household members	-0.863***	-1.078***	-0.836***	-0.858***	-1.074***	-0.836***
	(0.249)	(0.184)	(0.138)	(0.249)	(0.184)	(0.139)
Head of household - education dummy	-0.110	-0.0299	0.0130	-0.110	-0.0292	0.00860
	(0.119)	(0.0920)	(0.0674)	(0.118)	(0.0916)	(0.0677)
Income source: agriculture	0.290**	0.402***	0.243***	0.295**	0.405***	0.247***
	(0.125)	(0.153)	(0.0790)	(0.125)	(0.152)	(0.0791)
Income source: natural resource	0.165	0.165*	0.0775	0.188*	0.182*	0.0811
	(0.111)	(0.0946)	(0.0845)	(0.114)	(0.0966)	(0.0844)
Income source: labour	0.191**	0.142*	0.145***	0.186**	0.138	0.146***
	(0.0829)	(0.0827)	(0.0482)	(0.0828)	(0.0838)	(0.0486)
Constant	7.294***	8.063***	4.403***	7.328***	8.077***	4.534***
	(1.525)	(1.269)	(0.673)	(1.537)	(1.303)	(0.697)
Observations	1,536	1,536	1,536	1,536	1,536	1,536
R-squared	0.050	0.063	0.081	0.054	0.066	0.083
Number of observations	581	581	581	581	581	581

Ŏ Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 6: Impact of Negative Agriculture-related Shocks on Household Consumption (Household Income Control)

	Panel A Without Interactions			Panel B With Interactions		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)	ln kcal cons per capita (crops)	ln kcal cons per capita (crops & nat. resources)	ln real cons per capita (crops, nat. resources & groceries)
Shock, lost a little crop	0.155	0.104	-0.0339	0.0275	0.122	0.00907
	(0.190)	(0.151)	(0.110)	(0.292)	(0.236)	(0.174)
Shock, lost some crops	0.0366	0.0410	-0.0263	-0.155	-0.0725	-0.0805
	(0.174)	(0.138)	(0.101)	(0.260)	(0.210)	(0.155)
Shock, lost most of the crops	-0.549***	-0.486***	-0.300***	-0.742***	-0.626***	-0.397***
	(0.149)	(0.119)	(0.0861)	(0.236)	(0.190)	(0.140)
Shock, lost all of the crops	-0.802*	-0.776**	-0.383	0.646	-0.0379	0.0679
	(0.428)	(0.340)	(0.248)	(0.713)	(0.575)	(0.424)
Informal social capital, receive	0.00284	-0.239	0.0283	0.215	-0.209	0.119
	(0.206)	(0.165)	(0.119)	(0.404)	(0.326)	(0.240)
Shock, a little*Informal social capital, receive				-0.107	0.493	0.102
				(0.770)	(0.621)	(0.458)
Shock, some*Informal social capital, receive				-0.295	0.120	0.109
				(0.559)	(0.451)	(0.332)
Shock, most*Informal social capital, receive				-0.621	-0.436	-0.370
				(0.528)	(0.429)	(0.314)
Shock, all*Informal social capital, receive				6.546***	4.382**	1.303
				(2.213)	(1.785)	(1.316)
Informal social capital, give	0.00840	0.00232	0.00490	-0.265	-0.215	-0.138
	(0.127)	(0.101)	(0.0734)	(0.251)	(0.203)	(0.149)
Shock, a little*Informal social capital, give				0.408	0.103	0.115
				(0.403)	(0.326)	(0.240)
Shock, some*Informal social capital, give				0.333	0.333	0.194
				(0.353)	(0.285)	(0.210)
Shock, most*Informal social capital, give				0.477	0.396	0.276
				(0.316)	(0.255)	(0.188)
Shock, all*Informal social capital, give				-2.795***	-1.326*	-0.559
				(0.941)	(0.759)	(0.560)
Formal social capital	0.0247	-0.105	0.0261	0.0815	0.0222	0.121
	(0.130)	(0.103)	(0.0751)	(0.244)	(0.198)	(0.145)
Shock, a little* Formal social capital				-0.132	-0.222	-0.218
				(0.378)	(0.306)	(0.225)
Shock, some* Formal social capital				0.187	-0.118	-0.0957
				(0.375)	(0.303)	(0.223)
Shock, most* Formal social capital				0.0437	-0.0253	0.00153
				(0.306)	(0.248)	(0.182)
Shock, all* Formal social capital				-0.303	-0.910	-0.938
				(1.651)	(1.331)	(0.982)
Head of household age	0.144*	0.0745	0.0604	0.155*	0.0833	0.0660
	(0.0834)	(0.0663)	(0.0483)	(0.0826)	(0.0666)	(0.0491)
Head of household age^2	-0.00143**	-0.000813	-0.000660	-0.00150**	-0.000879	-0.000709*
	(0.000715)	(0.000568)	(0.000414)	(0.000707)	(0.000570)	(0.000420)
Number of household members	-1.312***	-1.367***	-1.173***	-1.351***	-1.410***	-1.200***
	(0.456)	(0.362)	(0.264)	(0.451)	(0.364)	(0.268)
Household income	-3.40e-06	4.63e-06	-1.06e-05	-1.79e-06	5.36e-06	-1.08e-05
	(1.53e-05)	(1.22e-05)	(8.86e-06)	(1.52e-05)	(1.22e-05)	(9.02e-06)
Income source: agriculture	0.284	0.246	0.279**	0.309	0.275	0.308**
	(0.235)	(0.187)	(0.136)	(0.234)	(0.189)	(0.139)
Income source: natural resource	0.0106	0.110	0.204	0.0388	0.125	0.216
	(0.240)	(0.191)	(0.139)	(0.238)	(0.192)	(0.141)
Income source: labour	0.370***	0.260**	0.257***	0.395***	0.281**	0.268***
	(0.140)	(0.112)	(0.0813)	(0.138)	(0.111)	(0.0821)
Constant	7.828***	10.19***	6.564***	7.595***	10.03***	6.474***
	(2.377)	(1.889)	(1.377)	(2.364)	(1.907)	(1.406)
Observations	843	840	843	843	840	843
Number of observation	482	480	482	482	480	482

Ŏ Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Ŏ Instrumented for household income (panel B). Excluded instruments: Lag household income

Table 7: Distribution of Agriculture-related Shocks by Income Quartiles

Income quartile	2010	2011	2012
1	0.69	0.59	0.82
2	0.73	0.60	0.79
3	0.60	0.66	0.85
4	0.53	0.60	0.78

Table 8: Testing Agriculture-related Shocks

Dependent Variable:	(1) ln kcal cons per capita (crops)	(2) ln kcal cons per capita (crops & nat. resources)	(3) ln real cons per capita (crops, nat. resources & groceries)
Shock, lost a little crop	0.178	0.103	0.116
	(0.160)	(0.150)	(0.117)
Shock, lost some crops	0.0240	0.0896	0.0787
	(0.163)	(0.146)	(0.103)
Shock, lost most of the crops	-0.323*	-0.273	-0.183
	(0.190)	(0.174)	(0.125)
Shock, lost all of the crops	-2.074***	-1.755***	-1.240***
	(0.443)	(0.411)	(0.299)
Shock, lost a little crop (t+1)	0.0587	0.000431	0.00106
	(0.226)	(0.209)	(0.150)
Shock, lost some crops(t+1)	-0.0453	-0.0178	-0.0452
	(0.242)	(0.202)	(0.142)
Shock, lost most of the crops(t+1)	0.0988	0.0989	0.0492
	(0.202)	(0.176)	(0.115)
Shock, lost all of the crops(t+1)	-0.404	-0.384	-0.198
	(0.363)	(0.319)	(0.217)
Informal social capital, receive	0.177	0.128	0.114
	(0.205)	(0.190)	(0.119)
Informal social capital, give	0.120	0.00745	0.0597
	(0.126)	(0.115)	(0.0830)
Formal social capital	0.296**	0.113	0.106
	(0.137)	(0.128)	(0.0917)
Head of household age	0.108**	0.0893***	0.0463**
	(0.0440)	(0.0338)	(0.0227)
Head of household age^2	-0.000824**	-0.000659**	-0.000325
	(0.000390)	(0.000299)	(0.000200)
Number of household members	-0.756***	-0.780***	-0.683***
	(0.148)	(0.132)	(0.104)
Household income	-0.0948	0.00136	0.0996
	(0.184)	(0.165)	(0.115)
Income source: agriculture	0.552**	0.528**	0.293
	(0.274)	(0.255)	(0.194)
Income source: natural resource	0.344	0.319	0.221
	(0.326)	(0.304)	(0.227)
Income source: labour	0.733	0.0114	-0.553
	(1.251)	(1.123)	(0.786)
Constant	6.970***	7.871***	5.248***
	(1.221)	(0.918)	(0.625)
Observations	374	374	374
R-squared	0.175	0.193	0.205

Ŏ Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Ŏ Reference category for shock (crop failure) is none

Ŏ Instrumented for household income (panel B). Excluded instruments: Lag household income

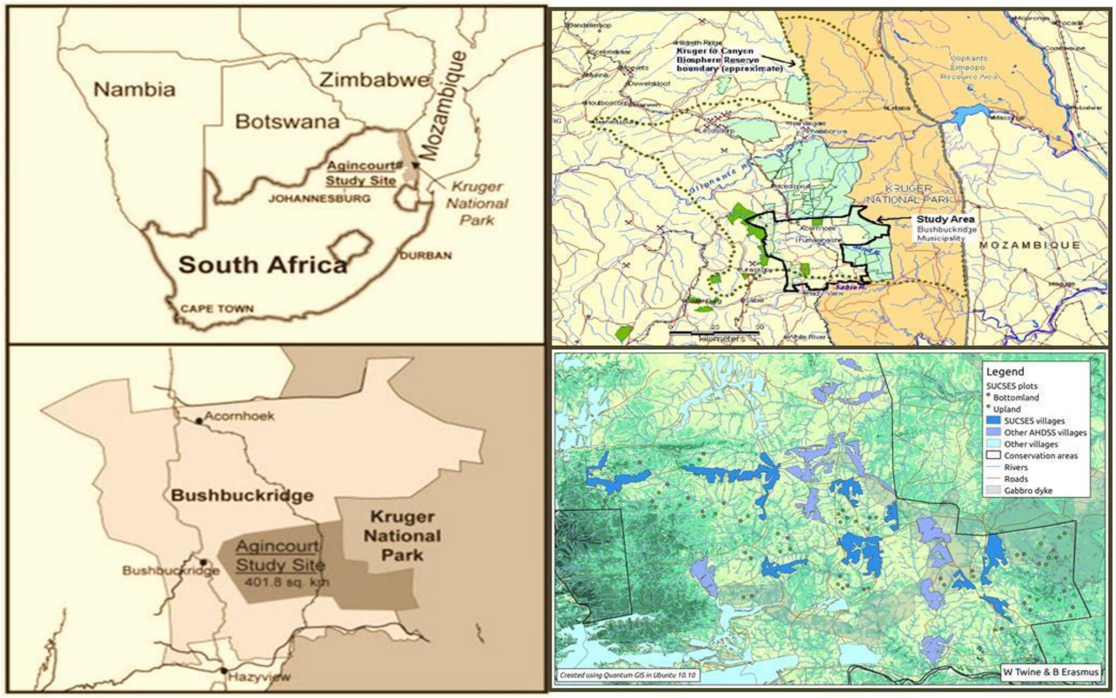
Appendix A

Table A.1: FAO Food Security Statistics

			Chad	Côte d'Ivoire	Ghana	Kenya	Malawi	Mozambique	Niger	Sudan	Togo	Uganda	Zambia
Income terciles: Poorest	• Food consumption, monetary value	US$/person/day	0.3	1.5	202.3	0.2	0.049	0.2	1.2	0.2	1.6	0.1	0.1
	• Dietary energy consumption	kcal/capita/day	1642.0	1716.6	1632.3	1251.7	1527.6	1244.9	1765.2	1563.0	1676.8	1608.6	1336.9
	• Share of own produced food in total food consumption (in dietary energy)	%	48.6	34.8	49.3	15.0	47.2	71.8	84.1	11.8	41.6	61.1	42.3
	• Share of own produced food in total food consumption (in dietary energy)	kcal/capita/day	797.2	598.1	805.2	188.1	721.0	893.8	1485.2	183.8	697.4	982.4	565.1
Income terciles: Medium	• Food consumption, monetary value	US$/person/day	0.6	3.0	349.9	0.4	0.1	0.4	1.6	0.4	2.8	0.2	0.2
	• Dietary energy consumption	kcal/capita/day	2418.6	2138.1	2369.0	1891.3	2167.6	2046.2	2036.7	2226.1	2279.0	2178.9	2046.0
	• Share of own produced food in total food consumption (in dietary energy)	%	37.0	20.6	33.6	16.4	51.0	69.8	79.0	6.3	69.0	57.5	37.0
	• Share of own produced food in total food consumption (in dietary energy)	kcal/capita/day	893.7	440.5	795.7	309.6	1105.9	1428.1	1609.0	139.4	1572.0	1253.1	756.0

Source: FAOSTAT

Figure 1: Agincourt/ SUCSES map



Source: SUCSES

Figure 2: Distribution of Informal Social Capital by Income Quintile

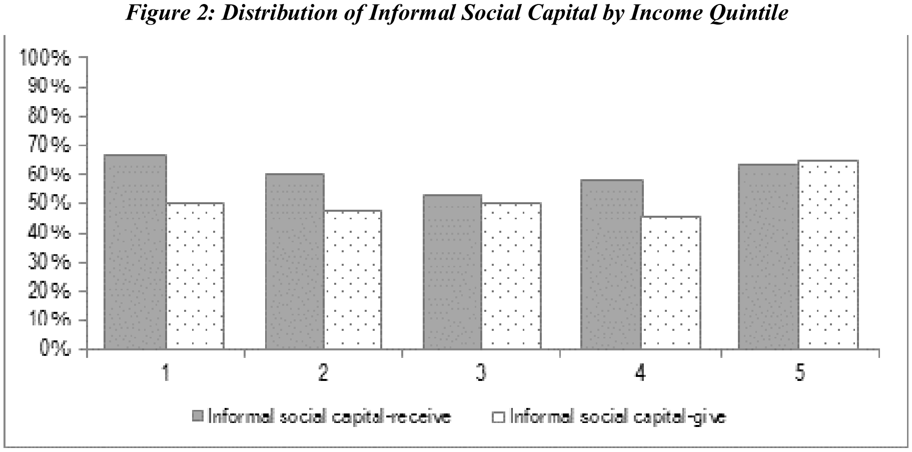


Figure 3: Distribution of Formal Social Capital by Income Quintile