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Taking from cotton to grow maize: The shifting practices of small-holder farmers in the cotton belt of Mali

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ABSTRACT

Cotton yields in Mali have fallen during the past 15 years while maize yields have risen. The objective of this study is to examine key changes in the agricultural system to understand how these changes might have influenced the production of these key crops. In particular, this study seeks to understand the causes of the drop in cotton yields in southern Mali and to question the hypotheses that rapid extensification of agriculture or soil fertility loss caused the decline. The study puts forth an alternative hypothesis that *fertilizer shifting* – whereby farmers apply fertilizers designated for cotton to grain crops – was an important and under-recognized factor in the decline in cotton and simultaneous rise in grain yields.

The study uses a mixed method approach which combines satellite image analysis with a household survey from the main cotton growing region in Mali and in-depth interviews with farmers for two key cotton growing areas to determine the causes of agricultural change.

The study uses satellite image analysis to document agricultural expansion and intensification over a 35 year period (1975–2010). It uses a household survey from nine villages in three cotton growing areas to document changes in the agricultural system and in production and yields for key crops including maize, cotton and other grains. It uses in-depth interviews with farmers from 15 villages in two cotton growing areas to study farmer decision-making in terms of farming inputs for crops.

The image analysis finds no evidence of rapid expansion of agriculture during the period of interest. These findings are supported by those from a household-level farm survey which finds that the major change in the agricultural system has been the increase in the area of intensively farmed crops along with a significant rise in maize yields. Finally, in-depth interviews with farmers growing cotton and maize find that the constraints on accessing fertilizer are a major determinant of farmer decision making.

We conclude that the past 15 years of agricultural change in southern Mali can best be described as one where agriculture expanded slowly with gradual intensification of grain farming centered on maize production and simultaneous disintensification of cotton production as farmers shifted resources from cotton to maize resulting in a decline in cotton yields.

> "Why do farmers embrace cotton cultivation when they are well aware of the difficulties that they may confront while doing so? We can understand this paradox by conceptualizing cotton growing as part of larger systems of which farmers value cotton production for more than its potential or actual income alone" (Koenig, 2008, p. 177).

1. Introduction

Cotton is a key agricultural crop in Mali as it is for a number of neighboring West African countries (Baquedano et al., 2010; Bassett, 2001; Moseley and Gray, 2008). Cotton farming in Mali is done primarily by smallholders involving nearly 300,000 farm households (Baffes, 2007). According to Tefft, cotton is Mali's number two export earner and contributes 15% of government revenues as well as 8% of GDP (Tefft, 2010). Cotton is thus critical to the national economy as well as many local livelihoods.

Cotton was the driver of successful agricultural development during the 20 years following Mali's independence in 1960. Cotton farmers were supported by research, extension services, and input credit resulting in substantially increased incomes and agricultural productivity. As a result, cotton yields more than tripled by the early 1980s (Baquedano et al., 2010). Following a steady rise over several decades, however, cotton yields began to decline during the 1990s. By 2008, national seed cotton yields averaged no more than those of the 1970s, only 900 kg/ha (Baquedano et al., 2010).

The causes of the decline in cotton yields have been attributed to several factors largely falling into two categories: (i) poor soil

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fertility management – the land degradation thesis; and (ii) the rapid expansion of cotton into marginal zones – the extensification thesis (Benjaminsen, 2001a, 2001b; Benjaminsen et al., 2010; Fok et al., 2000). The first thesis postulates that cotton is associated with "soil mining" resulting in nutrient deficits and soil fertility decline over time. If efforts are not taken to improve soil quality through fertilizers and other soil management techniques, the long term effects on farming will be a drop in yields. The second thesis argues that farmers seeking to maximize profits, as opposed to yields, rapidly expanded the area under cultivation while simultaneously reducing the inputs per unit area in order to maintain profits particularly following the period of structural adjustment in the mid-1990s (Benjaminsen, 2001a, 2001b; Benjaminsen et al., 2010).

Although it has long been argued that long term cotton production in Africa causes soil degradation and soil fertility loss (e.g., Lele et al., 1990; Van der Pol, 1992; Moseley and Gray, 2008), recent research has cast doubt on this position (Benjaminsen, 2001a, 2001b; Benjaminsen et al., 2010; Niemeijer and Mazzucato, 2002; Ramisch, 1999, 2005). While declining soil fertility has become a constraint to production for some people in some places and at some times, the problem with the commonly used large-scale extrapolations is that they tend to average nutrient balances over relatively large spatial scales and thus gloss over local dynamics and variations in time and space (Eyasu and Scoones, 1999; Niemeijer and Mazzucato, 2002; Ramisch, 1999, 2005; Scoones, 1997, 2001; Scoones and Toulmin, 1998). Indeed, recent work from the oldest cotton growing region in Mali, Koutiala, finds no evidence that cotton has caused significant soil fertility loss. Benjaminsen et al. (2010) compared the quality of soils in areas with continuous cultivation with those under fallow and found no clear trends of fertility loss. They conclude that, "Cotton yields have declined since the early 1990s, while the total use of fertilizers has increased. This is often interpreted as proof of soil exhaustion, but there is no clear indication in this study that cotton–cereal rotation as practiced by smallholders in southern Mali reduces soil fertility" (p. 647). Although one study is not sufficient to rule out soil degradation as a cause of the decline in yields, it does suggest that other factors are important given that the decline is a national phenomenon and that most areas in Mali have been in cotton production for a far shorter time period than Koutiala.

As an alternative hypothesis, Benjaminsen (2001a, 2001b) suggested that devaluation of the West African currency in 1994 drove up the cost of inputs resulting in a rapid expansion in cotton growing as farmers attempted to maximize profits. His argument is that Structural Adjustment Policies (SAPs) reduced the subsidies on fertilizers resulting in a price increase and subsequent lower fertilizer use which pushed farmers to increase acreage to compensate for lower yields. The decline in cotton yields was thus due to "rapid" farmer expansion of cropping area and simultaneous reduction in inputs per unit of land (known as disintensification) combined with movement into marginal lands and resulting mismanagement – a phenomenon we refer to as rapid extensification (Benjaminsen, 2001a, 2001b; Benjaminsen et al., 2010). Benjaminsen argues that despite the increasing total amounts of fertilizers used during the 1990s, these inputs were spread more thinly after devaluation because cultivated area increased comparatively quickly.

The two theses described above are not unrelated. The expansion of area farmed (extensification) and simultaneous reduction in fertilizer use per area (disintensification) could result in declining soil fertility over time resulting in a drop in yields (Tefft, 2010). One major issue with both theses, however, is that while cotton yields have been falling steadily since the early 1990s, those for maize and other grains have been rising steadily and significantly. Indeed, according to research by Foltz et al. (2012) Mali has experienced a "maize revolution" with yields increasing at an annual rate of over 2%. If soil degradation had caused the drop in cotton yields, it is improbable that yields for maize, which is grown in a rotation with cotton and is thought to depend on the fertilizer residuals for success, would see an increase during the same time period. Likewise, a process of disintensification would not necessarily produce the divergent trends described in further detail below.

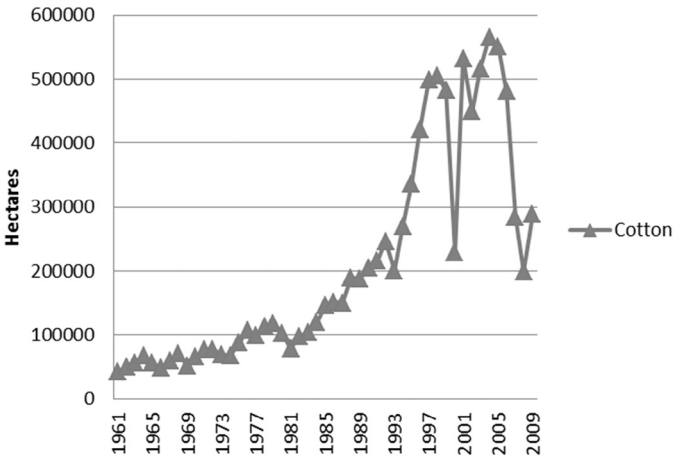

Fig. 1. Land under cotton production in Mali 1961–2010.

A second issue concerns the data used to support the extensification thesis. Benjaminsen (et al. 2010) used national-level data on cotton yields and area harvested. These data (Figs. 1 and 2) do indeed show a fall in cotton yields and near simultaneous increase in area of cotton farmed. Arguing that these two trends are causally linked is problematic, however, when using national-scale data because the expansion of cotton into new and fertile areas could have masked the actual relationship between expansion and falling yields. Importantly, CMDT (Compagnie malienne pour le développment du textile) expanded into the Kita region in 1995 (Koenig, 2008). The opening of the Kita zone resulted in the addition of approximately 15,000 farm households beginning cotton production as well as an increased number of households migrating to the new cotton zone.

Indeed, by 2000, there were over 200,000 farm households growing cotton in Mali, a 50% increase since 1993 (Tefft, 2010). The timing of the expansion into Kita corresponds well with the increase in area cited by Benjaminsen. As such, while Benjaminsen et al. make an important argument, their work does not provide data at the appropriate scale to support the extensification thesis nor does their analysis explain why yields have continued to decline long after devaluation and subsequent stabilization of currency.

According to classic Boserupian (Boserup, 1965) theory of induced intensification of agriculture, farmers respond to increasing land pressure due to population growth or increasing demand by intensifying land use – applying more inputs (labor or capital) to produce more output per unit area or time. Although often conceptualized in terms of an increase in inputs and/or advances in technology; intensification is also change in *land use*, specifically a reduction in the fallow period, resulting in more frequent cropping. If demand remains constant, intensification results in a contraction of the total amount of area used (Rudel et al., 2009). The intensification of agriculture, is thus defined here as an increase in the productive output per unit of land. Disintensification refers to the opposite. Extensification is the process of expanding agriculture into land areas that were previously unused. Extensification is sometimes used as a synonym for disintensification especially in cases where area is expanded without an increase in inputs.

In Mali, cotton is by most measures an intensively farmed crop. It is most often farmed using animal traction on frequently farmed rain fed plots requiring regular inputs of fertilizers. Cotton production is facilitated by agricultural services provided by the extension