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Yield Gap-Based Poverty Gaps in Rural Sub-Saharan Africa

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Summary. — Given Africa's challenge of feeding a growing population, narrowing yield gaps is an efficient way of raising production under covariate constraints. Using household panel data from 21 regions in eight sub-Saharan African countries, this article unravels the determinants of yield gaps. It also tests the hypothesis that poverty gaps are increasing with yield gaps. The results suggest that yield gaps are increasing with cultivated area; that yield differences are reducing with fertilizer use, particularly when combined with improved seeds in low production potential regions; that poverty gaps are increasing with yield gaps, particularly in low production potential regions.

Key words — sub-Saharan Africa, yield gaps, poverty gaps, panel data

1. INTRODUCTION

Agricultural productivity growth in SSA over the past four decades averaged only 2.4% compared with 4.0% in the rest of the developing world (World Bank, 2013). This disparity is in spite of policy reforms in the 1980s and 1990s which were reported to have brought about some modest gains in SSA (Yu & Nin-Pratt, 2011). The global food price hikes in 2007–08 and more recently in 2010 and 2012 have intensified the need for increasing agricultural productivity growth.

So, although agricultural productivity has outpaced population growth globally, food production in SSA has not always kept pace with population growth, creating substantial productivity differences across regions of the world that must not be overlooked (FAO, 2009; Tittonell & Giller, 2013). Indeed the productivity gap between Africa and the rest of the world continues to rise. For example, estimates using FAO data indicate that average cereal yields in Africa were 57% of that of the world average in the 1960s. By the 1980s and 1990s the yield difference had widened such that average yields in Africa were 47% and 42% of the world average respectively. This yield gap has since remained at the 1990s level. Over the same periods, yields have been increasing in Asia such that average cereal yields in that region are currently about 3% higher than the world average (FAOSTAT, 2013).

As one would expect, there exists enormous heterogeneity in yields across Africa. Yield gaps are lowest in Southern Africa where over the past decade average cereal yields, for example, were 86% of that of the world average compared with Western, Eastern, and Central Africa where average yields were only 18%, 29%, and 35% of the world average respectively (FAOSTAT, 2013). In essence, increasing the productivity of agricultural factor inputs remain at the core of the developmental challenge in SSA.

Using household-level data from 21 regions located in eight SSA countries, a group of Swedish and African researchers found not only substantial variations in staple crop yields between regions of a country, but also large differences within regions of the same country. This suggests that agroecological conditions alone cannot explain productivity differences.

As the world continues to face the challenge of feeding a growing population and global demand for food continues to rise (Koning & van Ittersum, 2009), strategies for increasing food production have become even more pertinent. Meeting the growing demand requires increasing area under cultivation and/or yields. But to ensure that ecosystems are preserved, increasing average yields by reducing the yield gap in a sustainable way rather than bringing more land under cultivation is preferred (Lobell, Cassman, & Field, 2009). In essence, narrowing the yield gap leads to the attainment of higher output through efficiency gains (Laborte, de Bie, Smaling, Moya, Boling, & Van Ittersum, 2012).

In fact, narrowing the yield gap is essential as it helps achieve the rate of growth in output required to feed a growing world population (particularly urban dwellers) faster than it would have taken at current average yield levels. Reducing the yield gap also has implications for food prices and food security as it is linked to average crop yields (Lobell *et al.*, 2009). Thus, if food production does not keep pace with demand the resultant price increases could lead to poverty and hunger, particularly among an already vulnerable population in most of rural SSA (van Ittersum, Cassman, Grassini, Wolf, Tittonell, & Hochman, 2013).

About half the population of SSA live on less than $1.25 a day at 2005 international prices (World Bank, 2013). Given that rural poverty rates are much higher than national

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averages, and that majority of the rural population in SSA have agriculture as their dominant economic livelihood activity (Davis *et al.*, 2010), a link has been drawn between rural poverty and agricultural productivity (see, for example, Ravallion, 2009). Productivity growth in smallholder agriculture is thus seen as a major window of opportunity for poverty reduction. This point was emphasized by the 2008 World Development Report (World Bank, 2007). State agriculture policies in SSA have taken almost as given that increasing farm productivity would lead to increased incomes and consequent poverty reduction. To this end, for several decades, governments and international development organizations have put together several programs and projects aimed at increasing agricultural productivity.

However, micro-level empirical research on the link between agricultural productivity differences and poverty gaps is scarce. Using household-level panel data from 21 regions in eight SSA countries this paper sets out to essentially answer two research questions. First, what factors account for observed crop yield gaps among smallholder farm household? Second, to what extent, if at all, do crop yield gaps explain economic welfare gaps at the household level? If the top performing farmers in terms of yields are also those on the highest levels of the economic wealth ladder, all other factors being equal, one can argue that narrowing the yield gap holds some promise for lifting rural households out of poverty. Indeed this is what most African country agriculture development policy initiatives assume.

2. YIELD GAPS

Cross-country differences in agricultural productivity are well known. At the micro level, however, available literature on yield differentials among farmers and farm households is thin. But understanding within-country, -region or even village-level yield differences is important. First, it could help isolate factors beyond agroecological conditions and other covariate (community-/region-specific) limits on productivity. Second, understanding productivity differences under similar existing agroecological conditions points to policies and interventions that may help raise yields to potentially achievable levels subject to agroecology-specific constraints. Lobell (2013) notes that identifying factors that explain observed yield gaps is necessary as it helps explain how average yields could be raised in order to narrow the yield gap thereby increasing production.

At the aggregate cross-country-level agricultural productivity gaps have been accounted for by inputs (labor, land, fertilizer, and machinery), technology, and factors such as education and research (Hayami, 1969; Hayami & Ruttan, 1970). At the micro level, similar to the findings in Djurfeldt, Aryeetey, and Isinika (2011), Jayne, Mather, and Mghenyi (2006) found substantial maize yield gaps comparing household-level median maize yields with their corresponding district-level median in Kenya, Mozambique, and Zambia. They suggest that crop input and management factors could be central in explaining this heterogeneity, and that understanding the variability at the micro level is important for achieving increased productivity.

In the agronomy literature, large food crop yield gaps have also been observed at the plot level under rainfed conditions in smallholder agriculture in Africa and the determinants differ by agroecological zone, demographic situations and market conditions (Affholder, Poeydebat, Corbeels, Scopel, & Tittonell, 2013; Tittonell & Giller, 2013).

The limited or non-adoption of agricultural technologies, which is among the factors that account for yield gaps, are influenced by both farmer and farm characteristics (Laborte *et al.*, 2012). The former includes knowledge or education, skill and risk aversion while the latter comprise poor soils, poor access to inputs, and input costs.

Plot-level yield gaps are influenced not only by biophysical factors and agroecological potential but also by factors related to poor farm management practices and limited access to chemical inputs and improved planting materials (Affholder *et al.*, 2013). Poor soil fertility and weed infestation have been found to be yield gap increasing. These problems are directly related to farmers' low purchasing power which leads to limited access to productivity enhancing inputs including herbicides and/or hired labor for weed control (Ramaswamy & Sanders, 1992). However, access to fertilizers and herbicides may not be enough for narrowing the yield gap, the adoption of water conservation technologies is essential (Sawadogo, 2011).

Affholder *et al.* (2013) argue that farming systems are more important drivers of yield gaps than climate. Land scarcity and high population density drive land-saving agricultural production technologies and intensive cropping resulting in higher yields and reduced yield gaps (Cassman, 1999). Where factor and product markets are well integrated, the yield gap is expected to be narrow (Affholder *et al.*, 2013). Product market participation also influences choice of crop varieties with subsistence producers tending to utilize traditional varieties with lower yield index and therefore widening the yield gap.

Using 95th percentile average famer yields as reference, Tittonell and Giller (2013) noted that the yield gap is sometimes exclusively explained by improved planting materials and/or agrochemical use. They argue that a substantial proportion of the yield gap can be reduced by good agronomic practices even without fertilizer application.

3. AGRICULTURE-LED POVERTY REDUCTION: THEORY AND EVIDENCE

Theoretically, the link between agricultural productivity and poverty reduction is not straight forward. It depends on a number of factors including scale of analysis: household (both inter- and intra-household), village, regional, and national (Irz, Lin, Thirtle, & Wiggins, 2001). The effect could be positive nationally, for example, but negative for net sellers at the household or local level. An extended review of the agricultural productivity poverty linkage and pathways literature can be found in Schneider and Gugerty (2011).

Increasing productivity, *ceteris paribus*, could increase the income of the poor engaged in farming (Minten & Barrett, 2008). But the productivity induced increase in income depends on the extent of participation in agriculture. In most of rural SSA where agriculture is still the dominant economic livelihood activity (Davis, Winters, Reardon, & Stamoulis, 2009), the potential effect of a productivity rise appears enormous. But for farm households, this depends also on the effect of a productivity increase on output and factor input prices.

Increased productivity could also generate nonfarm employment through its spillover effects (Eswaran, Kotwal, Ramaswami, & Wadhwa, 2009; Ravallion, 2009). This is important particularly because of a largely unskilled rural population for whom alternative higher-paying jobs may be elusive (de Janvry & Sadoulet, 2010). Ravallion (2009) argues that, as a first step, productivity growth in smallholder agriculture is imperative if SSA is to replicate China's success