African Agriculture Is Intensifying—
But Not by Much

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Overview

Common wisdom: Population pressure and improved market access are intensifying African agriculture.

Findings:

- Fallow practices for soil fertility regeneration have virtually disappeared.
- The use of chemical and organic fertilizer varies enormously across countries.
- In Ethiopia, Malawi, and Nigeria, nearly half or more of the farmers use chemical fertilizer. However, in Nigeria very little organic manure is used, putting soil fertility at risk. In Tanzania and Uganda, the share of farmers using chemical or organic fertilizer is so low that soil fertility on the land of most farmers cannot be sustained.
- Population pressure and market access have so far triggered an inadequate response of the farming systems with respect to irrigation and improved technology.
- The study adopted two innovative variables (agroecological potential and urban gravity) to gain further insights into intensification processes. The responses to these variables were mixed, and suggested the need for further research.

Conclusion: In response to rising population densities and market opportunities arising from urbanization and better market access, cropping intensities have increased everywhere, but the expected increase in the use of inputs, technology, and investments has been less than what could have been predicted under the Boserup-Ruthenberg model of intensification.

Policy messages: The process of intensification over many of these African countries has been far less beneficial to farmers than what could have been expected. This may be due in part to the poor policies and low public agricultural development expenditures that prevailed during the 1970s and 1980s, which started to improve only in the 1990s. But these improvements do not appear to have led to a better pattern of
intensification. Long-running panel data and additional intensification variables are needed to assess whether Africa will experience a virtuous cycle of growth and agricultural intensification. This holds an important area for further policy research.

The Issue: We Expected a Virtuous Cycle

A central issue in agricultural development is how agricultural production responds to higher population density and the development of markets. What will happen to the cropping intensities, adoption of technologies, and use of inputs and capital to enable yields to grow? Will soil fertility be maintained or increased to a sustainable level? Will these changes be sufficient to allow per capita agricultural incomes to rise sufficiently to maintain or improve per capita agricultural incomes? A rich body of literature on agricultural intensification addresses these issues. The Boserup-Ruthenberg (B-R) framework has long been used to understand the process of agricultural intensification across the developing world (see Boserup 1965; Ruthenberg 1980). Under this theory, population growth and market access first lead to a reduction in fallow periods—periods of rest for the land when soil fertility is restored. Farmers are likely to respond in a virtuous cycle for crop production, involving an increase in cropping intensity (the number or crops that are produced in a plot per year); increased use of organic manure and fertilizers; and investments in mechanization, land development, and irrigation. As observed in Asian countries, such changes have the potential to offset the negative impact of population growth on farm sizes, to maintain or increase per capita food production, and even increase farmers’ incomes. But it is also possible that the changes in farming practices and technology occur too slowly, and that the intensification process leads to a decline in farm income—a process referred to as agricultural involution (Geetz 1963). The agricultural development literature has produced an extensive body of evidence that summarizes or tests the B-R hypothesis in Africa and often confirms it.

In the past two decades, rapid population growth has put African farming systems under stress. At the same time, there has been a sharp increase in urbanization and economic growth that is providing new market opportunities for farmers. It is therefore a good time to investigate whether this has resulted in rapid intensification of farming systems, permitting rapid agricultural growth and increased incomes of the farming population.

The Analysis: Has There Been a Virtuous Cycle?

To address this question, the study describes the status of intensification of crop production in six African countries using the first round of data from the Living Standards Measurement Study–Integrated Surveys on Agriculture (LSMS-ISA). The six are Ethiopia, Malawi, Niger, Nigeria, Tanzania, and Uganda. The study does the following:

- Develops an internationally comparable measure of agroecological potential (AEP) based on estimated attainable crop yields across all agricultural areas of

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African Agriculture Is Intensifying—But Not by Much

AEPs are given in map 11.1, by enumeration area. Country averages are given in box 11.1. By defining AEP per capita, the study proposes an alternative measure of population pressure—one that reflects the potential of the area being assessed.

- Uses a measure of urban gravity (UG) to reflect the access of a particular location to urban demand, defining urban areas as those with a population of more than 500,000 (map 11.2 provides UGs by enumeration; box 11.1 provides country averages).
- Estimates the relationship between AEP and UG on population density, infrastructure, and market access, these being the main explanatory variables for agricultural intensification in the B-R framework.

But there are limits to using just cross-section data. Ideally, panel data are needed (data for the same households over time) to test properly whether the B-R framework currently applies to Africa. But only cross-section data are

Box 11.1 Calculating the Two Key Variables

The study considers several aspects of farming outcomes as important when analyzing the Boserup-Ruthenberg framework:

- Population density of the enumeration area
- Distance to the nearest road and nearest markets
- Average owned or cropped area per household
- Cropping intensity, defined as gross cropped area per net cropped area
- Proportion or area of land area under fallow
- Proportion of net crop area irrigated
- Proportion of households using different technologies: high-yielding varieties, organic manure, fertilizer, or pesticides.

These aspects were obtained from the Living Standards Measurement Study–Integrated Surveys on Agriculture data. But two key variables were obtained outside the household surveys:

Agroecological potential (AEP) is estimated using currently available global agroecological zone data from the International Institute for Systems Analysis and the Food and Agriculture Organization (Tóth et al. 2012). The study estimates yield potential for 15 crops (wheat, rice, maize, barley, millet, sorghum, white potatoes, cassava, soybean, coffee, cotton, groundnut, banana, sweet potatoes, and beans). These potentials are based on current climatic conditions, intermediate input use, and rainfed conditions. The 15 crops are aggregated into one index using average world prices over the past three years. Figure B11.1.1 gives the country averages; map 11.1 shows how the measure varies within each country. Because only recent crop prices and cropping patterns are used in the measure, it may not

box continues next page
reflect past AEPs. Therefore, the analysis assumes that today’s AEP is highly correlated with the AEP of the past.

The study measures population pressure in two ways. The traditional measure of population pressure (persons per square kilometer) does not account for the vast differences in AEP. An alternative measure is therefore used, defined as the AEP per square kilometer divided by the population density. This gives the AEP per person in each enumeration area. Unlike with population density, the lower this number is, the higher is the population pressure. The study finds that this measure ranks countries quite differently from rural population density rankings. Rural population density is therefore considered to be a weak measure of population pressure on natural resources.

*Urban gravity* is the intensity of light emitted as a proxy for economic activity in a particular urban area. Light intensity measures (unlike more orthodox measures of activity, such as gross domestic product) are available for specific areas in a country. The data come from the Defense Meteorological Satellite Program of the National Geophysical Data Center. Figure B11.1.1 shows how averages for urban gravity vary across countries, and map 11.2 shows how urban gravity varies within each country. As with AEP, the study assumes that current urban gravity is closely related to what it was in the past.

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**Box 11.1 Calculating the Two Key Variables (continued)**

**Figure B11.1.1 Higher Agroecological Potential per Person in Tanzania and Niger; Greater Market Access in Nigeria and Malawi**

![Graph showing urban gravity and agroecological potential per person in different countries](graph.png)

*Source:* Calculations based on LSMS-ISA data.

*Note:* AEP = agroecological potential.
available from the LSMS-ISA surveys. When the intensification measures are regressed against the AEP and UG variables, the coefficients reflect the direct effects of the intensification measures on the farming characteristics of interest, and the indirect effects via their influence on population density and infrastructure.
Agriculture in Africa

Map 11.2 Urban Gravities for the Six Countries

Source: Computations based on LSMS-ISA data. 
Note: UG = urban gravity.

The Results: Little Sign of a Virtuous Cycle

The analysis shows that the patterns of intensification observed across countries are not entirely consistent with the B-R framework.

*Cropping intensities have increased and fallow land has disappeared.* Given the rise in population pressure in all the countries, improvements in infrastructure, and growing urban demand, Africa’s land use intensity has reached the stage where land is cropped every year (permanent cropping) in all the countries. Fallow areas have virtually disappeared. Since fallowing is used to restore soil fertility, organic and chemical fertilizers are needed to do this job. This is as predicted by B-R.
Cropping intensity is defined as gross cropped area divided by net cropped area (figure 11.1). At 1.89, crop intensity is highest in Uganda, because of its bimodal rainy season, which, unlike in the other countries, allows for two crops per year. Cropping intensity is especially low in Malawi (1.01) and Tanzania (1.07). In the other countries, cropping intensities also remain below 1.2. Although cropping intensity is greater than 1 in all the countries, indicating that the stage of permanent cropping has been reached everywhere, it could have been higher in light of the observed population density and increased market access. This is especially the case for Malawi,

![Figure 11.1 The Practice of Fallowing Has More or Less Disappeared](image)

Source: Computations based on LSMS-ISA data.

Note: Cropping intensity is the gross cropped area per year divided by the cropped area and reflects the number of times the area is used for crop cultivation per year.

<table>
<thead>
<tr>
<th>Country</th>
<th>Average irrigated area (hectares)</th>
<th>Share of households (percent) using</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>0.016</td>
<td>Improved seeds: 18</td>
</tr>
<tr>
<td>Malawi</td>
<td>0.003</td>
<td>Inorganic fertilizer: 41</td>
</tr>
<tr>
<td>Niger</td>
<td>0.036</td>
<td>Organic fertilizers: 53</td>
</tr>
<tr>
<td>Nigeria</td>
<td>0.033</td>
<td>Agrochemicals: 23</td>
</tr>
<tr>
<td>Tanzania</td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>Uganda</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.029</td>
<td></td>
</tr>
</tbody>
</table>

Sources: Estimates based on LSMS-ISA data; Binswanger-Mkhize and Savastano 2017.

Note: — = not available; totals across countries are population weighted.
where agroecological population pressure is already high and, contrary to the B-R model, intensity of land use is low.

*Use of improved technology is uneven.* To be consistent with the B-R model, countries should have a proportionate use of new technologies combined with their AEP and population pressure. The countries exhibit very uneven input use, despite having cropping intensities at or above unity (figure 11.1). Except for Malawi, the proportion of households using improved seeds is less than 18 percent (table 11.1). More than 41 percent of the households in Ethiopia, Malawi, and Nigeria use chemical fertilizers. In Ethiopia, 53 percent of the households also use organic manure, which is an important input to maintain soil fertility. However, in Nigeria, only 3 percent of the households use organic manure, which means that even households that use chemical fertilizer may not be able to maintain soil fertility. In Tanzania, the use of these two inputs is very low; it is even worse in Uganda. With cropping intensities of more than unity, the use of organic and chemical fertilizer is surely insufficient to maintain soil fertility.

*Investments in irrigation are limited,* falling far short of what the high agroecological population pressures would imply. This finding partly also explains the lower cropping intensities. Across the six countries, the average area irrigated per farm is only 0.03 hectares, and the share of irrigated area in total area is only 4.4 percent. Surprisingly, the mean area under irrigation is higher in Tanzania (0.045 hectares) compared with Malawi (0.03 hectares), where land pressure is highest. This is not consistent with the B-R hypothesis. The warm arid zones have the largest mean irrigated area per farm, at 0.11 hectares, but, because of the large farm sizes, this amounts to just 2.4 percent of the land area. The warm semi-arid areas come next in the use of irrigation, followed by cool semi-arid and warm subhumid areas.

*The multivariate results are mixed.* The study finds significant responses of population density and infrastructure, farming system characteristics, farm technology, and profits per hectare to the measures of AEP and UG, and the signs are all according to expectations. However, there is a sharp divide between the nature of the impacts of AEP and UG across the variables:

- AEP increases population density and road investment, but does not reduce distance to markets. UG does not affect population density, but reduces the distance to roads and markets.
- AEP has no impact on key characteristics of the farming system, such as area farmed, crop intensity, and fallow areas. UG reduces all area measures and increases cropping intensity.
- Although neither AEP nor UG has an impact on irrigation investment, AEP affects the use of all four inputs, while UG only increases the use of improved seeds. The interpretation of these finding is that higher input use has significantly higher payoffs in areas of high AEP.
The Implications

The results of the study are far from reassuring for the ability of intensification to enhance agricultural incomes. In several countries, the intensification that has occurred in the recent past is likely to threaten long-term soil fertility. Instead, agriculture may persist in a low-yield equilibrium, consistent with the very slow growth of yields observed in Africa. Since average farm sizes have also declined in most of the countries, the findings are consistent with agricultural involution in some countries, a process where intensification is not fast enough to lead to per capita increases in income.

The implication of these results, and other observations of African agriculture, is that the process of intensification over many of the countries appears to have been far less beneficial to farmers than would be implied by the B-R framework. This finding may be due in part to the poor policies and limited public agricultural development expenditures that prevailed during the 1970s and 1980s. In addition, international agricultural prices remained at historic lows up to 2006. Institutions, public investment, and private investment take time to respond, leaving hope for an accelerating response in the future.

From a research point of view, the study’s cross-section analysis goes only so far, and certainly does not involve a rigorous test of the B-R hypothesis. For that, long-running panel data and additional intensification variables would be required.

Additional Reading

This chapter draws on:


Other key references:
