



Limits to Green Revolution in rice in Africa: The case of Ghana



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ABSTRACT

The Ghana National Rice Development Strategy in 2009 was developed to double rice production by 2018 with a 10% annual increase and to reduce overreliance on imports and help achieve national food security, increased income, and reduced poverty. Data show that rice production has been increasing at 7.5% annually since 2009, but most of this (6%) comes from land area expansion, and only 1.5% comes from productivity improvements. National average rice yield remains at 2.2–2.5 ton per hectare (t/ha) compared to the potential achievable yields of 6–8 t/ha based on on-farm trials.

Employing yield response models and profitability analysis, results show various practices contribute to yield improvements in irrigated and rainfed systems in 10 regions in Ghana. Evidence also shows that extension services on rice production are limited and that intensifying these services can contribute to increases in rice yield. While some technologies can contribute to increasing yields, marginal increases in yield from these technologies in rainfed systems are not high enough to match the productivity growth achieved during the Green Revolution in Asia. Expansion of irrigated areas, coupled with market infrastructure, will be necessary to boost rice productivity and production in Ghana.

1. Introduction

Rice is playing a key role in providing food security for low-income households of rural and urban populations not just in Asia but also in Africa south of the Sahara (SSA). Due to the rapid population growth and urbanization on the continent, the consumption of rice has been increasing far more rapidly than domestic rice production, thereby necessitating an increase in the net importation of rice (Balasubramanian et al., 2007). In West Africa, for example, rice increased from the fourth most consumed cereal in 1990 to the first in 2014, followed by maize, millet, and sorghum, in the region (United States Department of Agriculture, 2015). Annual rice consumption also increased in the region very quickly by an average of 5.51% per year between 2008 and 2012 against a rate of 2.08% for the period 2000–2007 (United States Department of Agriculture, 2014). In addition, rice is a major income-generation activity for many farming households; in Ghana, for example, rice-producing households sell 70% of their total rice harvest on average (Ragasa et al., 2013).

Realizing the role of rice as food security and highly commercial crop, the Coalition for African Rice Development was launched with the aim of doubling rice production in SSA within 10 years. Several countries have subsequently developed ambitious National Rice Development Strategies and implemented important policy measures

to stimulate domestic production (Seck et al., 2013). But growth in rice production and productivity remain slow, and reliance on rice imports continues at 40% of total rice consumption to cover for the continuous rise in rice consumption (AfricaRice, 2011). This is particularly the case in Ghana, despite political attention and policies initiated, including 40% tariff and taxes on imported rice (Ragasa et al., 2014).

While substantial investments in national rice production have been made, local production is still not able to keep up with growing demand for rice in Ghana. Although local production of milled rice recently has grown by 7% annually, from 242,000 t (mt) in 2004–604,000 mt in 2014, most of this growth in production has come from area expansion (5%), with the remaining 2.0% coming from productivity improvements (Fig. 1). Despite these efforts, Ghana imported 640,000 mt of rice in 2013, representing 53% of rice consumption, and 414,000 mt in 2014, representing 40% of rice consumption.

Compared to most countries in SSA, political and economic conditions in Ghana are more favorable and stable and therefore can showcase the potential of rice sector development in Africa and whether it can lead to a rice Green Revolution. Ghana has a middle income status and is among the few countries that achieved the Millennium Development Goals (MDGs) of reducing poverty and hunger. The profitability of rice production in Ghana is quite established (Ragasa et al., 2014; Akramov and Malek, 2012; Winter-Nelson

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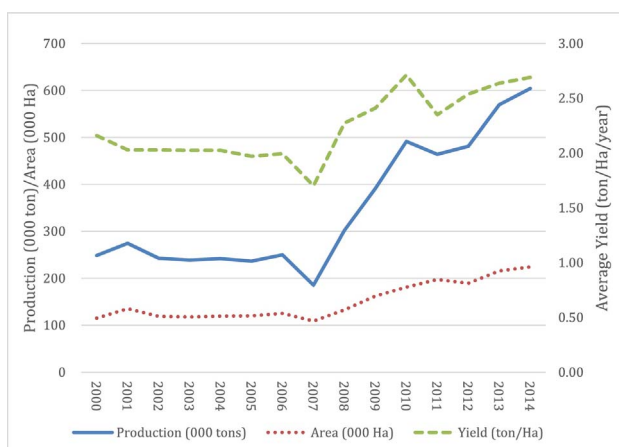


Fig. 1. Production, area cultivated, and yield of rice in Ghana, 2000–2014. Source of raw data: SRID, MoFA. Note: Ha = hectare.

and Aggrey-Fynn, 2008) in all rice systems at both private and social prices. But to further stimulate local production over in the face of concerns of about importation costs and, foreign exchange imbalances, and protection from price shocks, Ghana is among those with the highest protection on rice (up to 40% tariff and taxes).

On average, production of aromatic rice yields gross margins that are twice those of non-aromatic rice, while irrigated rice gives three times the margins of rainfed rice (Ragasa et al., 2014). Rice production in the Kpong irrigation area yields gross margins that are twice those of irrigated rice in the north and is considered to be driving a rural transformation in that part of Ghana (Takeshima et al., 2013). Rice yields in the north are systematically less than those in the south. This highlights the heterogeneity of conditions across Ghana.

Using a unique dataset covering both north and south and both irrigated and rainfed rice ecologies in Ghana, this study examines the rice sub sector in Ghana in order to gain a deeper understanding of the puzzle of high returns to technology on average at the same time as low adoption. This study looks at available technologies, including those transferred and adopted from the Asian context, to determine where and when they are productive and profitable. Unlike most studies on rice in Ghana which focus on the Northern region (see Owusu Coffie et al., 2016; deGraft-Johnson et al., 2014; Dogbe et al., 2014; Faltermeier and Abdulai, 2009; Yiridoe et al., 2006), our study covers other regions as the geographical distribution has shifted in recent years, with the Volta region (which is in the south) contributing the highest production, accounting for 31% of national rice production in 2014, surpassing the Northern region, accounting for 27%. With the Upper East region, which accounts for 18% of national production, these three regions account for more than 77% of national rice production. Production in the Northern and Upper East regions has been decreasing since 2011 due to poor weather condition, but production in Volta continued to increase and did not seem to be affected by less rain since 2011 (Ragasa et al., 2013).

We compare northern (mainly Northern and Upper East) and southern (mainly Volta) parts of Ghana and irrigated and nonirrigated rice ecologies. In addition, this paper analyzes rainfed production vis-à-vis irrigated systems and contributes to the debate about whether it is possible to have high yields without irrigation or whether irrigation is a necessary requirement for a rice Green Revolution in Africa, using the case of Ghana.

This paper also analyzes in detail the effect of fertilizer on productivity and the effect of fertilizer subsidies on rice profitability. This will help determine whether fertilizer subsidies contribute to enhancing technology adoption and change the economics of rice production.

The remainder of this paper is organized as follows. Section 2

discusses the empirical model and data. We present the results in Section 3, starting with a descriptive analysis of the extent of technology adoption and differences in rice yields, followed by the results of the production model and profitability analysis. Section 4 concludes with implications of results for policies on raising agricultural productivity in Ghana's rice system and similar rice production systems in other countries.

2. Data and methods

2.1. Production function

To examine the rice yield response to inputs and technologies (fertilizer, improved seed, and other improved technologies) in Ghana, we estimated a production function of the following form:

$$Y = f[V, F, X, Z], \quad (1)$$

where Y is the quantity and value of the crop produced per unit area; V is the vector of inputs including land characteristics, land size, seed, fertilizer, labor, and water used by the farmer on a particular plot; F is a vector of farm management practices; X is a vector of other plot or farm characteristics; and Z is the vector of farmer-, household- and village-level characteristics.

Despite some criticism regarding the quadratic or higher-order polynomial functional form (Grimm et al., 1987), we adopt this functional form because it permits 0 inputs and concavity in the yield response curves, a process that is more consistent with most biological relationships (Sheahan et al., 2013; Xu et al., 2009; Burke, 2012; Traxler and Byerlee, 1993; Kouka et al., 1995). We estimate the following model:

$$Y = \beta_0 + \beta_1 V + \beta_1' V^2 + \alpha_k F + \alpha_k' F^2 + \delta_m X + \delta_m' X^2 + \phi_n Z_n + \varepsilon, \quad (2)$$

where Y is the measure of productivity and value of production, which in our case is kilograms of rice produced and value of production per hectare; V represents the fertilizer nutrients (quantity of nitrogen from chemical fertilizer used), seed variables (including seeding rate and dummy variables for improved variety, certified and uncertified seed), land or plot size (in hectares) and a vector of land quality variables including farmers' perceptions of the soil fertility of their plots before fertilization,¹ labor (both hired and family labor in person-days used) and variables to capture rainfall availability given that the rural Ghana setting depends largely on rainfed agriculture.

The vector of F included farm management practices that are promoted in Ghana, including bunding, leveling, using a sawah system,² using a tillage method, organic fertilizer use, crop rotating, intercropping, row planting, and seed priming. Evidence in the literature suggests that yield within ecology within a country varies considerably (Saito et al., 2013) due to various types of practices including extent of irrigation, organic and mineral fertilizer use, timing of fertilizer application, timeliness of production and harvesting, weed control, and soil-fertility management including bunding and herbicide application (Becker and Johnson, 1999, 2001a,b; Haefele et al., 2000, 2001; Wopereis et al., 1999; Nhamo et al., 2014).

The vector Z included age, education and gender of household head, asset measures for the household, and measures of access to information and extension services, soil types and measures of soil quality, and other location controls. Table 1 summarizes the descriptive statistics of all the variables used in this study. Due to the small sample captured for upland rice ecology, it is excluded in the estimations. Average rice yields are twice greater in irrigated compared to lowland rainfed areas.

¹ Farmers were asked, "Before you had applied inorganic or organic fertilizer, kindly rate the inherent soil fertility of this plot [scale from 1 (not fertile) to 5 (very fertile)]."

² A technology package used in lowland areas involving bunding, puddling, and leveling to achieve better water control and nutrient management.

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