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Estimating the Impact of Transgenic *Bt* Cotton on West and Central Africa: A General Equilibrium Approach

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Summary. — West and Central Africa (WCA)'s cotton sector is experiencing rising production costs and lower yields, reversing decades of growth. Declining input use, soil fertility and inefficient chemical pest controls are contributing factors. We evaluate the potential impact of *Bt* cotton on WCA using a multiregion general equilibrium model and multicountry estimates of *Bt*-induced productivity. We find that *Bt* cotton raises growers' returns, land value and welfare. Released labor from cotton is shifted to food crops hence reducing labor shortage constraints. Overall, results indicate that potential gross benefits from *Bt* cotton are substantial for WCA cotton sector, and that the economic costs of nonadoption are equally significant.
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Key words — cotton, biotechnology, crop productivity, West Africa, applied general equilibrium

1. INTRODUCTION

The growth of the cotton sector in West and Central Africa (WCA) [1] over the last four decades is one of the few bright spots in economic development of sub-Saharan Africa. Since the 1960s, cotton production in WCA has expanded substantially, making cotton one of the drivers of regional economic growth. Over 1961–2000, WCA cotton production grew by 20-fold while yields increased by more than four-fold (Figure 1). In many WCA countries, cotton is the main engine of rural employment, affecting the economic livelihood of over two million in Burkina Faso (16% of total population), and 2.5 million in Mali (18% of total) (Table 1). For five countries (Benin, Burkina Faso, Chad, Mali and Togo) the cotton sector represents between 5% and 19% of GDP, and cotton is the most important export commodity for several countries. Currently, the WCA's share of world cotton exports stands at around 15%, second only to the United States.

Several factors, both institutional and technological, have contributed to cotton growth in WCA. First, cotton production and marketing are vertically integrated, with state enterprises typically providing input credit and technical support, and purchasing all produced cotton from farmers. Access to credit and steady prices—often higher than alternative crops—has attracted farmers to cotton. Improved technologies, such as introduction of animal traction, fertilizers and insecticides have been critical in raising yields and expanding cotton areas. In the 1970s, other pest management innovations such as the ultra-light volume (ULV) spraying, the switch to more effective pyrethroid pesticides and to higher yielding upland (or US) cotton varieties also helped expand cotton area and production (Follin & Deat, 1999).

More recently, however, the WCA cotton sector has been showing declining yields, rising costs of production and eroding profitability (Ghura, Goreux, & Masson, 2002; Tefft, Staatz, Dione, & Kelly, 1998). These factors are compounded by WCA vulnerability to world price fluctuations in response to global demand and supply shifts. Moreover, the CFA franc devaluation in 1994 and the phasing out of input subsidies have induced short-term production costs leading to an extensification of cotton

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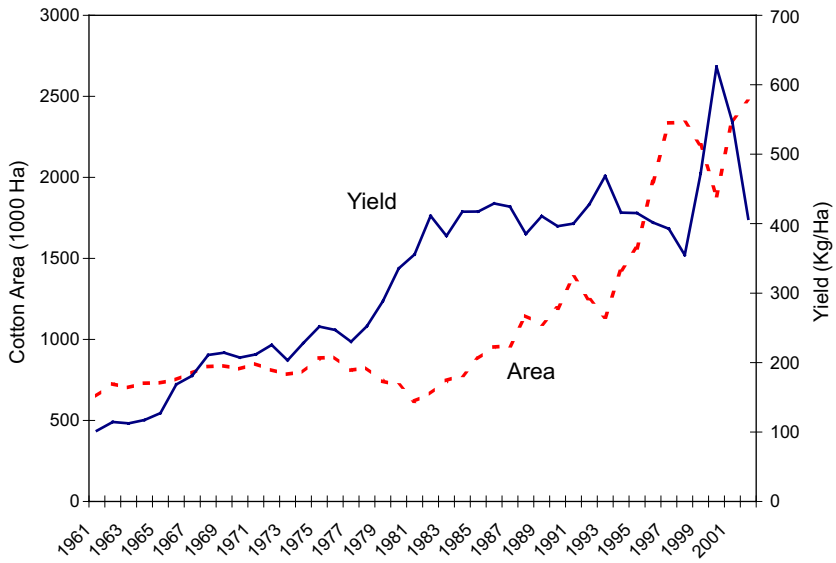

Figure 1. *Patterns of cotton area and yields for West and Central African region (Source: FAOSTAT, 2003).*

Table 1. *Importance of the cotton sector to West and Central African economies (1999)*

	Number of cotton farms (×1,000)	Cotton-dependent rural population (million)	Cotton share of total GDP (percent)	Cotton share of total export value (percent)	Ratio of cotton exports to food imports (% value)
Benin	NA	NA	8.8	44	88
Burkina Fas	250	2.0	6.9	58	99.5
Chad	400	NA	5.1	46	143.8
Mali	160	2.5	5	41	160.9
Togo	200	NA	4.9	19	169.6
Côte d'Ivoire	150	1.0	1.7	5	45.3
Cameroon	250	1.5	1.3	4	78.2
Central African republic	NA	NA	1.3	7	62.5

Sources: FAOSTAT (2003); *Coton et Developpement* (1999); NA: not available.

production with few input use. These changes have revealed the underlying weaknesses of the sector, and drawn attention to the need for longer-term productivity gains.

The emphasis on efficiency-boosting cost reduction requires a re-examination of chemical-based pest management at the core of the cotton production system in WCA, and the source of much of past yield gains (Follin & Deat, 1999). In recent years, however, yields have been falling even while pesticide use continues to increase (Ajayi *et al.*, 2002) revealing both short-term inefficiencies and long-term unsustainability. The increasing incidences of pest resistance to pyrethroids, particularly cotton bollworm (*Helicoverpa armigera*) are contributing to the declining effectiveness of pesticides (Martin, Chandre, Ochu, Vaissayre, & Fournier, 2002). Alternative approaches to calendar-based spray schedules, such as threshold applications or integrated pest management (IPM) methods are being tested in some WCA countries but the success is relatively slow (Ochut, Mattewest, & Mumford, 1998; Silvie, Deguine, Nibouche, Michel, & Vaissayre, 2001). Low levels of literacy, farmers' aversion to risk, and high requirements for insect scouting are all contributing factors.

Heavy reliance on insecticides is characteristic of most cotton production systems in the