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Markets for Cotton By-Products

Global Trends and Implications for African Cotton Producers

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Abstract

This paper analyzes and compares the structure of cotton by-products industries in selected countries (Uganda, Tanzania, Benin, and Burkina Faso) in the context of the global vegetable oil market. It reaches several conclusions. First, because the markets for various edible oils are highly integrated with each other, examination of each oil market should be done in conjunction with all other (relevant) edible oil markets. Second, the recent surge in demand for commodities used as feedstocks for biofuels is unlikely to become a new source of growth for the cotton oil market. Third, within the context of deepening the on-going reform efforts in West and Central African countries, cotton by-products should be taken into consideration, both in terms of the cotton price setting mechanism and the size of the organization of the cotton by-products industry. Fourth, trade policies including export bans or import tariffs to protect the domestic crushing industries, and policies that favor crude over refined oils, should be rationalized. Fifth, large cottonseed processing operations using advanced technology, while efficient from a technological perspective, tend not to be economically profitable in the African context. Last, research efforts for new cotton varieties should consider the value of by-products, not just lint.

This paper—a joint product of the Development Prospects Group and the Africa Region—is part of a larger effort to gain a deeper understanding of the contribution of cotton by-products to the welfare of cotton growers in the context of the recent commodity price boom. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org.
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Markets for Cotton By-Products: Global Trends and Implications for African Cotton Producers

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Acronyms and Abbreviations

ADF	Augmented Dickey-Fuller test for unit roots
AICB	*Association Interprofessionnelle du Coton du Burkina*
APHB	*Association des Producteurs d'huile des Hauts-Bassins*
CFAf	*Communauté Financière Africaine Franc* (US$ = 472 CFAf in 2009)
CFDT	*Compagnie Française pour le Développement des Fibres Textiles*)
CPPOD	*Coopérative des Producteurs de Produits Oléagineux et Divers*
DAGRIS	*Société du Développement Agricole du Sud*
ESA	Eastern and Southern Africa
GHH	*Groupement des Huiliers du Houet*
GTPOB	*Groupement des Transformateurs des Produits Oléagineux du Burkina*
IBCG	*Industrie Beninoise des Corps Gras*
ICA-GIE	*Industries Cotonnières Associées-Groupement d'Intérêt Économique*
jc	20-liter vegetable oil container (equivalent to 18 kgs)
LCB	*Le Label Coton du Bénin*
NCPA	National Cottonseed Products Association (of the US)
SN-CITEC	*Société Nouvelle Huilerie et Savonnerie Citec*
SNHB	*Société Nationale des Huileries du Burkina*
SOCOMA	*Société Cotonniére du Gurma*
SODECO	*Société de Développement du Coton*
SOFIB	*Société Industrielle Barro et Frères*
SOFITEX	*Société Burkinabé des Fibres et Textiles*
SONAPRA	*Société Nationale pour la Production Agricole*
SONICOG	*Société Nationale des Industries des Corps Gras*
SSA	Sub-Saharan Africa
TZ shs	Tanzanian shillings (US$ = 1,320 TZ shs in 2009)
UEMOA	*Union Economique et Monétaire Ouest-Africaine*
UG shs	Ugandan shillings (US$ = 2,030 UG shs in 2009)
WCA	West and Central Africa
WTO	World Trade Organization
VAT	Value added tax

Contents

Markets for Cotton By-Products: Global Trends and Implications for African Cotton Producers

The recent commodity boom, and especially the price increases for edible oils combined with the relatively stagnant prices for cotton, has reawakened interest in the potential of cotton by-products as a complementary source of revenue for cotton growers. Cotton oil, like other edible oils, has received particular attention in this regard because of its potential use as a feedstock for biofuels. The expansion of world demand for biofuels, including edible-oil-based biodiesel, has raised hopes that the development of biofuel industry might transform the African edible oil industry and the prospects for African cotton producers.

A key conclusion of a recent multi-country cotton study by the World Bank (Tschirley, Poulton, and Labaste 2009) is that cotton by-products in general have a growing market and are potentially an important complementary source of revenue for cotton growers. The same study also concludes that the markets for cotton by-products in Sub-Saharan Africa are not well developed and have considerable scope for improvement, especially in the context of the prices received by farmers (Gergely and Poulton 2009). On the other hand, cotton by-products are an area that has not received much attention.[1]

To assess more thoroughly the prospects of cotton by-products industries in Sub-Saharan African countries, this paper analyzes the global market for cotton oil in the context of the global vegetable oil market and demand for biofuel feedstock, and then compares the structure and recent behavior of cotton by-products industries in four African countries—Uganda, Tanzania, Benin, and Burkina Faso. The paper also looks briefly at the United States, not only because its much longer-established industry provides a useful benchmark, but also because of the nature of cotton ownership. Because cotton in most countries (including SSA) is primarily a smallholder crop, seed cotton is typically bought by traders or ginning companies at the farm level, and thus the ownership of cotton is transferred. In the United States (as well as some other cotton producing countries such as Australia and to a lesser extend Brazil), cotton growers retain ownership of the crop after ginning. Further, because many cotton producing countries (notably several in West and Central Africa and Central Asia) have few ginning companies, the markets for by-products are characterized by oligopolistic

[1] In a study undertaken at about the same time as the present study, Kelly and others (2010) examine at the cotton by-products sectors in Benin, Burkina Faso, Chad, and Mali. That study's key objectives are to describe the evolution, organization, and performance of the by-products industries as well as their institutional, political, and technological constraints.

and oligopsonistic arrangements, making the pricing of cotton by-products less transparent.

This paper uses the analytical framework developed in the World Bank's multi-country cotton study. It finds that though the SSA countries are unlikely to be able to produce biodiesel profitably from cotton oil at foreseeable levels of global energy prices, both cotton oil and meal production should feature explicitly in these countries' cotton sector policymaking. These by-products have increased their contribution to the total value of cotton and seem likely to maintain their enhanced value. The paper also finds that large cottonseed processing operations using advanced technology, while efficient from a technological perspective, tend not to be economically profitable in the SSA context. Smaller, less technologically efficient, labor-intensive operations perhaps constitute the future of the industry in SSA.

The paper is structured as follows. Section 1 examines the value and uses of cotton by-products, and recent trends in their contribution, versus that of lint, to the total value of cotton. Section 2 looks at the cotton oil market in the context of the global vegetable oil market, while Section 3 discusses issues regarding the use of cotton oil as a biofuel feedstock. Section 4 summarizes experience with the use of cotton by-products in the five countries. Section 5 offers policy conclusions and recommendations with the goal of enhancing the contribution of cotton by-products to the welfare of African cotton growers.

1. The Value and Uses of Cotton By-Products

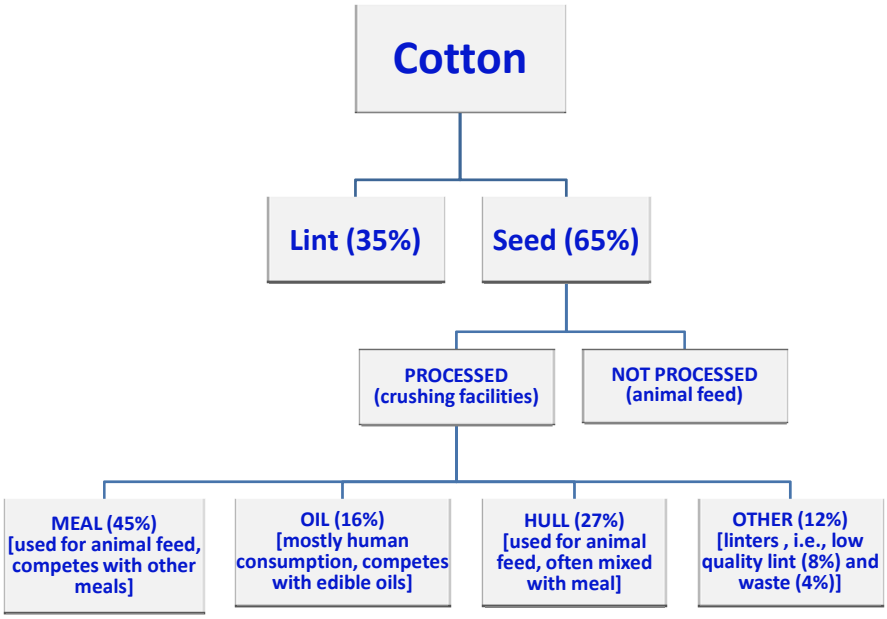
Though cotton is often taken to be synonymous with cotton lint, the farm product, seed cotton, also contains the by-product cottonseed.[2] Of lesser value than lint, cottonseed is typically crushed to separate oil from meal. Cotton oil, which competes with other vegetable oils, is typically used for human consumption and sometimes for soap manufacturing and other industrial uses such as plastics and pharmaceuticals. Cotton meal, which competes with other meals, is typically used as animal feed, while hulls or husks (the outer part of the seed) are either used to generate energy for the processing facility or are blended with meal for animal feed; less often hulls and husks are used as fertilizer. Linters—which are

[2] For the rest of this paper, seed cotton will refer to the farm product. Cottonseed and lint are the two co-products emerging from the ginning process and, depending on the context, output can be measured in terms of tons of lint or tons of cottonseed. Lint goes to textile manufacturing while cottonseed is crushed to produce cotton oil and cotton meal. To make the discussion easier, in this paper meal will refer to both meal and cake even though the two are different.

low-quality lint left over from the ginning process—are used in various manufacturing products, including yarn, plastics, and filling material (see ICAC 2000 for a detailed description of uses of cotton by-products.) Sometimes cottonseed is used unprocessed, directly for animal feed, especially in the dairy industry. This paper will discuss the two key by-products: oil and meal.

Though the composition of seed cotton by weight depends on numerous factors, typically one ton of seed cotton yields between 35 percent and 40 percent lint, about 10 percent cotton oil, and about 30 percent cotton meal.[3] The relative proportions partly depend on the ginning outturn ratio, which ranges between 30 percent and 40 percent of the weight of seed cotton, and the cotton oil extraction ratio, which ranges between 10 percent and 16 percent of the weight of cottonseed depending on the method of crushing (Blasi and Drouillard 2002). Figure 1 shows the current composition of the US cotton industry.

Figure 1
Weight Composition of Cotton and Potential By-Products



Source: *National Cottonseed Products Association* and author's estimates

[3] On average one metric ton of seed cotton in the US generates about 350 kgs of lint and 104 kgs of cotton oil. Of the remaining 546 kgs, meal accounts for more than half (293 kgs); hulls and linters account for 176 kgs and 52 kgs, respectively; and 26 kgs is waste. However, in WCA, one ton of cotton generates about 420 kgs of lint (because of the higher ginning out-turn ratio) and 70 kgs of cotton oil (when less technologically advanced methods of oil extraction are used).

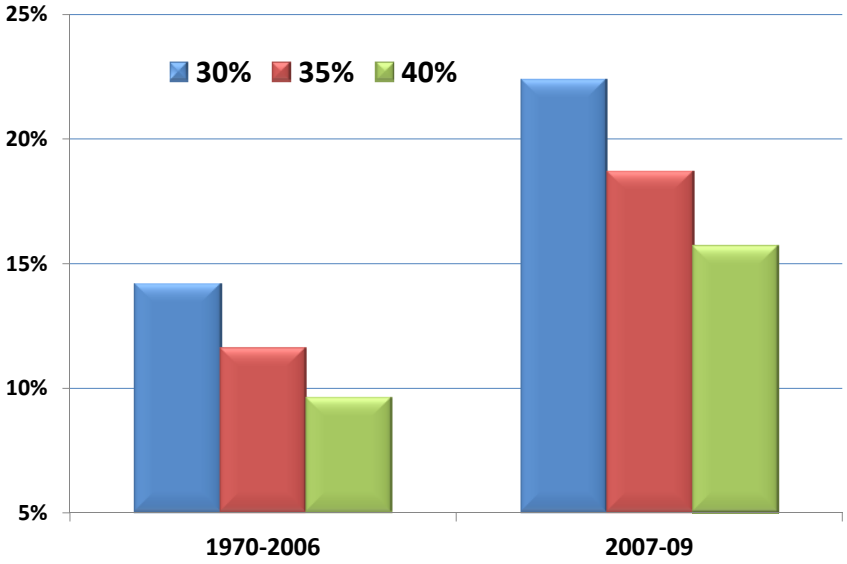
Cottonseed has a low oil content relative to most other oilseeds, partly because cotton research efforts have sought to maximize the quality and quantity of lint, rather than the oil or meal content. For example, ICAC (2000, p. 7) noted that "Unfortunately, not even a single variety on the basis of higher oil percentage has been released in any country in the world." But there are signs that a shift in research priorities may be taking place. For example, Auld and others (2006) have argued that two simple genetic modifications in cotton varieties could enhance the oil proportion by as much as 20 percent, implying that the oil content could increase from the current share of 16 percent to 19 percent. And Beltrão and Barbosa (2007) report that current research in Brazil is likely to generate new cotton varieties that will double the oil content without reducing the quality and quantity characteristics of lint.

The value of cotton by-products varies according to prices and market conditions, including the structure of the local cotton industry, the location of cotton production, demand by the dairy industry, the availability of competing oilseeds and meals, and the ginning and seed-crushing technologies employed. In the US, for example, with its large cattle industry, more than half of cottonseed is used unprocessed as animal feed. In most SSA countries, cottonseed is now typically processed with most of the resulting oil going for human consumption and the meal for animal feed. But until the mid-1980s, cottonseed in most West and Central African (WCA) cotton producing countries went to waste with no value attached.

Looking ahead, the outlook for the value of cotton by-products relative to lint depends heavily on expected trends in relative prices. Figure 2 depicts the contribution of cottonseed to the total value of cotton, based on three assumptions about the ginning ratio (40 percent, 35 percent, and 30 percent) and two scenarios of lint and seed prices. It shows that at the average prices of 1970-2006, the contribution of seed ranged from 9.6 percent to 14.2 percent, corresponding to the high and low ginning ratios. But at the lint and meal prices that prevailed in 2007-09, during the commodity price boom, the contribution of seed was larger, increasing to 15.7 percent and 22.4 percent, respectively (for details see data reported in Appendix E).

During 2000-08 the ratio of the lint to the cotton oil price was well below the long-term average, and in 2007 and 2008 it reached record low values (thus, in these latest two years, cotton oil was at its most expensive, compared to lint) (Figure 3).

Figure 2
Seed's Contribution to the Total Value of Cotton (percent)



Note: The percentages, 30%, 35%, 40% refer to ginning ratios and refer to differences in cotton varieties and ginning efficiency rather than cleanliness of harvested cotton
Source: Author's calculations.

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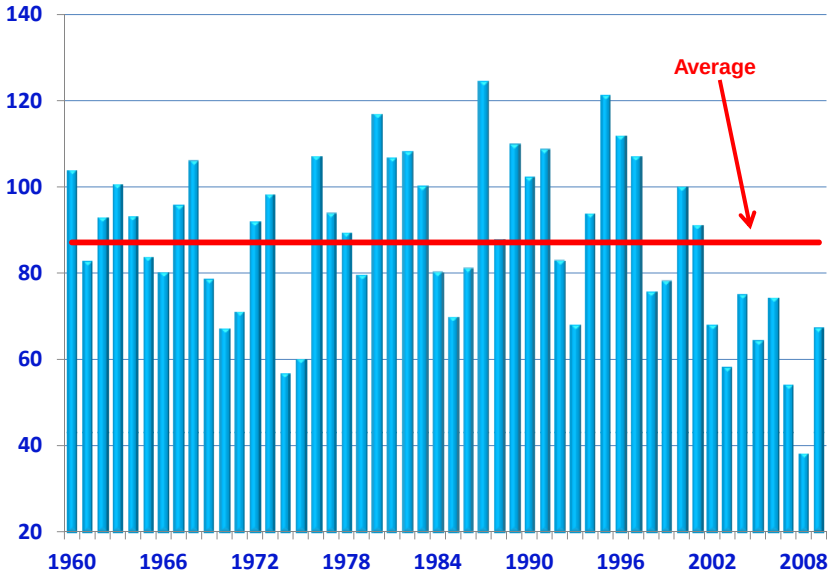
Figure 3
Lint to Oil Price Ratio (2000=100)

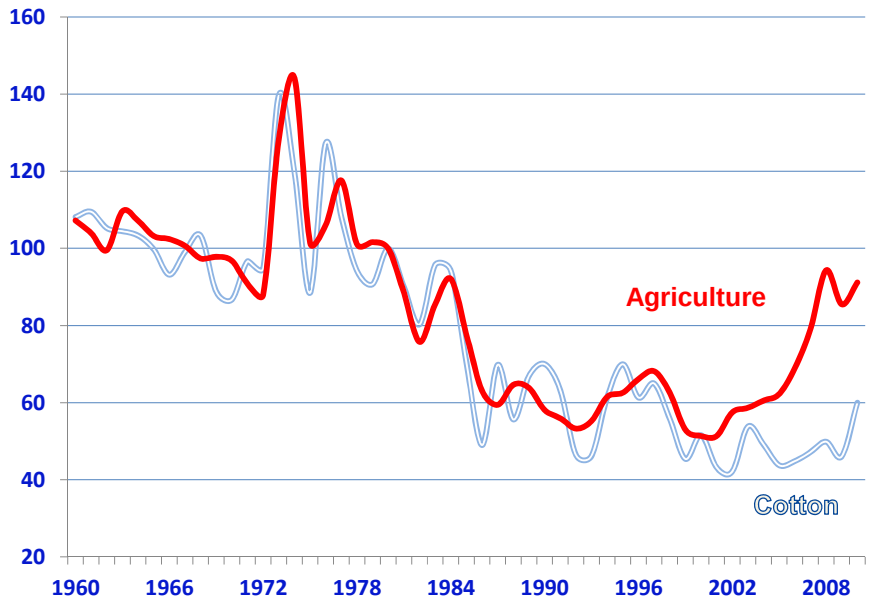


Source: World Bank

3

The chief reason behind the large increase in the relative value of cotton by-products during the commodity boom is that while the prices of by-products went up, like those of most other agricultural commodities, the price of cotton (lint) did not increase much. The divergence between the price of cotton and those of other agricultural commodities began in the early 2000s (Figure 4). Between 2000 and 2008, the World Bank index of nominal food prices increased by 147 percent but cotton prices increased by only 21 percent (from US$1.30 to 1.57 per kg).

Figure 4
Agricultural Price Index and Cotton Prices (Real, MUV-deflated, 1980=100)



Source: World Bank

There are three reasons why cotton prices did not join the commodity boom. First, cotton receives more subsidies than other commodities, encouraging more production than would have taken place without the support. Second, the boom in food prices was partly aided by growth in demand for biofuel production. The direct impact of biofuel demand is felt only by maize, sugarcane, and some edible oils, but the indirect impact is felt by almost all food crops, because of the strong substitutability both on the input side (mainly shifting of land from one crop to another) and on the output side (especially in edible oils, some of which are highly substitutable). In cotton, however, the indirect impact is very limited: cotton is not a substitute for any other commodity on the output side,

and its input substitutability is limited. The third, and perhaps most important, reason is the rapid and massive expansion of cotton production that took place in China and India, as a direct consequence of these countries' adoption of biotech cotton. During the five-year period 2002-07, China increased its cotton output by 56 percent (from 5.2 to 8.1 million tons) while India increased its output by 126 percent (from 2.3 to 5.2 million tons). Today, China and India account for more than half of global cotton production, mostly from biotech varieties.

Econometric evidence confirms that lint prices have diverged from cotton by-product prices, as proxied by the agricultural commodity price index. The degree of co-movement between cotton prices and the agricultural commodity price index was analyzed with the following ordinary least squares regression, using annual data from 1960 to 2009:

$$log(P_t^{COTTON}) = \mu + \beta_1 log(P_t^{AG\_INDEX}) + \beta_2 log(MUV_t) + \beta_3 t + \varepsilon_t. \qquad [1]$$

P_t^{COTTON} and $P_t^{AG\_INDEX}$ denote the price of cotton and the agricultural commodity price index in year t (expressed in nominal dollar terms), MUV_t denotes the deflator, t is the time trend, and ε_t denotes the error term; μ, β_1, β_2, and β_3 are parameters to be estimated. The model is expressed in logarithms to facilitate interpreting the estimated parameters as elasticities. The estimate of β_1 is expected to be positive while β_2 and β_3 can take any sign depending on the relative impact of technological progress and inflation on the particular commodity sector. Notice that while the price of cotton is part of the agricultural commodity price index, its contribution is only 3.9 percent, thus not driving the results.[4]

The parameter estimates of [1] are reported in the top row of Table 1. Specifically, the estimate of β_1 is 0.61 and highly significant with an adjusted-R^2 of 0.91 and an ADF statistic of -6.03, implying a very strong long-run co-movement between cotton prices and the agricultural commodity price index. The inflation coefficient, β_2, is highly significant as well. The time trend is highly significant and negative, with a relatively large estimate, implying that cotton prices have been declining faster than the agricultural price index, even after accounting for inflation.

[4] An alternative specification would have been to deflate both P_t^{COTTON} and $P_t^{AG\_INDEX}$ by MUV_t, which would effectively restrict the sum of the price and inflation coefficients to unity (i.e. $\beta_1 + \beta_2 = 1$). The advantage of having the inflation as a separate explanatory variable is that the homogeneity restriction is relaxed and a direct estimate of the effect of inflation can be obtained (Houthakker 1975).

Table 1
Co-movement between Cotton and Agricultural Commodity Prices

μ	*D1*	*D2*	β_1	$\beta_{11}D1$	$\beta_{12}D2$	β_2	$100*\beta_3$	*Adj-R²*	*ADF*
-0.23			0.61***			0.67***	-2.29***	0.91	-6.03***
(0.87)			(6.68)			(6.33)	(7.45)		
	-0.15	2.80***		0.85***	0.23	0.33**	-1.30***	0.93	-7.16***
	(0.57)	(2.73)		(7.53)	(1.30)	(2.16)	(2.69)		

Source: Author's estimates based on World Bank price data.

Notes: μ, β_1, β_2, and β_3 are the estimates of the constant term and the coefficients of the price, inflation, and time trend, respectively. The numbers in parentheses denote absolute *t-values* while asterisks denote parameter estimates significant at 10 percent (*), 5 percent (**), and 1 percent (***) levels, respectively. ADF is the Augmented Dickey-Fuller (Dickey and Fuller 1979) statistic for unit root and corresponds to the MacKinnon one-sided *p-value*. The lag length of the corresponding ADF equations was determined by minimizing the Schwarz-loss function.

To examine whether a structural change has taken place in the relationship between the two price series, relationship [1] was modified by adding two dummy variables (D_1 and D_2), taking the value of one during 1960-2003 and zero otherwise. D_1 and D_2 are applied to both the constant term and β_1. Hence, the equation to be estimated becomes:

$$log(P_t^{COTTON}) = D_1 + D_2 + \beta_{11}D_1*log(P_t^{AG\_INDEX}) + \beta_{12}D_2*log(P_t^{AG\_INDEX}) + \beta_2 log(MUV_t) + \beta_3 t + \varepsilon_t, \qquad [2]$$

If a structural break in the relationship between the price of lint and the agricultural commodity price index exists, then β_{11} would differ from β_{12}. Results reported in the second row of Table 1 show that, indeed, the parameter estimate of β_{11} is 0.85 and highly significant [*t-value* = 7.53] while that of β_{12} is 0.23 [*t-value* = 1.30], not significant even at the 10 percent level. Furthermore, the other statistics show that model [2] outperforms model [1] (e.g., adjusted-R^2 = 0.93 and ADF = -7.16).Thus, the econometric evidence shows that while there was a strong relationship between the price of cotton lint and the agricultural commodity price index up to 2003 that relationship effectively disappeared during 2004-09.

For the purposes of the current study, then, a key question is whether the two price series are likely to reconverge—that is, whether cotton by-products will continue to be as profitable, vis a vis cotton lint, as they have recently become. Part of the answer will be dictated by the factors depressing the price of cotton, discussed above, none of which appears to be reversible in the short term. It also depends on the prospects for cotton oil, and in particular, for cotton oil as a feedstock for biofuels. These are discussed in what follows.

2. Cotton Oil in the Context of the Global Edible Oil Market

Ranked by oil content, cotton seeds are the lowest among key oilseeds after corn (Figure 5). Ranked by its yield per unit of land, cotton oil averages 325 liters per hectare, twice as much as corn. Other edible oils have much higher yields, however, the highest being palm with 6,000 liters of oil per hectare (Figure 6).

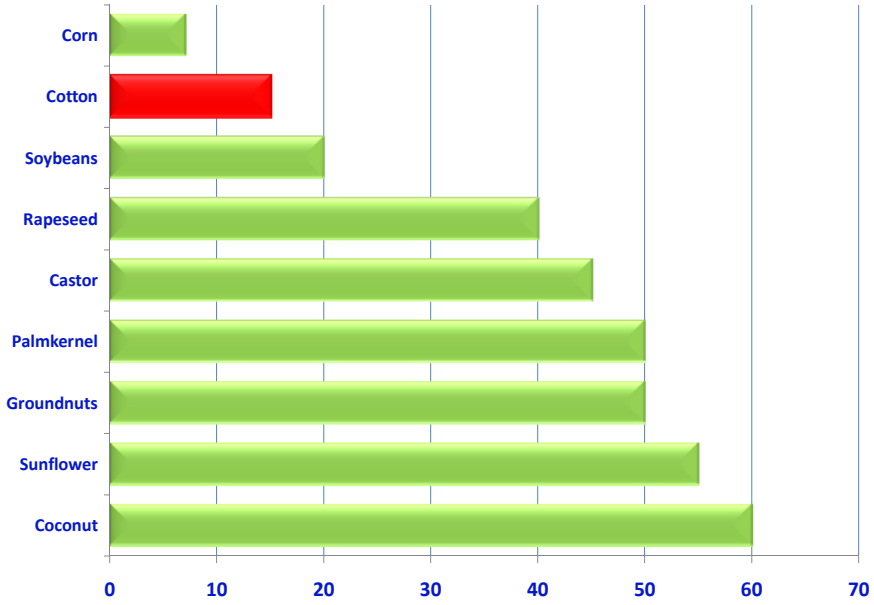
The global production of cotton oil is small compared to that of other internationally traded edible oils, accounting for only 3.3 percent of total fats and oils supplies, and the global cotton oil market is very thin, with only 3 percent of global production traded internationally. During 2006-08, global production of the major 17 fats and oils averaged 147 million tons. Two vegetable oils, palm and soybean, dominated the market, accounting for 50 percent and 70 percent of global output and exports, respectively (Table 2). Cotton oil production averaged a little more than 5 million tons during the same period.

Cotton oil is traded at about the same price level per ton as sunflower and corn oil, and a little higher than palm and soybean oil (Figure 7). Because cotton oil is a close substitute for other edible oils, its price depends on, and reflects, the availability and trade policies of such oils. Cotton oil prices move in concert with the edible oil index (Figure 8).[5] Between the mid-1980s and the early 2000s, they averaged US$600 per ton in nominal terms. They increased by 270 percent between January 2007 and July 2008, but declined sharply afterwards. During the first quarter of 2010 they averaged about US$700 per ton.

Historically, prices of cotton and other edible oils have followed the same path as those of other agricultural commodities. They were fairly stable before the first oil shock, doubled during the oil shock, and then declined until the mid-1980s. They entered a period of relative stability until 2005, then increased as part of the overall commodity boom. The World Bank's index of nominal prices of edible oils reached 340 (2000=100) in July 2008 but then declined sharply to about 225 during the first quarter of 2010. Even so, it remains more than double the 2000 level.

[5] Substitutability among edible oils comes from the consumption side, as various oils can be used for the same purpose. Substitutability among grains, by contrast, comes mostly from the production side, where inputs, especially land, can be shifted from one crop to another.

Figure 5
Average Oil Content of Key Oilseeds (percent of seed dry weight)



Source: Author's calculations from various sources

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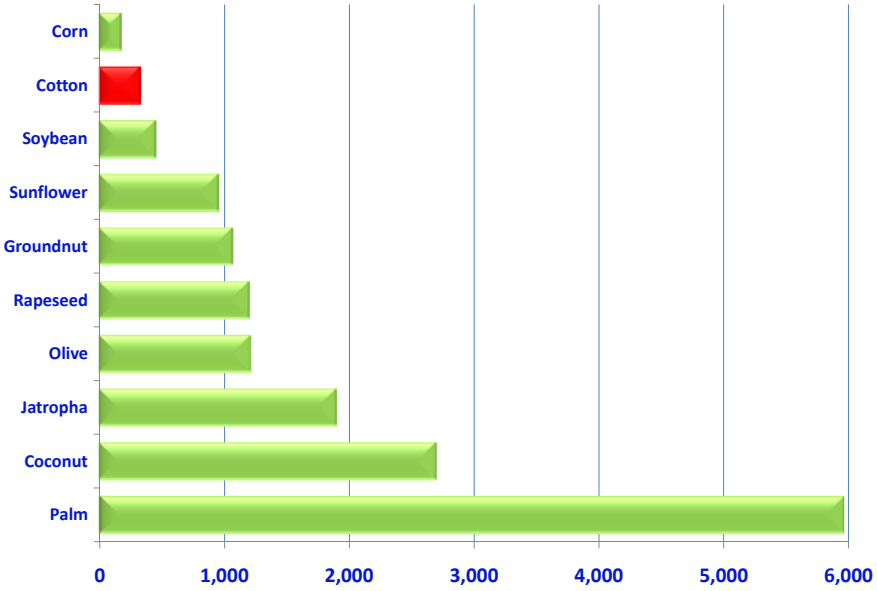
Figure 6
Average Oil Yield of Key Oilseeds (liters of oil per hectare)



Source: Author's calculations from various sources

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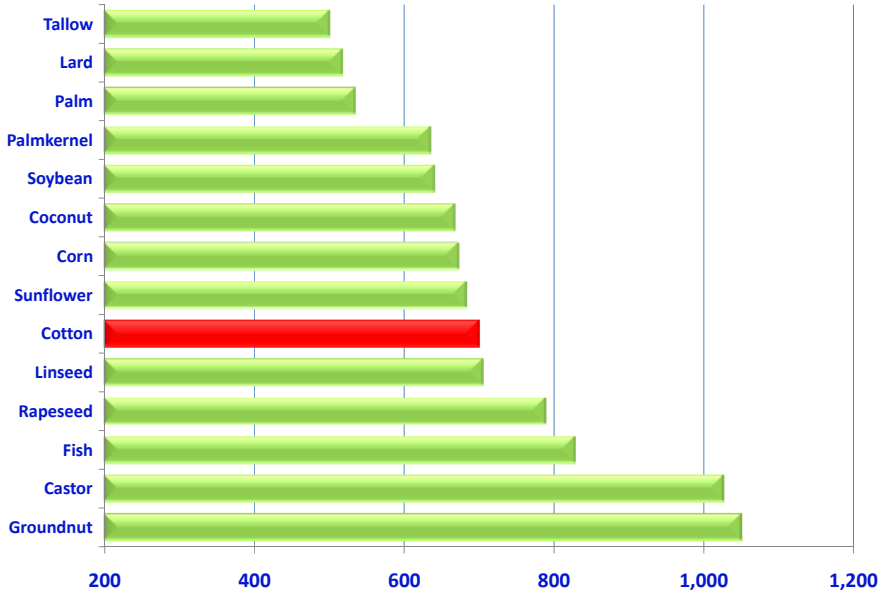
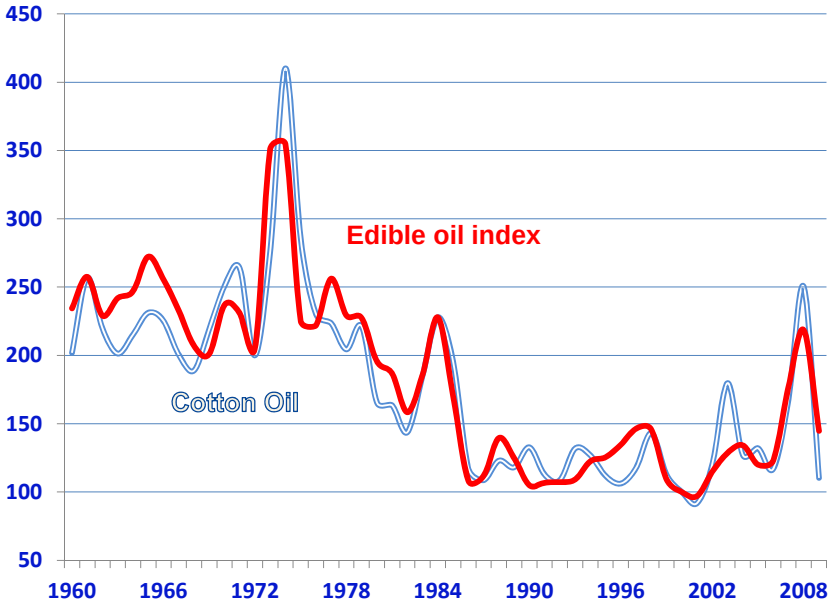
Figure 7
Prices of Major Edible Oils (nominal, US$/ton, 2005/07 average)



Source: *Oil World*, Hamburg [7]

Figure 8
Cotton Oil Prices and the Edible Oil Price Index (Real, MUV-deflated, 2000=100)



Source: World Bank [8]

Table 2
Global Balance of the 17 Major Fats and Oils, 2005/06-2007/08 Average

	Production (000 tons)	*Exports (000 tons)*	*Stocks (000 tons)*	*Traded Share (percent)*	*Production Share (percent)*
Palm	38,657	30,232	6,177	78.2	25.3
Soybean	36,371	10,727	3,926	29.5	23.8
Rapeseed	18,676	2,085	1,256	11.2	12.2
Sunflower	10,764	4,151	990	38.6	7.0
Tallow	8,515	2,244	502	26.4	5.6
Lard	7,672	120	438	1.6	5.0
Butter	6,882	728	639	10.6	4.5
Cotton	5,003	154	364	3.1	3.3
Palm kernel	4,516	2,523	562	55.9	3.0
Groundnut	4,360	190	306	4.4	2.9
Coconut	3,141	2,030	375	64.7	2.1
Olive	2,851	741	937	26.0	1.9
Corn	2,311	795	227	34.4	1.5
Fish	1,043	727	157	69.7	0.7
Sesame	834	34	46	4.1	0.5
Linseed	682	108	78	15.9	0.4
Castor	543	335	59	61.7	0.4
TOTAL	**152,821**	**57,928**	**17,039**	**37.9**	**100.0**

Source: *Oil World*, Hamburg.

Notes: Traded share is global trade as a percentage of global production. Production share is the contribution of each type of oil to global production of all 17 fats and oils. Lard (from pig fat), tallow (from beef fat), and butter (a dairy product) are classified as fats and the remainder as oils.

An econometric model similar to [1] was used to analyze the degree of co-movement between the prices of various edible oils and grains. Specifically,

$$log(P_t^i) = \mu + \beta_1 log(P_t^j) + \beta_2 log(MUV_t) + \beta_3 t + \varepsilon_t. \qquad [3]$$

P_t^j and P_t^j denote the prices of interest while the other parameters and variable are defined as before. The results, reported in Table 3, show a high degree of co-movement between the prices of three vegetable oils (cotton, soy, and palm) and the edible oil index (upper panel) as well as among the prices of the three oils (second panel). For example, all cross-price effects are significant at the one percent level and very close to unity while the adjusted-R^2s averaged 0.93. These estimates indicate a high degree of substitutability among the various edible oils,

reconfirming the strength of the relationship between the cotton oil price and the edible oil price index.

Table 3
Co-movement among Commodity Prices

	μ	β_1	β_2	$100*\beta_3$	$Adj\text{-}R^2$	*ADF*
I. COTTON OIL-OIL INDEX						
Cotton Oil – Oil Index	1.68***	0.88***	0.11	-0.01	0.90	-5.25***
	(5.06)	(10.36)	(1.05)	(0.11)		
Soy Oil – Oil Index	1.30***	1.14***	-0.17**	0.40	0.95	-7.54***
	(5.60)	(19.21)	(2.24)	(1.61)		
Palm oil – Oil Index	0.99***	1.17***	-0.12	-0.11	0.94	-4.83***
	(3.82)	(17.85)	(1.51)	(0.40)		
II. OILS						
Cotton Oil – Palm Oil	1.24***	0.66***	0.27**	-0.03	0.88	-4.67***
	(3.03)	(8.64)	(2.37)	(0.07)		
Cotton oil – Soy Oil	0.64**	0.78**	0.23**	-0.35	0.93	-5.40***
	(2.11)	(14.04)	(2.97)	(1.23)		
Soy Oil – Palm Oil	0.59**	0.90***	0.01	0.46*	0.94	-4.30***
	(2.12)	(17.35)	(0.07)	(1.64)		
III. GRAINS – PALM OIL						
Maize – Palm Oil	0.03	0.54***	0.37***	0.04	0.87	-5.58***
	(0.08)	(6.93)	(3.23)	(0.10)		
Wheat – Palm Oil	0.04	0.55***	0.29***	-0.04	0.87	-4.87***
	(0.12)	(8.32)	(2.99)	(0.41)		
Rice – Palm Oil	0.37	0.66***	0.31*	-0.63	0.69	-5.28***
	(0.60)	(5.67)	(1.83)	(1.01)		
IV. GRAINS						
Maize-Wheat	0.31	0.86***	0.04	-0.26	0.95	-4.82***
	(1.54)	(14.91)	(0.50)	(1.10)		
Rice - Maize	0.53	1.08***	0.04	-0.52	0.77	-5.80***
	(1.06)	(7.69)	(0.23)	(0.97)		
Rice - Wheat	0.62	1.07***	-0.20	-0.74	0.80	-4.25***
	(1.34)	(8.52)	(0.14)	(1.45)		

Source: Author's estimates based on World Bank price data.

Notes: μ, β_1, β_2, and β_3 are the estimates of the constant term and the coefficients of the price, inflation, and time trend, respectively as specified in model [3]. For other notes see Table 1.

Such substitutability is not restricted to the edible oil market; it extends to other commodity markets as well. For example, the co-movement between oils and grains is high as well as evidenced by the high adjusted-R^2s and ADF statistics for the regressions between wheat and maize with palm oil (panel III). Similarly, the co-movement among grains is high (panel IV). Such findings imply that policy actions or other factors affecting one vegetable oil or grain market will eventually affect most other grain and oilseed markets.

3. Issues in the Use of Cotton Oil for Biofuels

Given the growth of world demand for biofuels—which now consume an estimated 9 percent of global vegetable oil production—vegetable oils including cotton oil have often been mentioned as a possible new source of income for commodity producers in Sub-Saharan Africa.

Opinions differ about the virtue of using food commodities to produce biofuels: the practice is viewed as a problem by some (consumers of food commodities who pay higher prices) and as an opportunity by others (commodity producers who receive higher prices, as well as the biofuel industry). Of the three key sources of biofuels, sugarcane-based ethanol, produced mainly in Brazil, is the most profitable. Maize-based ethanol, produced mainly in the US, ranks second. Edible oil-based biodiesel, produced mainly in the EU, ranks third. The consensus is that, with the exception of sugar cane-based ethanol, production of biofuels would not have been profitable were it not for the various policies and mandates in force.

Demand for biofuels can affect the cotton oil market through three channels. First, it may directly increase demand for cotton oil as a biofuel feedstock. Second, it may increase demand for competing oils, and so indirectly raise the demand for cotton oil. Third, it may increase the demand for other commodities and thereby, through the reallocation of resources, affect the cotton oil market as well. To analyze the effect of biofuels on the cotton oil market thus requires a look at each of these three channels.

First, the country studies summarized later in this paper find that biofuel production in SSA countries, based on either cotton oil or other sources, is unlikely to be profitable at currently foreseeable energy prices, at least within the next decade. Most of the African cotton-oil producers surveyed believed that they could not profitably produce biodiesel from cotton oil unless it were heavily subsidized. Mitchell (2010) concluded that even sugarcane-based ethanol may not be profitable in SSA without incentives (although such technology is profita-

ble in Brazil) because of high production costs due to poor infrastructure, high operating costs, and the requirement to irrigate.

Second, the strong co-movement among edible oil prices, demonstrated in Section 2 above, implies that policy changes in one edible oil market will affect the other markets as well. For example, policies that mandate the use of rapeseed oil for the production of biofuels in the EU, or soybean oil use in the US, will not only drive up the demand and prices of these two oils (annual crops produced mainly in Europe and North and South America, respectively) but will also induce proportional changes in the demand and price of palm oil (a perennial crop produced mainly in Southeast Asia) and thus an expansion of palm oil production. The implication is that, whether biofuel mandates are applied to one or another edible oil market, the effect will eventually be diffused among *all* edible oil markets, including that for cotton oil.[6]

Third, the effect of biofuel production on commodity markets more broadly, and especially on commodity prices, is complex and the estimates from various models differ considerably (Box 1).

The issue is complicated by the fact that energy prices affect agricultural commodity prices through the cost structure, since agriculture is an energy-intensive activity. Thus, the recent increase in energy prices had a large impact on agricultural commodity prices even irrespective of biofuels. Table 4 reports transmission elasticities from energy prices to the edible oil index, using the model [3]. When the sample covers the 1960-2005 period (first row), before the recent price boom, the estimated transmission elasticity is 0.23, implying that a 10 percent increase in energy prices is associated with a 2.3 percent increase in the prices of edible oils. But when the sample period is extended to 2009 to include the recent price boom (second row), the elasticity rises to 0.31. It is tempting to attribute such an increase to biofuels, since edible oils are one of the three key biofuel feedstocks (the other two being maize and sugarcane), but similar increases in fact took place in all commodity sub-indices, including metals, fertilizers, and precious metals. For example, as shown in Figure 9, transmission elasticity estimates increased for all six main non-energy commodity price indices. (Baffes (2007 and 2010) discusses this issue in detail along with the evidence.)

[6] Hence, policies favoring biofuel production in the name of environmental benefits may in fact lead to less desirable outcomes. From a global perspective, the environmental benefits from switching from fossil fuel use to, say, rapeseed-based biodiesel in Europe or soybean oil-based biodiesel in the US may be less than the environmental costs of expanding palm oil production in East Asia.

Box 1: The Effect of Biofuels on Commodity Prices—Summarizing the Literature

The contribution of biofuels to the recent price boom, and especially the price spike of 2007/08, has been hotly debated, with the estimates ranging from a high to a negligible impact. Mitchell (2009) argues that biofuel production from grains and oilseeds in the US and the EU was the most important factor behind the food price increase between 2002 and 2008 — accounting, perhaps, for as much as two thirds of the price increase. Rosegrant (2008) concludes that biofuel growth during 2000-07 accounted for 30 percent of the food price increases seen in that period, with the contribution varying from 39 percent for maize to 21 percent for rice. FAO (2008) concludes that if biofuel production remains at 2007 levels in 2018 (as opposed to doubling), grain prices would be 12 percent lower, wheat prices 7 percent lower, and vegetable oil prices 15 percent lower. Similarly, OECD (2008) concludes that if biofuel support policies were abolished, vegetable oil price would be 16 percent lower, while prices of feed grains and wheat would be 7 and 5 percent lower, respectively.

Banse and others (2008) compared the impact of the EU's current mandate to a no-mandate scenario and a mandate under which the US, Japan, and Brazil adopt targets for biofuel consumption. They estimate that by 2020, under the no-mandate scenario, cereal and oilseed prices will have decreased by 12 and 7 percent, respectively. By contrast, under the "global" scenario, oilseed prices will have risen by 19 percent and cereal prices by about 5 percent. The European Commission's own assessment of the long-term (2020) impacts of the 10 percent target for biofuels predicts that prices of cereals will increase by 3 to 6 percent by 2020, with larger impacts on prices of oilseeds, particularly sunflower (+15 percent). Taheripour and others (2008), simulating the biofuel economy during 2001-06, estimate the impact of biofuels on coarse grain prices in the US, EU, and Brazil at 14 percent, 16 percent, and 9.6 percent, respectively.

A joint US Department of Agriculture and Department of Energy assessment (USDA/USDE 2008) concludes that the recent increase in maize and soybean prices appears to have little to do with the run-up in prices of wheat and rice. It finds that if the amounts of corn used for ethanol and soybean oil used for biodiesel in the US had remained unchanged at their 2005/06 levels, prices in 2007/2008 would have been 15 percent lower for maize, 17.5 percent for soybean, and 13 percent for soybean oil. Lastly, Gilbert (2009) finds little direct evidence that demand for grains and oilseeds as biofuel feedstocks was a key cause of the price spike.

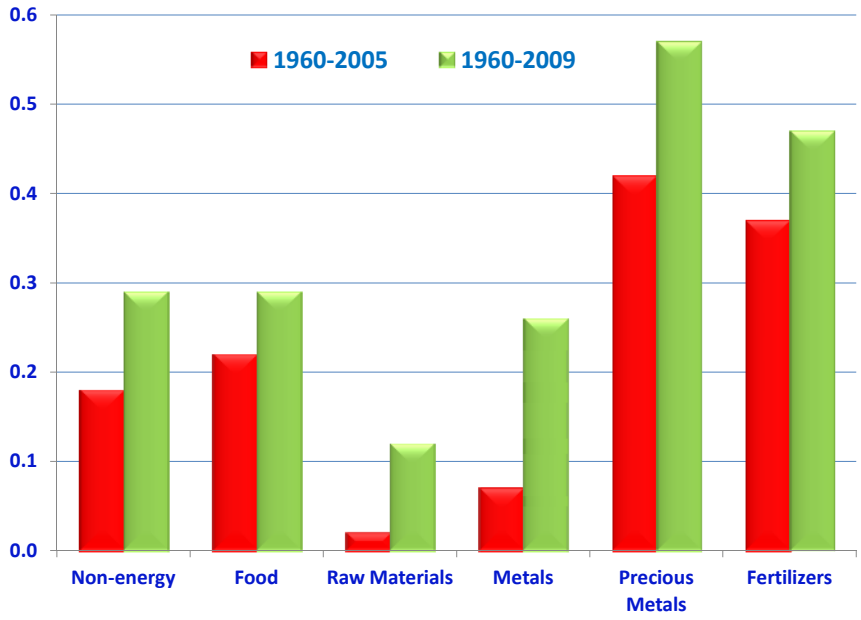
At some level, energy prices may provide a floor to agricultural prices. To explore this question one must consider not only the prices of the respective commodities (energy and feedstock for biofuels), but also numerous other elements including subsidies, mandates, trade restrictions, and sunk costs.

Table 4
The Energy/Edible Oil Price Link

	μ	β_1	β_2	$100*\beta_3$	$Adj\text{-}R^2$	ADF
1960-2005	2.75**	0.23***	0.34*	-1.37**	0.77	-2.86*
	(4.83)	(3.55)	(1.66)	(2.39)		
1960-2009	3.52**	0.31***	0.05	-0.57	0.77	-2.79*
	(6.92)	(5.00)	(0.27)	(1.14)		

Source: Author's estimates based on World Bank price data.
Notes: The model structure is the same as in equation (3), where P_t^i denotes the non-energy price index and P_t^j denotes the energy price index. For other notes see Tables 1 and 3.

Figure 9
Price Transmission Elasticities from Energy and Non-Energy Commodities (estimates based on model (3))



Source: Author's estimates based on World Bank price data

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4. The Cotton By-Products Industry in Sub-Saharan Africa

To gain a better understanding of the structure and issues of the cotton by-products industries in SSA, the experience of four countries was analyzed: Uganda and Tanzania in Eastern and Southern Africa (ESA); and Benin and Bur-

kina Faso in West and Central Africa (WCA).[7] Details on the historical and recent developments of the cotton by-products industries of the four countries can be found in Appendices A through D. The analysis was supplemented by a brief discussion of the by-products industry in the United States (Appendix E) and a short survey (see Appendix F).

Table 5 provides a summary comparison of the industries in the African countries. **Uganda** is a small cotton producer, averaging about 25,000 tons of lint annually (very little compared to the global production of 25 million tons of lint), almost all of which is exported. It has five privately-owned cottonseed processing companies, of which four are independent and one is associated with a ginning operation. Uganda has 50 ginneries each processing small volumes—which explains why most of the crushing facilities are independent entities. While Uganda's cotton production is spread around the country, all the seed-processing facilities are in or close to Kampala, the key oil consuming area.

Tanzania's cotton sector is much larger than Uganda's, producing about 100,000 tons of lint annually. It consists of 20 privately owned cottonseed processing companies, all but one of which are attached to ginneries. (Tanzania has 73 ginneries.) Almost all Tanzania's cotton production and all its processing facilities are located in the Mwanza region. Most of the country's cotton oil output is consumed in this region, though limited quantities go to Dar es Salaam.

All cottonseed in Uganda and Tanzania is processed, with most of the oil going for human consumption and the meal for animal use. Neither Uganda nor Tanzania exports cotton oil, and both are net importers of edible oil. In both countries there are established markets in the sense that cotton seeds, oil, and meal are all tradable commodities. The survey evidence shows that seed and oil prices move in concert within each country, indicating that the marketing structure functions well. Cotton oil prices spiked during the 2008 boom and declined in 2009 following the decline of world edible oil prices.

Cotton is a key cash crop in both Benin and Burkina Faso. **Benin's** cotton lint production averaged 114,000 tons during the past three seasons. **Burkina Faso** is SSA's largest cotton producer; its output of cotton lint averaged more than 200,000 tons during the past three seasons and reached almost 300,000 tons in 2006/07. Both countries have undertaken many policy reforms in the cotton sector during the past decade, including privatizing the former parastatal that handled all ginning and marketing. In both countries, cotton prices are set in a pan-seasonal and pan-territorial manner.

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[7] The cotton sectors of these four SSA countries are also analyzed in the multi-country cotton study (Tschirley, Poulton, and Labaste 2009).

Table 5
Characteristics of Cottonseed Processing Industries in Four SSA Countries

	Tanzania and Uganda	*Benin and Burkina Faso*
Organization of the industry	Competitive structure on seed and the products.	Oligopoly/oligopsony in Benin. Oligopoly and mix of oligopsony and competitive structure in Burkina Faso.
Ownership	All privately owned. Some are independent entities while others are associated with ginneries.	Privately owned but cotton companies have stake in the large companies. All are independent entities.
Size of operations	Daily processing capacity averages 80 tons and labor force averages 100 (both permanent and temporary workers).	Average daily capacity of large operations is 500 tons with labor force of 365. Burkina Faso's smaller operations have daily capacity of 35 tons and labor force of 45.
Input pricing	Seed prices are market determined and depend mostly on the size of the cotton crop.	Negotiated prices between the ginning and the seed processing companies.
Output pricing	Oil and meal prices are market determined, with considerable intra-year and cross-company variability.	Oil and meal prices are market determined, with considerable intra-year and cross-company variability.
Interest rates for operating capital	Relatively high in Uganda (average 21 percent), much lower in Tanzania (average 13 percent).	Average 13 percent for Burkina Faso's smaller operations; less than 10 percent for the large ones in both Benin and Burkina Faso.
Electricity supply	Frequent disruptions, cited as one of the industry's key problems.	Only minor complaints. Not an issue for the industry.
Trade policies	A 25 percent import duty on refined oils is imposed while crude oils enter duty-free.	Benin imposed a short-lived export ban in 2001. Currently, it applies 45 percent import duty on palm oil and 18 percent VAT on domestic sales.
Views on trade policies	While most (not all) owners or managers favored trade policy restrictions on imported edible oils, they do not feel very strongly about them.	Managers and owners favored trade restriction including import duties on edible oils and restrictions on seed exports.
Views on biofuels	Expressed strong doubts about the use of cotton oil for biofuel unless subsidies are involved.	Most owners and managers expressed doubts regarding cotton oil's potential for biofuel. Burkina Faso's largest company runs a pilot biofuel facility.
Information availability	Information was obtained easily from managers and was, for the most part, precise.	Difficult to convince managers to share information. Even when information was shared, it was not precise.

Source: Appendices A, B, C, and D.

The cotton by-product industries in Benin and Burkina Faso share a number of structural similarities and, to a great extent, reflect the structure and history of the cotton sector in WCA more broadly. Seed processing in WCA began only in the late 1980s. In fact, cottonseed was not considered a valuable by-product up until the early 1980s. On some occasions seeds would be exported to Europe for processing or to be used by the dairy industry; on other occasions they would go to waste (in fact, ginneries invested in transport equipment to remove cottonseed from their premises.) **Burkina Faso** has two types of cotton-oil producing company: three dominant seed processing companies (only one of which functions at present) and a large number of small firms scattered throughout the country, with a high concentration in Bobo Dioulasso, the country's largest cotton producing area. The official count of the smaller companies is 59; because the industry is still at its early stages, there is considerable entry and exit, and not all operations are registered with the respective associations. Most of Burkina's small cottonseed processing companies began operation during the mid-2000s when the cotton sector experienced a large expansion. **Benin's** industry is highly concentrated with only three seed processing companies, two of which are functioning currently (unconfirmed reports indicate that only one company processed cotton seeds during 2009/10). In both countries the seed processing companies buy cottonseed at a fixed price, but meal and oil prices move according to demand and supply conditions, as in Uganda and Tanzania.

The cottonseed processing facilities of Uganda, Tanzania, and Burkina Faso's small companies use traditional expeller pressing technology rather than the more technologically advanced solvent-based approach; they currently extract about 60 percent of the oil content of the cottonseed they process, instead of the 95-96 percent made possible by the solvent-based technology. By contrast, Benin's companies and Burkina Faso's large company use solvent-based technology. The survey respondents in Uganda and Tanzania felt that on a cost-benefit basis, introducing the more advanced technology is unlikely to increase their profitability, because of: (i) the high cost of installing and operating the advanced machinery, (ii) not having enough cottonseed to utilize the machinery at full capacity, and (iii) the higher labor intensity of the older technology than the new—an important advantage in countries with relatively low wage rates. Two of Burkina Faso's large processing companies that used the solvent-based technology have gone out of business. Consumers are not judged willing to pay the higher prices for the better oil that the advanced machinery would produce.

In all four SSA countries, the possibility of producing biodiesel either from cotton oil or other feedstocks has been frequently discussed at the government level but not much has taken place on the ground. Only one facility in Burkina

Faso has experimented with producing biodiesel from cotton oil. The operators and managers of the cottonseed processing companies in the four countries take the view that producing biodiesel from cotton oil would not be profitable unless it were heavily subsidized. Further, because their companies face enough domestic demand for edible oils (all countries are net importers of edible oils) they see no need to diversify their operations.

In Uganda and Tanzania, all imports of refined oils are subject to a 25 percent duty, while edible oils imported in crude form enter duty free. Most industry representatives argued that while most oil in fact enters in refined form, it is declared as crude to escape the import duty. Benin introduced a short-lived seed export ban in 2001 that was never strictly enforced and a 45 percent import duty on palm oil (the key competing product to cotton oil). Yet in Benin, as in ESA, traders report that in most cases import duties are not collected on edible oils. Some of the owners and managers who were interviewed favored stricter protection of Benin's edible oil industry while others did not. The views in favor of import restrictions were stronger in WCA than in ESA.

Several other issues were identified during the interviews. Overcapacity was cited as a problem in all four countries. Electricity disruptions were cited as a key constraint in Tanzania and Uganda but not in Benin or Burkina Faso. High interest rates for operating capital were an issue in Uganda only. Attracting labor (either skilled or unskilled), was not an issue.

While the surveys undertaken in the four SSA countries allow us to have a deeper understanding of the structure of the cotton by-products industries, they do not offer enough quantitative detail for a full statistical assessment of the contribution of cotton by-products to the value of cotton. Furthermore, the data are not directly comparable for a number of reasons. For example, as mentioned earlier, the ginning costs in the US are paid by the cotton growers who retain the ownership of both lint and by-products. On the contrary, SSA cotton growers sell their seed cotton to ginners or traders, hence the ginning costs are accounted by ginneries. Furthermore, while there are reliable estimates of ginning costs in WCA, no such estimates exist for ESA. Nevertheless, the following conclusions can be drawn:

- In West Africa unlike in the US, the value of cotton by-products is small compared to the costs of ginning. In 1999/2006, the revenue from cottonseed covered only 23 percent of ginning costs in Benin and 28 percent in Burkina Faso. For comparison, consider that the value of byproducts in the US is expected to cover the ginning costs. This implies that not only cottonseed is valued much less in WCA than in the US but also that ginning costs are much higher in WCA than in the US.

- In both Benin and Burkina Faso, the contribution of cottonseed to the total value of cotton doubled during 2007/08 compared to earlier years. This is consistent with the large increase that took place in the US, from 11.6 percent in 1970-2006 to 18.7 percent in 1999/2006, as well as the trend that took place in the global markets.
- In Burkina Faso after 2003/04, consistent with the entry of smaller companies and hence more intense competition, the contribution of cottonseed to the value of cotton increased. No such increase took place in Benin. Since 2007/08, the contribution of cottonseed to the value of cotton has been higher in Burkina Faso, at 19 percent, than in Benin, at 13 percent. Furthermore, the contribution doubled after 2007/08 in both countries, consistent with the increase in global markets.
- There have been considerable differences in the input/output price ratios among the countries examined. During 2007/08 and 2008/09, the ratio of the price of cottonseed to the price of seed cotton received by growers (in lint equivalent, properly adjusted by the respective ginning outturn ratios) was highest in Uganda (39 percent), followed by Tanzania (28 percent), Burkina Faso (25 percent), and Benin (17 percent). The ratio in the US is 19 percent. Although such ratios may not be directly comparable because the prices have been subjected to various distortions (at least in WCA and the US) and because ginning costs have been excluded from the calculation in the US, one may conclude that by-products are valued more in lint-price terms in ESA than in WCA and the US.

5. Conclusions and Policy Implications

This paper has examined the cotton by-products industries of four SSA cotton producing countries—Benin, Burkina Faso, Tanzania, and Uganda—in the context of global market trends and the apparent divergence between lint prices and the prices of other agricultural commodities, including cotton by-products. The paper reaches several methodological and policy-related conclusions.

Most edible oil markets, including that for cotton oil, are highly integrated with each other. Although the market for cotton oil is very thin, with only 3.3 percent of global production traded internationally, the fact the most edible oils are close substitutes for each other implies that examination of the market for any one edible oil should take into consideration all the (relevant) edible oils. Thus, policies targeting one edible oil market will inevitably affect all edible oil markets.

Industry representatives in the four SSA countries all said that they face a large demand for cotton oil for human consumption and see no potential for using cotton oil for biofuel production. Furthermore, biofuel production is unlikely to be profitable in SSA under current energy and non-energy prices unless mandates and subsidies are involved. Therefore, the only channel through which biofuels can increase profitability to African cotton growers is through their effect on commodity prices.

Efforts to deepen the reforms in the cotton industries of WCA should consider cotton by-products as well as lint. To the extent that price-setting mechanisms are a result of negotiations between cotton producers and ginning companies, the value of by-products should play a key role in the calculation of price. Moreover, any policy actions regarding the future of the industry should cover the by-products industry as well.

The size and nature of the industries in the countries studied here show that large operations using advanced technology, while efficient from a technological perspective, tend not to be economically profitable in the SSA context. Smaller, less technologically efficient, labor-intensive operations perhaps constitute the future of the industry. Wherever applicable, policies should facilitate the transition towards this model. It should also be ensured that small processors of oil for human consumption adhere to certain health standards.

Because cotton oil competes with imported edible oils, there have been calls for imposing trade restrictions on such oils in African countries. Policy measures including prohibiting exports and imposing high import tariffs are common, but they go against the rules agreed within regional trade arrangements and may conflict with the interest of consumers. It is imperative that policymakers reconsider these measures. Current trade policies that favor the import of crude oils over refined oils should also be reconsidered: while the idea behind such policies is to encourage domestic value addition (and, perhaps, generation of tax revenue), industry representatives believe that almost all the imported oil recorded as crude actually enters in refined form. Therefore, import duties should be uniform and small enough to give the importers an incentive to pay rather than avoid the tax.

Because lint contributes most of the value of cotton, research on new cotton varieties has traditionally focused on maximizing the quantity and quality of lint. Now that cotton by-products are becoming increasingly important in value terms, research into new cotton varieties should focus on the properties and contribution of cottonseed as well. Researchers see potential for substantially raising the oil content of cotton without jeopardizing the existing quantity and quality of lint.

References

Ahohounkpanzon, M., and M. Y. Zakariallou (2010). "Étude sur les Mécanismes de Fixation du Prix du Coton Graine et la Prise en Compte des Co-produits du Coton au Bénin." Report prepared for the Department of Agricultural Economics, Michigan State University, and the West African Cotton Improvement Program.

Anderson, Kym, and Ernesto Valenzuela (2007). "The World Trade Organization's Doha Cotton Initiative: A Tale of Two Issues," *The World Economy* 30: 1281-1304.

Argüello, Priscilla B. (2008). "Cottonseed: Derived Demand and Price Analysis." Master's Thesis, Department of Agricultural and Applied Economics, Texas Tech University.

Auld, Dick, Efrem Bechere, Jim Davis, Lindy Seip, and Jack Brown (2006). "Lint, Cottonseed Oil, or Biodiesel?—Breeding Cotton for the Next Decade." Paper presented at the ASA-CSSA-SSSA International Meetings. November 12-16.

Baffes, John (2010). "More on the Energy/Non-Energy Commodity Price Link," *Applied Economics Letters*, DOI: 10.1080/13504850903120683.

_____ (2009). "The 'Full' Potential of Uganda's Cotton Industry," *Development Policy Review* 27: 67-85.

_____ (2007). "Cotton Developments in West Africa: Domestic and Trade Policy Issues and the WTO." In J. Morrison and A. Sarris, eds., *WTO Rules for Agriculture Compatible with Development*. Rome: Food and Agriculture Organization of the United Nations.

_____ (2007). "Oil Spills on Other Commodities," *Resources Policy* 32: 126-134.

_____ (2005). "The Cotton 'Problem'," *World Bank Research Observer* 20: 109-144.

_____ (2004). "Tanzania's Cotton Sector: Reforms, Constraints, and Challenges," *Development Policy Review* 22: 75-96.

Beltrão, Napoleao E. M., and Sebastiao Barbosa (2007). "The Development of Bio-Fuels in Brazil: Implications for Cottonseed." Paper presented at the World Cotton Research Conference, Lubbock, Texas, US. September 10-14.

Banse, M., H. van Meijl, and G. Woltjer (2008). "The Impact of First and Second Generation Biofuels on Global Agricultural Production, Trade, and Land Use." GTAP Conference Paper, June 2008. https://www.gtap.agecon.purdue.edu/ resources/download/3693.pdf

Bayoulou, J. (2010). "La Prise en Compte des Co-produits du Coton dans le Mécanisme de Fixation du Prix de Coton Graine au Burkina Faso." Report

prepared for the Department of Agricultural Economics, Michigan State University, and the West African Cotton Improvement Program.

Blasi, Dale A., and Jim Drouillard (2002). "Composition and Feeding Value of Cottonseed Feed Products for Beef Cattle." Kansas State University, Agricultural Experiment Station and Cooperative Extension Service.

Dickey, David, and Wayne A. Fuller (1979). "Distribution of the Estimators for Time Series Regressions with Unit Roots," *Journal of the American Statistical Association* 74: 427-431.

Falck-Zepeda, Jose, Daniela Horna, and Melinda Smale (2007). "The Economic Impact and the Distribution of Benefits and Risks from the Adoption of Insect Resistant (*Bt*) Cotton in West Africa." *Discussion Paper No. 718*. Washington, DC: International Food Policy Research Institute,.

Food and Agriculture Organization (FAO) (2008). *The State of Food and Agriculture—Biofuels: Prospects, Risks, and Opportunities.* Rome: FAO.

_____ (2004). *The State of Food and Agriculture—Agricultural Biotechnology: Meeting the Needs of the Poor?* Rome: FAO.

Gergely, Nicolas (2009). "The Cotton Sector of Benin." *Africa Region Working Paper Series No. 125.* Washington, DC: World Bank.

Gergely, Nicolas, and Colin Poulton (2009). "Valorization of Cotton By-Products." In D. Tschirley, C. Poulton, and P. Labaste, eds., *Organization and Performance of Cotton Sectors in Africa: Learning from Reform Experience*. Washington, DC: World Bank.

Gilbert, Christopher (2009). "How to Understand High Food Prices." CIFREM and Department of Economics, University of Trento, Italy.

Hinkle, Lawrence E., and Peter J. Montiel (1999). *Exchange Rate Misalignment; Concepts and Measurements for Developing Countries.* Oxford: Oxford University Press for the World Bank.

Houthakker, Hendrik S. (1975). "Comments and Discussion on 'The 1972-75 Commodity Boom' by Richard N. Cooper and Robert Z. Lawrence," *Brookings Papers on Economic Activity* 3: 718-720.

Jarvis, Michael (2009). "Faire Tache d'Huile: Cooking Oil Fortification in West Africa." Case Study prepared for *Business Innovation to Combat Malnutrition*. World Bank Institute. Washington, DC: World Bank.

International Cotton Advisory Committee (ICAC) (2010). "Gossypol in Cotton Seed," *ICAC Recorder*, XXVIII: 3-8.

_____ (2000). "The Cotton Seed," *ICAC Recorder*, XVII: 3-8.

Kelly, Valerie, Sonja Perakis, Boubacar Diallo, and Niama Nango Dembéle

(2010). "Cottonseed, Oil, and Cake: Co-Products or By-products in the C-4 Cotton Sectors?" Department of Agricultural Economics, Michigan State University.

Martin, Steve D. (1990). "Gossypol Effects in Animal Feeding Can Be Controlled." Originally published in *Feedstuffs*, vol. 62. Reprinted by the National Cottonseed Products Association. http://www.cottonseed.com

Mitchell, Donald (2010). *Biofuels in Africa: Prospects for Sustainable Development.* Draft report. Washington, DC: World Bank.

_____ (2009). "A Note on Rising Food Prices." *Policy Research Working Paper 4682*. Washington, DC: World Bank.

Nixon, H. C. (1930). "The Rise of the American Cottonseed Oil Industry," *Journal of Political Economy* 38: 73-85.

Organization for Economic Cooperation and Development (2008). *Economic Assessment of Biofuel Support Policies.* Directorate for Trade and Agriculture. Paris: OECD. http://www.oecd.org/dataoecd/19/62/41007840.pdf

Poulton, Colin, and Wilbald Maro (2009). "The Cotton Sector of Tanzania." *Africa Region Working Paper Series No. 127*. Washington, DC: World Bank.

Rosegrant, Mark (2008). "Biofuels and Grain Prices." Washington, DC: International Food Policy Research Institute. http://beta.irri.org/solutions/images/publications/papers/ifpri_biofuels_grain_prices.pdf

Subramanian, Arjunan, and Matin Qaim (2010). "The Impact of *Bt* Cotton on Poor Households in Rural India," *Journal of Development Studies* 46: 295-311.

Sumner, Daniel A. (2006). "Reducing Cotton Subsidies: The DDA Cotton Initiative." In Kym Anderson and Will Martin, eds., *Agricultural Trade Reform and the Doha Development Agenda*. Washington, DC: World Bank.

Taheripour, F., D. K. Birur, T. W. Hertel, and W. E. Tyner (2008). "Biofuels and Their By-products: Global Economic and Environmental Implications." GTAP Conference paper, Helsinki, June.

Tripp, Robert (2009). *Biotechnology and Agricultural Development: Transgenic Cotton, Rural Institutions, and Resource-Poor Farmers*. New York: Routledge, Taylor, and Francis Group.

Tschirley, David, Colin Poulton, and Patrick Labaste (2009). *Organization and Performance of Cotton Sectors in Africa: Learning from Reform Experience*. Washington, DC: World Bank.

US Agency for International Development (USAID) (2006). *Adding Value to West African Cotton: Assessment of the Cotton Textile Apparel Value Chain*. Technical Report No 21. Accra: USAID, West Africa Trade Hub.

US Department of Energy/Department of Transportation (2008). "Impact of Biofuels on Food and Gasoline Prices." Washington, DC.

Vasilaky, Kathryn (2009). "Cotton Byproducts in Uganda and Tanzania." Report prepared for the World Bank. June.

Zanfongnon, Noureni (2009). "Study of Market for Cotton By-Products in Benin and Burkina Faso." Report prepared for the World Bank. August.

APPENDIX A: UGANDA[8]

Introduced in the early 20th century, cotton was Uganda's most important cash crop for several decades. Output reached 60,000 tons of lint during the early 1930s and was sustained at this level for almost four decades, with an annual value of about US$300 million in today's terms. The success of cotton in Uganda pre-1970 partly reflects the fact that this was a forced-labor crop. Output fell drastically as the result of the political and economic turmoil of the 1970s; in just four years it dropped from 78,000 tons of lint to 14,000 tons (1972-76), and reached a record low of 2,000 tons in 1987.

Uganda's policy reform program, begun in the late 1980s, addressed both macro and sectoral issues, including in agriculture. Reforms introduced in the cotton sector in 1993, coupled with the high cotton prices of the mid-1990s, evoked a considerable supply response, with cotton production reaching 20,000 tons in two years. A well-functioning research program was put in place. Growers began receiving prompt payments and entrepreneurial activity increased enormously, following the entry of many private entities at all levels of primary processing, marketing, and trade.

Despite these achievements, however, cotton output in 2005-09 averaged only about 25,000 tons of lint. In a recent review of Uganda's cotton sector post-reform, Baffes (2009) conjectures that the fundamental issue is low profitability. This partly reflects low productivity—especially in areas with productive soils, cotton has been displaced by higher priced food crops—and partly the fact that cotton is a new crop for many of its producers, who have limited knowledge of its growing requirements.

The history of cotton by-products in Uganda mirrors that of cotton. Before the reforms of the early 1990s, all cotton seed processing facilities were owned and operated by the cooperative unions or the Cotton Board. After the reforms, all cotton seed processing facilities were privatized, as were the ginning operations. Currently, Uganda has five privately-owned cotton seeds processing companies, of which four are independent and one is associated with a ginning operation. It has 50 ginneries each handling very small volumes—which explains why the crushing facilities are independent entities. The ginning overcapacity reflects the large size of the sector during the 1950s and 1960s.

Demand has determined the location of the cotton seeds processing industry. While Uganda's cotton production is spread around the country, all five cottonseed processing companies are located in or near Kampala, the key oil con-

[8] Most of the information in this Appendix is based on Vasilaky (2009).

suming area, implying that the seed has to be transported there for crushing.

Of the five cottonseed crushing companies in Uganda, four were visited for this study in May 2009.[9] Statistics related to their key characteristics are reported in Table A1.

Table A1
Summary Statistics of Uganda's Cotton By-Products Industry (Four Companies)

	I	*II*	*III*	*IV*
I. Nature of operation				
Permanent employees	4	4	100	4
Temporary employees	21	25	100	26
Capacity (tons/day)	10	50	200	18
Year operation began	1993	1998	2000	2005
Type of operation	Free standing	Free standing	Free standing	Part of a ginnery
II. Crushings (tons of seed)				
2007	1,100	—	10,000	2,900
2008	1,600	2,800	5,000	3,600
2009	2,500	5,000	10,000	4,800
III. Prices paid for cotton seeds (UG shs per kg)				
2007	400	220	200	420
2008	480	475	450	465
2009	225	410	300	325
IV. Prices received from cotton oil (000 UG shs per 20-liter container)				
2007	37	35	37	55
2008	62	58	54	65
2009	60	58	51	58
V. Cotton meal sold (tons)				
2008	800	1,400	500	1,800
2009	—	—	350	2,400

Notes: '—' implies not reported.
Source: Vasilaky (2009).

Three of the companies employ about 30 workers on average (both temporary and permanent) while the fourth employs 200. The daily crushing capacity ranges from 10 to 200 tons of seed. Three facilities can crush other seeds (mainly

[9] The four companies interviewed were: Busunju Oil Millers (Wakiso District); MM Holdings (Nakasero District); Agro Nile Industries Ltd. (Jinja District); and Agencies Ltd. Cotton Ginneries, Oil Millers, Importers, Exporters (Iganga District).

sunflower) in addition to cotton. All the facilities use expeller pressing technology rather than the more efficient but much more costly solvent-based approach for extracting oil. Most of the expelling machinery, like most of Uganda's ginning equipment, is imported from Indian companies.

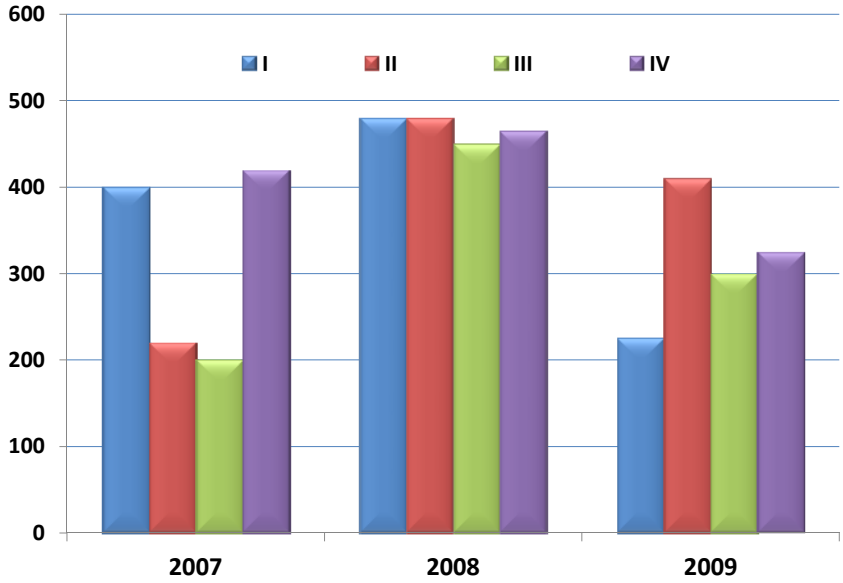
The wage rate of unskilled workers ranges from 3,000 to 4,000 UG shs/day (depending on whether other benefits are provided), which at an exchange rate of 2,000 UG shs/US$ implies earnings of US$1.50 - 2.00 per day. Financing for operating the factories is obtained from local banks at interest rates ranging from 19 - 24 percent, which are considered very high by the owners of the operations. Almost all buying and selling is on a cash basis. On the few occasions when cotton oil is sold on credit, the transactions reflect personal long-term relationships rather than formal credit arrangements.

Prices paid by the companies for cottonseed varied widely during 2007, from 200 to 400 UG shs per kg. The following year, however, when world edible oil prices reached their peak, all four companies paid between 450 and 480 UG shs per kg for the seed. With the decline of world prices in 2009, the price paid for seed declined accordingly (Figure A1). On average for the three years presented here, prices paid by cotton seed processor as a ratio to the prices received by farmers (properly adjusted by the ginning outturn ratio of 0.35) gives a ratio 0.39, indicating that a substantial part of the revenues realized by the ginning companies comes from cotton by-products.

Across companies, the sale price of oil varied much less than the purchase price of seed. It increased from an average of 41,000 UG shs per 20-liter container (jc) in 2007 to 61,000 UG shs per jc in 2008, and declined to 57,000 UG shs per jc in 2009 (Figure A2). The seasonal price variation in 2008 (data not reported), the year for which all four companies reported their prices was very small, at 64 - 62, 57 - 60, and 45 - 55 thousand UG shs per jc.

Almost all cotton oil is sold locally for human consumption to wholesalers, bakeries, and supermarkets (one factory used some cotton oil for soap manufacturing). Only minimal stocks of cotton oil are held. The four companies also produce cotton meal, with a recovery rate from seed of about 50 percent. The meal is sold to local dairy and poultry famers. Asked what were the key problems facing the industry, the managers of all the companies cited electricity disruptions and high interest rates for operating capital. When asked about the prospects of using cotton oil as a feedstock for biodiesel production, they all dismissed the idea as either unprofitable or an unnecessary diversification for their firms, given the high demand in Uganda for cotton oil for human consumption (indeed Uganda is a net importer of edible oils). They favored policy restrictions on imported edible oils but did not feel very strongly about them.

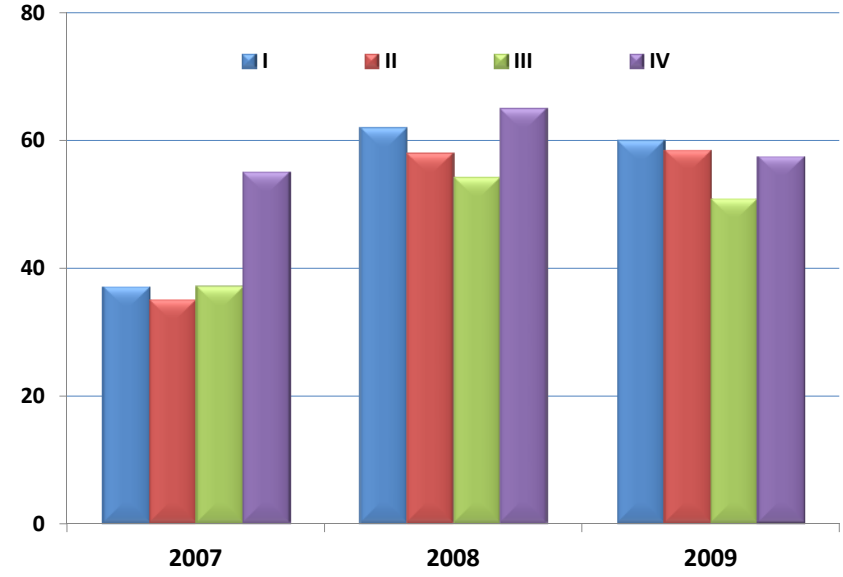
Figure A1
Uganda: Seed Prices Paid by Cotton Oil Processors (UG shs/kg)



Note: The numbers represent annual average; I, II, III, and IV refer to the 4 companies interviewed.
Source: Interviews with industry representatives (Vasilaky 2009).

9

Figure A2
Uganda: Oil Prices Received by Processors (UG 000 shs/20-liter container)



Note: The numbers represent annual average; I, II, III, and IV refer to the 4 companies interviewed.
Source: Interviews with industry representatives (Vasilaky 2009).

10

APPENDIX B: TANZANIA[10]

Early efforts to establish cotton as a plantation crop in Tanganyika bore no fruit, but during the 1920s new efforts focused on smallholder production. Cotton production rose significantly following the development of local varieties along with a better organization of the sector, and by 1966, Tanzania's cotton output was 80,000 tons of lint, almost 1 percent of global production.

During the mid-1960s, most aspects of the country's cotton industry, including ginning, marketing, and trade, were transferred to cooperative unions and the Cotton Board. These entities soon became large bureaucracies failing to respond to the needs of the sector and, not surprisingly, the cotton sector began deteriorating. Despite various reform attempts, for the next two decades the sector performed poorly. Only after the privatization efforts of the early 1990s—set forth by the Cotton Act of 1994—did the sector get back on a sustainable path (see Baffes 2004 for an account of the cotton sector reforms in Tanzania and Poulton and Maro 2009 on recent policy developments and performance.) In recent years, Tanzania has produced an average of 100,000 tons of cotton lint, almost all in the Mwanza region (districts of Mwanza, Shinyanga, and Bunda). Tanzania has 73 ginneries.

Production of cotton by-products has evolved similarly to ginning operations. The 1994 cotton reforms also applied to by-products in the sense that both ginning seed processing operations were privatized, while new entrants were allowed to enter the market. Currently, there are 20 cotton crushing operations in Tanzania, ten of which were visited for this study in May 2009.[11] Nine of these ten are associated with ginneries.

The key characteristics of the ten facilities are reported in Table B1. The ten companies employ an average of 120 temporary and permanent workers, ranging from a minimum of 35 to a maximum of 260, and their daily crushing capacity ranges from 30 to 200 tons of seed. Most of them operate on a 24-hour basis during the cotton seasons. Only three of them crush other oilseeds.

[10] Most of the information in this Appendix is based on Vasilaky (2009).

[11] The ten seed processing companies interviewed were: Birchand Oil Mill Ltd.; Voil/Vegetable Oil Industries, Ltd.; I. C. K. Cotton Oil Co. Ltd (Mwanza District); Afrisan Ginning Ltd.; Gaki Investment Co. Ltd; Jambo Group of Companies Ltd.; Fresho Investment Co. Ltd. (Shinyanga District); SM Holdings Ltd./Nkalalo Ginnery; Verrian Tanzania Ltd./Bunda Oil Industries; S&C Ginnery/Balamba Ginnery (Bunda District).

Table B1
Summary Statistics of Tanzania's Cotton By-Products Industry (Ten Companies)

	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*
I. Nature of operation										
Permanent employees	35	60	30	15	3	12	8	9	57	3
Temporary employees	32	275	100	30	90	90	46	45	200	33
Capacity (tons/day)	75	90	100	70	100	60	60	30	200	50
Year operations began	1996	1967	2008	2006	2003	1999	2001	2008	1999	1997
II. Crushings (000 tons of seed)										
2007	40.0	16.5	4.0	6.4	—	—	—	—	—	—
2008	9.0	4.5	6.2	7.1	10.0	8.0	7.5	1.2	20.0	20.0
2009	9.0	4.2	20.0	10.0	7.5	9.0	12.0	4.5	45.0	10.0
III. Prices paid for cottonseed (TZ shs per kg)										
2006	—	—	—	120	—	130	—	—	—	—
2007	150	—	—	200	250	250	—	150	205	—
2008	250	250	250	210	250	250	—	250	175	–
2009	190	190	180	—	150	190	—	150	—	—
IV. Prices received from cotton oil (000 TZ shs per 20-liter container										
2007	25.0	—	—	—	12.0	32.0	22.0	—	—	28.0
2008	21.5	46.8	31.9	26.0	15.0	35.0	25.0	—	—	30.0
2009	30.0	36.0	27.0	30.0	20.0	27.0	27.0	—	25.0	24.0
V. Cotton meal sold (tons)										
2006	—	6,440	—	8,500	3,150	—	—	—	—	—
2007	—	7,590	—	3,692	700	—	—	—	—	—
2008	5,000	2,070	2,000	3,200	850	4,000	450	500	10,000	—
2009	—	1,932	—	—	—	—	—	—	20,000	—

Notes: Some of the 2009 figures are estimates. '—' implies not reported. Some companies did not report seed prices because most of the seed came from their own ginning operations.
Source: Vasilaky (2009).

All the facilities use expeller pressing technology rather than a solvent-based approach for extracting oil. Most of their machinery is imported from Indian companies: Kumar (Delhi) and Umas (Mumbai). Three quarters of them produce semi-refined cotton oil, and few of them bleach or deodorize the oil. Installing a double refinery operation to improve the quality of the oil would cost approximately US$200,000, which for an average oil refining facility would double the costs of producing cotton oil.

The wage rate of unskilled workers in cotton by-products facilities ranges from 2,500 to 3,000 TZ shs/day, which at an exchange rate of 1,200 TZ shs/US$ implies US$ 1.5 - 2.5 per day (very similar to Uganda). Interest rates paid by the companies for loans range from 8 percent to 16 percent, much lower than in Uganda. Sales of cotton oil are made on both a cash and a credit basis. There are no formal forward arrangements except for some long-term relationships.

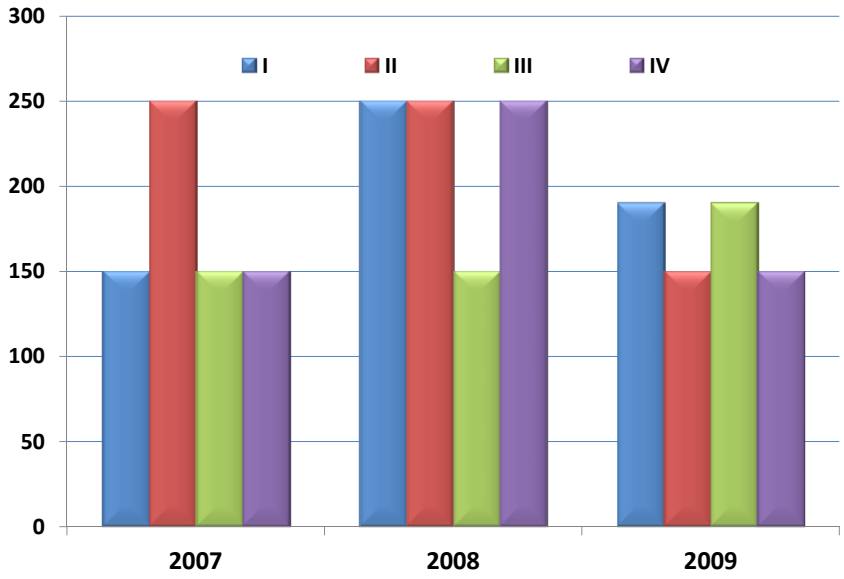
Prices paid for cottonseed averaged 200 TZ shs per kg during 2007, ranging from 150 to 250 TZ shs per kg (Panel III, Table B1). They increased to 235 TZ shs per kg, on average, during 2008, consistent with the peak of world prices, and then declined to 175 TZ shs per kg in 2009. The price variability across companies was much smaller in 2008 and 2009. Of the six companies that reported full statistics for 2008 and 2009, all but one paid 250 TZ shs per kg for seed during 2008, while the 2009 price fluctuated within a narrow range of 150 and 180 TZ shs per kg (Panel III, Table B1 and Figure B1).

The seasonal price variation of seed in 2008, the year for which most companies reported prices, was quite high (Figure B2) while for cotton oil sales, the price variation among companies in 2009 was relatively low (Figure B3).

The gap between the companies' highest and lowest oil prices as a percentage of the high price—an approximate measure of variability—averaged 0.24, and is remarkably similar to the gap in Tanzania's cotton oil market (see Figure B4, which depicts similar statistics for seven companies).

Most of Tanzania's cotton oil is consumed locally in the Mwanza region and is distributed through wholesalers and supermarkets. Only one company reported shipping some oil to Dar es Salaam. Two factories use limited quantities of oil for soap manufacturing. Three companies use their own oil label. Some companies hold stocks for a few months.

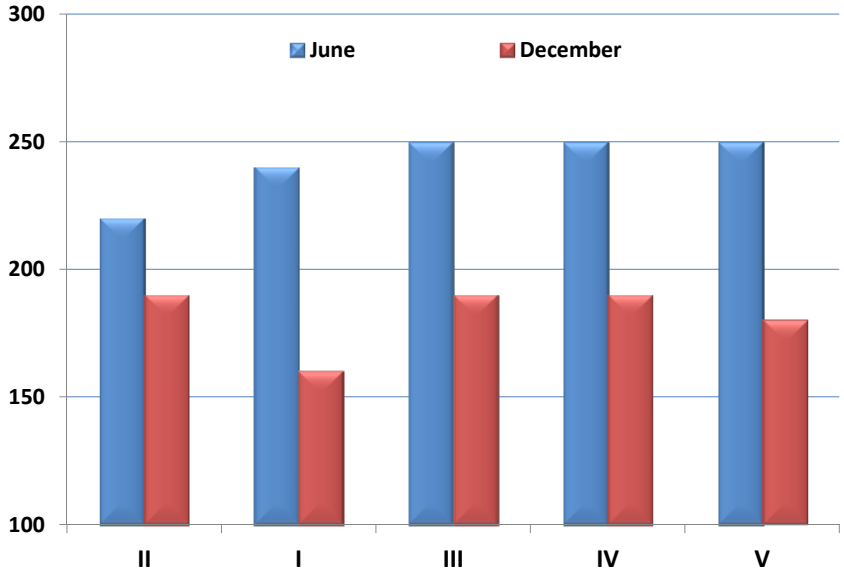
Figure B1
Tanzania: Seed Prices Paid by Cotton Processors (TZ shs/kg)



Note: The numbers represent annual average; I, II, III, and IV refer to 4 of the companies interviewed.
Source: Interviews with industry representatives (Vasilaky 2009).

11

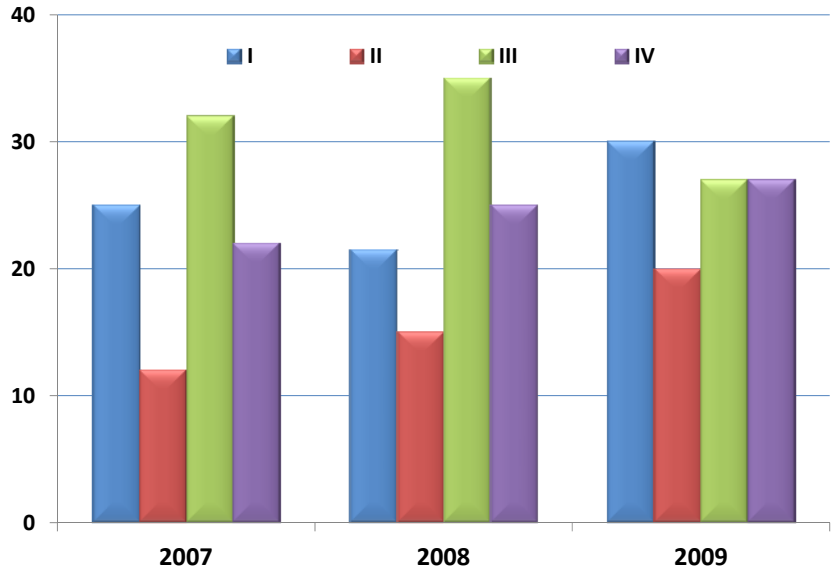
Figure B2
Tanzania: 2008 Seasonal Price Variation of Seed (TZ shs/kg)



Note: The numbers refer to companies that reported complete data
Source: Interviews with industry representatives (Vasilaky 2009).

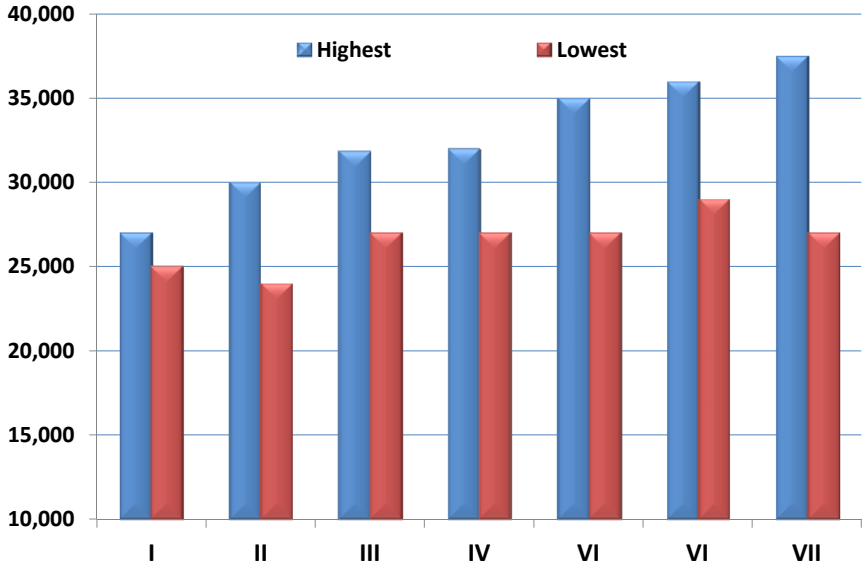
12

Figure B3
Tanzania: Oil Prices Received by Processors (TZ 000 shs/20-liter container)



Note: The numbers represent annual average; I, II, III, and IV refer to 4 of the companies interviewed.
Source: Interviews with industry representatives (Vasilaky 2009). 13

Figure B4
Tanzania: 2008 Seasonal Price Variation of Oil (TZ shs/20-liter container)



Note: The numbers refer to companies that reported complete data.
Source: Interviews with industry representatives (Vasilaky 2009). 14

The companies also produce cotton meal, obtaining a recovery rate from seed of about 55 percent—a little higher than Uganda's average of 50 percent. While some limited quantities of meal are sold locally, most is transported elsewhere, including to Dar es Salaam and Arusha, with some exported to Uganda, Kenya, and South Africa. Only one company reported an export cake price: US$340 per ton in 2008 and US$140 per ton in 2009.

Table B2 reports the weight and value composition of cottonseed, based on information received from three seed processing companies. On average, one ton of cottonseed generate 140 kgs of cotton oil, 550 kgs of husks, 260 kgs of meal, and 50 kgs of waste. In 2008 US$ value terms, the total revenue from one ton of cottonseed was US$195: of this US$129 came from cotton oil (66 percent), US$55 from cake (28 percent), and US$11 (6 percent) from husks.

Table B2
Revenue Breakdown of One Ton of Cottonseed for 2008 (Four Companies)

	Quantity (kgs)	*Unit Price (TZ shs/kg)*	*Revenue (TZ shs)*	*Revenue (US$)*
Oil	140	1,100	154,000	128.72
Meal	260	120	66,000	55.17
Husk	550	150	13,000	10.87
Waste	50	0	0	0.00
Total	1,000	NA	233,000	194.76

Notes: The US$ value was calculated at an exchange rate of US$ = 1,196 TZ shs. Some husks are used for energy generation. 'NA' means non-applicable.
Source: Vasilaky (2009).

Following a calculation similar to Uganda for the three years presented here, prices paid by cotton seed processor as a ratio to the prices received by farmers (properly adjusted by the ginning outturn ratio of 0.35) gives a ratio 0.30, indicating that almost one third of the revenues realized by the ginning companies comes from cotton by-products.[12]

Asked what were the key problems facing the industry, the managers and operators of all the companies cited the erratic supply of electricity and associated disruptions. When asked about the prospects of using cotton oil as a feedstock for biodiesel production, they all dismissed the idea as either unprofitable or unnecessary for their firms, given the high demand in Tanzania for cotton oil for human consumption (Tanzania, like Uganda, is a net edible oil importer.) Only

[12] Several respondents in Tanzania noted that cotton oil is the most profitable part of their operation (including ginning).

one manager said that he had sold cotton oil to a company in Germany for production of biodiesel for experimental purposes.

Managers' views about policy restrictions on imported edible oils were similar to those in Uganda. While they favored such restrictions, they did not feel strongly about them because of the high local demand for edible oils. Some managers stated that in practice most edible oil imports are labeled as crude, even though they are refined, and thus escape Tanzania's 25 percent import duty on refined oil.

APPENDIX C: BENIN[13]

Introduced in the mid-1950s under the auspices of the French state-owned company CFDT (*Compagnie Française pour le Développement des Fibres Textiles*), cotton is an important cash crop in Benin. Seed cotton production has averaged 270,000 tons during the past three seasons (about 0.5 percent of global production), after reaching 400,000 tons in the early 2000s. Like Burkina Faso, Benin has undertaken many policy reforms in the cotton sector during the past decade, including privatization of ginning and marketing.

In 1984 all aspects of the sector were transferred to a new parastatal, SONAPRA (*Société Nationale pour la Production Agricole*). Changes in the structure of the sector were first contemplated in the early 1990s, mainly in response to an earlier crisis when a combination of a larger than expected crop, low world prices, high producer price, appreciation of the CFAf, and limited ginning capacity caused SONAPRA huge financial losses.[14] Most input supply activities were privatized and three new ginning operations were added in 1995, followed by several more in 1998. Yet the new structure caused numerous conflicts resulting in frequent political interference. In response, the government created entities that assumed responsibilities for various aspects of the cotton industry.

Reforms continued during the early 2000s, with the stated objective of "developing a private but nationally integrated cotton supply chain" whose management would be transferred from the government to an inter-professional body. The actual outcome was a highly regulated system without many competitive elements. On the other hand, following the weakening of the global cotton market, producer prices fell and cotton output was halved within just four years (from 400,000 tons of seed cotton in 2001/02 to less than 200,000 tons in 2005/06). Though cotton production has recovered somewhat during the last few years, it remains far below the levels of the early 2000s.

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[13] Most of the information in this Appendix is based on Zanfongnon (2009). Also see Gergely (2009) for an in-depth discussion of Benin's cotton sector.

[14] The CFA (*Communauté Financière Africaine*) franc or CFAf is a currency used in 14 countries of West and Central Africa (12 former French colonies, Guinea-Bissau, and Equatorial Guinea). The CFAf was pegged to the French franc (FF) until 1999 and to the euro since then (1 € = 655.957 CFAf). Since its creation in 1945 it has been adjusted only twice: in October 1948 (from 1 FF = 1.70 CFAf to 2.00 CFAf) and in January 1994 (from 1 FF = 100 CFAf to 200 CFAf). Although the CFAf has been praised for offering macroeconomic stability to its members, during episodes of overvaluation it places the export sectors of the respective countries at a competitive disadvantage (Hinkle and Montiel 1999). It is believed that this has been the case during the early- and mid-2000s.

When SONAPRA was privatized in 2008, after several postponements, three new companies emerged: SODECO (*Société de Développement du Coton*), with ten ginneries; ICA-GIE (*Industries Cotonnières Associées-Groupement d'Intérêt Économique*) an industrial group comprising five societies with five ginneries; and LCB (*Le Label Coton du Bénin*), with one ginnery. One third of SODECO's shares are held by the government, one third by producers, and one third by a private company. Cotton prices are still determined in a pan-seasonal and pan-territorial manner.

As in most cotton producing countries in WCA, cottonseed in Benin was left largely unprocessed before 1980. Some seed was exported to Europe where there was strong feed demand from the dairy industry. During the mid-1980s SONICOG (*Société Nationale des Industries des Corps Gras*), a state-owned oilseed processing company, began crushing limited quantities of cottonseed obtained under favorable terms from SONAPRA.

The cotton reform efforts of the 1990s affected the cotton by-products industry as well. In 1996, a new seed processing company, *Fludor-Bénin*, entered the market, building a new oil crushing facility with an investment of CFAf 3.4 billion and annual capacity of 90,000 tons. In 1997, SONICOG was privatized and two new companies were created: SHB (*Société des Huileries du Bénin*), with an initial investment of CFAf 4.2 billion and annual capacity of 120,000 tons, capable of producing 19,200 tons of oil and 45,600 tons of meal; and IBCG (*Industrie Beninoise des Corps Gras*), with an investment of CFAf 3.5 billion with annual capacity of 40,000 tons (Table C1). However, IBCG has been idle since 2006 (also, there have been unconfirmed reports that SHB did not operate during the 2009/10 season).

Table C1
Quantities of Cottonseed Crushed in Benin (tons)

	Labor force (total)	*Capacity (tons/year)*	*Seeds crushed (tons/year)*				
			2003/04	*2005/06*	*2006/07*	*2007/08*	*2008/09*
FLUDOR	420	90,000	72,186	58,573	65,710	47,582	70,000
SHB	310	120,000	105,000	33,000	57,000	78,000	57,000
IBCG	100	40,000	0	0	0	0	0
Total	830	250,000	177,186	91,573	122,710	125,582	127,000

Source: Ahohounkpanzon and Zakariallou (2010) and Zanfongnon (2009).

In effect, Benin's cotton by-products industry now consists of two large companies: SHB and Fludor-Bénin. SHB has 110 permanent and 200 temporary employees while Fludor has 250 permanent and 170 temporary employees. Both

companies borrow funds on a short-term basis to run their operations, with interest rates ranging between 8 percent and 10 percent. Their purchases of seeds are made with 40 percent - 50 percent cash and the remainder on credit.

All the cotton oil produced goes for human consumption. Though the two companies sometimes crush other seeds, cotton is by far their key raw material source. Unlike seed processing companies in Tanzania and Uganda, both companies use the solvent method to extract the oil. With this advanced technology they can obtain an extraction rate of oil up to 16 percent of the weight of the cottonseed, very similar to the US average. The price they pay for seeds is the same throughout the season (similar to the pan-seasonal and pan-territorial pricing mechanism for lint). The price they receive for cotton oil, however, varies throughout the season depending largely on demand conditions. Sales of oil and meal are mostly for cash.

Most cotton oil is domestically consumed, while some is exported to Nigeria. Detailed data on exports of cotton oil are not available since most of these exports are unrecorded.[15] An estimated 90 percent of cotton meal is exported, mostly to South Africa, which has a large cattle industry. Europe used to be a key destination for Benin's cotton meal but stringent requirements for limiting aflatoxin led to high rejection rates.[16]

Benin's trade policies on cottonseed and derived products have been controversial. In 2001, the government banned exports of cottonseed in order to ensure adequate supplies for the domestic market, but the ban was never strictly enforced and was removed in the 2004/05 crop year. A ban on oil imports was introduced in 2006 but was later contested by neighboring Togo (most of Benin's imported oil comes through Lomé, Togo's main port) because it violated UEMOA (*Union Economique et Monétaire Ouest-Africaine*) rules.[17] In 2007 Benin conformed with the UEMOA's decision and since then has allowed edible oil imports from UEMOA countries. Currently, Benin imposes a 45 percent import duty on palm oil, but traders report that in most cases this is not paid. Benin also imposes an 18 percent value added tax on all domestic edible oil sales—a tax

[15] The figures on trade are subject to debate. Some believe that the cotton seed processors sell cotton oil to traders who have export permits (and thus intend to export) but in reality those traders sell it in the domestic market thus avoiding the VAT.

[16] Aflatoxin is a toxic and carcinogenic substance found often in cereals, oilseeds, and spices as well as milk in animals which have been fed with contaminated feed. Most food regulatory authorities (e.g., the Food and Drug Administration in the US) have established recommended levels of aflatoxin that various food items should not exceed.

[17] UEMOA is a monetary union of the following West African countries: Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo.

that, many argue, forces companies to export the oil, since exports are not subject to the sales tax. As a result local demand is met by imported oil.

Until 2005, the government took an active part in negotiations between the ginners and the cottonseed-processing companies, in order to ensure that seed supplies were sufficient to keep the processing companies in business. Currently, the price of cottonseed is a result of negotiations between the ginning and seed-processing industries. While it has been reported that ginners often do not honor the agreement and export part of their cottonseed if that will yield them a higher price, the figures reported in Table C1 indicate that this does not happen on a large scale. In fact, during 2009, more seed was crushed in Benin than domestic production—perhaps reflecting unrecorded imports of cottonseed from neighboring countries, assuming that the statistics are accurate.

Table C2 reports detailed price and quantity statistics for one of the two companies surveyed. Prices paid for seeds increased considerably during the past three seasons from 22,500 CFAf per ton in 2006/07 to 46,000 CFAf per ton in 2007/08 and 70,000 CFAf per ton in 2008/09 (the prices paid to farmers in these three seasons were 170, 170, and 190 CFAf per kg). However, the prices received by the company for cotton oil did not increase much: they rose from 500,000 in 2006/07 to 600,000 in 2007/08 and then declined back to 500,000 CFAf per ton in 2008/09. If the numbers are correct, they imply that the domestic market is somewhat isolated from the international markets of edible oils.

Table C2
Price and Quantity Statistics for Benin and SHB, 1999-2009

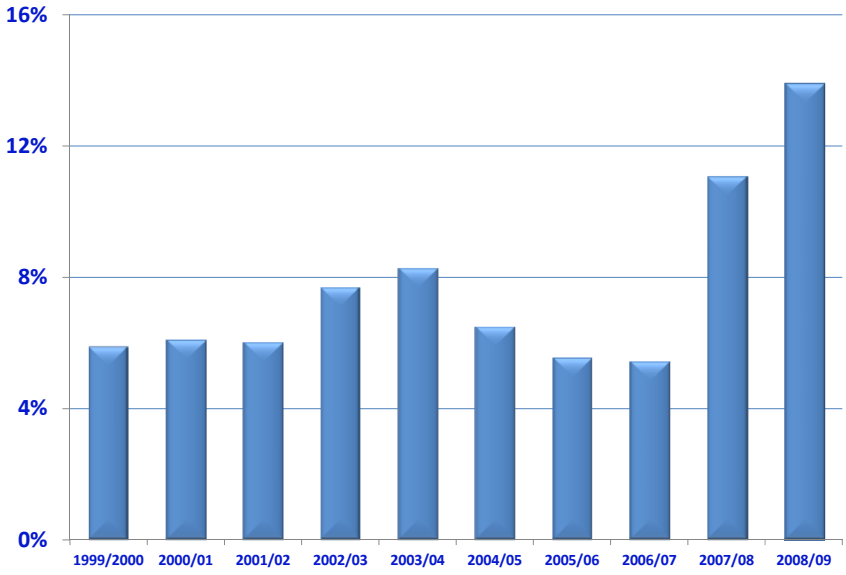
	Quantities (tons)				*Prices (CFAf/kg)*			
	Cotton	*Seed*	*Oil*	*Meal*	*Cotton*	*Seed*	*Oil*	*Meal*
1999/00	364,000	27,000	4,000	14,700	185	26	—	—
2000/01	336,000	62,000	12,000	29,000	200	29	390	90
2001/02	415,000	100,000	16,000	32,000	200	28	440	66
2002/03	334,000	75,000	13,000	32,000	180	33	390	56
2003/04	332,000	92,000	14,000	37,000	190	37	500	37
2004/05	427,000	105,000	9,700	26,000	201	30	445	40
2005/06	191,000	33,000	9,800	22,000	170	23	450	37
2006/07	271,000	57,000	9,600	23,000	170	23	500	54
2007/08	269,000	78,000	12,000	22,000	170	46	600	100
2008/09	216,000	57,000	8,500	22,000	221	70	500	100

Notes: The first and fifth columns refer to the entire country's seed cotton crop while the remaining columns refer to SHB. The seed price during 2006/07 ranged from CFAf 15 to 30 per kg. '—' means not reported. Cotton prices refer to final payments (base price plus supplement).
Source: Zanfongnon (2009).

The contribution of cottonseed to the total value of cotton seems to have increased in Benin consistently with the changes that took place in the global markets. When the price of cottonseed paid by the seed processing companies is expressed as a share of the total value of cotton (i.e. the sum of the price received by the producers, reported in the second column of table C2, plus the ginning costs, estimated at about CFAf 160 per kg of lint), the average contribution increased from 6 percent (average 1999/2000 to 2006/07) to 13 percent over the past two seasons (Figure C1).

However, the value of cottonseed has remained very low in relation to ginning costs. As shown in Figure C2, cottonseed prices in Benin covered only 23 percent of actual ginning costs during 1999/2000-2006/07. In the US, by contrast, the value of cotton by-products is traditionally expected to cover ginning costs (see Appendix E).

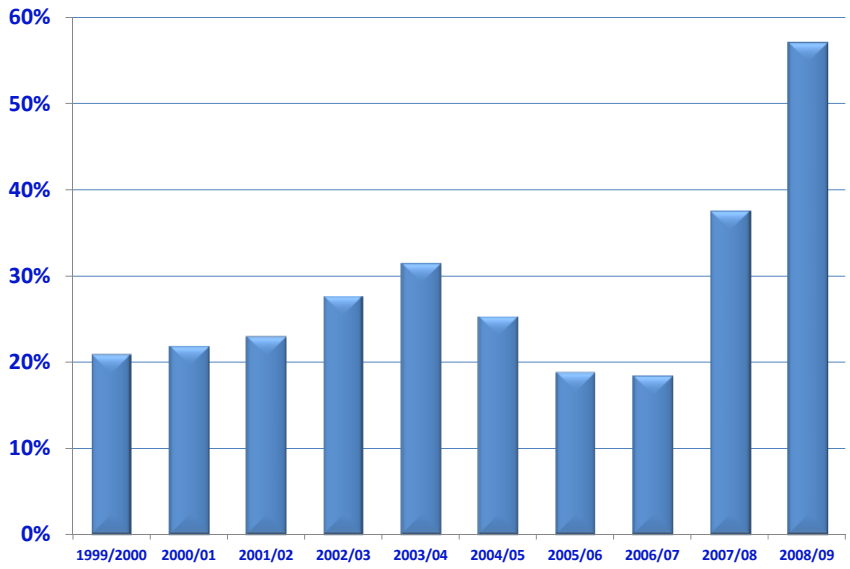
Figure C1
Benin: Seed's Contribution to the Value of Cotton (percent)



Note: This is the ratio of the price of cotton seed over the sum of the grower's price and ginning costs
Source: Author's calculations based on industry data

16

Figure C2
Benin: Seed Value to Ginning Costs Ratio (percent)



Note: This is the ratio of the price of cotton seed over the ginning costs
Source: Author's calculations based on industry data

17

APPENDIX D: BURKINA FASO[18]

Cotton was introduced in Burkina Faso towards the end of the colonial period, and the country is now SSA's largest cotton producer; its seed cotton output averaged half a million tons during the past three seasons (about one percent of world output) and exceeded 700,000 tons in 2006/07. Cotton is the country's most important export item, accounting for more than half of its total merchandise trade and about 5 percent of GDP.

Development of the sector was originally the responsibility of the French state-owned company CFDT, which remained in charge until 1975 when it was replaced first by a joint venture between the government and CFDT and in 1979 by a new cotton parastatal, SOFITEX (*Sociètè Burkinabé des Fibres et Textiles*).

Reforms of the cotton sector were first considered in 1991 when the management responsibilities of the sector were transferred to growers and SOFITEX. In 1998, the government further reduced its stake in the cotton company by transferring 30 percent of its shares to a producer organization and 30 percent to CFDT's successor DAGRIS (*Société du Développement Agricole du Sud*).[19] In 1999 a committee was formed to coordinate the functions of the cotton company and the producers' organization for activities such as the determination of farmgate prices and the management of the research program. Finally, the sector was opened to (limited) competition when two private cotton companies received permission to enter the market. These companies—SOCOMA (*Société Cotonniére du Gurma*) and *Faso Coton*—were given an eight-year exclusive right to buy cotton from specific zones which produce about 15 percent of the country's cotton output. In 2006, an umbrella organization, the Burkina Cotton Interprofessional Association (AICB, *Association Interprofessionnelle du Coton du Burkina*), which represents cotton farmers and ginners, was created to coordinate actions of all three cotton companies.

In response to the CFAf devaluation by 100 percent in 1994, the policy reforms, and the high prices received by cotton growers induced considerable supply response, with seed cotton output reaching a record high of 713,000 tons in the 2004/05 season, a two-fold increase from a decade earlier.

Subsequently, however, the unsustainably high prices paid to cotton growers due to the deterioration of the world cotton market imposed fiscal pressure on the cotton companies (and the government), in turn causing production

[18] Most of the information in this Appendix is based on Zanfongnon (2009).

[19] In January 2008 DAGRIS was purchased by the *Advens Group* (51 percent) and CMA-CGM (49 percent) and was renamed to *Geocoton*.

to decline to less than half a million tons during the past two seasons. The appreciation of the CFAf against the US dollar played an important role as well.[20] In response, AICB introduced a new pricing mechanism supported by a smoothing fund (*fonds de lissage*), which takes into consideration historical and current prices, price forecasts, and other market conditions.

Burkina Faso has been a leader among SSA cotton producers in that it began biotech cotton trials earlier this decade in partnership with Monsanto. In 2008 the research had progressed to on-farm trials, by 2009 it had expanded to more than 100,000 hectares of commercial plantings by small-scale farmers, and by the 2010 planting season it is expected to have led to full conversion to biotech cotton varieties (apart from refuge set-asides).[21] (Box D1.)

Box D1: Economic Effects of Biotech Cotton Varieties

The pros and cons of adopting biotech cotton varieties have been extensively discussed (see Tripp 2009 for a comprehensive review of the literature). FAO's (2004) review showed that on balance, biotech cotton growers are better off than growers of conventional varieties. Baffes (2005) argued that in addition to subsidy elimination and domestic reforms, adoption of biotech varieties should have been a priority among policymakers in low-income cotton producing countries. Similarly, Falck-Zepeda and others (2007) concluded that the downward pressure on world cotton prices caused by the large-scale adoption of biotech cotton is likely to force other countries to adopt the technology in order to compete in the global market. The data certainly confirm the presence of such pressure. Anderson and Valenzuela (2007) found that the benefits from full adoption of biotech cotton varieties by African cotton-producing countries could be even greater than the benefits of the removal of all cotton subsidies by the US and the European Union. Subramanian and Qaim (2010) found that the expansion of biotech cotton in India contributed to poverty reduction and rural development.

Cottonseed processing in Burkina Faso goes back to the 1980s when the government acquired a private oilseed processing company under the name SNHB (*Société Nationale des Huileries du Burkina*), later renamed CITEC and more recently SN-CITEC (*Société Nouvelle Huilerie et Savonnerie Citec*).

[20] The euro's appreciation against the US dollar during the early to mid-2000s has been a key constraint faced by the WCA cotton sectors. Between 2000 and 2007, for example, nominal world cotton prices experienced a 7 percent increase, from US$1.30/kg to 1.40/kg. The CFAf, however, appreciated against the US$ from CFAf 712 in 2000 to CFAf 479 in 2007. Thus, in domestic (nominal) currency terms, WCA cotton producers experienced a 28 percent decline.

[21] *Cotton Outlook* (March 9, 2010, p. 14) quoted a SOFITEX researcher who asserted that "the result [of biotech cotton] has been a significant gain in productivity, by virtue both of reduced costs and improved yields."

Today for all practical purposes SN-CITEC is Burkina Faso's only large cottonseed processing company, coexisting with multiple much smaller, less technologically advanced, companies. Following the company's privatization in 1995, an investment of CFAf 12 billion was made to modernize its cotton crushing facilities. *Geocoton* (the successor of DAGRIS) holds a 52.5 percent stake in SN-CITEC while most of the remainder is held by SOFITEX, implying that SN-CITEC receives preferential access to cottonseed over its competitors. This begs the question of whether SN-CITEC would have been profitable if it bought cottonseed at market prices.

By most accounts, SN-CITEC is the most technologically advanced cottonseed processing operation in WCA. The company's maximum annual capacity is 120,000 tons with a total labor force of almost 1,000 employees (Table D1). As much as 95 percent of its energy requirements are met by the use of husks and it achieves more than a 16 percent oil extraction rate, equivalent to the rates achieved in the US. SN-CITEC produces fully refined oil and in 2008 began fortifying it with Vitamin A under its own label (Jarvis 2009). It has also installed a pilot plant for biofuel production with an annual capacity of 3,000 tons, and plans to expand this to 10,000 tons (Bayoulou 2010).

Table D1
Price and Quantity Cotton Statistics for Burkina Faso and SN-CITEC

	Quantities (tons)				*Prices (CFAf/kg)*			
	Cotton	*Seed*	*Oil*	*Meal*	*Cotton*	*Seed*	*Oil*	*Meal*
1999/00	254,189	108,817	15,234	52,135	185	24	467	35
2000/01	275,800	100,064	16,555	47,083	170	29	449	39
2001/02	378,522	103,217	17,798	50,667	200	29	485	40
2002/03	404,419	107,320	17,252	55,013	192	32	502	45
2003/04	483,390	90,210	12,250	47,690	191	40	490	33
2004/05	632,503	97,134	14,798	47,660	215	40	461	36
2005/06	713,123	103,046	19,448	53,279	179	40	450	38
2006/07	684,958	98,268	16,244	51,781	170	40	503	45
2007/08	355,422	88,442	15,596	47,793	163	82	738	103
2008/09	451,473	115,000	19,550	63,250	179	82	602	124

Notes: The first and fifth columns refer to the entire country's cotton crop. The remaining columns refer to SN-CITEC. Cotton prices refer to final payments (base price plus supplement).
Source: Zanfongnon (2009) and Bayoulou (2010).

A second large company, SOFIB (*Société Industrielle Barro et Frères*), began cottonseed processing in 1984 with annual capacity of 36,000 tons and labor force

of 425 (Table D2). SOFIB has had very low capacity utilization during recent years while it did not process any cottonseed during the 2009/10 season. A third major company, JOSSIRA Industries, entered the market in 2001 with annual capacity of 45,000 tons, but has not been in operation since 2007. Both these companies have been in arrears with SOFITEX.

Table D2
Size of Major Seed Processing Companies in Burkina Faso

	Labor force (all employees)	*Capacity (tons/year)*		
		Seed	*Oil*	*Meal*
SN-CITEC	990	120,000	20,000	70,000
SOFIB	425	36,000	5,000	30,000
JOSSIRA	165	45,000	6,000	35,000
Total	1,580	201,000	31,000	135,000

Notes: JOSSIRA has not been in operation since 2007 while SOFIB did not process any cottonseed during 2009/10.
Source: Zanfongnon (2009).

Numerous smaller cotton seed processing companies joined the industry during the mid-2000s, as the result of the policy reforms and the subsequent expansion of the cotton sector. These firms are scattered throughout the country, with a high concentration in Bobo-Dioulasso, the country's key cotton producing region. The expansion of the industry, which also reflected strong demand for cotton meal by neighboring countries, was aided by investments made by expatriates who returned to Burkina Faso because of the civil conflict in Côte d'Ivoire.[22]

Because the smaller processors had difficulty obtaining seeds from SOFITEX during their early years of operation, they formed an association (APHB, *Association des producteurs d'huile des Hauts-Bassins*) in 2003 to facilitate their supply of seeds from SOFITEX, as well as easing their access to funds from financial institutions and promoting the quality of cotton oil through a national labeling system. In 2005 a competing association was formed, GTPOB (*Groupement des transformateurs des produits oléagineux du Burkina*), which acquired most of APHB's membership and eventually replaced its competitor. Internal conflicts led some members to form two new associations in 2008: GHH (*Groupement des*

[22] The minimum equipment requirement (i.e., one cold pressing machine which is produced domestically) costs about 2 million CFAf (equivalent to about US$4,200, in 2010 US dollars). Therefore, setting up an average-size operation with five pressing machines costs a little more than US$20,000.

Huiliers du Houet) and CPPOD (*Coopérative des Producteurs de Produits Oléagineux et Divers*). As of 2009 GTPOB was the dominant one with 42 members, followed by GHH (11 members), and CPPOD (6 members.) While membership in these three associations gives the official count of Burkina Faso's small cotton seed processing companies, it should be noted that the industry is at the early stages of development, with considerable entry and exit, and also that because some companies are not members of any of these associations the actual number of companies may be much higher.

For the current study, 21 of the smaller companies were surveyed, accounting for about one third of the smaller seed processing companies in Burkina Faso.[23] Summary characteristics and key statistics on quantities and prices are reported in Table D3. The average age of the companies is three years. Their average daily capacity is 34 tons and their average labor force is 43 workers, mostly on temporary arrangements. The wage rate paid to temporary employees averaged CFAf 33,750 per month (equivalent to about US$ 2.50 per day, assuming 25 working days per month). During 2007/08 and 2008/09 they crushed an average of 1,860 and 1,770 tons of cottonseed, respectively. During the 2008/09 season the combined quantity crushed by all the small companies reached 50,000 tons of seed, or one third of the total seed crushed in Burkina Faso.

The 21 smaller companies surveyed here—accounting for one third of all small seed processing companies in Burkina Faso—crushed a total of 35,000 tons of seed in 2008/09. If 50,000 tons were crushed in total, this means that the remainder (about 40) companies crushed only 15,000 tons. This may not be an unreasonable estimate given that the ones surveyed were the more established. In some sense, the smaller companies compensate for the gap left by SOFIB and JOSSIRA. On a few occasions they crush other seeds, though they find cotton by far the most profitable. Their oil extraction rate varies between 6 percent and 10 percent (much lower than SN-CITEC's 16 percent). Yet, the smaller seed processors' lower oil extraction rates do not necessarily imply lower overall profitability, because the oil remains in the meal, increasing its protein content and hence its value.

[23] The 21 companies surveyed were: AGROPA (Fada N'Gourma region); Birba et fils; COMITRA; Délice Huilerie; SHS du Faso; Karamongo Lanfera; Huilerie Lodoun; NIDOR; OMORY; SOCHIB; AKAMAF; HUNOFA; DJENE DIOR; TRAORE et frères; NATILGUE; ANGO-FASO (Bobo-Dioulasso region); Sana Moussa; SIPAB; LIZA et fils; GENOL; SATOS (Ouagadougou region).

Table D3
Summary Statistics of 21 Cottonseed Processing Companies in Burkina Faso

	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*	*X*	*XI*
I. Nature of operation											
Number of employees	33	7	13	103	20	55	42	107	8	8	46
Capacity (tons/day)	30	30	25	70	20	31	50	40	3	6	60
Year operations began	2007	2006	2006	2007	2007	2006	2008	2006	2005	2007	2004
Wage rate (CFAf/month)	40,000	30,000	48,000	—	—	32,000	38,000	32,000	25,000	25,000	31,115
II. Seed statistics											
Crushings in 2008 (tons)	200	100	700	5,773	—	2,000	2,000	7,500	120	80	490
Crushings in 2009 (tons)	700	100	1,140	5,240	730	1,050	2,000	6,000	200	180	1,600
Seed price in 2008 (CFAf/ton)	92,000	90,270	75,000	75,000	—	90,250	75,000	75,000	92,270	90,250	90,270
Seed price in 2009 (CFAf/ton)	92,000	90,270	75,000	75,000	75,000	90,250	75,000	75,000	92,270	90,250	90,270
III. Oil and meal statistics											
Oil price in 2008 (CFAf/jc)	—	—	13,000	12,000	—	10,500	13,000	9,000	11,250	—	12,500
Oil price in 2009 (CFAf/jc)	—	—	10,000	11,750	—	13,000	12,000	9,000	11,250	—	9,500
Meal sold in 2008	—	—	612	—	—	—	1,700	6,200	—	70	320
Meal sold in 2009	—	—	997	—	—	918	1,700	5,020	—	150	1,040
Meal price in 2008 (CFAf/ton)	90,000	90,000	100,000	100,000	—	—	100,000	70,000	100,000	95,000	92,500
Meal price in 2009 (CFAf/ton)	90,000	110,000	100,000	105,000	—	60,000	110,000	70,000	100,000	95,000	92,500

Continued next page

Table D3 (continued)
Summary Statistics of 21 Cottonseed Processing Companies in Burkina Faso

	XII	*XIII*	*XIV*	*XV*	*XVI*	*XVII*	*XVIII*	*XIX*	*XX*	*XXI*
I. Nature of operation										
Number of employees	58	24	14	112	32	39	73	18	65	30
Capacity (tons/day)	36	20	12	70	50	40	60	10	40	20
Year operations began	2007	2009	2007	2005	2008	2006	2001	2008	2007	2009
Wage rate (CFAf/month)	31,000	40,000	30,000	50,000	25,000	35,000	30,000	32,000	40,000	27,000
II. Seed statistics										
Crushings in 2008 (tons)	1,440	—	700	2,000	1,000	2,360	4,944	850	1,200	—
Crushings in 2009 (tons)	2,800	500	1,000	2,000	3,500	1,640	2,593	675	2,500	1,000
Seed price in 2008 (CFAf/ton)	91,368	—	92,545	90,270	90,270	75,000	75,000	75,000	90,270	—
Seed price in 2009 (CFAf/ton)	91,368	90,250	92,545	90,270	90,270	75,000	75,000	75,000	90,270	75,000
III. Oil and meal statistics										
Oil price in 2008 (CFAf/jc)	—	—	11,500	14,000	13,730	10,000	13,500	12,500	14,000	—
Oil price in 2009 (CFAf/jc)	—	11,000	9,500	10,000	9,180	8,300	11,000	12,000	12,500	8,300
Meal sold in 2008	1,224	—	595	—	870	1,780	3,955	256	1,200	—
Meal sold in 2009	2,380	360	850	—	3,000	1,360	2,075	263	2,500	832
Meal price in 2008 (CFAf/ton)	111,223	—	95,000	97,500	95,000	75,775	80,000	90,000	95,000	—
Meal price in 2009 (CFAf/ton)	97,058	80,000	95,000	97,500	80,000	74,775	80,000	90,000	100,000	78,929

Notes: '—' implies data not reported or the answer was not very clear. Wage rate is for unskilled laborers; whenever specified in days or hours, the conversion to monthly wage rate was made by assuming 8 hours per day and 25 days per month. Similarly, when the oil price was reported in tons, it was divided by 55 [≈1,000/18] to convert it to 20-liter can (jc) equivalent.
Source: Zanfongnon (2009) from company statistics.

Because Burkina's smaller seed processing companies produce partly, rather than fully, refined oil, concerns have been expressed that their oil is of poor quality and perhaps dangerous for human consumption. SN-CITEC, which produces fully refined (and high quality) oil with its own label, has complained repeatedly that some of the smaller companies use its label. A USAID (2006) report commented (p. 43) that: "The large processors complain that competition from smaller, more artisanal production units also undercuts them in the market. These firms operate outside the fiscal net, so they typically do not pay taxes and they do not apply the appropriate '*textes*' (regulations). These firms reportedly use unhygienic production methods and their unrefined oil is dirty, contaminated, and inferior to the vegetable oil of large processors."

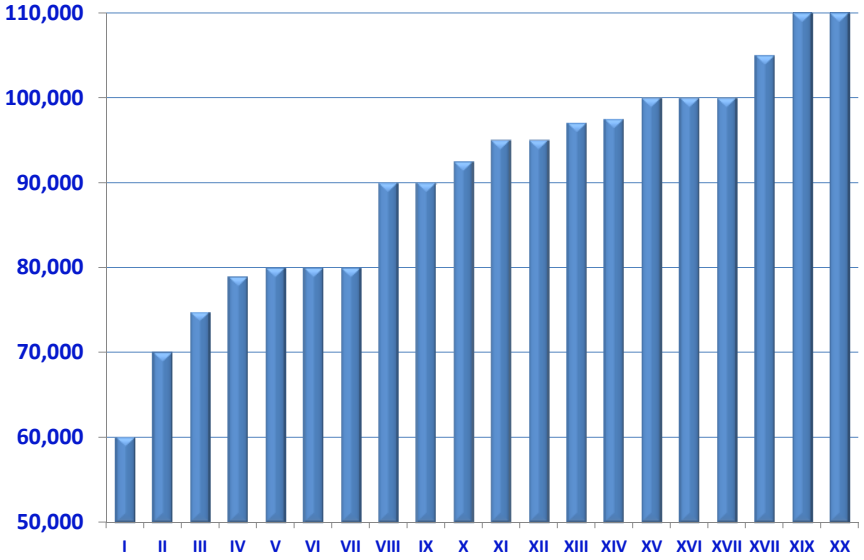
The pricing of cottonseed bought by the smaller companies in Burkina Faso is pan-territorial and pan-seasonal—similar to that of seed cotton. During 2008 and 2009, SOFITEX sold cottonseed at CFAf 75,000 per ton net of any taxes; when taxes are included, a ton would cost the companies more than CFAf 90,000.[24]

The prices charged for oil and meal, however, differed considerably among companies. Meal prices during 2009 varied from a low of CFAf 60,000 per ton to a high of CFAf 110,000 per ton (Figure D1) while oil prices varied from CFAf 8,300 per jc to 13,000 per jc (Figure D2), a range similar to those recorded in Uganda and Tanzania. There are numerous reasons for such price variability, including oil quality, location of company, time of sale, etc.

A comparison of the oil and meal prices received by the smaller companies with those received by SN-CITEC shows, surprisingly, that the large firm's price premium for meal sales is larger than its premium for oil sales. SN-CITEC sold its meal at CFAf 103,000 per ton in 2007/08 and 124,500 per ton in 2008/09. The average meal prices received by the smaller companies during these two seasons were CFAf 92,750 per ton and 90,300 per ton, implying that SN-CITEC commanded a premium of 11 percent and 38 percent over the smaller companies. Such premium seems justifiable for a number of reasons, including that SN-CITEC is an established company using advanced crushing technology and better packaging, and has a larger marketing network.

[24] Table D3 (Panel II) reports prices paid for seed by the 21 companies surveyed. When the price was quoted without tax, it was the same for all companies, CFAf 75,000/ton. When it was quoted with tax it was not the same (for example, company ***IX*** paid CFAf 92,270/ton while company ***X*** paid CFAf 90,270/ton.) It is not clear what explains the difference.

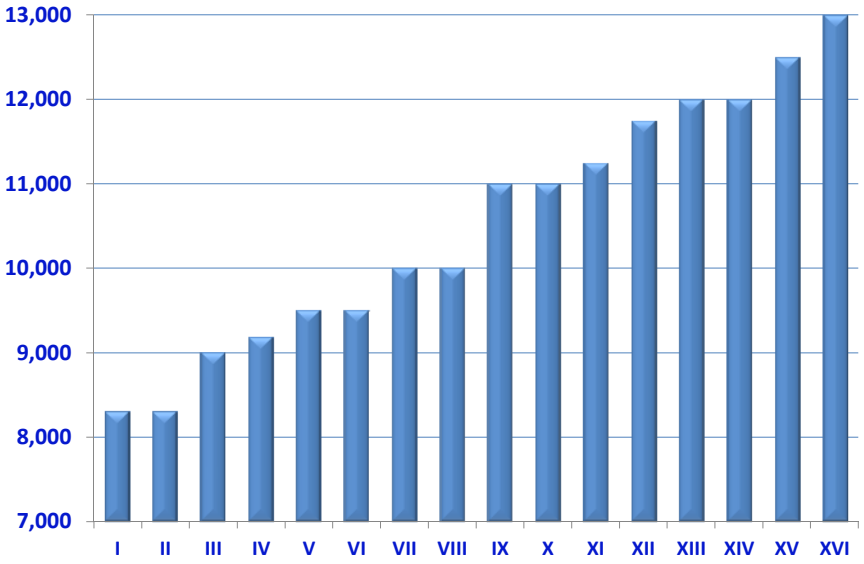
Figure D1
Burkina Faso: Meal Price for 20 Companies, 2009 (CFAf/ton)



Note: The numbers represent companies for which data were obtained (from lowest to highest)
Source: Interviews with industry representatives (Zanfongnon 2009).

17

Figure D2
Burkina Faso: Oil Prices for 16 Companies, 2009 (CFAf/20-liter container)



Note: The numbers represent companies for which data were obtained (from lowest to highest)
Source: Interviews with industry representatives (Zanfongnon 2009).

18

The prices received for cotton oil give a different picture, however. SN-CITEC received CFAf 13,400 per jc and 10,850 per jc during 2007/08 and 2008/09 while the smaller companies received CFAf 12,200 per jc and 10,500 per jc during these two seasons, implying premiums of only 10 percent and 3 percent.[25] One would have expected SN-CITEC to command an even larger premium for oil, given its advantages mentioned above as well as the high quality oil it produces.

There are two mutually reinforcing explanations for the company's low oil premium. First, quality is not adequately priced by the consumers and, second, the edible oil market is highly integrated in Burkina Faso, in the sense that imported oils dictate the price (in the same way that the edible oil markets are integrated at the world market level, as the discussion in the main text established). This has important implications because it shoes that large cotton seed processing operations using advanced technology, while efficient from a technological perspective, may not be economically profitable in the SSA context.

Unlike in Uganda and Tanzania, most companies in Burkina Faso did not report electricity problems (in fact, 18 out of 21 managers said that they have not experienced any electricity disruption). Most respondents strongly favored the imposition of high tariffs on imported edible oils as well as export restrictions on oilseeds. The interest rate paid by the companies averaged 13 percent, broadly in line with Tanzania's rates and lower than Uganda's. Lastly, when managers were asked about cotton oil's potential for biofuel use, some responded that they were not aware of such potential, and those that were aware expressed doubts for the profitability of cotton oil as a biofuel feedstock.

Half of the respondents said that the cotton oil they produce is consumed domestically while the remainder said that some of their oil is exported to neighboring countries, including Mali, Niger, and Senegal. About 12 percent of SN-CITEC's cotton oil is exported, primarily within the region. Burkina Faso's trade policies on cotton by-products are less restrictive than Benin's; in 2005/06 it banned exports of cottonseed, and it also imposed an 18 percent value added tax.

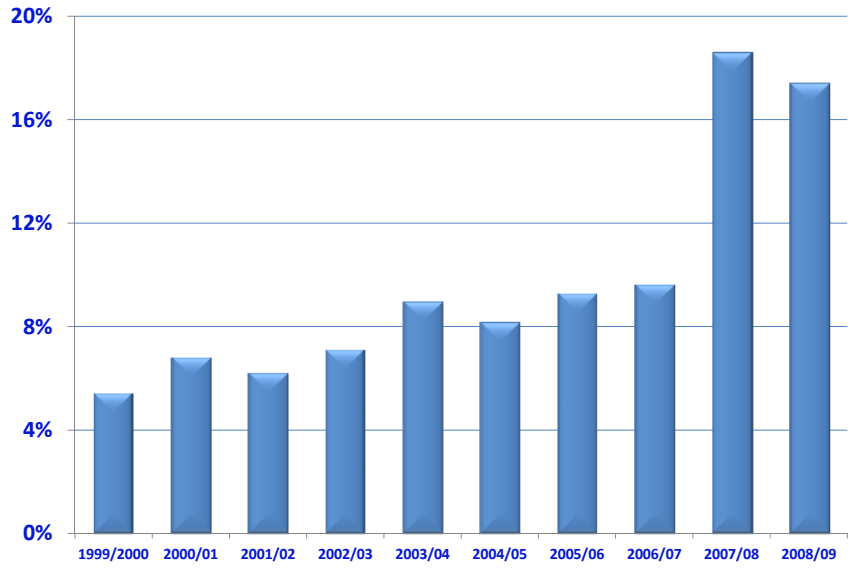
Most of Burkina Faso's cottonseed is consumed domestically by the seed processing industry. An estimated 1 percent is used unprocessed as animal feed. There have been reports that an export ban on cottonseed was introduced in 2005/06. However, statistics indicate that during this season Burkina Faso exported an estimated 81,643 tons, equivalent to 20 percent of the country's cottonseed output, while similar level of exports were recorded for the subsequent two seasons (Bayoulou 2010). On the import side, it appears that some cottonseed is

[25] In table D2, SN-CITEC's price is reported in tons; it has been converted to 20-liter container by dividing by 55. A similar conversion was made in table D3 for the smaller companies.

imported from the Northern regions of Côte d'Ivoire (the highest recorded figure was 30,000 tons in 2002/03).

Figure D3 depicts the contribution of cottonseed to the total value of cotton over the past decade. The contribution (calculated the same way it was calculated for Benin) averaged 8 percent, between 1999/2000 and 2006/07, and it increased to 19 percent for the past two seasons. This sharp rise is very similar to that in Benin and consistent with what took place in world markets.

Figure D3
Burkina Faso: Seed's Contribution to Cotton's Value (percent)

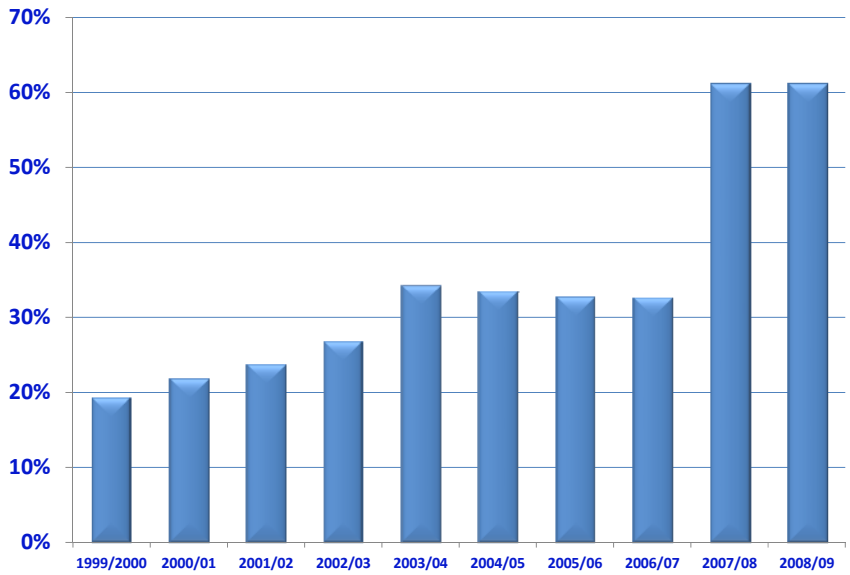


Note: This is the ratio of the price of cotton seed over the sum of the grower's price and ginning costs
Source: Author's calculations based on industry data

20

Similarly, cottonseed prices in Burkina Faso covered a little more than one quarter of actual ginning costs up to 2006/07, while during the past two seasons their share has more than doubled (Figure D4). Unlike in Benin, their share increased slightly after the smaller companies entered the cottonseed processing industry. Although the increase is too slight to be viewed as a statistically solid result, nevertheless it is consistent with the expectation that competition drove seed prices up.

Figure D4
Burkina Faso: Seed Value to Ginning Costs Ratio (percent)



Note: This is the ratio of the price of cotton seed over the ginning costs
Source: Author's calculations based on industry data

21

APPENDIX E: UNITED STATES

The origins of the US cotton industry date from the 17th century when European settlers began experimenting with cotton cultivation. The expanded use of the saw gin—which was invented in 1793 and made the process of separating lint from seed commercially viable—rendered cotton a chief cash crop. Within a few decades, the US became the world's dominant cotton supplier, accounting for more than half of global cotton output, which was mostly exported to England to supply its textile industry. Apart from a short hiatus during the Civil War, the US kept its dominance in the cotton market well into the 20th century.

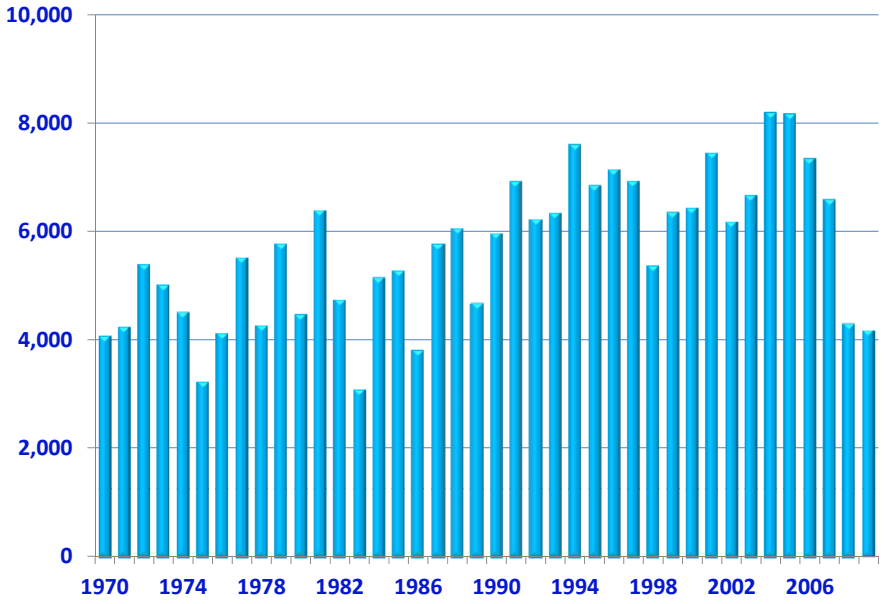
In 2008/09 the US was the world's third largest cotton producer with 2.7 million tons of lint (following China with 8 million tons and India with 4.9 million tons), down from five million tons during the mid-2000s. World production of lint was 23.4 million tons. The US is still the world's dominant cotton exporter, accounting for 45 percent of the global trade of 6.4 million tons.

The US cotton sector has benefited from large budgetary transfers that were instituted during the farm programs of the 1930s. It received an estimated US$2.2 billion of assistance during 2009 and is expected to receive US$2.4 billion in 2010, according to the US Department of Agriculture's February 2010 update. The transfers, which by some accounts have been a key reason for the slow progress of the Doha Development Agenda, have been the subject of two WTO (World Trade Organization) cases. In 2002 Brazil began its WTO case against the US, arguing that US cotton subsidies lowered world prices and thus lowered export revenues from cotton. In 2003 four WCA countries—Benin, Burkina Faso, Chad, and Mali, often referred to as Cotton-4 or C-4—launched the Initiative in Favor of Cotton, in effect demanding compensation for their export revenue losses caused by lower cotton prices resulting from subsidies. (See Baffes (2007) and Sumner (2006) for detailed accounts of these two WTO cases).

Cottonseed processing in the US goes back to 1799 when a patent was granted for extracting oil from cottonseed. Cotton by-products were commercialized during the early 1830s when the first cottonseed processing facilities were built (Nixon 1930). Cotton meal was used as animal feed and on some occasions as fertilizer. Cotton oil was the key vegetable oil in the US until it was displaced by other vegetable oils (mainly soybean) during the 1950s.

US cotton seed production reached a maximum of 8 million tons in 2005 (Figure E1). However, it declined to almost 4 million tons in 2008 and 2009, mainly because of the diversion of land to biofuel commodities (especially corn), and low world cotton prices (see discussion in main text).

Figure E1
Cotton Seed Production in the US (000 tons)



Source: *US Department of Agriculture*

21

Cottonseed prices in the US reflect the interplay of numerous factors, including the size of the cotton crop, prices of competing edible oils (Figure E2), prices of competing meals (especially soybean meal), and prices of other feed grains such as corn. These factors in turn determine how much cotton seed will be used by the dairy industry in unprocessed form and how much will go for crushing. During the 2007/08 season for example, 6.5 million tons of cottonseed were produced in the US, of which 3.1 million was consumed by the diary industry, 2.7 million tons was crushed, while 0.6 million tons was exported, a pattern that has been representative of the past ten years. [26] Nominal prices of cottonseed fluctuated around US$100 per ton up to 2006, but they have averaged US$180 per ton during the past three years, reaching a high of US$220 per ton in 2008 (Table E1).

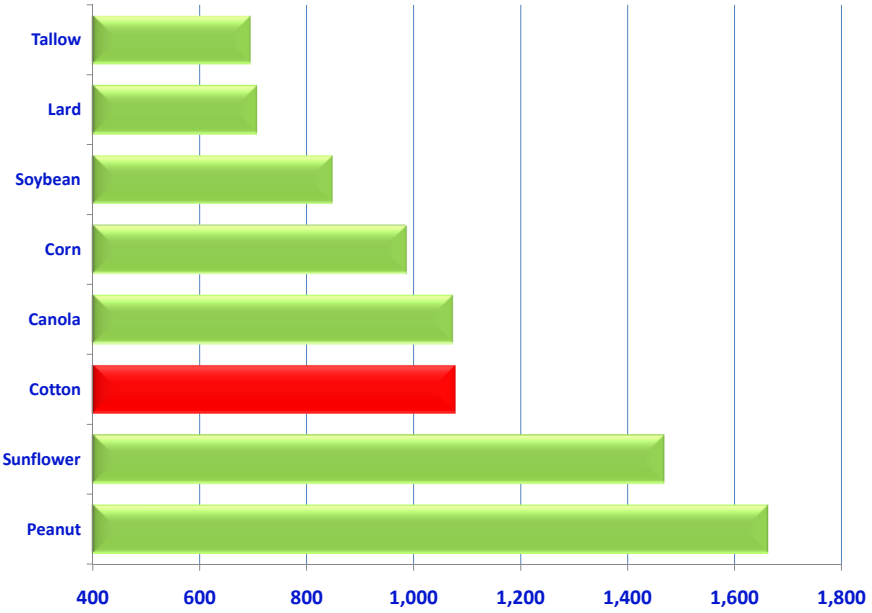
[26] The dairy industry uses unprocessed cotton seeds because of their unique protein, energy, and fiber content. However, dairy cows can only consume certain amounts of cotton seeds due to the presence of gossypol, a naturally occurring plant pigment found in the seed. Cotton seeds contain between 0.4 and 2 percent gossypol, depending on species-variety and growing conditions. When the cotton seeds are processed, the level of gossypol declines to 0.1-0.2 percent (Blasi and Drouillard 2002). The effects of gossypol on animal health have been studied extensively and guidelines have been developed (Martin 1990). Moreover, research under way in the US indicates that cotton varieties will be developed soon with low levels of gossypol while maintaining all other characteristics of the cotton plant (ICAC 2010).

Table E1
Value Composition of Cotton in the US, 1970-2009

	Nominal prices (US$/kg)		*Value (US$/ton of seed cotton)*			*Contribution (%)*	
Year	*Lint*	*Seed*	*Lint*	*Seed*	*Total*	*Lint*	*Seed*
1970	0.63	0.06	221	37	258	85.8	14.2
1971	0.74	0.06	259	37	296	87.5	12.5
1972	0.79	0.05	278	32	310	89.6	10.4
1973	1.36	0.10	474	65	539	87.9	12.1
1974	1.42	0.14	495	88	583	84.9	15.1
1975	1.16	0.10	406	63	469	86.6	13.4
1976	1.69	0.10	592	67	659	89.8	10.2
1977	1.55	0.07	544	46	590	92.2	7.8
1978	1.57	0.11	550	74	624	88.1	11.9
1979	1.69	0.12	591	79	670	88.3	11.7
1980	2.05	0.13	716	84	800	89.5	10.5
1981	1.85	0.09	646	56	702	92.0	8.0
1982	1.60	0.08	559	50	609	91.8	8.2
1983	1.85	0.17	649	108	757	85.7	14.3
1984	1.79	0.10	625	65	689	90.6	9.4
1985	1.32	0.07	461	43	504	91.5	8.5
1986	1.06	0.08	370	52	422	87.7	12.3
1987	1.65	0.08	577	54	631	91.5	8.5
1988	1.40	0.12	490	77	566	86.5	13.5
1989	1.67	0.11	586	68	654	89.6	10.4
1990	1.82	0.12	637	79	715	89.0	11.0
1991	1.68	0.07	587	46	633	92.7	7.3
1992	1.28	0.10	447	63	511	87.6	12.4
1993	1.28	0.11	448	73	522	85.9	14.1
1994	1.76	0.10	617	66	683	90.4	9.6
1995	2.13	0.11	745	69	814	91.5	8.5
1996	1.77	0.13	621	82	703	88.3	11.7
1997	1.75	0.12	612	79	690	88.6	11.4
1998	1.44	0.13	506	84	590	85.8	14.2
1999	1.17	0.09	410	58	468	87.6	12.4
2000	1.30	0.11	456	68	524	87.0	13.0
2001	1.06	0.09	370	59	429	86.3	13.7
2002	1.02	0.10	357	66	422	84.5	15.5
2003	1.40	0.12	490	76	566	86.6	13.4
2004	1.37	0.11	478	70	548	87.3	12.7
2005	1.22	0.10	426	62	488	87.2	12.8
2006	1.27	0.11	443	72	515	86.0	14.0
2007	1.40	0.16	488	105	594	82.3	17.7
2008	1.57	0.22	551	145	696	79.2	20.8
2009	1.38	0.16	484	103	587	82.4	17.6

Notes: It is assumed that one ton of seed cotton gives 350 kgs of lint and 650 kgs of cottonseed.
Source: Author's calculations from *US Department of Agriculture* data.

Figure E2
US Prices of Fats and Oils (Nominal, US$/ton, 2006/09 average)



Source: *US Department of Agriculture* 22

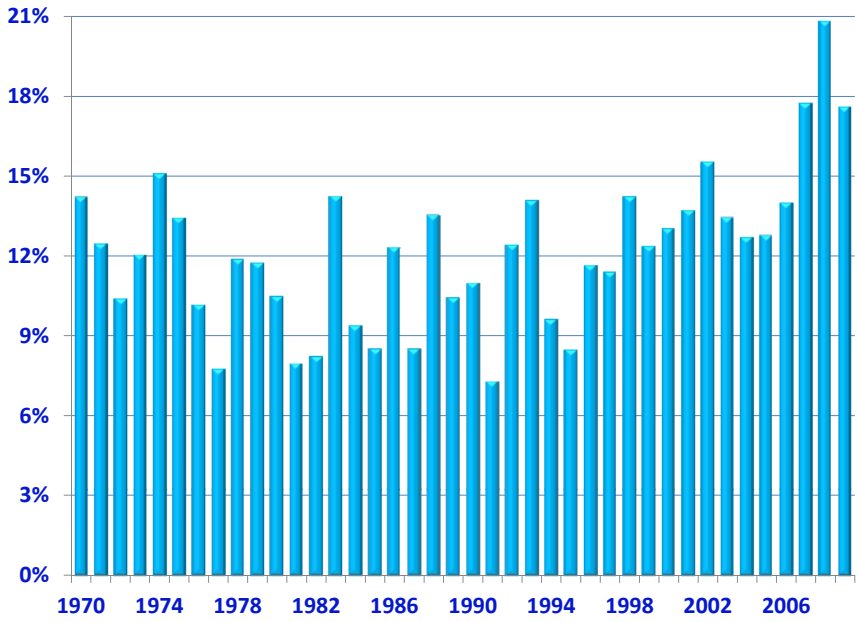
In a study of demand for cottonseed by the US dairy industry, Argüello (2008) found that cotton meal has an own-price demand elasticity of -0.41 but much higher cross-price elasticities from competing feed grains and meals (some even greater than unity), implying that it is these substitute and complement products that matter most. This should not be surprising since the US and global market for feed grains is much larger than the cotton meal market and therefore, it is the demand and supply conditions of these markets that drive prices of cotton by-products (similar to the small size of the cotton oil market compared to the global edible oil markets discussed in the main text).

During the past 40 years the contribution of cottonseed to the total revenue from cotton has fluctuated considerably, from a low of 7.8 percent in 1977 to a high of 20.8 percent in 2008, evaluated at the US average ginning outturn ratio of 35 percent (see Figure E3). The average contribution in the period up to 2006 (i.e., excluding the recent boom) was 11.6 percent while the average in the past three years was 18.7 percent. This rise is remarkably similar to that in the global cotton oil/lint price ratio, discussed in the main text. Typically cotton growers in the US expect the value of by-products to cover their ginning costs. Unlike in most other countries (including the four SSA countries reviewed here), where

growers sell their seed cotton to ginning companies, US cotton growers use ginning services on a fee basis thus allowing them to retain ownership of the lint and seed after ginning. US retail consumers (and in other countries) prefer certain vegetable oils over others. Cotton oil, being one of the less-preferred oils, is not marketed as 'cotton oil' but generically as 'vegetable oil.' Paradoxically, the price of cotton oil (one way of gauging how much consumers value it) is higher than those of a number of edible oils such as corn oil that are sold at retail under their own names, (see Figures 6 and E2 for world domestic US prices).

A representative from the US food industry noted the following: "The consumer attaches value to some oils—peanut oil tastes better and fries well, canola and sunflower oil tout health benefits. When there is no discernable consumer reaction to the label it is easier to use a generic brand. This would allow a processor to include the best available oil at the lowest cost to the consumer and reduce the expense of constantly re-working the main elements of the label. Labeling laws enter into the picture as well." (Interview, April 22, 2010.) Cotton oil's poor reputation in the US goes as far back as the 1850s when cotton oil was mixed with domestically produced animal fats. One representative of the cotton oil industry has been quoted as saying in 1857: "We dare not call it cotton seeds oil lest it might prejudice the sale" (Nixon 1930, p. 77).

Figure E3
US Cotton Seed's Share in Value Terms (percent)



Source: Author's calculations based on *US Department of Agriculture* data

23

APPENDIX F
Questionnaire for Cottonseed Processing Companies

I. General questions

1. Name of operation, place, cotton region(s) it receives seeds
2. Size of operation (# of permanent and temporary employees, managers, engineers)
3. Wage rate of daily laborers and conditions of employment (i.e., how long is the employment contract, lunch or any other benefits provided, etc.)
4. Does the operation require working capital? If yes, does it have access to credit? Under what terms (e.g., interest rate, duration of loan, amount, etc.)?
5. How old is the machinery and equipment of the crushing facility?
6. How many years is the facility in operation?
7. Ownership structure (individual, company, cooperative, other)
8. Is the operation linked to a ginnery? If yes, which one? If not, is it part of a major operation or is it a free standing operation?
9. Total crushing capacity of the facility (e.g., tons of cottonseed per day)
10. Does the facility operate during cotton harvest only or does it go beyond that period (or perhaps it operates for a shorter period by starting later)?
11. Do they crush other types of oil seeds or just cottonseed?
12. Should there be any restrictions on the imports of other competing edible oils in order to keep cotton oil prices higher?

II. Cottonseed

13. Actual crushings for 2008 (and earlier years, if known)
14. Estimated (or actual) crushings for 2009
15. Who delivers the seeds (farmers, traders, middlemen, ginner representative?) What is the share for each group?
16. How many kgs is every seed delivery (average)?
17. Are there quality issues/problems with respect to seeds (e.g., seeds which have less oil content or lower quality oil)?
18. Does the oil facility have its own buyers that buy seeds from ginneries?
19. What is the average price paid for seed (as many years as possible)?
20. Does the price paid for seeds depend on the size of the delivery?
21. Is the price the same throughout the season? If not, what is the highest and lowest price?

22. Are there any long-term contracts between ginneries and cotton processing companies or are all transactions spot?
23. Are payments made in cash always or are deliveries made on credit?

III. Cotton oil

24. What is the average quantity sold per transaction?
25. What is the average sale per day?
26. Does the operation keep stocks or is all cotton oil sold after crushing?
27. Who buys the oil (individual consumers, companies, middlemen, traders)?
28. To the best of your knowledge, where is the oil consumed (locally, regionally, exported)?
29. Is the quality of the oil consistent or it depends on where the seeds come from?
30. Is all cotton oil going for human consumption or some goes to industrial uses?
31. Is there a standard packaging process (e.g., a 20-kg plastic container)?
32. Is cotton oil sold in bulk quantities?
33. What is the average price received for oil (as many years as possible)?
34. Does the price received depend on the size of the transaction?
35. Is the cotton oil price the same throughout the season? If not, what is the highest and lowest price?
36. Are all purchases made on cash or are there credit transactions?
37. Does the cotton oil go through any treatment or bleaching process?
38. Is there any discussion/idea of using cotton oil as feedstock to biodiesel?

IV. Cotton meal

39. How much cotton meal did the operation sell?
40. Was it sold in bulk?
41. Who were the buyers?
42. What is the average price received from the cotton meal?