Cotton Supply Response in Brazil: Traditional vs. Expansion Region

By

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COTTON SUPPLY RESPONSE IN BRAZIL:
TRADITIONAL VS. EXPANSION REGION

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Abstract

A linear supply system acreage allocation model is estimated for Brazil's four dominant field crops (cotton, soybeans, corn and rice) in Brazil's new and expanding cotton producing states of Mato Grosso and Goais, and the traditional South-Southeast and North-Northeast cotton producing regions. Cotton acreage response to additional field crop land (scale effect) and own and cross crop price elasticities are estimated. Results indicate that Goais has a higher cotton scale elasticity than Mato Grosso (0.72 versus 0.69), and that cotton acreage in the expanding region is significantly affected by own price and corn price behavior, but not by rice prices.

Introduction

The United States is the world's largest exporter of cotton accounting for 25% of world exports in the 1990's. Six countries account for forty percent of the world's cotton imports: The European Union (EU), Indonesia, China, Brazil, South Korea and Thailand. The United States exports to all these major markets, however, U.S. exports to the EU and Brazil represent only a small proportion of total cotton imports by these two countries. The world's four largest producing and consuming countries are China, the United States, India and Pakistan, which collectively account for 60% of world cotton production and consumption. The next three largest

consuming countries are Turkey, Brazil and Mexico, all of which also produce cotton but are often large importers (USDA-ERS, 2002).

For decades Brazil has been a major cotton producing, consuming and exporting country. Throughout the 1970's and 80's Brazil was a net cotton exporter, but by 1991 domestic cotton production was inadequate to satisfy domestic demand, and Brazil became a net importer. Brazil's importation of cotton increased throughout the early and mid 1990's, and reached a peak in 1996, when Brazilian cotton production was 305,906 MT, more than 56% less than the 700,000 MT Brazil produced in 1991.

A recent USDA-ERS study determined that the level of future U.S cotton exports will depend on two crucial factors: (1) consumption gains in markets relying largely on imported cotton like Mexico and Southeast Asia, and (2) the degree to which cotton producers like China, Turkey, and Brazil rely on imports rather than domestic production to meet the growing needs of their textiles industries (USDA-ERS, 2000c). Brazil is now viewed as a sleeping giant with the potential to become a major competitor to U.S. Cotton exports in international markets. Brazil has more than 89 million hectares of uncultivated land in the Cerrado Savannah, located in the Brazil's central plateau region, rich in water resources with ideal climatic and agronomic conditions for cotton production.

Structural Change

Beginning in 1996, the Brazilian cotton sector has undergone a radical transformation. Cotton production substantially declined in the traditional producing regions of South and Northeast Brazil, and rapidly expanded into the Cerrado Savannah. Historically, Brazilian cotton production was concentrated in two main regions, the south-southeast and the north-northeast areas of the country. In 1989/90 these two regions collectively accounted for 96% of Brazilian

total cotton acreage and 93% of total cotton production in 1989/1990. However, by 2002/2003, the share of total Brazil cotton acreage and production in these two regions had decreased to 46% and 30% respectively. During this time period cotton production was expanding in the new fertile and resource abundant Central West area of the country. Cotton production in the central west area jumped from a 4% acreage share and 7% production share in 1989/1990 to shares of 54% and 63% respectively in 2002/2003.

Various factors motivated the shift of cotton production from the traditional regions to the extensive Cerrado Savannah of the central west states. The most important factors were the development of new technologies for managing cerrado soil, advances in crop varieties, Cerrado's cheap and abundant land and water resources, ideal climatic and agronomic conditions, large parcels of land suitable for large highly mechanized crop production, and government incentives to expand the agricultural frontier in the new region. Another crucial factor facilitating cotton expansion and relocation into the new region are the extremely high cotton yields.

The Cerrado Savanna consists of 207 million hectares and totally or partially encompasses 9 of the 27 Brazilian states (Mato Grosso, Mato Gross do Sul and Goais, Rondonia, Minas Gerais, parts of Bahia, Tocantis, Piaui and Maranhao), all of which share common agricultural conditions and characteristics. To date, only 47 million hectares of the Cerrado Savannah has been brought into agricultural production, but EMPRAMPA, Brazil's Agricultural Research Organization estimates that another 89 million hectares could be developed for large scale, mechanized agriculture in the near feature. This potential new acreage is greater than the combined U.S. area of corn, soybeans, wheat, and feed grains (rye, oat and sorghum) (http://agbrazil.com/brazil_s_agriculture_frontier.htm). Within the Cerrado Savanna,

cotton production is now heavily concentrated in the states of Mato Grosso and Goais, however, the seven other states spanned by the Cerrado Savannah have significant acreage suitable for large scale cotton production. This analysis incorporates all Brazilian cotton producing states and classifies the South-Southeast region and North-Northeast region as the traditional cotton producing regions and two central west states, Mato Grosso and Goais, as the new or emerging Brazilian region. Between 1996/97 and 2000/01 cotton acreage planted in these two states increased from 125,000 hectares to 520,000 hectares, and represented 58% of the Brazil's total cotton acreage in 2000/2001. Cotton production in this new region increased from 104,000 MT in 1996/97 to 645, 000 MT in 2000/2001 **(Figure 1)**, rising from a 34% share of total production in 1996/97 to 69% share in 2000/2001. This rapid expansion allowed Brazil to become cotton self-sufficient in 2001, with a production volume of 938,000 MT, and a net exporter in 2002.

In both the traditional and new regions, cotton competes for agricultural resources with the other major field crops such as soybeans, corn, rice and wheat. Similarly, these crops compete with pasture, food crops and livestock activity. The traditional and new regions are distinguished by differences in climate, cropping patterns and other farm characteristics, particularly farm size (Scneph, et. al.). The traditional regions (specially the South-Southeast area) , being closer to the country's urban centers and major ports, have an advantage in transportation and marketing infrastructure relative to the new region. A major disadvantage confronting the traditional regions is that small farm size has inhibited economies of scale and large mechanization. Even though the new region has a less developed infrastructure, the existence of larger, more mechanized farms has allowed the advance of economies of scale and technological developments, increasing production efficiency and yielding higher per hectare yields. Average cotton yield was 1.36 MT/HA in Mato Grosso in 2001 compared to an average

yield of 1.01 MT/HA in the traditional area **(Figure 2)**. As a frame of reference, average U.S. cotton yield is 0.7 MT/HA. Besides Brazilian advantage in terms of cotton yields and land availability, the country has lower production costs relative to most other cotton producing countries **(Figure 3)**. The net cost of production in Brazil is 35 U.S. cents per pound (US$ 772 /MT), almost half the United States net cost of production of 68 U.S. cents per pound (US$ 1499 / MT) (Lima, 2002).

The recent changes in the Brazilian cotton sector, coupled with the enormous potential to expand cotton production, indicate that Brazil has the potential to become a powerful competitor to U.S. cotton in international export markets. In 2003 Brazil was the 5th largest cotton producing and the third largest cotton exporter country in the world. Given the high yields, abundant acreage, favorable growing conditions, and low net cost of production of the new region, it is likely that future cotton production increases will emanate from the new area. Therefore it is important to know the cotton supply response to future increases in agricultural land in the Brazil's new region, as well as, the impact that own and competing crop prices have on the acreage allocation decision to gage Brazil's potential to become an increasingly important competitor in world cotton export market.

The objective of this study is to statistically estimate the cotton supply response in Brazil's cotton producing regions, taking into account anticipated future increases in land availability, and the relative gross profitability of the major competing field crops (soybeans, corn, rice and cotton) grown in Brazil's agricultural areas. The main focus of the analysis is on the new region's cotton supply response since Brazilian cotton production is now concentrating in this region. Scale elasticities, and own and cross price elasticities will be derived from an econometric model that estimates the acreage allocation equations within a supply systems

framework. The scale elasticity provides a statistical estimate for the percentage change in cotton acreage that would result from a 1% percentage change in total agricultural area devoted to field crops.

Methods and Procedures

Bettendorf and Blomme (1994) and Barten and Vanloot (1996) developed an econometric model to estimate acreage response elasticities within a supply system framework that incorporates a total acreage constraint, allowing the calculation of acreage scale elasticities, defined as the response of a particular crop to an increase in total agricultural land. The Bettendorf and Blomme (1994) and Barten and Vanloot (1996) models (BB-BV) assume the decision making process a farmer uses when determining how to allocate available crop acreage to each crop is similar to the investment decision an investor makes who diversifies the composition of his investment portfolio based on own and relative prices, individual risk preferences and budget availability. Thus, the acreage allocation decision is a function of the total acreage constraint, expected returns, and risk of expected returns. Based on these behavioral assumptions, BB and BV develop a linear acreage allocation system. These authors show that scale elasticities, and own and cross price elasticities can be readily derived from their acreage allocation system. The BB and BV model was specified as a one-region first-order differential time series allocation model.

Holt (1999) subsequently developed a variation of the BB-BV model, termed the "Linear Approximate Acreage Allocation Model". Holt explicitly notes that there are cases when the first-order differential acreage allocation model proposed by BB-BV is neither practical nor feasible; particularly, when only cross sectional or panel data with few time series observations are available. Given that only 14 time series observations on each of the 4 crops was available

for the 4 dominant Brazilian cotton producing regions, this study adopts Holt's empirical specification.

Acreage, yield and price data was collectively obtained from IBGE, the Brazilian Research Institute, and FGVDADOS, a privately owned Brazilian database service. The cotton production, yield, and producer price data used in this analysis is for seed cotton as opposed to lint cotton. A conversion factor of 0.35 was estimated from a 14-year Brazilian time series data set for lint yield per pound of processed bulk cotton.

A systems approach was used estimate the acreage allocation model for four crops consisting of: cotton (i=1), soybeans (i=2), corn (i=3) and rice (i=4) using panel data for the four Brazilian cotton producing regions which are specified as Goais (k=1), Mato Grosso (k=2), South-Southeast (k=3) and North-Northeast (k=4). The first two regions, Goais and Mato Grosso constitute two individual states that are collectively referred to as the new or emerging production region. The other two regions are conglomerates of states located in the North-Northeast and South-Southeast areas of the country. Between 1990 and 2003, the average share for cotton acreage in the new region was 3.69%, and the average shares for soybeans, corn and rice were 59.71%, 24.65% and 11.91% respectively. Although other crops are produced within the region, the statistical model only includes those crops that directly compete with cotton. Wheat was excluded because it represents only a small percentage of total acreage in the new region and does not compete with cotton acreage. Other activities such as food crop, pasture and ranching also do not directly affect cotton production decisions in a given year.

In any given year, the share of acreage allocated to a given crop is a function of the total acreage dedicated to the four crops and own and competing crop gross revenues. The dependent variable is the share of available acreage devoted to crop i in region k in year t (V_{ikt}). By

construction, the total quantity of agricultural land that can be allocated to the four competing

crops in a given year and region (A_{kt}) is equal to the sum of the acreage allocated to the each of

the four crops in a given year and region (a_{ikt}). This relationship is shown in equation (1):

(1)
$$A_{kt} = \sum_{i=1}^{4} a_{ikt}$$

Where A_{kt} is total land available in region k in year t and a_{ikt} is land allocated to crop i, in state k,

and year t. The crop acreage share for crop i in state k in year t (V_{ikt}), is derived by dividing the

quantity of acreage allocated to each crop by total available acreage in the given state and year

and is calculated using equation (2):

(2)
$$V_{ikt} = a_{ikt} / A_{kt}$$

Expected gross revenue per hectare (GR) for each crop in a given year, is used to explain

the share of acreage allocation to each crop in that year. Net revenue per hectare, the difference

between gross revenue and costs, is the preferred explanatory variable but state level cost data

was not available. If we assume that crop production cost does not vary significantly over time,

then expected crop gross revenue can be used as a proxy for expected crop net revenue. We

assume the producer bases the acreage allocation decision on prior year yield and expected

market price. Expected per hectare gross revenue for crop i in region k in year t (GR_{ikt}) was

calculated using equation (3):

(3)
$$GR_{ikt} = P_{ikt} * (Y_{i,k,t-1})$$

Where P_{ikt} is the average monthly price received by farmers, for crop i in region k in marketing

year t (MY_t), measured in Brazilian Reais ($R) per metric ton (MT). To be consistent with our

assumptions concerning producer behavior, MY_t was defined as beginning in September of year

t-1 and ending in August of year t, which is the month prior to the time when the acreage

allocation decision is made in year t. $Y_{i,k,t-1}$ is average per hectare yield for crop i planted in state k in the prior year.

Using the constructed variables presented in equations (1) to (3), the acreage allocation system was estimated using the Non-Linear Seemingly Unrelated Regression (SUR) procedure provided by the SHAZAM Econometric Software package (Version 9). The four share crop equation allocation system was estimated as:

$$(4) \qquad V_{ikt} = B_i + \sum_{j=1}^{4} S_{ij}\, GR_{jt} + SS_{ijh}(P_h * GR_{jkt}) + \sum_{k=2}^{4} C_{ik}D_k + U_{ikt}$$

where B_i and S_{ij} and C_{i1} are the coefficient parameters to be estimated in each share equation. In the ith share equation the B_i parameter represents the *average scale effect* in the reference state (Goais), and measures how much more (less) acreage will be planted to the ith crop if total land availability increases. The S_{ij} parameters measure how the share of acreage allocated to a specific crop i responds to change in its own gross return (i=j) and changes in other crop gross returns (i≠j) in the new region states, Goais and Mato Grosso. The C_{ik} parameter in each share equation adjusts for potential differences in the scale effect between the each region used in the pooled data estimation procedure, where k=2 for Mato Gross, k=3 for the South-Southeast region and k=4 for the North-Northeast region. The variable D_2 (an intercept shifter) is a dummy variable that has the value of 1 if the state is Mato Grasso and a value of 0 otherwise; D_3 takes a value of 1 if the region is South-Southeast and 0 otherwise, and D_4 takes a value of 1 if the region is North-Northeast and 0 otherwise. The SS_{ij} parameter in each share equation accounts for the difference in gross revenue parameters between the traditional and new regions. The variable P_h is a slope shifter dummy variable that takes a value of 1 for traditional regions of North-Northeast and South-Southeast and a value of 0 otherwise. The slope shifting parameters allow

the supply response to changes in relative gross return to vary between production regions, due to differences in agronomic and climate factors, in addition to possible differences in producer behavior existing between the two regions. The term U_{ikt} is the random error term with mean zero. The theoretical restrictions of adding up, homogeneity, and symmetry were imposed on the estimated model. The imposed restrictions used in equations (4) are defined as $\sum_i B_i = 1$, $\sum_i S_{ij} = 0$, and $\sum_i C_{i1} = 0$ and $\sum_i SS_{ij} = 0$ (adding up); $\sum_j S_{ij} = 0$ (homogeneity), and $S_{ij} = S_{ji}$ (symmetry). Two sets of homogeneity and symmetry restrictions were imposed on the estimated model. One set of restrictions was applied to the emerging region and a second set to the traditional region. By imposing the restrictions in this manner, the estimated price effect parameters are allowed to vary between regions while maintaining theoretical consistency within each region. Because the covariance matrix associated with the error terms in equation (4) will be singular, an equation must be deleted in estimation (Barten, 1969). Accordingly, the rice equation was dropped in estimation. Economic theory suggests that S_{ii} parameter should be positive implying that acres planted to crop i will increase as the expected return to crop i increases. Conversely, S_{ij} ($i{\neq}j$) is expected to be negative as acreage allocated to crop i is likely to decrease if crop j return increases.

The coefficients of the estimated model can be transformed into scale elasticities, and own and cross-price elasticities for purposes of estimating the percentage increase (decrease) in acreage allocated to each crop. The scale elasticity, η_i, estimates the percentage increase or decrease in acreage devoted to crop i for a 1% increase available crop acres. As usual the own price and cross price elasticities, ε_{ij}, respectively measure the percentage change in acreage allocated to specific crop i for a 1% change in the crop i gross revenue, and the percentage change in acreage allocated to crop i for a 1% change in the price of crop j.

Equations (5) and (6) present the elasticity calculation used in this analysis.

(5) $\qquad \varepsilon_{ij} = (\partial a_i / \partial P_j) * (P_j / a_i) = S^*_{ij} / V_i$ $\qquad$ (Price elasticities)

(6) $\qquad \eta_i = (\partial a_i / \partial A_k) * (A_k / a_i) = B^*_{ij} / V_i$ $\qquad$ (Scale elasticities)

Where $S^*_{ij} = S_{ji}$ for crop acreage in the new region and $S_{ij} + SS_{ij}$ for crop acreage in the traditional region. Similarly, $B^*_{ij} = B_{ij}$ when calculating scale elasticity for Goais (region 1) and is equal to $B_{ij} + C_{ik}$ in other regions.

Results

Parameter estimates, multiplied by 100, are reported in **Table 1**. Overall, 19 of the 24 estimated coefficients are statistically significant at the $\alpha = 0.05$ level. Of special relevance to this analysis is that the scale effect coefficients for all the crops and regions, B_i, were statistically significant at the $\alpha = 0.01$ level, or higher. Moreover the statistical significance of two of the three fixed effect parameter in the cotton share equation, C_{1k}, implies a significant difference in the cotton scale effect between Goais and the two traditional regions, but an insignificant difference with Mato Grosso, the other emerging state. Thus, the cotton scale effect is similar in both new region states. The R^2 for the cotton, soybeans, corn, and rice equations are 46%, 97%, 91%, and 88% respectively.

Focusing on the cotton allocation equations for the emerging region, the parameter estimates for the scale effect, own gross returns and cross gross returns for soybeans and corn are statistically significant. The cross-gross return coefficient for rice is not significant. Collectively these results suggest that cotton acreage significantly responds to changes in own and corn gross returns but does not directly compete with rice for available acreage. Although the cross

soybeans gross return parameter is statistically significant, it has the wrong sign, implying that cotton acreage responds positively to increases in soybean gross returns. This result might be explained by the fact that Brazilian government has actively encouraged soybean production and acreage expansion within the Cerrado Savannah through a variety of incentive and support programs over the last twenty years. Given increase in total available land in combination with the relocation of cotton acreage into the new region, cotton producers migrating into the new region may have been more focused on relocating and establishing large scale cotton production in the new region y than competing soybean prices when planting their land to cotton.

Somewhat surprisingly, within the emerging region the cotton scale effect coefficient is the smallest of all the crop scale coefficients. Soybeans has the highest scale coefficient, followed by corn in Goais, and rice in Mato Grosso. In the traditional South-Southeast and North-Northeast regions, the cotton supply response is inconsistent with regional economic signals. The own, soybeans and corn gross return coefficients in the cotton share equations in the two regions are incorrectly signed. However, the Brazilian cotton sector has been moving rapidly into the new region due to the new regions competitive advantage throughout this time period. It is likely the economic signals generated by the expansion region such as cheaper land and abundant water resources, higher yields and lower production costs had a greater influence on Brazilian cotton producers to reduce acreage in the traditional areas and expand acreage in the new region regardless of the regional price signals in the traditional region.

Calculated scale, own price, and cross-price elasticities are reported in **Table 2** with their associated t-values. The cotton scale elasticities in the traditional regions are greater than for the emerging regions, but since cotton production is concentrating in the expansion region and no substantial increases in crop land are expected in the traditional regions, the emerging region

scale elasticities are likely more representative of the future Brazilian cotton acreage response to additional land. The estimated cotton scale elasticity is 0.69 for Mato Grosso, and 0.72 for Goais indicating that a 10% increase in land devoted to field crops in the Mato Grosso state would result in a 6.9% increase in area devoted to cotton in that state. Similarly, a 10% increase in land devoted to field crops in Goais state, would increase cotton acreage by 7.2%. The own cotton price elasticity is 0.35 for Mato Grosso and 0.32 for Goais , meaning that a 10% increase in cotton price would cause farmers to increase cotton acreage by 3.5% in Mato Grosso and 3.2% in Goais. The corn price elasticity of -0.23 for Mato Grosso and -0.20 for Goais indicates that a 10% decrease in corn prices would result in a 2.3% increase in cotton acreage in Mato Grosso and 2.20% in cotton acreage in Goais.

In the emerging region, the scale elasticity for rice was the greatest, followed by the corn, soybeans and cotton. The rice scale elasticity is 1.26 for Goais and 1.21 for Mato Grosso, almost double their respective cotton scale elasticities. These results suggest that as crop land increases, Brazilian farmers have tended to allocate higher proportions of land to rice, corn and soybeans than to cotton in the emerging region. However, since the cotton world acreage base is much smaller than the other crops worldwide, and given that Brazil is an important cotton producer, even modest increases in cotton acreage in Brazil's rapidly growing new agricultural frontier, will generate substantial increases in Brazilian cotton production. Significant production increases will increase Brazilian cotton exports, where Brazil is already the third largest cotton exporter in the world, and could significantly impact the world cotton market.

Conclusions

Brazilian cotton production is becoming increasingly concentrated in Brazil's central-west states of Mato Grosso and Goais, which comprise part of the extensive Cerrados Savannah. Brazilian

potential to significantly increase cotton production and exports in the medium-long term is enormous due to its comparative advantage in terms of extensive uncultivated land availability, abundant water resources, ideal climatic and agronomic conditions, extremely high cotton yields and low net production costs. The realization of that potential will depend on various crucial factors such as cotton future profitability and the ability of cotton to out compete corn, soybeans and rice for the acreage in the future, as well as the degree to which the Brazilian government implement adequate policies and support programs to promote a massive expansion in Brazil's cotton production and exports (the Brazilian government has already shown a willingness to help soybeans producers in the region). Another decisive factor for the realization of that potential will be implementation of private and public efforts in order to improve transportation and marketing infrastructure in the Brazilian expansion region.

The acreage allocation model suggests that Brazilian cotton acreage is significantly responsive to economic signals in the new region, but not in the traditional region mainly due to the ongoing structural transformation of the Brazilian cotton sector. Moreover, results indicate that cotton is the least responsive crop to increases in field crop land in relation to rice, soybeans, and corn in the emerging region. This suggests that as field crop land increase in the emerging states of Mato Grosso and Goais, cotton acreage will grow more slowly than rice, soybeans and corn acreage. However, considering the small worldwide cotton acreage base, and Brazil's significant role as a major cotton producing country, additional agricultural land, favorable cotton prices and appropriate government incentives may significantly increase Brazil's production levels and make Brazil an even more influential player in the world cotton export market.

References

Barten A. P. "Maximum Likelihood Estimation of a Complete System of Demand Equations." European Economic Review, 1 (Fall 1969): 7:73.

Barten, A. P., and C. Vanloot . "Price dynamics in Agriculture: An exercise in Historical Econometrics." Econometric Modeling, 13 (July 1996): 315-31.

Bettendorf, L., and J. Blomme. "An Empirical Study of the Distribution of Crops in Agricultural Land in Belgium." Historical Social Res, 19 (1994): 53-63.

Gertulio Vargas Foundation, FGVDADOS, Brazil's Producer Prices. Internet Source: http://fgvdados.fgv.br/. Data accessed: August 15, 2003.

Holt, Matthew T. "A Linear Approximate Acreage Allocation Model", Journal of Agricultural and Resource Economics, 24 (2), (1999): 383-397.

Instituto Brasilero de Geografia e Estadistica (IBGE). Bank of Aggregated Data. Brazil Ministry of Planning, Organization and Development. Internet Source: http://www.sidra.ibge.gov.br/bda/ Data accessed: July 20, 2003.

Lima, Campos, Aluisio. "Causes and Consequences of Low Prices in the Cotton Sector"; Presented paper at the Conference on Cotton and Global Trade Negotiations. Whashington D.C. July 9, 2002.

Schepf, R.D., E, Dohlma and C. Bolling. Agriculture in Brazil and Argentina: Development and Prospects for Major field crops: U.S. Department of Agriculture, ERS For Agr. Econ. Rep., January 2003.

U.S. Department of Agriculture, Economic Research Service. Briefing Room: Cotton, 19 July 2002. Internet Source: http: //www.ers.usda.gov/Briefing/Cotton/. Data accessed: January 25, 2003.

U.S. Department of Agriculture, Economic Research Service. Briefing Room: Background, 19 July 2002. Internet Source: http://www.ers.usda.gov/Briefing/ Cotton/background; Data accessed: January 30, 2003.

U.S. Department of Agriculture, Economic Research Service. <u>Briefing Room: Cotton: Trade, 19 July 2002</u>. Internet Source: [http://www.ers.usda.gov/Briefing / Cotton/trade](http://www.ers.usda.gov/Briefing); Data accessed: January 30, 2003.

U.S. Department of Agriculture, Economic Research Service. Briefing Room: Brazil: Trade, 19 July 2002. Available from http://www.ers.usda.gov/Briefing /Brazil/trade; Internet; Accessed 30 January 2003.

Table 1. Estimated Acreage Allocation Model Parameters

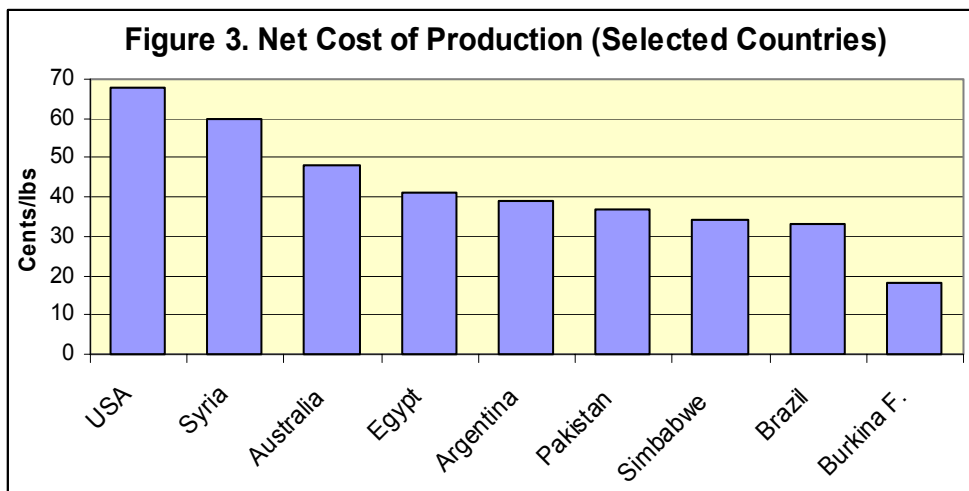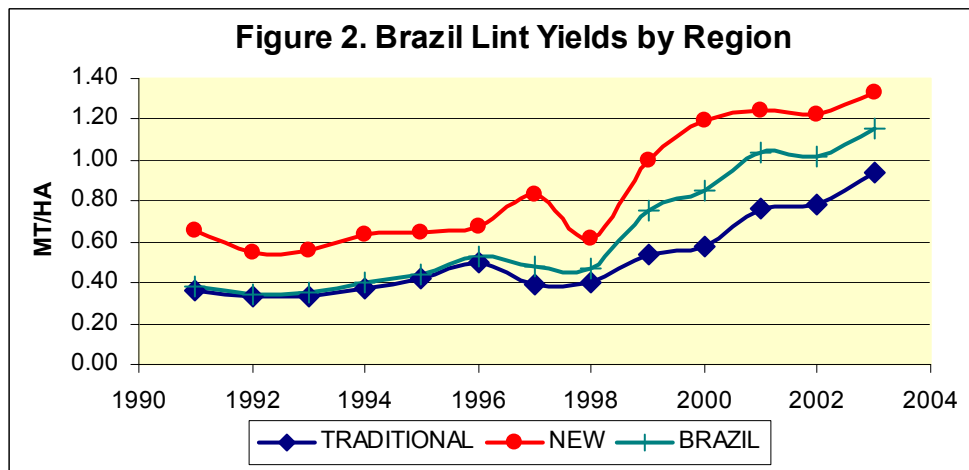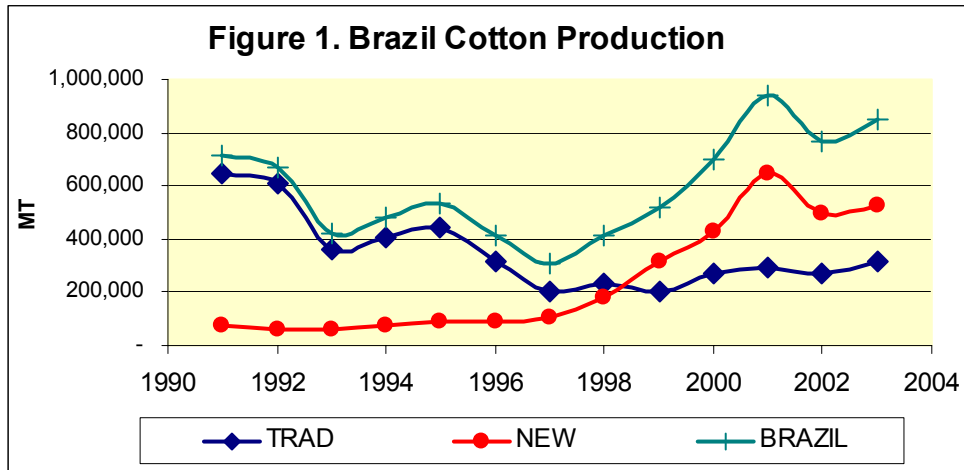|	Parameter	Std. Error	t-Ratio	p-Value
B_{11}	2.609	0.006	4.506	0.000
S_{11}	0.002	0.000	2.482	0.014
S_{12}	0.003	0.000	2.109	0.037
S_{13}	-0.003	0.000	-2.125	0.036
C_{11}	-0.336	0.008	-0.434	0.665
C_{12}	2.878	0.009	3.266	0.001
C_{13}	3.415	0.009	3.636	0.000
SS_{11h}	-0.006	0.000	-2.673	0.009
SS_{12h}	-0.002	0.000	-0.537	0.592
SS_{13h}	0.011	0.000	3.576	0.001
B_{21}	46.525	0.012	37.436	0.000
S_{22h}	0.022	0.000	3.190	0.002
S_{23h}	0.004	0.000	1.085	0.280
C_{21}	16.947	0.016	10.678	0.000
C_{22}	-6.516	0.018	-3.713	0.000
C_{23}	-41.731	0.019	-21.515	0.000
SS_{22h}	-0.012	0.000	-1.314	0.192
SS_{23h}	-0.017	0.000	-3.723	0.000
B_{31}	35.050	0.012	29.280	0.000
S_{33h}	0.007	0.000	1.719	0.088
C_{31}	-19.388	0.017	-11.171	0.000
C_{32}	12.591	0.019	6.466	0.000
C_{33}	11.397	0.019	5.956	0.000
SS_{33h}	-0.016	0.000	-4.228	0.000

Log Likelihood: 360.4597

Cotton: $R^2 = 0.463$

Soybeans: $R^2 = 0.973$

Corn: $R^2 = 0.9185$

Rice: $R^2 = 0.889$

Notes: R^2 denotes the square of the simple correlation between observed and fitted allocations. There are a total of 52 observations. For B_i, S_{ij}, C_{il} and SS_{ijh} i=1 (Cotton), 2 (Soybeans), 3 (Corn), and 4 (Rice);l=2 Mato Grosso; 3 South-Southeast, and 4 North-Northeast; and h=1 in the South-Southeast And North-Northeast regions.

Table 2: Estimated Scale, Own-Price and Cross-Price Elasticities

	N_i		Cotton Price		Soybeans Price		Corn Price		Rice Price	
	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Goais										
Cotton	0.72	4.51	0.32	2.48	0.36	2.11	-0.21	-2.13	-0.19	-1.82
Soybeans	0.94	37.44	0.04	2.11	0.18	3.19	0.02	1.08	-0.09	-3.00
Corn	1.02	29.28	-0.05	-2.13	0.05	1.08	0.06	1.72	-0.07	-2.03
Rice	1.27	14.24	-0.12	-1.82	-0.46	-3.00	-0.18	-2.03	0.98	5.75
Mato Grosso										
Cotton	0.69	3.66	0.36	2.48	0.40	2.11	-0.23	-2.13	-0.19	-1.82
Soybeans	0.95	56.89	0.03	2.11	0.13	3.19	0.02	1.08	-0.07	-3.00
Corn	1.05	12.23	-0.12	-2.13	0.11	1.08	0.13	1.72	-0.17	-2.03
Rice	1.22	20.57	-0.10	-1.82	-0.37	-3.00	-0.15	-2.03	0.80	5.75
South-Southeast										
Cotton	1.36	8.08	-0.61	-1.95	0.15	0.57	0.58	3.07	-0.47	-1.80
Soybeans	0.95	30.01	0.02	0.57	0.10	1.68	-0.08	-3.11	0.01	0.17
Corn	0.96	27.23	0.11	3.07	-0.10	-3.11	-0.05	-2.07	-0.08	2.66
Rice	1.59	5.53	-0.96	-1.80	0.09	0.17	0.86	2.66	-0.57	-0.93
North-Northeast										
Cotton	1.31	8.51	-0.54	-1.95	0.14	0.57	0.51	3.07	-0.42	-1.80
Soybeans	0.72	3.43	0.16	0.57	0.61	1.68	-0.53	-3.11	0.74	1.83
Corn	0.96	31.74	0.12	3.07	-0.11	-3.11	-0.05	-2.07	0.08	2.66
Rice	1.06	38.47	-0.10	-1.80	0.01	0.17	0.09	2.66	-0.06	-0.93

Figure 1. Brazil Cotton Production

Figure 2. Brazil Lint Yields by Region

Figure 3. Net Cost of Production (Selected Countries)

Source: Lima, 2002