Assessing the Competitiveness of Indian Cotton Production: A Policy Analysis Matrix Approach

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Abstract

This paper uses a modified policy analysis matrix (PAM) approach to assess the efficiency of cotton production in five major producing states in India. The results indicate that cotton is not efficiently produced in the second-largest cotton-producing state in the country. Without government interventions in this state, it is likely that acreage will move away from cotton to more profitable crops such as sugarcane and groundnut. In addition, we conclude that cotton is not the most efficiently produced crop in the other four states; however, there is at least one crop in each state that is less efficiently produced than cotton. These findings suggest that Indian policies directed at maintaining the availability of cheap cotton for the handloom and textile sectors have induced major inefficiencies in the cotton sector.

Key words: agricultural policy, cotton production, efficiency, India, protection.

Assessing the Competitiveness of Indian Cotton Production: A Policy Analysis Matrix Approach

Introduction

This study is an application of a policy analysis matrix (PAM) to assess the competitiveness of Indian cotton, which is produced under a web of contradictory policies, including price supports, and various input subsidies, such as fertilizer, power, irrigation, and credit subsidies. Because cotton is produced under a wide range of heterogeneous conditions in India, this study attempts to measure the efficiency of cotton production by state. Interestingly, the results suggest that the second-largest cotton-producing state in India, Maharashtra, does not have a comparative advantage in cotton. This is inconsistent with results from the standard Hechscher-Ohlin model, which would predict that Maharashtra would have a comparative advantage in such labor-intensive crops as groundnut and sugarcane because of its large labor endowment rather than in cotton, which is a more capital-intensive crop. In 1996/97, cotton used 866 man-hours per hectare compared to 1,765 for sugarcane and 1,066 for groundnut. These findings suggest that Indian policies directed at maintaining the availability of cheap cotton for the handloom and textile sectors have induced major inefficiencies in the cotton sector and that significant improvements in productivity will have to take place if cotton is to be competitive in states such as Maharashtra.

India is the third-largest cotton producer in the world, behind China and the United States, accounting for 25 percent of the world acreage but for only 14 percent of world production (calculated from the U.S. Department of Agriculture's Production, Supply and Distribution database). Despite being one of the largest cotton producers in the world, historically India has been more or less nonexistent on the world cotton market. However, following a series of unilateral economic reforms undertaken by policymakers in the early 1990s, India has started to re-emerge as a major player in the world cotton market, accounting for an average of 6 percent of world imports since 1999 and for 5 percent of all U.S. cotton sold in 2000 (USDA 2001). During the first four months of the 2001 marketing year, India accounted for an extraordinary 9 percent of all U.S. cotton sold for exports. Although the policy reforms were directed primarily towards industry and the international trade regime, India’s re-emergence as a cotton importer can be partly attributed to a reduction in input subsidies. More recently, the Government of India (GOI) announced its intent to reform the cotton and textile sector, however, no specifics were given as to what would be done or when.

Despite ongoing GOI efforts to reform the cotton and textile sectors, severe external and internal constraints remain in place. One of the external constraints was imposed by the Multifibre Arrangement (MFA), which included import quotas in the developed European and North American markets in contravention of the General Agreement on Tariffs and Trade (GATT) principles of open and non-discriminatory trade rules. Even more important are the internal constraints. They include a mandate to sustain the small-scale traditional handloom sector, export constraints on yarn, government fixing of cotton ginning and pressing fees, subsidization of raw cotton production, and an overvalued exchange rate that holds domestic producer prices well below world prices.

During the next decade, both the internal GOI interventions and the external trade constraints originally imposed under the MFA will fall. The Uruguay Round Agreement set a deadline of 2004 for returning textiles and apparel to the World Trade Organization (WTO) disciplines that govern other commodities. India is also removing its own import restrictions in order to meet its WTO obligations, and profound changes are likely for cotton and textile production in both India and in the rest of the world as this wave of unilateral and multilateral liberalization overturns long-established patterns of production and trade.

In light of these forthcoming external and internal changes, it is important to examine the competitiveness of the Indian cotton sector. In the following section, a brief description of cotton production in India, along with policies affecting cotton production, is presented. In the next section, the PAM technique is described. The third section provides a discussion of the data used and the modeling assumptions. The final section presents results with a discussion of the implications of the findings.

Indian Cotton Production and Policy

As shown in Figure 1, Indian cotton production has been concentrated in the western half of the country. It can be divided broadly into three major regions based on climatic differences and regional heterogeneity in the availability of water and other natural resources that influence the mix of crops in various parts of the country. These regions are the northern region (Haryana, Punjab, and Rajasthan); the central region (Maharashtra, Gujarat, and Madhya Pradesh); and the southern region (Karnataka, Tamil Nadu, and Andhra Pradesh). The northern region is the primary producer of short and medium staple cotton while the southern states primarily grow long staples. The central region produces mostly medium and long staples.

In the last decade, cotton acreage in each of the regions has increased significantly, with the total area increasing by nearly 2 million hectares during the period from 1990 to 1997. Although the acreage in each of the regions grew in the last decade, the yield has grown in an erratic manner. For example, between 1981 and 1994, yields in the northern and southern regions grew at a rapid annual rate of 6.6 and 4.2 percent, respectively, as

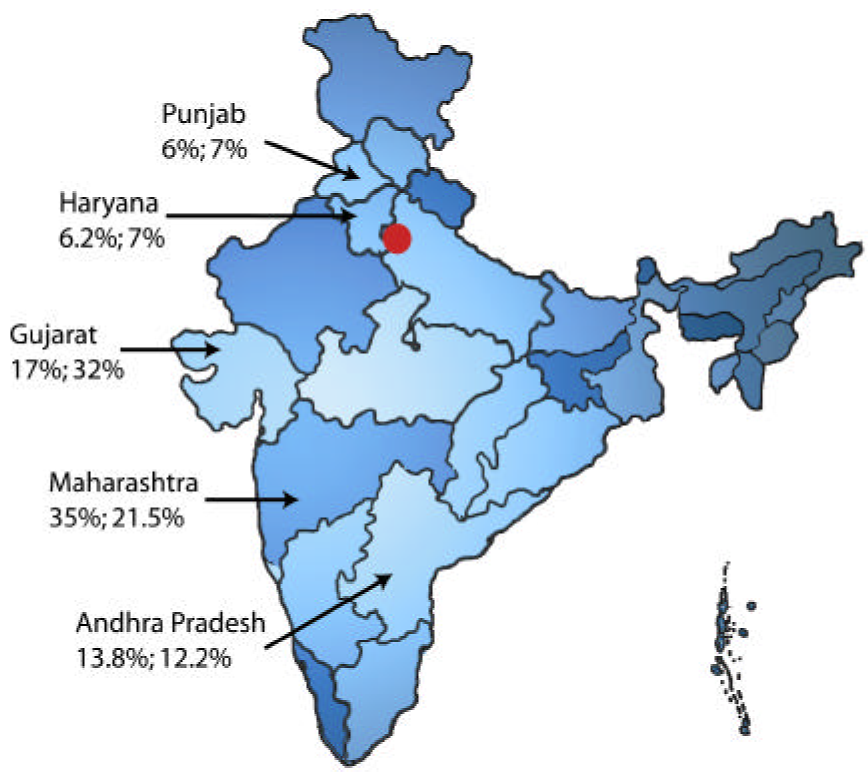

FIGURE 1. Indian cotton-producing states (area and production share in 1998/99)

compared to negative (–0.7 percent) growth in the central region (Chakraborty et al. 1999). Because of the negative yield growth in the central region in the last decade, Maharashtra with 35 percent of the total cotton area accounted for only 21.5 percent of total production (Figure 1). The major reason for the yield increases in both the northern and southern regions may be the adoption of improved varieties and irrigated production, whereas the central region, particularly in Maharashtra, has witnessed little to no growth in yield because of the use of low-yielding varieties and the reliance on rainfall. Overall, cotton yield in India is one of the lowest in the world, mainly because of the lack of irrigation, limited supplies of quality seeds, and poor management practices.

Cotton production policies in India historically have been oriented toward promoting and supporting the textile industry. The GOI announces a minimum support price for each variety of seed cotton (*kapas*) based on recommendations from the Commission for Agricultural Costs and Prices. In all states except Maharashtra, where there is state monopoly procurement, the government-run Cotton Corporation of India (CCI) is entrusted with market intervention operations in the event that prices fall below the minimum support price. In Maharashtra, cotton cultivators are prohibited from selling seed cotton to any buyer other than the Maharashtra State Cooperative Marketing Federation. However, with market prices above the minimum support level (50-70 percent on average during 1989/90-1994/95), the CCI's role in cotton procurement has declined substantially over the years. In order to compensate cotton farmers for low support prices, the Indian government has supplied inputs to the farmers at highly subsidized rates. The important production inputs that are subsidized by the government include fertilizer, power, and irrigation. Fertilizer subsidies, the largest input subsidy, have more than doubled in the last decade, increasing from 60 billion rupees in 1992/93 to 140 billion rupees in 2001/02.

Three major groups market both cottonseed and lint: private traders, state-level cooperatives, and the CCI. Of these three groups, private traders handle more than 70 percent of cottonseed and lint, followed by cooperatives and the CCI. Normally, Indian farmers sell their cotton in the form of *kapas* or seed cotton, mostly in a regulated market, which was established under the State Agricultural Product Markets Act (Chakraborty et al. 1999). The cheap cotton pricing policy is pursued at the border with the announcement of yearly export quotas for quantity and types of cotton lint depending on the local supply and demand situation. In addition, a minimum export price is also established to act as a disincentive to export.

The Policy Analysis Matrix and Measures of Comparative Advantage

The PAM is a computational framework, developed by Monke and Pearson (1989) and augmented by Masters and Winter-Nelson (1995), for measuring input use efficiency in production, comparative advantage, and the degree of government interventions. The basis of the PAM is a set of profit and loss identities that are familiar to anyone in business (Nelson and Panggabean 1991). The basic format of the PAM, as shown in Table 1, is a matrix of two-way accounting identities.

The data in the first row provide a measure of private profitability (N), defined as the difference between observed revenue (A) and costs (B+C). Private profitability demonstrates the competitiveness of the agricultural system, given current technologies, prices for inputs and outputs, and policy. The second row of the matrix calculates the social profit that reflects social opportunity costs. Social profits measure efficiency and comparative advantage. In addition, comparison of private and social profits provides a measure of efficiency. A positive social profit indicates that the country uses scarce resources efficiently and has a static comparative advantage in the production of that commodity at the margin. Similarly, negative social profits suggest that the sector is wasting resources that could have been utilized more efficiently in some other sector. In other words, the cost of domestic production exceeds the cost of imports, suggesting that

TABLE 1. Policy Analysis Matrix

		Value of Input		
	Value of Output	**Tradable**	**Domestic Factor**	**Profit**
Private prices	A	B	C	N
Social prices	D	E	F	O
Policy transfer	G	H	I	P

Source: Monke and Pearson 1989.
Note: Private profit: $N=A-(B+C)$; Social profit: $O=D-(E+F)$; Output transfer: $G=A-D$; Input transfer: $H=B-E$; Factor transfer: $I=C-F$; Net policy transfer: $P=N-O$.

the sector cannot survive without government support at the margin. The third row of the matrix estimates the difference between the first and second rows. The difference between private and social values of revenues, costs, and profits can be explained by policy interventions.

The PAM framework can also be used to calculate important indicators for policy analysis. The nominal protection coefficient (NPC), a simple indicator of the incentives or disincentives in place, is defined as the ratio of domestic price to a comparable world (social) price. NPC can be calculated for both output (NPCO) and input (NPCI). The domestic price used in this computation could be either the procurement price or the farmgate price, while the world reference price is the international price adjusted for transportation, marketing, and processing costs. The other two indicators that can be calculated from the PAM include the effective protection coefficient (EPC) and the domestic resource cost (DRC). EPC is the ratio of value added in private prices ($A–B$) to value added in social prices ($E–F$). An EPC value of greater than one suggests that government policies provide positive incentives to producers while values less than one indicate that producers are not protected through policy interventions.

DRC, the most useful indicator of the three, is used to compare the relative efficiency or comparative advantage among agricultural commodities and is defined as the shadow value of nontradable factor inputs used in an activity per unit of tradable value added ($F/(D-E)$). The DRC indicates whether the use of domestic factors is socially profitable (DRC<1) or not (DRC>1). The DRC values are calculated for each commodity in each state. The commodities can be ranked according to the DRC values, and this ranking is taken as an indication of comparative advantage or disadvantage within that state. A state will have a comparative advantage in a given crop if the value of the DRC for that crop is lower than the DRC for other crops grown in that state. Although the DRC indicator is widely used in academic research, its primary use has been in applied works by The World Bank, the Food and Agriculture Organization, and the International Food Policy Research Institute to measure comparative advantage in developing countries. However, DRC may be biased against activities that rely heavily on domestic, nontraded factors such as land and labor. A good alternative to the DRC is the social cost/benefit (SCB) indicator, which accounts for all costs (Fang and Beghin 1999; Beghin and Fang

2002). The SCB is calculated as a ratio $(E+F)/D$. Land is more restricted than other domestic factors in India's crop production. Therefore, an indicator for the SCB without land cost (LSB) is used to measure the return to this fixed factor. Higher values of SCB and LSB suggest stronger competitiveness.

One of the main strengths of this approach is that it allows varying degrees of disaggregation. It also provides a straightforward analysis of policy-induced effects. Despite its strengths, the PAM approach has been criticized because of its static nature. Some do not consider the results realistic in a dynamic setting (Nelson and Panggabean 1991). One of the ways to overcome this limitation is to conduct sensitivity analysis under various assumptions.

Data and Modeling Assumptions

The data requirements for constructing a PAM include yields, input requirements, and the market prices for inputs and outputs. Additional data such as transportation costs, port charges, storage costs, production subsidies, import/export tariffs, and exchange rates are also required to calculate social prices. In this study, a PAM will be compiled for cotton and its competing crops in five major cotton-producing states for 1996/97. These five states account for more than 85 percent of India's cotton production and represent the various types of cotton grown in India. Most data are available from the GOI's *2000 Cost of Cultivation of Principal Crops in India* (India, Ministry of Agriculture 2000). The survey is a comprehensive scheme for studying the cost of cultivation of principal crops. The survey is based on a three-stage stratified random sampling design with *tehsils* (a group of villages) as the first-stage unit, village/cluster of villages as the second-stage unit, and holding as the third-stage unit. Each state is demarcated into homogenous agro-climatic zones based on cropping pattern, soil types, rainfall, and other features. The primary sampling units are selected in each zone, with probability proportional to the area under the selected crops.

The most difficult tasks for constructing a PAM are estimating social prices for outputs and inputs and decomposing inputs into their tradable and non-tradable components (Yao 1997). For computing social prices for various commodities, including both outputs and inputs, world prices are used as the reference prices in the study. U.S.

FOB Gulf prices are used as reference prices for wheat, corn, and sorghum. Other representative prices used are the canola cash price, Vancouver, for rapeseed; the cotton A-index CIF Northern Europe (an average of the cheapest five types of cotton offered in the European market) for cotton; the raw sugar price FOB Caribbean and U.S. runner for sugar; and the 40 to 50 percent shelled basis CIF Rotterdam for groundnut. These world prices are obtained from various commodity yearbooks published by the U.S. Department of Agriculture. The world prices are adjusted for transportation costs and marketing costs to be comparable with farmgate prices. For imported commodities, social prices at the farmgate are calculated by adding marketing costs from the respective CIF Mumbai prices (calculated by adding the ocean freight charge to the FOB price) in domestic currency. Similarly, for exported commodities, social prices at the farmgate are calculated by adding the marketing cost from the respective world reference price in the domestic currency, converted to domestic currency. Freight rates from Gulf ports and Rotterdam are collected from Pursell and Gupta (1999) and added to the FOB Gulf and CIF Rotterdam prices. These prices are converted to domestic currencies using market exchange rates. Finally, marketing costs are added to compare with farmgate prices. Following Pursell and Gupta (1999), marketing costs consist of an interest charge for two months at an 18 percent rate applied to the CIF prices plus 10 rupees per metric ton to represent other marketing expenses. Similar procedures are used for calculating input shadow prices for fertilizers and pesticides.

Following Gulati and Kelley (2000), the social valuation of land is calculated as the ratio of net returns to land to the average of NPCOs of competing crops. The figure for net returns to land is calculated as the gross value of output minus the cost of production plus the rental value of owned land. Another important component of this analysis is the disaggregation of nontraded and traded inputs. Based on Monke and Pearson (1989), who suggested that decomposing all input costs is a tedious task and has only a very insignificant effect on results, some inputs such as land, labor, farm capital depreciation, animal power, and manure are assumed to be totally nontradable. Once the inputs are disaggregated into tradable and nontradable components, PAMs are constructed for cotton and its competing crops in each of the five states.

Interpretations of PAM Indicators

The summary results on protection coefficients for cotton in various states are reported in Table 2. The NPCO coefficients show that domestic prices in two out of five states (Maharashtra and Haryana) have remained above their corresponding international reference prices. Of the three remaining states, NPC in Punjab is very close to one, suggesting that the domestic price is slightly below the international price, whereas in the other two states (Gujarat and Andhra Pradesh) NPCs are much lower than one. Similarly, NPCI values of less than one in all cases suggest that the government policies are reducing input costs for cotton in all of the five states. NPC values of less than one for all input and most output markets clearly show government efforts to support the textile sectors by providing raw cotton at a cheaper price.

The EPC is a more reliable indicator of the effective incentives than the NPC, as the former recognizes that the full impact of a set of policies includes both output price

TABLE 2. Summary results of the protection coefficients in major cotton-producing states in India (1996/97)

		Wheat	Rice	Cotton	Groundnut	Rapeseed	Corn	Sugarcane
Punjab	NPCO	0.70	1.21	0.91				
	NPCI	0.72	0.69	0.88				
	EPC	0.70	1.34	0.92				
Haryana	NPCO	0.73	1.57	1.09		0.85		
	NPCI	0.72	0.69	0.81		0.69		
	EPC	0.72	1.88	1.13		0.87		
Maharashtra	NPCO			1.01	0.51			0.43
	NPCI			0.81	0.94			0.73
	EPC			1.06	0.45			0.41
Gujarat	NPCO	1.11		0.67	0.52	0.80		
	NPCI	0.78		0.85	0.93	0.68		
	EPC	1.17		0.64	0.46	0.81		
Andhra Pradesh	NPCO		1.45	0.63	0.44			0.47
	NPCI		0.75	0.85	0.91			0.74
	EPC		1.71	0.57	0.37			0.45

enhancing effects (import tariffs) and cost reducing effects (input subsidies). The EPC nets out the impact of protection on inputs and outputs and reveals the degree of protection accorded to the value-added process in the production activity of the relevant commodity. The EPC values in Table 1 show that there are significant differences in the degree of policy transfer for cotton across the major growing states. Haryana and Maharashtra farmers enjoy a support of 13 and 6 percent respectively for their value added whereas in the other three states, particularly in Gujarat and Andhra Pradesh, farmers face a net tax of around 40 percent on their value added.

The other PAM indicators, such as DRC, SCB, and LSB, for cotton and competing crops in each state are reported in Table 3 and their rankings in each state are reported in

TABLE 3. Results of the state-wide indicators for cotton and its competing crops (1996/97)

		Punjab	Haryana	Maharashtra	Gujarat	Andhra Pradesh
Cotton	DRC	0.65	0.96	1.35	0.55	0.78
	SCB	0.72	0.97	1.27	0.60	0.82
	LSB	7,141	11,017	2,281	15,781	19,265
Wheat	DRC	0.41	0.39		1.12	
	SCB	0.49	0.46		1.10	
	LSB	23,634	21,356		8,547	
Sugarcane	DRC			0.33		0.46
	SCB			0.37		0.49
	LSB			58,304		67,283
Rapeseed	DRC		0.44		0.88	
	SCB		0.47		0.89	
	LSB		14,124		13,291	
Rice	DRC	0.91	1.37			1.42
	SCB	0.93	1.24			1.3
	LSB	7103	91			841
Corn	DRC					0.36
	SCB					0.44
	LSB					10,698
Groundnut	DRC			0.34	0.44	0.27
	SCB			0.41	0.51	0.36
	LSB			16,461	20,223	16,182

Table 4. These indicators reaffirm the conclusions reached with the protection coefficients earlier. For high protection states like Maharashtra and Haryana, DRC values for cotton are much larger than their respective competing crops. In Maharashtra, the DRC value for cotton is estimated to be 1.35 as compared to 0.33 and 0.34 for sugarcane and groundnut respectively, suggesting that Maharashtra has a comparative advantage in producing sugarcane and groundnut rather than cotton. Government cotton policies, however, have led to significant allocative inefficiency because much land in Maharashtra is still planted to cotton. Similarly, in Haryana, the DRC indicator for cotton is close to one and is the second largest behind rice out of the four crops included in this study. DRC values for Haryana clearly indicate that it has a comparative advantage in producing wheat and groundnut as compared to cotton and rice. In the other three states (Punjab, Gujarat, and Andhra Pradesh), DRC values for cotton are found to be lower than

TABLE 4. Comparative advantage ranking by crop

State	Commodity	DRC	SCB	LSB
Punjab	Wheat	1	1	1
	Cotton	2	2	2
	Rice	3	3	3
Haryana	Wheat	1	1	1
	Rapeseed	2	2	2
	Cotton	3	3	3
	Rice	4	4	4
Maharashtra	Sugarcane	1	1	1
	Groundnut	2	2	2
	Cotton	3	3	3
Gujarat	Groundnut	1	1	1
	Cotton	2	2	2
	Rapeseed	3	3	3
	Wheat	4	4	4
Andhra Pradesh	Groundnut	1	1	3
	Corn	2	2	4
	Sugarcane	3	3	1
	Cotton	4	4	2
	Rice	5	5	3

one but not the lowest among the competing crops. In Punjab, the DRC value of wheat (0.41) is much lower than that of cotton (0.65), suggesting that the Punjab has a comparative advantage in producing wheat. However, at the same time, the DRC value of rice is much larger than that of cotton, even higher than one, implying a definite comparative disadvantage relative to competing crops. Similar situations exist in both Gujarat and Andhra Pradesh, where DRC values for cotton are significantly lower than one, although not the lowest among the five crops. In both states, there is at least one crop with a DRC higher than one, suggesting that cotton is not produced inefficiently in these states. At the same time, cotton is not the crop with the greatest comparative advantage (highest ranking) in either state.

Identical rankings were obtained using the SCB values, lending support to the DRC values. The LSB indicators lead to similar rankings in four of the five states, Andhra Pradesh being the exception, where the commodity ranking based on LSB is slightly different. Overall, the results suggest that cotton production in Maharashtra is not competitive and will be seriously affected by the withdrawal of government support. Low cotton yields in Maharashtra, the lowest among the major cotton-producing states, is the primary reason for its lack of competitiveness. To further illustrate this point, cotton yields in Andhra Pradesh and Gujarat are around 350 and 240 percent higher than are those in Maharashtra. Despite these low yields, Maharashtra still accounts for a large share of Indian cotton production by virtue of its large cotton area; 35 percent of total cotton acreage (largest in the country) and 22 percent of total production (second largest in the country) comes from this state.

Based on these results, it seems clear that any unilateral or multilateral trade liberalization of the cotton sector in India will have serious implications for agriculture in Maharashtra, with acreage being diverted from cotton to more profitable crops such as sugarcane and groundnut. Another important point to note is that cotton is not the most efficiently produced crop in any of the other four major cotton-growing states included in this study. This may imply that while cotton production in these states many not be seriously affected by either unilateral or multilateral market liberalization, any area diverted from less efficient crops (DRC>1) is likely to go to crops with greater comparative advantage than that of cotton.

Sensitivity Analysis on Comparative Advantages

Following Yao (1997), sensitivity analyses are conducted to test whether the results would be substantially altered by changes in the underlying assumptions. In the first scenario, CIF cotton prices are moved up by 20 percent. The results indicate that this change does not affect the comparative rankings. Similarly, rankings remain unchanged when CIF prices are reduced by 20 percent. For the state of Maharashtra, cotton prices would have to increase by more than 30 percent for the DRC value to go below one and would have to rise by more than 100 percent for cotton to become more competitive over sugarcane and groundnut. Similar exercises were conducted by changing prices of competing crops, but the results remained more or less the same. For example, a 50 percent decline in either sugarcane or groundnut prices did not cause cotton to gain comparative advantage over these two crops in Maharashtra. In Haryana, a 30 percent increase in the price of rice would alter the comparative advantage in favor of rice over cotton.

Changes in the input prices can produce similar results. The inputs most likely to alter the comparative advantage in favor of cotton depend on the competing crops. For example, in Maharashtra, the cost of irrigation is the variable likely to alter comparative advantage in favor of cotton over sugarcane. The sensitivity analyses results suggest that a 2000 percent increase in irrigation charges would alter the comparative advantage of sugarcane in favor of cotton.

Conclusions

This study applies a PAM for cotton and its competing crops in five major cotton-producing states in India. The PAM indicators suggest that cotton is not efficiently produced in Maharashtra, the second-largest cotton-producing state in the country. Sugarcane and groundnut have significant comparative advantages in that state over cotton. In addition, the results also suggest that cotton is not the most efficiently produced crop in the other four states; however, there is at least one crop in each state that is less efficiently produced than cotton. Interestingly, in the major grain-producing states in India—Punjab, Haryana, and Andhra Pradesh—rice is found to be the least efficiently produced crop. In Gujarat, wheat is found to be the least efficiently produced crop. These results are consistent with the government policies of achieving food security in grain through high procurement price and heavy subsidization of inputs.

The validity of these results is further strengthened by the sensitivity analyses. We find that very large changes in either output or input prices are necessary to alter the results for Maharashtra. However, the comparative advantage results in other states can be altered by more modest changes in the input and output prices. The general conclusion from this analysis is that trade liberalization and domestic policy reforms that alter the current levels of effective protection could significantly affect the constellation of crops produced in different regions of the country. Because the Indian agricultural sector is so large, even modest changes in the mix and location of different crops could cause important changes in trade patterns. For example, wheat acreage could expand in places such as the Punjab and Haryana at the expense of crops such as rice and cotton. If such tendencies held for India as a whole, cotton imports could increase. If the current mix of price policies translates into cotton that is cheaper than world prices, such a change could harm small textile producers. Such costs would be more than offset by the gains from trade following the policy reforms but it would be important to pay attention to the way in which these gains are distributed to avoid putting undue stress on particular Indian industries.

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