Reforms in Indian Agro-processing and Agriculture Sectors in the Context of Unilateral and Multilateral Trade Agreements

A. Ganesh-Kumar, Manoj Panda and Mary E. Burfisher

Reforms in Indian Agro-processing and Agriculture Sectors in the Context of Unilateral and Multilateral Trade Agreements

A. Ganesh-Kumar[a], Manoj Panda[a] and Mary E. Burfisher[b]

a   Indira Gandhi Institute of Development Research (IGIDR)
General Arun Kumar Vaidya Marg
Goregaon (E), Mumbai- 400065, INDIA
b   Economic Research Services, United States Department of Agriculture
Washington D. C., U.S.A.
Email (corresponding author): agk@igidr.ac.in

Abstract

In this paper, we explore the potential impacts of trade and investment-related policy reforms on India's agro-processing sector. We consider the direct effects of policy reforms within the processing sector, and the indirect effects on agro-processing of policy reforms in the primary agriculture sector, in the Indian economy as a whole, and in a multilateral framework. Towards this, we develop a 22-sector, 16-region version of the GTAP computable general equilibrium (CGE), global model for our analysis.

We find that trade and investment-related reforms in agro-processing together can help the sector to grow. Policy reforms that stimulate investment and help to improve productivity will be crucial in offsetting the contractionary pressures of trade reform alone on the production of processed agricultural products. We also find that indirect effects on agro-processing from India's policy reforms in other sectors are more important than reforms in agro-processing itself. Our findings argue for an economy-wide perspective when targeting reform or development of the agro-processing sector in India.

Compared to trade reform, comprehensive domestic reforms in the agro-processing and agriculture sectors relating to investment are critical for achieving growth in agro-processing. However, while the impacts of trade reform *per se* seem to be small, trade reform - by ushering in a higher degree of competition - could itself be a stimulus for investment and productivity gains in India.

At present, unilateral reforms, especially those that improve productivity in agro-processing and in primary agriculture, are more important to agro-processing than multilateral trade reforms. Nevertheless, our findings also suggest the importance of pursuing a domestic reform agenda within a multilateral trading strategy that can accommodate the expected economic growth of India and its future role in global markets, with general equilibrium effects on agro-processing

Key words: Agriculture, Agro-processing, Trade agreements, CGE models

Reforms in Indian Agro-processing and Agriculture Sectors in the context of Unilateral and Multilateral Trade Agreements

A. Ganesh-Kumar, Manoj Panda and Mary E. Burfisher

1. Motivation

Agro-processing industries have a potentially important role in the economic development of developing countries - directly as a source of income and employment and indirectly for their backward linkages with agriculture. The latter is especially critical for the commercialization of agriculture in developing countries, which is widely recognized as important for adoption of modern farming technologies, improving agricultural productivity and incomes, and eventually for rural poverty reduction.

The agro-processing industry in India has traditionally been confined mainly to a select few commodities such as sugar, edible oils, tea, coffee and spices. In recent times, this sector has been expanding and diversifying into new commodities such as fruits, vegetables, meat (poultry), dairy products, etc. Nevertheless, the sector remains by and large small compared to the availability of raw products and also in relation to the demand for processed food products, especially in urban areas. For example, in the case of edible oils, domestic production meets only about half of domestic demand and consequently India is one of the largest importers of edible oils in the world.

In the past, the agro-processing sector was highly protected in India.[1] On the trade front, there were high levels of tariff and non-tariff barriers. In recent years, the non-tariff barriers have been removed, but moderate levels of applied tariffs continue to prevail. On the production side also, the sector had been largely reserved for small-scale firms that prevented entry of large scale manufacturing units and also the expansion of existing firms (Birthal et al. 2005). Further, severe restrictions were also imposed until recently on the entry of foreign firms into this sector (as in most other sectors of the economy). These restrictions have prevented the sector from benefiting from technological progress and scale economies and from becoming internationally competitive. Besides, the agro-processing sector has also been subject to numerous restrictions with regard to inter-state movement of some agro-based goods, differential inter-state tax structure, marketing restrictions, etc. that have discouraged investment in large scale, integrated, agro-processing enterprises. As a result, the growth of the agro-processing sector in India has not achieved its full potential.[2]

In this paper, we explore the direct and indirect impacts of trade and investment-related policy reforms on India's agro-processing sector. We first consider the direct effects of trade and investment-related reforms within the processing sector. Investment-related reforms refer to a broad set of policy and regulatory reforms that can help to stimulate investment and productivity gains. We then consider a series of policy reforms with potentially important indirect impacts on agro-processing. We analyze the effects of trade and investment-related reforms in the primary agricultural sector, which can help to lower the costs of inputs to agro-processing. We also analyze economy-wide trade policy reform, which may help to stimulate economic activity, with positive income effects on the demand for agro-processed products.

---

[1]   See for example Srinivasan (2004) for a discussion on the edible oils sector.

[2]   Chand and Jha (2001) also mention the high growth potential for agro-processed products.

Finally, we analyze the effects of a multilateral elimination of tariffs and agricultural support, which may help to "level the playing field" for the development of India's agro-processing industry.

We develop a 22-sector, 16-region version of the GTAP computable general equilibrium (CGE) model for our analysis.[3] The general equilibrium model allows us to simulate the impacts of policy reform on the agro-processing sector while taking into account its linkages to other sectors in India and to the global economy through intermediate demand, final demand, factor competition, and trade. We allow full domestic factor mobility so that our results reflect long-term, equilibrium outcomes after the full adjustment of the Indian economy to each policy shock.

2. Background

2.1 Recent trends in the agro-processing sector in India

In 2000-1, the agro-processing sector accounted for about 13% of manufacturing GDP and about 2% of total GDP in India (Table 1). Its share in total economic activities has remained almost the same for more than a decade. About 55% of food processing is undertaken by factories registered under the Factories Act[4] in India and the rest by the unregistered or informal sector.

If we look at a more disaggregated picture, output of sectors like meat and fishery products, fruits and vegetables products, animal feed, cocoa and confectionary products, and

---

[3]   The model has a 2001 base year, and data are from GTAP database version 6.5, November 2004. See appendix for a listing of sectors and regions in the version of the CGE model developed for this paper. The standard GTAP model is documented in Hertel, ed. (1997).

[4]   Production units that employ 10 or more workers with power and 20 or more workers without power need to register under the Factory Act. These units form the registered sector and the database for them are more reliable. The unregistered manufacturing sector operates informally and the data are collected through sample surveys of the production units.

soft drinks has grown at a fast rate by 12-17% per annum during 1989-90 and 1997-98, while sectors like edible (vegetable) oils, dairy products, grain milling, bakery products, sugar and wine have grown at a slow rate varying between 2.5% to 8% (Table 2). Investment in meat and fishery products, fruits and vegetables, confectionary and soft drinks have grown by more than 20% per year.

Agro-processing exports of India have fluctuated at about US$5 billion per year and, in fact, their value fell slightly during 1996 and 2002, even as total exports of India moved up from US$33 billion to 52 billion in the same period (Table 4). As a result, the share of agro-processing in total exports earnings has fallen from about 15% to 9%. Processed imports, on the other hand, nearly doubled from $1.6 billion in 1996 to $3.2 billion in 2002, accounting for a 5% share in total imports in 2002.

So far as composition of the imports of agro-processed products is concerned, during the period 1996 to 2002, it is dominated by two items: vegetable oils and fats account for 41-60% and fruits and vegetables (fresh and frozen) another 17-39%. The export basket of processed products, on the other hand, is somewhat diversified. Four items account for about 63% to 73% of agro-processing exports: fishery products 22% to 30%, prepared animal feeds, food wastes and residues 7% to 20%, fruits and vegetables 13% to 21% and coffee, tea mate 10% to 21%.

2.2 The Indian agro-processing sector in the GTAP database

The GTAP database describes the agro-processing sector in India in 2001, within a global database that balances incomes, expenditures, production and trade across 87 countries or regions of the world and 57 sectors. The characteristics of the Indian agro-processing described in these data drive the results of our analysis of policy reforms (Table 4). Most notable is the relatively small role currently held by the agro-processing sector in the Indian

economy: it accounts for about 4 percent of aggregate value added (factor incomes) in India. However, agro-processing is relatively intensive in its use of unskilled labor, accounting for almost 6 percent of India's total unskilled employment.

The potential role of agro-processing in stimulating primary agriculture through the demand for intermediate inputs is confirmed in the GTAP data. We calculate the backward linkages of each sector in the economy, finding that food processing sectors' backward links all exceed one, the economy-wide average level.[5] Agro-processing is relatively intensive in its use of intermediate inputs compared to value added, and relatively intensive in its use of inputs that are domestically produced, rather than imported. However, the small share of agro-processing in the Indian economy limits it current role as a driver of growth in the industries that supply its inputs.

Agro-processing sectors have an unweighted, average tariff of 35 percent. There is at present relatively little trade in most processed products: imports account for about 8 percent of consumption and exports account for about 7 percent of production. An important exception is edible oils, for which imports account for 38 percent of consumption, and exports account for 3 percent of production.

3. Model scenarios

We first consider policy reforms with direct impacts on India's agro-processing sector. In scenario one, we eliminate all tariffs on imports of agro-processed products (Table 5). In scenario two, we describe a broader reform agenda that in addition eliminates regulations and policies that have impeded investment, productivity growth and technological change in the

---

[5]   Following Hewings (1989), we calculate the backward linkage for sector j as $(R.j/n)r^*$, where R = the Leontief inverse matrix = $(I-D^\wedge A)-1$, I is an identity matrix, , $D^\wedge$ is a diagonal matrix of domestic share in firm demands for each sector, $R.j$ is the row sum of R, n = number of sectors, and r^* is the average value of all elements of R.

sector. We describe this scenario as an investment reform, which we proxy with a 25-percent increase in total factor productivity (TFP) in all agro-processing sectors. This TFP growth is assumed to be achieved over the long-run (about 10 years), after prices and quantities have fully adjusted to the policy shocks. [6]We next explore policy reforms with indirect impacts on India's agro-processing sector that operate primarily through intermediate input supply, competition for workers or capital, final demand, and trade. In scenarios 3 and 4, we consider a comprehensive reform of both the agro-processing and primary agricultural sectors, which are linked chiefly through the supply of raw materials to processors and their competition for unskilled labor. In scenario 3, we eliminate all agricultural tariffs. In scenario 4, we again proxy a more general set of policy reforms that lead to increased investment and productivity in the primary sector as a 25-percent increase in primary agriculture's total factor productivity. Some of the policy reforms that could help to achieve this outcome include changes to tenancy laws that restrict investment in land and other agricultural infrastructure, removal of various restrictions and policy induced distortions in agricultural markets, reforming the agricultural extension and credit services, institutional arrangements that govern irrigation and water markets, amongst others.In scenario 5, we simulate economy-wide policy reform in India, defined as the unilateral removal of tariffs in all sectors. We expect the indirect effects of this reform on India's processing industry of economy-wide reforms to stem mainly from the broad stimulus it could provide to economic growth and therefore to consumer demand for food products, as well as from increased competition by manufactures for the unskilled workers on which the agro-processing sector is dependent.

---

[6] To place this assumption of a long-run, 25-percent TFP gain into perspective, consider that Virmani (2004) estimated the average rate of total factor productivity in agriculture during 1992-93 through 2003-04 at 2.1 percent annually, and that of manufactures, including agro-processing, at 2.8 percent annually. Martin and Mitra (1999) examined total factor productivity in agriculture and manufacturing in a large sample of countries over the period 1967-92. They estimated India's TFP growth in agriculture at 1.9 percent annually, and -.2 percent in manufactures. India's annual TFP growth rate in this period was slightly above the average of developing countries for agriculture (1.8) but below the developing country average for manufactures (.92). India's annual TFP growth rate was considerably below that of developed countries, estimated at 3.4 for agriculture, and 3.3 for manufactures annually. See also Kumar (2001) in this context.

In scenarios 6 though 8, we analyze the effects of multilateral policy reforms on India's agro-processing agricultural sector. These scenarios allow us to consider the extent to which the agro-processing sector has been negatively impacted by the large distortions that characterize global agricultural markets, particularly for products that compete with the local supplies of processors' inputs. In scenario 6, we eliminate all global tariffs. In scenario 7, we additionally eliminate developed countries' domestic support to agriculture. In scenario 8, we add the elimination of domestic agricultural support by developing countries, including India.

4. Trade and Investment Reforms in Agro-Processing

We begin by examining the impact of unilateral trade and investment reforms by India in the agro-processing sector. The impacts on the agro-processing sector from scenarios (1) and (2) are reported in Table 6, and for primary agriculture sector in Table 7.[7] The impacts are measured as percentage change in value from the base scenario levels, which are also reported in the table.

As might be expected, removal of tariff protection in India's agro-processing sector (Scenario 1) reduces output (-6 percent) and employment (-2 percent), particularly in the meats, and in the vegetable oils and fats sectors, in which import competition is already substantial. The domestic market prices of the agro-processing sector fall by 1.3 percent, consistent with the Armington specification of imperfect substitutability of imports and domestic products in the GTAP model.

Imports more than double, and partially displace domestic products in Indian consumption of processed foods. Although in percentage terms, all agro-processing sectors show a significant rise in imports, the import basket continues to be dominated by vegetable

---

7 These two tables also report the results for Scenarios 3 and 4, which are discussed later.

oils and fats. Export expansion of 23%, while significant, builds on very low base levels of exports, and follows from the fall in domestic prices of agro-processing products relative to international prices.

As output in the agro-processing sectors contract, their demand for agricultural inputs falls, resulting in a one-half-percent decline in output in primary agriculture, and a four-percent decline in imported primary agricultural products (Table 7). On the other hand, exports of primary agriculture rise by nearly 10 percent, driven by the declining prices of Indian commodities. Employment of unskilled labor in primary agriculture falls by one percent mainly due to the large decline in output and employment of the oilseeds sub-sector.

Essentially, the elimination of tariffs in agro-processing while maintaining tariffs on the primary products used as inputs is effective "dis-protection" of processed products. The negative impacts of this policy on agro-processing are limited by the currently small share of imports in its intermediate use.

Broader policy reform undertaken in conjunction with trade reform, that will help to stimulate investment and productivity gains, will be crucial in enabling agro-processing industries to survive increased import competition. Even when it is assumed to result in a modest TFP gain of 25% (Scenario 2), India's food processors could expand output (12%) despite an 86% increase in imports (Table 6). Export growth of more than 300% in this scenario is a result of both some displacement due to import growth, as well as the increased competitiveness of Indian processed food products on world markets. Note that the rise in imports (exports) in this scenario is less (substantially higher) than that in Scenario 1. This is largely driven by the significant fall in domestic market prices by about 21% due to productivity gains. An implication of rising productivity will be a lower demand for unskilled workers (-13 percent) in India's agro-processing industries. Demand for agricultural inputs

10

rises, and is met from both domestic production as well as imports. Domestic output of primary agriculture declines by a lesser extent (-0.2 percent) in this scenario compared to the previous scenario (-0.5 per cent), while primary imports actually increase by 1.3 percent compared to a fall of 4 percent in the previous scenario (Table 7).

A notable result of both these scenarios is the decline in employment of unskilled labor in both agro-processing as well as in primary agriculture. The displaced labor is absorbed in both manufacturing and services sectors given the full employment assumption in the model.

5. Comprehensive Agricultural Policy Reform

Trade and investment reforms in the agro-processing sector present an opportunity to pursue a similarly comprehensive approach in the primary agricultural sector. Related reforms that stimulate investment and productivity gains in primary agriculture can help it meet the increased intermediate demand for its products. In the next set of scenarios (3 and 4) we assess the impact of agricultural policy reforms in addition to the reforms in agro-processing sectors discussed above. Scenario 3 covers only unilateral trade reforms in agriculture over and above those in Scenario 2 above. In Scenario 4 we allow for a rise in agricultural total factor productivity by 25% representing the outcome of comprehensive reforms in agriculture (over and above the agricultural trade reforms introduced in Scenario 3) covering diverse aspects such as with regard to investment in land, irrigation and other agricultural infrastructure, domestic markets for agriculture, overhaul of agricultural extension and credit services, etc.

The results for these two scenarios are also reported in Tables 6 and 7 for agro-processing and agriculture, respectively. In comparison with policy reform in agro-processing, the addition of tariff elimination in primary agriculture increases import competition, reducing agricultural output by one-percent and employment 1.6 percent from base levels (Table 7),

while imports increase 61 percent. This scenario further stimulates agro-processing output but the expansion is largely trade-driven.

As in the agro-processing sector, broad policy reform that stimulates investment and productivity growth in primary agriculture will be crucial in enabling the sector to improve its competitiveness. Assuming this leads to a 25-percent increase in TFP in primary agriculture, the sector's total output will increase by 17 percent and imports will decline by 16 percent. The productivity rise results in a fall in domestic market price of about 29% over base levels in primary agriculture as a whole. This improves the competitiveness of Indian agriculture in international markets dramatically, resulting in an eight-fold increase in agricultural exports. However, employment of unskilled labor in primary agriculture – which is labor intensive - will fall significantly as productivity improves, lowering demand for unskilled labor by 10 percent from the base level.

An increase in productivity in primary agriculture will generate greater benefits for the processing sector than even the direct effects of trade and investment reforms in that sector. Agro-processing sector output increases by 27% over the base in Scenario 4 as against a rise of only 12% in Scenario 2. Increased farm-level productivity leads to increased processor profitability from the cost side, by lowering the cost of intermediate inputs and increasing the availability of unskilled labor. This cost advantage is seen especially in the case of vegetable oils and fats, dairy products, and sugar, which experience a significant reduction in domestic prices and commensurate increases in exports and declines in imports. Besides this cost advantage, comprehensive agricultural reforms also provide an important stimulus from the demand side. Rising incomes from agricultural production and lower aggregate food prices contribute to a 12-percent increase in consumer demand for processed food products. Thus, coordinated reforms in the primary agricultural sector could be part of a comprehensive

12

approach to stimulating agro-processing through its effects on both lowering agro-processing production costs and increasing demand for agro-processing output.

6. Economy-wide Trade Reform in India

Elimination of tariffs in the manufacturing and service sectors in India can further increase the stimulus to agro-processing, compared to a comprehensive agricultural policy reform. In Scenario 5, we remove all taxes and subsidies on imports and exports of the manufacturing and services sectors (over and above the comprehensive reforms in agro-processing and agriculture captured in Scenario 4). Thus, this scenario corresponds to economy-wide unilateral free trade by India.

Table 8 reports the results for broad sectors.[8] The unilateral trade liberalisation by India in all sectors increases agro-processing output by an additional three percentage points, and reduces the loss of employment by almost two percentage points, compared to reform of the agro-processing and agricultural sectors only (Scenario 4).

The demand stimulus for agro-processing provided by unilateral trade reform is not as great as that from reform of the primary agricultural sector, and in fact is slightly negative. This result suggests that more than trade reforms *per se*, it is gains in productivity, especially in primary agriculture, which is a key macro policy for stimulating aggregate demand in the Indian economy.

One driver of increased output in agro-processing in this scenario is the increased availability of unskilled labor, as the demand for workers in the manufacturing sectors falls following removal of all tariff protection. The small size of the agro-processing sector within the Indian economy means that it is unlikely to have a significant role in absorbing unskilled

---

[8]   This table also reports the results for the multilateral reforms scenarios (6, 7 & 8), which are discussed later.

labor displaced by policy reforms. In fact, we find that much of the displaced labor is absorbed in the services sectors given the full employment assumption in the model. These sectoral shifts in the demand for unskilled labor suggest the importance of employment shocks as a social and political concern linked with trade and investment reforms in India.

Welfare measures capture the change in aggregate purchasing power due to policy reform. Welfare declines slightly in this unilateral scenario compared to the case of agro-processing and agricultural reforms described in Scenario 4 (Table 9). The main reason is the terms-of-trade deterioration which is sufficient to negate the substantial allocative efficiency gains achieved throughout the Indian economy as a result of trade reforms. Domestic trade and investment reforms stimulate economic activity in India. As As India demands more imports from, and supplies more exports to, global markets, its terms of trade deteriorate – its growing demand drives up world prices of its imports and its growing supply drives down the world prices of its exports. This problem of relatively fast economic growth in India becomes greater as India moves from agriculture-only reforms to an economy-wide trade reform. The effects of the terms of trade loss on agro-processing is to lead to further increases in output as processed imports decline and exports increase, compared to the agriculture-sector only reforms.

7. Multilateral Trade and Domestic Support Reforms

In this section, we analyse the impacts of multilateral trade reforms on India, focusing the discussion on the agro-processing and agriculture sectors. Three experiments are carried out here. In Scenario 6, we allow for full trade liberalisation in all sectors by all countries over and above those covered in Scenario 5. The next scenario (7) extends Scenario 6 and incorporates elimination of all domestic agricultural support by the developed countries (Australia & New Zealand, Rest of East Asia, Canada, USA, European Union). Scenario 8

extends Scenario 7 to cover agricultural subsidy support by all countries. The results of these scenarios for India are reported in Tables 8 and 9.

Compared to unilateral trade and investment reforms, multilateral trade reforms (Scenario 6) are relatively unimportant as a stimulus to the Indian economy, including agro-processing and agriculture sectors, in terms of output, employment, prices, imports, exports and welfare. The small gains from multilateral trade reforms for India reflects the currently low share of trade in production and consumption in India in various sectors including agro-processing. Low trade shares mean that changes in the relative prices of trade and domestic goods due to multilateral reform have little weight in determining over-all price levels in India, so that changing price signals to Indian producers and consumers from global markets are relatively weak.

One of the main benefits of multilateral reform for India operates through its effect on improving the terms-of-trade. The adverse terms-of-trade effect on welfare is reduced by about a third when Indian reforms are part of a multilateral effort (Table 9). Multilateral reforms that stimulate economic activity in the rest of the world will become increasingly important to India as its economy expands. Thus, although trade linkages between India and global markets are still relatively small, multilateral reforms could be viewed as a long-term strategy for fostering global market conditions that are favorable to rapid economic growth in India, and which in turn can contribute to increased demand for agro-processed products.

Domestic agricultural reform by developed countries (Scenario 7) presents small additional stimulus to Indian agro-processing industries, similar to the impact of multilateral tariff elimination. However, a multilateral domestic agricultural reform (Scenario 8) process that also includes elimination of India's own domestic agricultural subsidies would slightly

15

reduce domestic farm output, offsetting any benefits to India agro-processors from expanding the global agenda beyond tariffs to include domestic reforms in developed countries.

8. Conclusions

The agro-processing sector in India is small relative to the primary agriculture sector; its role as a driver in agricultural development and employment is therefore not critical at present. We find that indirect effects on agro-processing from India's policy reforms in other sectors are more important than reforms in agro-processing itself. This is especially true of policy reforms in primary agriculture, which can impact agro-processing through both input supply and aggregate demand. Our findings argue for an economy-wide perspective when targeting reform or development of the agro-processing sector in India.

Compared to trade reform, comprehensive domestic reforms in the agro-processing and agriculture sectors that stimulate investment and increase productivity, are critical for achieving growth in agro-processing. If these reforms achieve a 25% rise in productivity in the agro-processing sector, the result is a GDP gain of 2% (over and above that due to agro-processing trade reforms) and a welfare gain of about 10%. A similar rise in the productivity of primary agriculture results in a gain in GDP of about 7% and a welfare gain of about 30%. In contrast, gains from unilateral or multilateral trade liberalisation for both GDP and welfare are less than one per cent.[9] However, while the impacts of trade reform *per se* seem to be small, trade reform - by ushering in a higher degree of competition - could itself be a stimulus for productivity improvements in India.

At present, unilateral reforms, especially those that improve productivity in agro-processing and in primary agriculture, are more important to agro-processing than

---

[9] Other studies using national CGE model for India also found small GDP impacts. See for example, Subramanian (1993), Parikhh et al. (1995, 1997), Panda and Quizon (1999).

multilateral trade reforms. Nevertheless, our findings with regard to terms-of-trade suggest the importance of pursuing a domestic reform agenda within a multilateral trading strategy that can accommodate the expected economic growth of India and its future role in global markets, with general equilibrium effects on agro-processing.

We used a global, computable general equilibrium model to simulate our trade and investment reform scenarios. Our findings suggest areas for further model development. In particular, the assumption that workers can costlessly shift among sectors as relative prices change understates the real economic and social costs associated with the adjustment of workers and their families to a changing economic environment. The model has a single, representative household although differences among households in their endowments and adjustment capacities can be expected to lead to distributional implications from changing prices and wages, with implications for such policies as social safety nets. Despite these and other limitations, the model is a powerful tool that supports a rich analysis of the structural and welfare implications of Indian policy reforms within a global setting.

References

Birthal, P.S., Joshi P.K. and Gulati A. (2005). "High Value Food Commodities and Vertical Coordination in India: Implications for Smallholders." International Food Policy Research Institute (IFPRI), paper presented at the Symposium "Toward High-Value Agriculture and Vertical Coordination: Implications for Agribusiness and Smallholders" National Agricultural Science Centre, Pusa, New Delhi, 7 March 2005.

Chand, R., and Jha D. (2001). "Trade Liberalization, Agricultural Prices and Social Welfare." in S.S.Acharya and D.P.Chaudhri (eds.) *Indian Agricultural Policy at the Crossroads: Priorities and Agenda*, Jaipur and New Delhi: Rawat Publications.

Hertel, Thomas W., editor (1997). *Global Trade Analysis: Modeling and Applications.*

Cambridge: Cambridge University Press.

Hewings, Geoffrey J.D., Manuel Fonseca, Joaquin Guilhoto, and Michael Sonis (1989). "Key Sectors and Structural Change In the Brazilian Economy: A Comparison of Alternative Approaches and Their Policy Implications." *Journal of Policy Modeling*, Vol. 11, No. 1, pp. 67-90.

Kumar, P. (2001). "Agricultural Performance and Productivity". in S.S.Acharya and D.P.Chaudhri (eds.) *Indian Agricultural Policy at the Crossroads: Priorities and Agenda*, Jaipur and New Delhi: Rawat Publications.

Martin, Will and Davashish Mitra (1999). "Productivity Growth and Convergence in Agriculture and Manufacturing." Trade, Development Research Group, World Bank, Paper No. 2171. Washington, DC: World Bank.

Panda M. and Quizon J. (1999): "Growth and Distribution Under Trade liberalization in India", Indira Gandhi Institute of Development Research, Mumbai. Forthcoming in a volume edited by A. Guha, A. Lahiri and K. L. Krishna to be published by NIPFP/Ford Foundation, New Delhi.

Parikh, K.S., Narayana, N.S.S., Panda M. and Ganesh-Kumar A. (1995), "Strategies for Agricultural Liberalization: Consequences for Growth, Welfare and Distribution", Report Submitted to the World Bank, PP-16, Indira Gandhi Institute of Development Research, Mumbai.

Parikh, K.S., Narayana, N.S.S., Panda M. and Ganesh-Kumar A. (1997), "Agricultural Trade Liberalization: Growth, Welfare and Large Country Effects", Agricultural Economics, 17(1).

Srinivasan, P.V. (2004). "Managing Price Volatility in an Open Economy Environment: The Case of Edible Oils and Oilseeds in India." International Food Policy Research Institute (IFPRI), MTID Discussion Paper No. 69, Washington, DC: IFPRI.

Subramanian, S. (1993). "Agricultural Trade Liberalisation and India", Development Centre, Paris, OECD.

Virmani, Arvind (2004). "Sources of India's Productivity Growth: Trends in Total Factor Productivity." India Council for Research on International Economic Relations (ICRIER), Working Paper No. 131. New Delhi: ICRIER.

Table 1: Trends in value added in the Indian food agro-processing sector, shares (%)

Year	In registered manufact-uring	In unregistered manufact-uring	In total manufact-uring	In total GDP	Registered sector in total food processing
1989-90	12.4	16.0	13.7	2.3	57.8
1990-91	10.4	16.0	12.5	2.1	52.8
1991-92	10.6	16.8	12.8	2.0	53.0
1992-93	10.5	16.2	12.6	2.0	53.0
1993-94	11.4	15.6	12.9	2.1	57.8
1994-95	11.5	16.8	13.2	2.2	57.8
1995-96	10.0	15.8	11.9	2.1	55.6
1996-97	9.1	15.7	11.3	2.1	54.4
1997-98	10.8	15.7	12.5	2.2	56.6
1998-99	10.5	15.9	12.4	2.1	55.1
1999-00	10.2	16.0	12.2	2.0	54.2
2000-01	10.5	16.3	12.5	2.2	54.6

Source: National Accounts Statistics, Central Statistical Organization, Government of India, various issues.

Table 2: Growth in the Indian agro-processing sector, 1989-90 to 1997-98

S. No.	Industry	Output (Rs. Lakhs)	Value added (Rs. Lakhs)	Invest-ment (Rs. Lakhs)	Employees (No.)	Workers (No.)
		Annual % growth rate				
1	Meat product	17.4	23.0	35.3	4.1	4.8
2	Fishery products	17.0	19.6	21.5	10.7	10.8
3	Fruits & Vegetables products	13.8	14.4	24.7	7.3	7.8
4	Oils and fats	4.2	7.8	3.7	1.3	0.9
5	Dairy products	7.2	7.6	11.2	5.0	5.2
6	Grain milling products	6.5	8.4	5.0	4.5	4.1
7	Starch products	5.6	7.0	1.6	0.9	1.0
8	Animal feeds	15.0	15.5	14.8	10.5	11.0
9	Bakery products	8.0	6.7	13.0	5.0	5.0
10	Sugar	4.1	5.6	-6.2	-0.7	-1.3
11	Cocoa & confectionary products	11.8	3.1	30.0	4.2	4.9
12	Spirits & alcohol	9.5	9.9	2.4	3.1	2.8
13	Wine	2.5	3.9	1.3	-2.5	-2.9
14	Malt products	6.4	6.7	4.9	5.6	6.2
15	Soft drinks	17.1	17.7	22.4	4.9	6.2

Source: Annual Survey of Industries, Central Statistical Organization, Government of India, various issues.

Table 3: India's trade in agro-processed products, 1996-2002

Year	Exports (US $ Millions)			Imports (US $ Millions)		
	Agro-processing	Total	Agro-processing in total (%)	Agro-processing	Total	Agro-processing in total (%)
1996	4996.6	33469.9	14.9	1630.8	39132.4	4.2
1997	5057.8	34785.0	14.5	1822.6	41484.5	4.4
1998	4108.2	33218.7	12.4	3019.1	42388.7	7.1
1999	4440.2	36822.5	12.1	2978.2	49738.1	6.0
2000	4824.3	44560.3	10.8	2159.6	50536.5	4.3
2001	4595.8	43826.7	10.5	2759.3	51413.3	5.4
2002	4764.6	52719.4	9.0	3248.0	61412.1	5.3
Average growth rate (%)	-0.6	7.6	-8.2	9.1	7.0	2.2

Source: http://commin.nic.in/ (Ministry of Commerce (web site), Government of India).

Table 4 – Base data on India's agro-processing sector in CGE model

	Sector share in aggregate value added	Sector share in unskilled employment	Backward intermediate demand linkages	Import tariff rate	Import share of consumption	Export share of production
Meats	0.03	0.024	1.10	32.55	49.94	47.99
Fats/oilseeds	0.21	0.19	1.25	27.08	37.61	3.15
Dairy products	0.12	0.11	1.36	0.00	0.39	1.03
Processed rice	2.12	4.01	1.08	20.00	0.03	3.48
Sugar	0.25	0.25	1.23	33.82	0.25	3.81
Other foods	0.54	0.50	1.29	110.64	3.97	22.63
Bvrg/tobacco	0.45	0.44	1.12	21.37	2.10	1.25
Total	3.74	5.52	-	34.10	7.73	7.40

Source: GTAP, version 6.5, November 2004. Base data describe a 2001 equilibrium base year.

Table 5: Model scenarios

Scenario no.	Scenario description
Agro-processing Policy Reforms	
1	Unilateral free trade in agro-processing sectors
2	(1) plus investment reform (25% increase in agro-processing productivity)
Comprehensive Agricultural Policy Reform	
3	(2) plus unilateral free trade in agriculture
4	(3) plus comprehensive reform in agriculture (25% increase in agricultural productivity)
Economy-wide Policy Reform	
5	(4) plus unilateral free trade in India, all sectors
Multilateral Policy Reforms	
6	(5) plus multilateral free trade in all sectors
7	(6) plus developed country removal of domestic agricultural support
8	(7) plus developing country removal of domestic agricultural support

Table 6 – Effects of agricultural policy reform on the agro-processing sector

	Scenario	1	2	3	4
	Base value	Tariff elimination in agro-processing	(1) plus investment reform in agro-processing	(2) plus remove tariffs in primary agriculture	(3) plus investment reform in primary agriculture
	Levels	Percentage change from base value			
Output (in millions)					
Total agro- processing	50,966	-6.1	11.5	12.6	26.8
Meats	653	-20.7	184.7	194.4	192.8
Vegetable oils / fats	5,272	-53.4	-26.2	-24.6	9.6
Dairy products	4,674	0.0	11.6	12.4	35.0
Processed rice	19,095	0.2	6.4	6.6	10.9
Sugar	5,917	0.0	9.7	10.4	24.9
Other foods	9,962	-1.0	35.5	38.0	62.3
Bvrg/tobacco	5,393	-1.7	3.4	3.5	9.3
Market price index					
Total agro- processing	1.0	-1.3	-20.9	-21.4	-26.3
Meats	1.0	-2.8	-21.3	-21.7	-21.8
Vegetable oils / fats	1.0	-3.6	-21.9	-22.6	-32.6
Dairy products	1.0	-1.2	-20.8	-21.7	-31.1
Processed rice	1.0	-0.8	-20.2	-20.5	-22.3
Sugar	1.0	-1.3	-20.7	-21.3	-31.5
Other foods	1.0	-1.2	-21.9	-22.8	-28.8
Bvrg/tobacco	1.0	-1.0	-20.7	-21.0	-20.0
Imports (in millions)					
Total agro-processing	3,929	124.4	85.5	83.8	69.9
Meats	343	85.2	73.6	73.3	91.5
Vegetable oils / fats	3,102	130.4	92.7	90.9	72.1
Dairy products	19	181.9	37.0	31.9	-3.6

23

Table 6 – Effects of agricultural policy reform on the agro-processing sector

	Scenario	1	2	3	4
	Base value	Tariff elimination in agro-processing	(1) plus investment reform in agro-processing	(2) plus remove tariffs in primary agriculture	(3) plus investment reform in primary agriculture
	Levels	Percentage change from base value			
Processed rice	6	254.1	106.6	104.3	103.1
Sugar	14	172.0	53.1	50.1	13.5
Other foods	323	88.2	26.2	23.7	13.8
Bvrg/tobacco	122	157.6	104.3	103.9	119.0
Exports (in millions)					
Total agro-processing	2,038	23.2	325.2	347.1	779.8
Meats	202	22.6	417.0	435.6	426.2
Vegetable oils / fats	1,541	26.9	348.3	373.0	928.0
Dairy products	15	8.4	383.6	421.1	1065.9
Processed rice	4	3.3	123.7	127.1	138.1
Sugar	10	5.6	143.1	150.8	301.0
Other foods	213	4.6	143.2	153.2	232.9
Bvrg/tobacco	53	2.2	65.6	66.6	61.6
Employment (unskilled, in 1000's)					
Total agro- processing	8,495	-2.0	-12.8	-12.3	-4.9
Meats	38	-20.6	128.8	137.0	138.9
Vegetable oils / fats	295	-53.4	-40.7	-39.3	-10.7
Dairy products	175	0.1	-10.3	-9.5	10.0
Processed rice	6,155	0.2	-14.7	-14.4	-10.3
Sugar	389	0.1	-11.8	-11.2	1.7
Other foods	761	-0.9	8.9	11.1	32.3
Bvrg/tobacco	681	-1.6	-16.9	-16.7	-11.0

Table 7 – Effects of agricultural trade and investment policy reform on the primary agriculture

	Scenario Base value	1 Tariff elimination in agro-processing	2 (1) investment reforms in agro-processing	3 (2) plus eliminate tariffs in primary agriculture	4 (3) plus investment reforms in primary agriculture
	Levels	Percent change relative to base			
Output in millions					
Total primary agric.	144,064	-0.5	-0.2	-0.9	16.7
Paddy rice	9,599	0.4	-5.6	-5.4	6.7
Wheat	16,128	0.4	1.4	1.8	24.7
Other grains	4,347	0.2	1.5	1.5	7.3
Horticulture	25,958	-0.3	0.5	-2.6	9.3
Oilseeds	18,046	-6.2	-3.8	-3.6	6.8
Cotton/fibers	7,803	0.1	-4.5	-4.2	2.7
Other crops	23,095	0.4	0.3	-0.6	29.1
Cattle	4,099	-1.1	-1.1	-1.7	-7.9
Other animals	9,990	0.5	2.7	3.0	20.2
Milk	22,517	0.6	2.3	2.7	23.9
Wool	2,483	1.8	2.6	-7.0	58.9
Market price index					
Total primary agric.	1.0	-2.0	-0.4	-2.1	-29.4
Paddy rice	1.0	-1.9	-2.2	-3.8	-32.0
Wheat	1.0	-1.4	0.3	-0.8	-25.6
Other grains	1.0	-1.8	0.3	-1.3	-30.4
Horticulture	1.0	-2.0	-0.2	-2.6	-29.9
Oilseeds	1.0	-3.6	-1.4	-2.8	-30.4
Cotton/fibers	1.0	-1.8	-1.6	-3.1	-30.7
Other crops	1.0	-1.7	-0.2	-2.0	-26.9

Table 7 – Effects of agricultural trade and investment policy reform on the primary agriculture

	Scenario	1	2	3	4
	Base value	Tariff elimination in agro-processing	(1) investment reforms in agro-processing	(2) plus eliminate tariffs in primary agriculture	(3) plus investment reforms in primary agriculture
	Levels	Percent change relative to base			
Cattle	1.0	-2.0	-1.2	-2.7	-37.2
Other animals	1.0	-1.9	-0.1	-1.7	-30.8
Milk	1.0	-1.9	0.2	-1.4	-29.3
Wool	1.0	-1.6	-0.2	-3.0	-28.9
Imports in millions					
Total primary agric.	2,962	-4.0	1.3	61.4	-15.7
Paddy rice	0.5	-9.2	-9.2	569.3	36.9
Wheat	1	-5.9	3.5	1084.7	287.8
Other grains	2	-2.3	2.8	48.8	0.7
Horticulture	1,507	-3.2	1.9	70.9	6.9
Oilseeds	15	-8.7	-1.4	98.8	-4.6
Cotton/fibers	0.1	-4.8	-3.1	12.2	-50.0
Other crops	946	-4.3	0.4	44.2	-35.0
Cattle	2	-4.6	-1.0	45.7	-37.7
Other animals	89	-1.8	3.7	14.0	-12.9
Milk	1	-6.7	1.7	-3.5	-65.4
Wool	398	-6.5	1.0	72.8	-57.5
Exports in millions					
Total primary agric.	2182	9.9	0.2	15.6	818.1
Paddy rice	0.4	14.8	14.8	29.0	524.1
Wheat	1	11.8	-4.2	5.1	646.5
Other grains	2	4.6	-1.0	2.9	132.4

Table 7 – Effects of agricultural trade and investment policy reform on the primary agriculture

	Scenario Base value	1 Tariff elimination in agro-processing	2 (1) investment reforms in agro-processing	3 (2) plus eliminate tariffs in primary agriculture	4 (3) plus investment reforms in primary agriculture
	Levels	Percent change relative to base			
Horticulture	969	6.3	-0.4	8.0	185.7
Oilseeds	10	19.1	6.5	13.7	338.7
Cotton/fibers	0.1	9.6	7.4	15.7	410.4
Other crops	793	10.3	0.3	11.6	409.1
Cattle	2	7.2	3.7	9.7	396.9
Other animals	78	4.8	-0.1	4.0	130.4
Milk	1	13.3	-1.6	9.5	643.2
Wool	325	20.9	1.2	51.0	3887.3
Employment (unskilled in 1000's)					
Total primary agric.	39,586	-1.0	-0.5	-1.6	-10.5
Paddy rice	3,256	0.0	-6.3	-6.4	-18.7
Wheat	3,415	0.1	1.3	1.3	-3.9
Other grains	1,204	-0.1	1.5	1.1	-18.2
Horticulture	7,544	-0.7	0.4	-3.4	-16.6
Oilseeds	5,131	-7.0	-4.3	-4.5	-18.6
Cotton/fibers	2,423	-0.2	-5.0	-5.1	-22.0
Other crops	6,717	0.1	0.1	-1.2	-0.2
Cattle	0.2	-1.5	-1.4	-2.4	-30.5
Other animals	2,848	0.1	2.8	2.7	-7.6
Milk	6,683	0.3	2.3	2.4	-4.6
Wool	365	1.6	2.7	-8.1	24.9

Table 8 – Effects of Economy-wide and Multilateral Reforms on India

	Scenario	4	5	6	7	8
	Base value in millions	Trade and investment reforms in primary and processed agriculture	(4) plus unilateral tariff elimin. all sectors	(5) multilateral tariff elimination of all tariffs	(6) plus developed countries eliminate domestic agric. Subsidies	(7) plus developing countries eliminate domestic agric. subsidies
	Levels	Percent change relative to base				
Output in millions						
Primary agric.	144,064	16.7	17.3	17.2	17.7	16.4
Agro-processing	50,966	26.8	29.9	31.2	31.4	31.2
Manufactures	244,019	-3.0	-5.6	-5.3	-5.6	-5.0
Services	382,670	3.9	4.6	4.6	4.6	4.7
Market prices						
Primary agric.	1	-29.4	-30.2	-29.1	-28.4	-27.2
Agro-processing	1	-26.3	-28.1	-27.0	-26.7	-26.6
Manufactures	1	3.69	-2.36	-1.44	-1.27	-1.48
Services	1	5.83	2.93	4.41	4.60	4.28
Imports in millions						
Primary agric.	2,962	-15.7	-18.1	-12.8	-12.3	-10.4
Agro-processing	3,929	69.9	63.7	64.4	64.8	65.7
Manufactures	44,869	12.9	84.5	96.0	96.3	95.7
Services	11,811	15.5	10.4	14.1	14.3	13.9
Exports in millions						
Primary agric.	2,182	818.1	890.8	952.3	966.3	987.6
Agro-processing	2,038	779.8	911.2	692.9	740.3	726.4
Manufactures	33,532	-22.0	31.2	42.8	41.6	43.8
Services	11,811	-17.4	-9.0	-12.8	-13.2	-12.3

Table 8 – Effects of Economy-wide and Multilateral Reforms on India

	Scenario	4	5	6	7	8
	Base value in millions	Trade and investment reforms in primary and processed agriculture	(4) plus unilateral tariff elimin. all sectors	(5) multilateral tariff elimination of all tariffs	(6) plus developed countries eliminate domestic agric. Subsidies	(7) plus developing countries eliminate domestic agric. subsidies
	Levels	Percent change relative to base				
Employment (unskilled)						
Primary agric.	39,586	-10.5	-9.8	-9.8	-9.2	-10.5
Agro-processing	8,495	-4.9	-3.7	-4.6	-4.5	-4.5
Manufactures	22,919	-1.0	-3.8	-3.4	-3.8	-3.0
Services	77,040	6.5	7.3	7.3	7.2	7.7

Table 9 – Welfare and GDP impacts of policy reforms on India (% change from base)

Scenario	1	2	3	4	5	6	7	8
Allocative efficiency	1.1	1.2	1.5	2.2	5.5	6.3	6.3	6.8
Technical change	0.0	10.7	10.7	41.4	42.0	42.1	42.2	41.9
Terms of Trade	-0.4	-1.1	-1.3	-2.1	-6.3	-4.6	-4.6	-4.5
Investment/Savings	0.0	0.0	0.0	-0.1	0.0	0.1	0.1	0.1
Total welfare change	0.7	10.8	10.9	41.3	41.2	43.9	44.1	44.3
GDP quantity index	0.2	2.5	2.6	9.3	10.1	10.3	10.3	10.3

Appendix table 1: Model classification – Regions

No.	Code	Region description	Comprising
1	ANZ	Australia and New Zealand	Australia; New Zealand; Rest of Oceania.
2	CHN	China	China.
3	IDN	Indonesia	Indonesia.
4	MYS	Malaysia	Malaysia.
5	REAS	Rest of East Asia	Hong Kong; Japan; Korea; Taiwan; Rest of East Asia.
6	IND	India	India.
7	ROSA	Rest of South Asia	Philippines; Singapore; Thailand; Vietnam; Rest of South-East Asia; Bangladesh; Sri Lanka; Rest of South Asia.
8	CAN	Canada	Canada.
9	USA	United States	United States.
10	ARG	Argentina	Argentina.
11	BRA	Brazil	Brazil.
12	ROAM	Rest of Americas	Mexico; Rest of North America; Central America; Rest of FTAA; Rest of the Caribbean; Colombia; Peru; Venezuela; Rest of Andean Pact; Chile; Uruguay; Rest of South America.
13	EUR	European Union	Austria; Belgium; Denmark; Finland; France; Germany; United Kingdom; Greece; Ireland; Italy; Luxembourg; Netherlands; Portugal; Spain; Sweden; Switzerland; Rest of European Free Trade Area;
14	CEE	Central and Eastern Europe	Rest of Europe; Albania; Bulgaria; Croatia; Czech Republic; Hungary; Malta; Poland; Romania; Slovakia; Slovenia; Estonia; Latvia; Lithuania; Russian Federation; Rest of Former Soviet Union.
15	ME	Middle East	Cyprus; Turkey; Rest of Middle East.
16	AFRW	Africa and Rest of World	Morocco; Tunisia; Rest of North Africa; Botswana; South Africa; Rest of South African Customs Union; Malawi; Mozambique; Tanzania; Zambia; Zimbabwe; Rest of SADC; Madagascar; Uganda; Rest of Sub-Saharan Africa; Rest of World.

Appendix table 2: Model classification – Sectors

No.	Code	Sector description	Comprising
1	PDR	Paddy rice	Paddy rice.
2	WHT	Wheat	Wheat.
3	GRO	Cereal grains nec	Cereal grains nec.
4	V_F	Vegetables, fruit, nuts	Vegetables, fruit, nuts.
5	OSD	Oil seeds	Oil seeds.
6	C_B	Sugar cane	Sugar cane, sugar beet.
7	OCR	Crops nec	Plant-based fibers; Crops nec.
8	CTL	Cattle, sheep, goats, horses	Cattle, sheep, goats, horses.
9	OAP	Animal products nec	Animal products nec.
10	RMK	Raw milk	Raw milk.
11	WOL	Other agriculture	Wool, silk-worm cocoons.
12	NRES	Natural Resources	Forestry; Coal; Oil; Gas; Minerals nec.
13	FSH	Fishing	Fishing.
14	CMT	Meat cattle, sheep, goat, horse	Meat: cattle, sheep, goats, horse; Meat products nec.
15	VOL	Vegetable oils and fats	Vegetable oils and fats.
16	MIL	Dairy products	Dairy products.
17	PCR	Processed rice	Processed rice.
18	SGR	Sugar	Sugar.
19	OFD	Food products nec	Food products nec.

20	B_T	Beverages and tobacco products	Beverages and tobacco products.
21	Mnfcs	Manufactures	Textiles; Wearing apparel; Leather products; Wood products; Paper products, publishing; Petroleum, coal products; Chemical, rubber, plastic prods; Mineral products nec; Ferrous metals; Metals nec; Metal products; Motor vehicles and parts; Transport equipment nec; Electronic equipment; Machinery and equipment nec; Manufactures nec.
22	Svces	Services	Electricity; Gas manufacture, distribution; Water; Construction; Trade; Transport nec; Sea transport; Air transport; Communication; Financial services nec; Insurance; Business services nec; Recreation and other services; Public Admin / Defence / Health / Education; Dwellings.