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# India's Poultry Sector
## Development and Prospects


***Rapid poultry sector growth is being driven by an expanding middle class and the emergence of vertically integrated poultry producers.***

**India's Poultry Sector: Development and Prospects.** Maurice Landes, Suresh Persaud, and John Dyck. Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture, Agriculture and Trade Report WRS-04-03.

## Abstract

Poultry meat is the fastest growing component of global meat demand. India, the world's second largest developing country, is contributing to the expansion through the rapid growth of its poultry sector. In India, poultry sector growth is being driven by rising incomes, together with the emergence of vertically integrated poultry producers that have reduced consumer prices by lowering production and marketing costs. Integrated production, a market transition from live birds to chilled and frozen products, and policies that help ensure supplies of competitively priced domestic or imported corn and soybeans are keys to future poultry industry growth in India and in other developing countries.

**Keywords:** India, developing countries, poultry, demand, prices, vertical integration, contract growing, feed, policy, trade, economic model.

## Acknowledgments

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Cover Photos: Chicken Center at INA Market in New Delhi, India.

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# Executive Summary

Poultry meat is the fastest growing component of global meat production, consumption, and trade, with developing and transition economies playing a leading role in the expansion. In addition to providing opportunities to increase poultry exports, rising poultry production spurs growth in global import demand for feeds and other inputs and in investment opportunities in these sectors. India, the world's second largest developing economy, now has a large and rapidly expanding poultry sector. Expansion in India is being driven by rising incomes and a shift in industry structure toward integrated ownership and coordination of the input, production, and marketing operations involved in poultry production (vertical integration). These factors, in addition to government policies affecting feed supply levels, will help shape future growth in the poultry industry in India, as well as in emerging trade and investment opportunities.

Several key findings based on developments in India's poultry market may provide insights to prospects for poultry industry growth in other developing countries:

- Poultry meat demand is highly price sensitive among low- and middle-income consumers. Policies that protect the domestic poultry market may also slow growth in consumption and production.
- Factors that discourage transport and distribution of poultry within India, including limited demand for frozen products, a poor and high-cost transport infrastructure, and limited and unreliable cold chain, or frozen storage, facilities, are also strong impediments to poultry imports and may be as important as tariffs in constraining trade.
- Vertical integration can promote industry growth by enhancing production and marketing efficiency and reducing consumer prices. In India, the gains in marketing efficiency appear more significant than in production efficiency.
- Competitive feed prices are key to competitive poultry and egg production. Policies that protect local feed producers are also likely to slow growth in poultry and egg output, imposing significant losses on producers and consumers.

## Implications for U.S. Agriculture

Prospects for Indian imports of poultry meat are limited. Competitive local production costs, low demand for frozen meat, and poor cold chain facilities, as well as high tariffs, are major constraints to trade. Growth in demand for corn and soybean meal, however, will likely outstrip gains in local production, creating demand for corn imports and reducing exports of soybean meal. India's corn import policy, and the pace of gains in corn and soybean productivity, will influence the amount of trade.

Foreign direct investment (FDI) has, so far, not been a major factor in the development of India's poultry sector. But India's fast-growing, competitive, and potentially large industry offers investment opportunities in input activities, such as breeding, medicines, feed, and equipment, as well as vertical integration and processing. While the country permits FDI in these activities, investments are constrained by market and policy uncertainty, poor power and transport infrastructure, and high taxes on processed food.

## Incomes, Changing Market Structure, Drive Growth

Available data indicate that, since the early 1990s, poultry meat has been the fastest growing sector of animal product production and consumption in India. Factors driving the industry's expansion include quickening growth in per capita incomes, a young and increasingly urban population, and declining real poultry prices. With recent studies suggesting that most Indians do not have strict vegetarian dietary preferences, income and price are likely to continue to influence rising demand.

The expanding role of poultry integrators, primarily in South and West India, has contributed to declining poultry prices. Integration, typically encompassing enterprises ranging from breeding, feed milling, and contract growing to wholesale and retail marketing, appears to have increased production efficiency and significantly reduced marketing margins and consumer prices. Future industry expansion may depend on the pace at which integrated poultry operations spread in the West, East, and, particularly, the affluent North.

Expansion of poultry sector integration, in turn, may depend on the pace of transition in India's poultry sector from a live-bird market to a chilled/frozen-product market. Live-bird sales now dominate the market, preventing exploitation of regional comparative advantages in production, or the use of storage, domestic product movements, and international trade to stabilize supplies and prices. A shift to mechanical, and more hygienic, processing that would be an integral part of a transition to a chilled/frozen-product market may also have public health benefits, although there is little evidence that current practices are creating health problems.

## Competitive Production Costs

Data also suggest that India is an internationally competitive producer of poultry meat. Producer prices of whole birds in India, while higher than in Brazil, compare favorably with those in other Asian countries and the United States. Poultry production in India benefits from improved management practices and the availability of local supplies of corn and soybean meal at internationally competitive prices. Competitive local prices, combined with high tariffs, poorly defined phytosanitary requirements, and a limited market for frozen poultry, are constraints to significant poultry meat imports in the near term.

If recent trends in poultry and egg production in India are sustained, growth in demand for corn and soybean meal is likely to outpace gains in domestic production. For corn, variable domestic production, expanding feed use, and tariff and quota restrictions on corn imports could combine to constrain growth in both the poultry and egg industries, raising production costs and consumer prices and slowing consumption. For soybean meal, the Indian poultry and egg industries benefit from local surpluses and ready availability, although rising internal demand may erode exports.

## Policies Affecting Market Integration and Feed Trade Key to Future Growth

With the expansion of India's poultry industry, the country's government must address a number of new issues, including economic tradeoffs between poultry producers, feed producers, and consumers, potential public health concerns

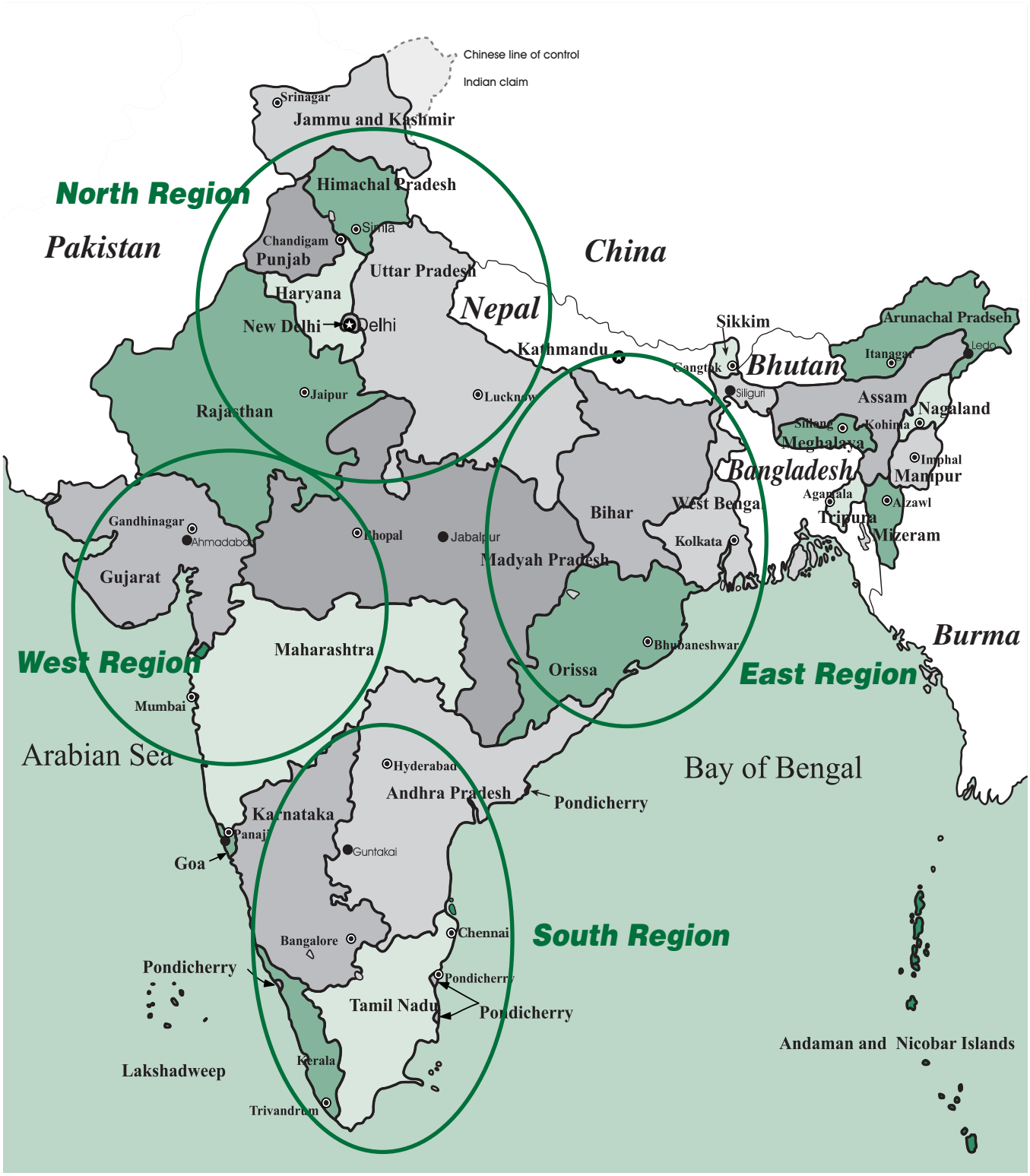
associated with traditional slaughter and marketing practices, and appropriate tariff and nontariff policies for imports of poultry and industry inputs. Although government policy has traditionally given priority to promoting self-reliance in agricultural products, it is unclear how future policy will weigh the competing interests of, among others, poultry and egg producers, consumers, and feed producers.

Poultry sector integration can yield substantial benefits for the sector and, particularly, consumers of poultry meat. Feed shortages, however, can have significant adverse effects on producers and consumers of poultry meat and, particularly, eggs. Although Indian corn producers may gain from higher prices associated with import restrictions, these gains must be weighed against losses to producers and consumers of poultry meat and eggs, as well as to the potential international competitiveness of Indian poultry production. Development and adoption of technology that can improve the competitiveness of domestic feed production would allow all producers and consumers to benefit from poultry sector expansion.

## Data Limitations Constrain Policymakers

Analysis of developments in India's poultry sector is made difficult by the lack of reliable and timely official data on such variables as production, consumption, feed use, and production and marketing costs. Information from industry sources suggests that production and consumption of poultry meat in India has grown by as much as 15 percent annually since the mid-1990s, far faster than indicated by official data. Based on these findings, poultry will likely grow in importance to the Indian diet and to farm income and create new pressures for appropriate policies in industries that supply inputs to poultry producers, as well as in poultry processing and marketing activities. Better data and information will be needed to support public and private sector decisionmaking.

## Map of India


Chinese line of control
Indian claim
Srinagar
Jammu and Kashmir
North Region
Himachal Pradesh
Pakistan
Shimla
Chandigam
Punjab
Uttar Pradesh
China
Haryana
Nepal
New Delhi
Delhi
Kathmandu
Sikkim
Arunachal Pradseh
Gangtok
Bhutan
Itanagar
Ledo
Jaipur
Lucknow
Siliguri
Assam
Nagaland
Rajasthan
Shilong
Kohima
Meghalaya
Bangladesh
Imphal
Manipur
Agartala
Aizawl
Bihar
West Benga
Tripura
Gandhinagar
Ahmadabad
Bhopal
Jabalpur
Kolkata
Mizeram
Madyah Pradesh
Gujarat
Burma
Bhubaneshwar
West Region
Maharashtra
Orissa
East Region
Mumbai
Arabian Sea
Bay of Bengal
Hyderabad
Andhra Pradesh
Pondicherry
Karnataka
Panaji
Guntakal
Goa
Chennai
Bangalore
South Region
Pondicherry
Pondicherry
Tamil Nadu
Pondicherry
Andaman and Nicobar Islands
Kerala
Lakshadweep
Trivandrum

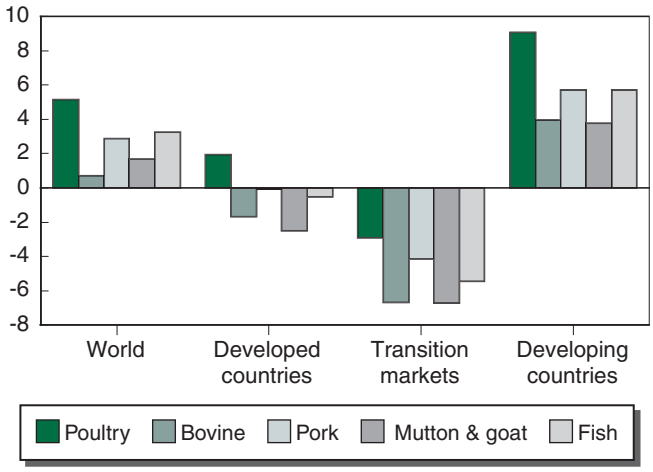
# India's Poultry Sector

## Development and Prospects

### Introduction

Since the 1970s, global production, consumption, and trade of poultry meat has grown faster than that of any other meat. During the 1990s, when demand growth slowed for other meats, including fish, demand growth for poultry meat accelerated and poultry continued to lead the expansion of meat trade.[1] Although demand for poultry meat was strong relative to demand for other meats in developed countries during the 1990s, the rapid global gains in poultry meat supply, demand, and trade were led by gains in developing countries (fig. 1). Expansion has been most rapid in the developing Asia region, including China, South Asia, and Southeast Asia, as well as in Latin America. The emergence of the poultry sectors in developing countries, such as India, has the potential to affect global and U.S. markets for poultry products, feeds, and related inputs.

Figure 1
**Growth of meat consumption by region, 1990-99**




Source: FAOSTAT database.

With a population of more than 1 billion and real per capita incomes now growing 3-4 percent annually, India constitutes a large potential market for poultry meat. Poultry production and consumption in India appear to be expanding rapidly, fueled by rising incomes as well as changes in the structure of poultry production and marketing. The key structural change spurring production growth is the emergence of integrated producers, which are combining breeding, feed milling, contract growing, and marketing activities, and fostering improved productivity and reduced marketing costs. Although the country's expanding poultry sector now relies on local supplies of corn and soybean meal, it is unclear whether India will evolve over the longer term as an importer, or as a competitive producer, of poultry and feed. Development of the sector may depend on the pace of change in the structure of poultry production and marketing, as well as government policies toward production and trade of poultry and feeds.

This report assesses the supply, demand, structure, and policy factors affecting the growth of the Indian poultry industry. The objectives of the study are twofold: to gain a better understanding of the prospects for the poultry industry in one of the world's largest and fastest growing developing economies, and to take advantage of the information developed on India's diverse sector to draw implications for growth prospects in the poultry sectors in other developing countries. To help meet these objectives, the study analyzes the impacts of alternate economic, technical, and policy assumptions on poultry supply and demand prospects and the implications for feed trade.

[1] See appendix table 1.1 for a complete summary of trends in meat and fish supply, demand, and trade.

# Recent Trends in Poultry Supply and Demand

Assessing recent trends in Indian poultry production and consumption is complicated by poor and conflicting data. Government and industry sources publish very little reliable data on the Indian poultry sector. Available government data consist only of periodic poultry population estimates, with the most recent estimates based on a 1992 livestock census. Government sources also report wholesale poultry prices for a few markets, but there are no official statistics on poultry consumption, marketing, processing, or feed use. The Food and Agriculture Organization of the United Nations (FAO) and the U.S. Department of Agriculture (USDA) publish estimates of Indian poultry supply and use, but, in the absence of supporting survey information, these estimates do not have a strong statistical foundation. Trade associations, including the Poultry Federation of India, also do not currently compile industrywide data. Thus, assessments of recent trends rely heavily on information provided through interviews with various industry sources.[2]

USDA estimates that India's poultry meat production grew about 6 percent annually during the 1980s, accelerating to 11 percent annually in the 1990s and nearly 19 percent during the 1997-2002 period (table 1 and fig. 2). With poultry production of 1.4 million tons in 2002, India ranked as the sixth largest poultry producer in the world, behind the United States, Brazil, the European Union, China, and Mexico. USDA estimates of Indian poultry production since the mid-1990s were revised sharply upward in 2002 to reflect information from industry sources and are significantly higher than other official estimates. FAO estimates, which are based on Government of India (GOI) data, suggest much lower production and growth than the USDA data. A third set of estimates, included in a study by the U.S.A. Poultry & Egg Export Council (USAPEEC) and reportedly derived from official GOI and FAO data, is roughly consistent with USDA data but ends in the mid-1990s.

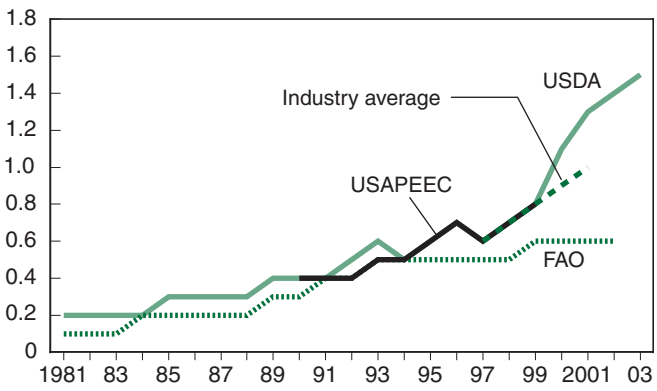
**Table 1—Growth rates of poultry production in India**

| Period | USDA | FAO | USAPEEC[1] | Industry average[2] |
|---|---|---|---|---|
| | | *Growth rates (percent)* | | |
| 1980-90 | 6.0 | 11.7 | -- | -- |
| 1990-00 | 11.0 | 5.3 | 7.7 | -- |
| 1990-96 | 9.8 | 5.8 | 8.3 | -- |
| 1997-02 | 18.6 | 2.5 | -- | 14.8 |

-- = Not available.
[1] USAPEEC is 1990-99 instead of 1990-2000.
[2] Industry average is 1997-2001 instead of 1997-2002.

Source: FAOSTAT database, August 2002.

Figure 2
**Estimates of poultry production in India**




Sources: USDA PS&D database, FAOSTAT database, U.S.A. Poultry & Egg Export Council.

The lack of timely national survey data makes it difficult to assess actual production trends. Several factors, however, suggest that the most recent USDA series, based primarily on private industry estimates, more accurately captures actual developments than the other sources. First, private industry estimates are more likely to account for the rapid technical and structural change in the sector. The industry estimates are based on technical parameters and assessments of breedwise placements of broiler parents and grandparents by companies familiar with the industry. The GOI estimates, by contrast, are based on surveys administered

[2] The data and information reported in this study are based primarily on ERS field research in India in August 2001. The ERS team, comprising Suresh Persaud, Rip Landes, and David Harvey, traveled throughout India interviewing representatives of poultry hatcheries, producers, processors, wholesalers, retailers, feed producers, and poultry integrators, collecting data and information on their operations and local market developments. Invaluable support for the field research was provided by Dr. V. Shunmugam, FAS Agricultural Specialist in the U.S. Embassy in New Delhi, and Dr. A.P. Sachdev, local representative of the U.S. Feed Grains Council, both of whom helped identify key industry contacts.

to known poultry operators every several years, which may not reflect new capacity and technical change.[3]

Second, trends in income growth and prices are consistent with faster growth in poultry consumption and production since the mid-1990s (table 2). Faster growth in income (per capita GDP) during the late 1990s, together with population growth, suggests that demand increased. The lower growth rate for poultry prices relative to rates for all foods and all meats, at a time of rising demand, suggests that poultry meat production grew faster in the late 1990s than in the earlier periods.[4] Slower growth in the price of corn, which accounts for a large share of poultry production costs, also supports faster growth in poultry production, as well as slow growth in poultry prices, during the late 1990s.

Finally, most private sector sources of information, including hatcheries, feed suppliers, and integrators, report that the industry is expanding more rapidly than the 3-4 percent annual growth implied by the FAO data. It should be noted that industry sources focus mostly on the organized commercial elements of the sector. However, the noncommercial elements of the sector now reportedly account for only 10-20 percent of broiler supplies and are unlikely to alter broad industry trends.

**Table 2—Wholesale price and income growth in India**

| Period | Wholesale price indices | | | | Per capita GDP |
|---|---|---|---|---|---|
| | All food | Poultry | Eggs, fish, and meat | Corn[1] | |
| | *1981/82=100* | | | | *Rs.* |
| 1979-81 | 92 | 123[2] | 87 | 87 | 5,333 |
| 1989-91 | 201 | 165 | 193 | 167 | 7,063 |
| 1994-96 | 335 | 277 | 378 | 290 | 8,095 |
| 1998-2000 | 453 | 304 | 491 | 346 | 9,742 |
| | *Growth rates (percent)* | | | | |
| 1980-90 | 8.1 | 4.3[3] | 8.3 | 6.8 | 2.9 |
| 1990-99 | 9.5 | 7.0 | 10.9 | 8.4 | 3.3 |
| 1990-95 | 10.8 | 10.9 | 14.3 | 11.6 | 2.8 |
| 1995-99 | 7.8 | 2.3 | 6.8 | 4.5 | 3.8 |

[1] Index of average wholesale prices in Bihar, Karnataka, and Uttar Pradesh.
[2] 1982-84 average.
[3] 1983-90 growth rate.

Sources: *Agricultural Prices in India*, GOI, various issues; *Economic Survey*, GOI, various issues.

Trade or storage of poultry products in India is negligible, so the estimates of poultry consumption are virtually identical to production (app. table 1.2). Again, while the consumption numbers constructed from the industry average production estimates, trade data, and assumed storage behavior must be used with caution, the faster consumption growth implied by the USDA estimates is consistent with other information, including trends in income and prices, and the views of industry experts interviewed during field surveys. In particular, faster growth in per capita incomes and declining real poultry prices suggest that growth in poultry consumption is likely to have increased significantly since the mid-1990s.

[3] Although the industry methods are also susceptible to error, it does not appear that they have a consistent bias. For example, one of the industry sources reported that its production estimate may be understated because the marketing staff that does the assessments is rewarded based on market share performance and, hence, has an incentive to underestimate competitor placements. On the other hand, another source indicated that its estimates may tend to overstate production because some of the firms may have provided inflated numbers to suggest an impending oversupply that would lead competitors to reduce placements.

[4] Assuming income- and own-price elasticities of demand of 1.7 and -1.5, respectively, the implied growth rates of poultry consumption and production for the periods analyzed would be 1980-90: 10.5 percent; 1990-99: 9.3 percent; 1990-95: 4.5 percent; and 1995-99: 14.7 percent.

## Growth in India's Poultry Sector Relative to Other Countries

FAO data provide the most complete coverage of global poultry production and consumption for use in comparing growth in various countries and regions. According to FAO data, growth in India's poultry sector was slow relative to growth in other developing countries in both the 1970s and 1990s but fast in the 1980s (table A-1). USDA estimates, however, may provide a more accurate assessment of the growth and structural change in the Indian poultry industry, particularly during the 1990s (see page 2). A comparison of the USDA estimates for India with the FAO data for other regions suggests that Indian poultry production and consumption are now expanding at a pace consistent with other fast-growing developing countries. According to USDA estimates, India is now the sixth largest poultry producer in the world, after the United States, Brazil, the European Union, China, and Mexico.

**Table A-1—Growth rates of poultry production and consumption, by global region[1]**

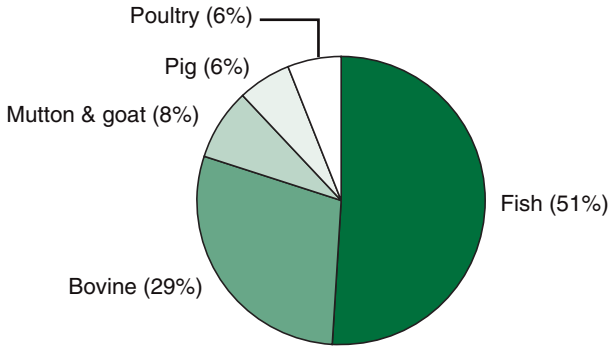
| | Production | | | Consumption | | |
|---|---|---|---|---|---|---|
| Region | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 |
| | | | *Growth rate (percent)* | | | |
| World | 5.8 | 4.6 | 5.3 | 5.7 | 4.7 | 5.1 |
| Developed countries | 5.1 | 3.5 | 2.4 | 4.8 | 3.6 | 1.9 |
| United States | 3.7 | 5.0 | 4.5 | 3.2 | 5.0 | 3.1 |
| Transition markets | 7.7 | 2.6 | -5.3 | 7.9 | 2.6 | -2.9 |
| Developing countries | 7.5 | 6.9 | 9.1 | 7.8 | 6.5 | 9.1 |
| Asia developed | 8.6 | 2.2 | -0.6 | 8.7 | 3.6 | 1.7 |
| Asia developing | 6.3 | 8.2 | 9.7 | 7.2 | 7.5 | 9.8 |
| South Asia | 3.4 | 9.6 | 6.3 | 3.5 | 9.6 | 6.3 |
| China | 5.4 | 8.8 | 13.5 | 5.4 | 9.0 | 13.6 |
| East & S. East Asia | 6.5 | 7.4 | 5.9 | 6.3 | 6.9 | 5.9 |
| Near East | 9.0 | 7.6 | 5.3 | 12.9 | 5.0 | 5.0 |
| Latin America & Caribbean | 9.9 | 5.5 | 9.0 | 9.3 | 5.4 | 9.1 |
| Africa developing | 5.6 | 6.0 | 4.6 | 6.5 | 5.5 | 4.7 |
| India | | | | | | |
| FAO data | 3.2 | 11.5 | 6.0 | 3.2 | 11.5 | 6.0 |
| USDA data[2] | 5.9 | 6.3 | 9.2 | 5.9 | 6.3 | 9.2 |

[1]Compound annual growth rates between 3-year averages centered on the years indicated.
[2]1975-1980 growth rates instead of 1970-1980.

Sources: FAOSTAT database, August 2002; USDA PS&D database, January 2003.

The major meats consumed in India are fish, bovine (cow and buffalo), mutton and goat, pig, and poultry (fig. 3).[5] Although consumption of poultry meat appears to be underestimated in the FAO data, the data indicate that poultry consumption grew faster than consumption of other meats and animal products, including milk and eggs, during the 1990s (table 3). Using the higher USDA estimates of poultry consumption, poultry's share of Indian meat consumption is about 8 percent, higher than both mutton and goat and pig meat. According to all major sources—FAO, USDA, and industry estimates—consumption of poultry meat is growing faster than consumption of any other major animal products since 1990.

Figure 3
**Meat consumption shares in India, 1997-99 average**




Source: FAOSTAT database.

Industry sources in India tend to minimize the significance of religious practices as constraints on growth in poultry consumption, although there is disagreement on this issue. Some industry sources claim that the share of the population that does not eat meat due to religious practices, as opposed to economic necessity, is fairly small, perhaps as low as 10-20 percent. A 1994 study entitled "People of India," conducted by the Anthropological Survey of India and based on a survey of 2,469 communities, indicated that only 20 percent of the "communities" surveyed were vegetarian. According to the survey, men were more likely to be nonvegetarian, and older people were more likely to be vegetarian.[6] The age structure of the Indian population indicates a large potential market for poultry in the years to come, as 30 percent of the 2000 population were between age 10 and 24. A national food survey, also conducted in 1994 in 32 cities, indicated that 74 percent of urban households were nonvegetarian.[7]

Disagreements have also arisen among government and industry sources in India regarding the relative popularity and consumption of various meats, particularly beef and fish, as indicated by the FAO data. Fish, with the highest level of consumption according to FAO, is widely consumed and strongly preferred in some regions, particularly in coastal areas and in eastern India. Fish availability, however, is highly seasonal in much of northern and central India and, for this reason, some analysts question the high level of consumption at the national level.

The apparent popularity of beef consumption in a predominantly Hindu country is both surprising and controversial. The beef consumed is primarily buffalo meat, which has less religious significance than cow meat, but some observers still question the high level of consumption indicated by the FAO data. Beef, along with pork, is generally the cheapest meat available in India, and its consumption is reported to be concentrated among Muslims and lower income consumers, and in the southern region. Consumption of both beef and pork appears to be growing relatively slowly compared with other meats, although there is now significant growth in Indian exports of beef, primarily to Middle Eastern markets. Mutton is generally the most expensive meat to buy, and available data suggest that both production and consumption are growing relatively slowly.

Poultry meat, which is showing the fastest growth in consumption according to available information, seems to have broad regional acceptance. Poultry meat is also generally low cost relative to mutton and fish. Low poultry prices in South India, due largely to the prevalence of poultry integrators in the region, are reported to have stimulated rapid growth in consumption. Several sources indicate that per capita poultry consumption in South India is about 4 kgs, about four times the national

[5] According to FAO data, which provide the most complete coverage of Indian livestock product consumption.

[6] Published in *Indian Express*, Bombay, April 13, 1994.

[7] Conducted by the Indian Market Research Bureau.

**Table 3—Trends in animal product consumption in India**

| Period | All meat | Fish and seafood | Bovine meat | Mutton and goat meat | Pig meat | Poultry meat | Milk | Eggs |
|---|---|---|---|---|---|---|---|---|
| | | | | *1,000 tons* | | | | |
| FAO estimates: | | | | | | | | |
| 1979-81 | 2,550 | 2,132 | 1,628 | 450 | 263 | 111 | 27,170 | 496 |
| 1989-91 | 3,776 | 3,262 | 2,299 | 603 | 417 | 330 | 45,878 | 1,009 |
| 1997-99 | 4,526 | 4,546 | 2,626 | 682 | 545 | 542 | 62,058 | 1,424 |
| | | | | *Growth rate (percent)* | | | | |
| 1980-90 | 4.0 | 4.3 | 3.5 | 3.0 | 4.7 | 11.5 | 5.4 | 7.4 |
| 1990-98 | 2.3 | 4.2 | 1.7 | 1.5 | 3.4 | 6.4 | 3.8 | 4.4 |
| | | | | *1,000 tons* | | | | |
| USDA estimates: | | | | | | | | |
| 1979-81 | 1,330 | -- | 601 | 408 | 72 | 214 | -- | 1,202 |
| 1989-91 | 3,079 | -- | 1,802 | 827 | -- | 393 | -- | 1,272 |
| 1999-01 | 2,722 | -- | 1,399 | 918 | -- | 1,050 | -- | 1,991 |
| | | | | *Growth rate (percent)* | | | | |
| 1980-90 | 8.8 | -- | 11.6 | 7.3 | -- | 6.3 | -- | 0.7 |
| 1990-00 | -- | -- | -2.5 | 1.0 | -- | 10.3 | -- | 4.6 |

-- = Not available.

Sources: FAOSTAT database, USDA PS&D database.

average based on industry consumption estimates, but no firm data support this claim.

## Income and Price Sensitivity of Demand

Growth in the Indian poultry industry is driven primarily by gains in real per capita incomes and changes in poultry prices. All sources note the importance of incomes in driving poultry demand, and most recognize the important role of poultry prices. The degree to which consumption responds to changes in income (or price) can be expressed as an "elasticity," which indicates the percentage change in consumption resulting from a 1-percent change in income (price). Formal estimates of income or price elasticities of demand for poultry in India are not available. One recent study provides income elasticity estimates for "meats" of .85 (rural) and .63 (urban) and an own-price elasticity for meats of -.88 (both rural and urban).[8] Given the relatively fast growth in poultry demand relative to other meats, it seems likely that the elasticities for poultry are higher than these group averages. For example, USDA estimates of poultry consumption growth since the mid-1990s (app. table 1.2), together with growth rates in per capita income and real poultry prices (table 2) during the same period, are consistent with elasticities of demand on the order of 1.7 for income and -1.5 for price.

Current patterns of poultry consumption provide additional evidence of the important roles of income and price. First, poultry consumption is higher in urban areas, where both average incomes and the number of high-income consumers are highest. Second, per capita poultry consumption is higher, perhaps as much as four times higher, in South India where retail poultry prices are significantly lower than in other regions. Given the evidence of sensitivity to both income and price, the recent trends toward faster growth in per capita incomes, as well as declining real prices for poultry, are likely to contribute to more rapid growth in poultry consumption.

## Regional Demand Patterns

India's States and regions are diverse in terms of economic factors affecting food demand, including population, income, and urbanization. The northern and eastern regions account for the largest shares of India's population, but their populations tend to be less

[8] P. Kumar, *Food Demand and Supply Projections for India*, Agricultural Economics Policy Paper 98-01, IARI, New Delhi, 1998.

## Income Growth and Poultry Meat Demand: A Cross-Country Comparison

The rapid apparent growth in poultry demand in India is consistent with patterns reflected in cross-country data for countries in the Asia and Near East region. Norton and Alwang provide estimates of income elasticities of demand for poultry and eggs for a number of developing countries in Asia and other regions (table B-1). The estimates indicate that poultry demand is relatively responsive to income in India, compared with other developing countries.

The relationship between per capita income and consumption of total meat and poultry for a number of Asia and Near East countries is shown in figures B-1 and B-2. This analysis is based on 1999 FAO consumption data and 1999 World Bank national per capita income data that are adjusted for differences in the purchasing power of national currencies. The figures, graphed in logarithms to provide a clearer picture, indicate that total meat consumption is strongly related to per capita income, particularly when countries reach the equivalent of about $3,000 of per capita income on a purchasing power parity (PPP) basis. India's 1999 PPP income is estimated at $2,230.

Among the meats analyzed in the region, poultry meat consumption is shown to be the most responsive to income and to have the strongest statistical relationship with income (table B-2). Fish is the next most responsive to income.[1] Mutton and goat meat consumption has a very weak and insignificant relationship with income among the countries analyzed.

[1] Muslim majority countries are excluded from the analysis of pork consumption.

**Table B-1—Income elasticities of demand for poultry and eggs for selected countries**

| Country | Poultry | Eggs |
|---|---|---|
| India | 1.50 | 1.00 |
| Indonesia | 1.50 | 1.20 |
| Egypt | 1.30 | 0.70 |
| Kenya | 1.20 | 1.30 |
| Turkey | 1.20 | 0.80 |
| South Korea | 1.00 | 0.80 |
| Nigeria | 1.00 | 1.20 |
| Philippines | 1.00 | 1.00 |
| Mexico | 0.93 | 0.59 |
| Malaysia | 0.87 | 0.73 |
| Brazil | 0.64 | 0.55 |
| Thailand | 0.50 | 0.50 |

Source: Norton and Alwang, p. 43.

Figure B-1

**Total meat consumption and income for selected Asian countries**

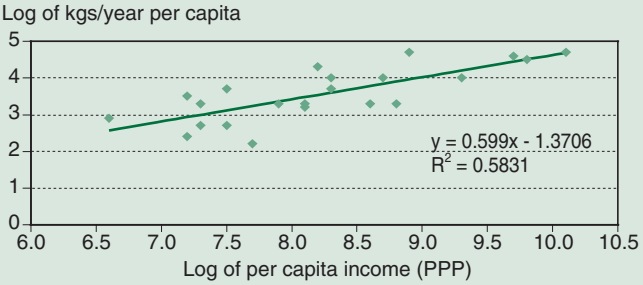
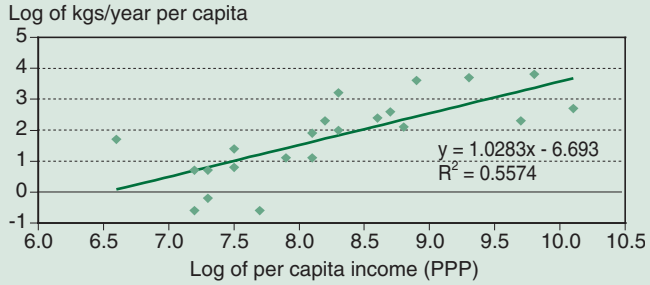



Figure B-2

**Poultry meat consumption and income for selected Asian countries**




Sources: ERS calculations using FAOSTAT per capita consumption and World Bank per capita income data.

Patterns of meat consumption in India may differ from other countries in the Asia and Near East region due to differences in availability, price, consumer preference, and other factors. Indian consumption of pork and beef appears not to be showing the signs of income responsiveness revealed in a number of the other countries in the region. On the other hand, traditional preferences and relatively high local prices may lead Indian demand for mutton and goat meat to be more responsive to income than in many other countries in the region. However, in the case of poultry, international comparisons provide support for the prospects for relatively rapid growth in poultry consumption.

**Table B-2—Implied income elasticities of demand for meats for Asia and the Near East**

| Meat | Income elasticity | R-square | n |
|---|---|---|---|
| Total meat | 0.60 | 0.58 | 22 |
| Poultry | 1.03 | 0.56 | 22 |
| Pork | 0.48 | 0.08 | 14 |
| Beef | 0.37 | 0.29 | 22 |
| Mutton & goat | -0.10 | 0.00 | 21 |
| Fish | 0.59 | 0.25 | 22 |

n = number of Asia and Near East countries. Near East countries are excluded for analysis of pork.

Sources: Computed from FAO per capita consumption and World Bank per capita purchasing power parity (PPP) income data.

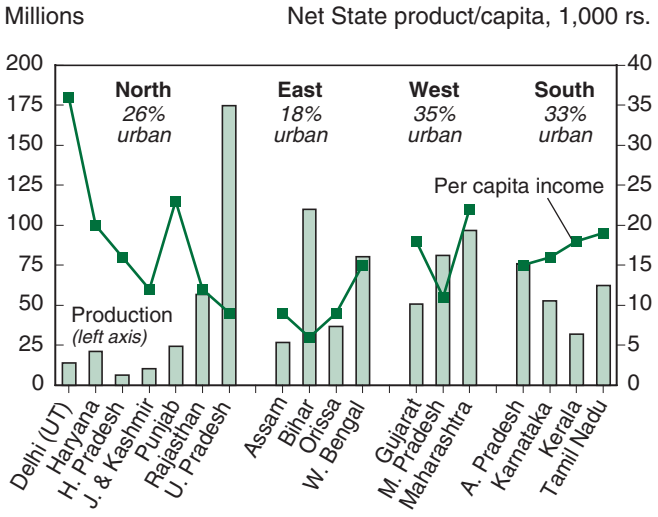
urbanized than in the southern and western areas (fig. 4 and app. table 1.3). In contrast, the southern and western regions are the most urbanized and have the highest average per capita incomes. The northern region also has areas with relatively high incomes and urbanization, but its averages are weighed down by low incomes and urbanization in Uttar Pradesh, by far India's largest State. The eastern region, including India's poorest State, Bihar, has substantially lower average per capita incomes and urbanization than India's other regions.

High incomes and urbanization in the South are supportive of the region's rapid gains in poultry demand, supply, and commercialization. These factors also support the rapid growth now extant in the western region, particularly around the large Mumbai market. The northern region, where the poultry industry is not growing as rapidly as in the South or West, does, however, have areas of high income and urbanization, particularly in Delhi, Haryana, and Punjab, that can support growth in poultry demand. Demand fundamentals in the eastern region, however, suggest that poultry demand growth may remain slow relative to the other regions.

## Substitutes and Complements

The degree to which consumers switch between, or substitute, different foods because of changes in price can be expressed as cross-price elasticities of demand.

Figure 4
**Regionwise population and income in India**




Source: *Economic Survey*, 2001/02, Ministry of Finance, Government of India, 2002.

Formal estimates of cross-price relationships between poultry and other foods in India are not available. Based on information supplied by industry and academic sources, fish is an important substitute for poultry, and there is a strong correlation between the prices of these commodities. Goat meat is also a significant substitute for poultry meat based on relative prices. Given their different uses in food preparation and the diet, eggs and, particularly, milk were not considered strong substitutes for poultry meat.

Most likely some substitution between cereals and pulses and poultry meat occurs among middle- and lower income consumers, if not among higher income consumers. Cereals and pulses account for a large, and relatively price-inelastic, share of the diet, so relative prices are likely to affect allocations to poultry. Pulses and cereals, as well as milk and eggs, are important sources of dietary protein, but there is little evidence that consumers substitute among foods on the basis of protein content. Most consumers, reportedly, are unaware of the protein content of their daily menu. Instead, they maximize variety on the plate subject to a budget constraint.

Poultry meat is still somewhat of a luxury good in India, but its status is changing. In the past, chicken was considered to be a delicacy and was more expensive than mutton. But, with the strong gains in poultry production over the years, poultry prices are now lower than mutton prices and consumption among middle-class consumers is expanding rapidly.

Although the price of beef is lower than poultry, and the quantity consumed is significantly higher according to available data, it is not clear whether beef will be a major source of competition for poultry. At present, in contrast to the relatively universal appeal of poultry, beef consumption is mostly in Kerala and Tamil Nadu and, to a lesser extent, in West Bengal and the north-eastern States where beef slaughter is permitted. From a socioeconomic standpoint, beef is consumed primarily by Muslims and the relatively poor.

## Preferences for Dark and White Meat

Indian consumers prepare poultry in a variety of ways, the most popular being curries, kabobs, and tandoori (barbecue) dishes. Although these dishes are generally made with a mix of white and dark meat, industry sources claim that Indian consumers have a preference for the dark meat portions. This preference for dark

meat is not, however, reflected in noticeable price premiums for dark meat.[9] Sales of chicken parts are limited to high-end urban shops, but per kilogram prices for dark and white meat parts were the same, or very nearly the same, in all the markets visited. It is possible, however, that these prices are skewed by the nature of the clientele in such shops, and that many consumers would pay some premium for dark meat pieces if they were widely available.

## Seasonality in Demand

Perhaps the most significant impacts of religious practices on consumption of poultry and other meats in India are the strong seasonal patterns in demand in some regions. Seasonal religious observances can lead to significant fluctuations in demand. In some cases, religious practices prohibit meat for specified periods, and in others, celebrations and festivals lead to increases in meat demand. In the Mumbai region, religious observances significantly reduce poultry consumption for about 3 months of the year, although some festivals can lead to offsetting increases in demand. In Calcutta, on the other hand, an increase in poultry consumption is associated with the Durga Puja festival, and no significant seasonal downswings in consumption are reported.

With limited frozen storage facilities or interregional movement of live birds, the seasonal swings in demand contribute to volatility in market prices of poultry meat in some regions. For example, during August 2001, a seasonal drop in demand helped push prices in the Mumbai market down sharply, and below production costs for most producers in the region.

[9] This is in contrast to East Asian markets, in which dark meat prices are higher than white meat prices, and to North American markets, where prices for white meat are higher than for dark meat. These international differences in price for poultry cuts drove much of the growth in global poultry meat trade in the 1990s.

# Poultry Production: Structure and Technical Performance

The structure and costs of production in the Indian poultry meat industry vary from region to region. While independent and relatively small-scale producers still account for most production, relatively large-scale integrated producers account for a growing share of output in some regions. Integrated operations include large regional firms that incorporate all aspects of production, including raising grandparent and parent flocks, rearing day-old-chicks (DOC), contracting production, compounding feed, providing veterinary services, and wholesaling.[10] Most integrated firms also have some presence in retail marketing, largely for the purpose of establishing price leadership and having influence over wholesale-retail margins (see section on poultry marketing). Some integrators (about six to eight nationwide) also process a share of their production in modern, automated, or semi-automated plants.

India's poultry industry also has a number of smaller, partially integrated firms that typically omit one or more of the major input enterprises, such as breeding or feed milling, and may have little or no contract production. Large-scale integrated producers are most prominent in the southern and western regions. Smaller, independent, and sometimes partially integrated producers account for most poultry production in the northern and eastern regions.

Commercial broilers and eggs are produced by separate enterprises using specialized broiler and layer breeds and distinct management practices. Joint production of poultry meat and eggs from dual-purpose birds is confined to noncommercial "back yard" operations. Although data on noncommercial production of poultry and eggs is not available, industry sources indicate that this industry segment is declining and probably accounts for only 10-20 percent of India's total output. This study excludes analysis of this component of production.

[10] The poultry breeding chain starts with "pure line" flocks that are multiplied into "grandparents" and then "parents," which are the source of eggs for the day-old chicks (DOC) used in broiler enterprises. Smaller enterprises may simply purchase DOCs from a hatchery, while larger enterprises can reduce DOC costs by integrating maintenance of parent and grandparent flocks into their operation.

## Data Collection Methods

The data used in this study were collected during a field survey by an ERS team that visited India in August 2001. Because of significant regional variations in poultry demand and in the structure of poultry production, the team traveled throughout the country, visiting Delhi, Punjab, and Haryana in the North; Ahmedabad, Mumbai, Pune, and Nashik in the West; Coimbatore, Hyderabad, and Bangalore in the South; and the Calcutta region in the East. In the absence of a reliable listing of producers from which to draw a sample, and to contain data collection costs, survey respondents were selected based on recommendations of industry sources, who identified individuals that had both knowledge of the industry and reliable records.

In each region, the team visited poultry hatcheries, producers, processors, wholesalers, retailers, and feed producers, asking each respondent the same operations-related questions. The production and marketing cost data are based on 18 respondents (4 in the North, 5 in the West, 8 in the South, 1 in the East) who provided complete and consistent data. Although the sample size is small for such a large country, the variation in responses within regions is generally small, increasing confidence in the reliability of the regional and national averages. Because of the small sample size, however, the results should be interpreted with caution. In particular, the sample size is very small in the East (1) and is likely skewed toward larger integrated operators in the West.

## The Role of Integrated Poultry Production

Poultry integrators have been expanding most rapidly in southern India, particularly in the Coimbatore area of Tamil Nadu, where, reportedly, integrators now account for about 75 percent of production and consumption. Integrators have recently become more prevalent in western India, including Pune, Nashik, and Mumbai, where they now account for about 35 percent of production and consumption. In northern and eastern India, integration has moved more slowly,

accounting for about 10 percent of the market. In the North, integrators have found it difficult to enlist and manage contract growers and, despite the presence of the large and affluent Delhi market, there are no major, fully integrated contract growers in the region. In the East, lower per capita incomes and low demand for poultry meat are likely contributors to the slow rate of growth.

In southern India, the process of integration began in the mid-1990s and accelerated rapidly as independent growers found the guaranteed returns of contract farming preferable to the vagaries of market returns. As integration expanded, some formerly independent hatcheries and feed millers found it necessary to become integrators themselves or risk going out of business. Integration has brought two important changes to the poultry industry in southern India: lower average costs of production through improved technology and management practices and, particularly, a collapsing of the margins previously commanded for the various production inputs; and smaller producer-retail margins and lower retail prices for poultry meat, which has been a key demand stimulus in the southern and western regions (see section on poultry marketing and prices).

In the last 2-3 years, several integrators have begun to operate around the Mumbai market in western India, primarily in the Pune and Nashik areas. They include poultry integrators who are expanding from southern India, ventures by national or regional hatchery and feed businesses, and local poultry wholesaling firms, all competing to enlist contract growers and expand market share in the region. This competition, combined with seasonally weak demand due to religious observances, led at times to severely depressed producer and retail prices in the Mumbai market in 2001.

For integrators to succeed in the Mumbai market as they have in southern India, they must overcome the dominant role of the traditional Mumbai wholesale trade. Traditional trading relationships, together with the high cost of establishing an effective retail presence, may prevent integrators from competing down marketing margins and expanding their share of the market. The firms that are entering this market, however, all have significant financial resources and plan to address this issue through strategic links with existing food retailing operations.

Integrators are also expanding in the areas of Bangalore and Hyderabad in the South and Calcutta in the East. The only major region where large integrators have not yet made significant inroads is in North India, including the large Delhi market. In this region, some individual producers have expanded into feed mixing and direct retail marketing. No producers, however, are involved in rearing parent or grandparent flocks, and very few are contracting out production. The lack of poultry integration in the North may be due to difficulties in enforcing contract-farming agreements.[11] Also, climatic extremes of hot and cold make poultry production more management- and capital intensive in the North, compared with the other regions. Lastly, unlike other regions where the integrators have flourished, the Punjab-Haryana-Western Uttar Pradesh area near Delhi is heavily irrigated and highly productive for crop farming. As a result, allocating management and labor to contract farming for the margins fixed in standard broiler contracts may be less appealing. Contract models that call for farmers to serve only as the owner of the houses, with the integrator providing all labor and management, may be more successful in this region (see section on farmer's compensation under integration).

According to most of the survey respondents, the primary constraint in expanding integrated poultry operations is marketing. Most integrators sell the bulk of their output as live birds in the wholesale markets, with a small share sold in retail markets as either live or dressed birds or products. With limited demand or capacity for frozen products, and the high cost of moving live birds to distant markets, integrators are mostly confined to their local regional market and its seasonal demand patterns (see section on marketing). Another common concern among survey respondents is high interest rates. Producers or integrators looking to expand facilities can expect to pay interest rates of about 15 percent on commercial loans that, at the current rate of wholesale price inflation, imply a 9-10 percent real cost of borrowing. In general, the availability of feed grain or oil meal was not considered to be a significant problem, although seasonal shortages of corn can and have resulted in higher prices. Only in northern India did integrators regard enlistment, organization, or management of contract farmers as a significant problem.

[11] At present, India does not have a law covering contract farming and the contracts between farmers and contractors cannot technically be enforced. Integrators and growers in other regions appear to be working together smoothly despite this problem, but this is not the case in North India.

So far, foreign direct investment (FDI) has been a minor factor in the expansion of integrated poultry operations in India. A large integrator in both the southern and western regions operates a processing facility built recently with the assistance of private Saudi Arabian investment. Two large Asian integrators, Japfa from Indonesia and CP from Thailand, have been in the feed business in India for several years but have, so far, not expanded into poultry integration.

## Poultry Breeds

Although a number of poultry breeds are available in India, the Cobb 100 breed owned by Venkateshwara Hatcheries (VH) currently accounts for 60-70 percent of all broilers in India. VH has a nationwide infrastructure that supplies its breed to broiler operators, either as grandparents, parents, or DOCs, and also provides comprehensive veterinary services to its growers. At present, all broilers supplied by VH are the Cobb 100, a relatively older breed based on breeding stock imported from the United States and benefiting from a long period of adaptation to Indian climatic and disease conditions. A Cobb 500 line, based on more recently imported breeding stock, is reported to be under development, as is a Cobb 400 line, based on a cross between the Cobb 500 and the acclimatized Cobb 100. Other breeds present in India include Ross (U.K.), Hybro (Netherlands), Hubbard (U.S.), Avian (U.S.), and Anak (Israel).

The dominant position of VH and its Cobb 100 in broiler breeding in India stems from a combination of factors: government restrictions on imports of grandparent lines that were in place until 1995, and the entrepreneurial skills of the late VH founder, who is known as the founder of the Indian poultry industry. Prior to loosening restrictions on imports of grandparent stock, only pure line imports were permitted. Cobb became one of the few imported pure line breeds available in India, and the breed was developed, acclimatized, and spread throughout the country as VH built a nationwide infrastructure of hatcheries and veterinary services. Most of the other imported breeds now present in India have entered only since 1995. As a result, promoters of other breeds have had a much shorter period to acclimatize their breeds to Indian conditions, establish products in the marketplace, and develop production facilities and marketing networks.

Industry sources report that the dominant role of the Cobb 100 breed and VH in the Indian broiler hatchery industry has both advantages and disadvantages for the growth of the broiler industry. On the technical side, the well-acclimatized Cobb 100 is known for its hardiness in Indian climate and disease conditions. It has also proved to be a good "breeders bird," producing a relatively high number of hatching eggs per parent, compared with other breeds. Another advantage is the generally ready availability of chicks and veterinary support services from VH's widespread operations. The Cobb 100, however, is primarily a layer and, hence, provides a relatively low 75-percent meat yield, compared with 77-78 percent for newer, specialized broiler breeds. The Cobb 100 is also a very old breed, with superior breeds available internationally.

Perhaps a more significant concern with the dominant role of the Cobb 100 relates to the implications of concentration and market power in the broiler chick business. Several integrators indicated that their allocations of grandparents, parents, or DOCs have been reduced in certain market conditions, ostensibly to support broiler prices, but also having the effect of limiting the growth of some integrators. With the owner of the Cobb 100 breed also venturing into integrated operations, other firms feel they are at a competitive disadvantage. Several integrators resorted to importing and developing their own breeding operations because they felt they could not rely on sufficient allocations of Cobb 100s to meet their needs and expansion plans. Data collected from study respondents suggest that firms that integrate grandparent breeding enterprises into their business, as opposed to purchasing Cobb 100 parents or DOCs, experienced significant cost savings (table 4).

With the expansion of large-scale integrators since the mid-1990s, and the liberalization of grandparent imports in 1995, imports of breeding stock of various international breeds have increased. Given the apparent cost advantages to integrated firms, this trend is likely to continue. But it is unclear how long it will take for the new breeds to become sufficiently accli-

**Table 4—Average day-old-chick costs in India**

| Region | Integrators | Other farms |
|---|---|---|
| | *Rs/bird* | |
| North | NA | 11.79 |
| West | 8.75 | 14.00 |
| South | 7.89 | 10.00 |
| East | 10.00 | NA |

NA = Not available.

Source: ERS field survey, August 2001.

matized to Indian conditions to counter the hardiness and breeding advantages of the Cobb 100. Although Indian firms are importing breeding stock and technology from foreign breeders, there is currently no FDI in broiler breeding in India.

## Poultry Production Practices

Poultry production practices in India vary across regions, based on differences in climate and on the presence of poultry integrators, who impose a standard level of technology and operational efficiency on poultry enterprises. In general, the larger and/or integrated operations, particularly in southern India and the Mumbai region, appear to be quite technically and economically efficient, with operators exhibiting strong knowledge of correct breeding, feeding, veterinary, and rearing practices. In general, technical performance indicators for these operations, including numbers of DOCs per parent, days-to-market, feed conversion, and mortality, are comparable with average levels achieved in U.S. operations.

**Facilities and equipment.** Climate conditions are most suited to poultry production in southern India, where average temperatures, though fairly high, tend to avoid the extreme heat of the eastern and western regions, and the extremes of both hot and cold found in northern India. The capacities of houses range from 8,000 to 20,000 birds and from 6,000 to 15,000 square feet. Based on the field survey, production facilities and equipment in the four regions can be characterized as follows:

- *South*. In the South, poultry houses tend to be built of brick pillars, with open sides, tile roofs, and concrete floors. Cooling, when needed, is provided by ceiling fans, and heating is unnecessary except for brooding. Bedding is generally paddy husks. Manual feeders and bell-type drinkers are most common, with little use of automatic watering and feeding systems.
- *West*. In the Mumbai region, where average summer temperatures are higher than in the South, houses are also built of brick with tile roofs and concrete floors, but tend to be mostly enclosed with evaporative automatic cooling systems. Automatic watering and feeding systems are more common in this area.
- *East*. In the region north of Calcutta, houses are constructed of brick pillars with open sides, very similar to houses in the South, although side curtains are generally present to help hold in warmth in the slightly cooler winters. Feeding and drinking equipment is generally manual, and ceiling fans provide summer cooling.
- *North*. In the North (Punjab, Haryana, western U.P.), both summer and winter weather are more extreme than in the other regions. Houses are built of brick and concrete and have either enclosed sides or side curtains and concrete floors. Some houses have automatic systems for both evaporative cooling and heating. Because land prices are significantly higher in this region, two-storied houses are common. Both manual and automatic watering and feeding equipment is seen in this region.

**Breeding practices.** While independent operators generally purchase DOCs from local hatcheries, such as VH, integrators generally produce their own chicks from either parent stock or grandparent stock raised in their own facilities. For integrators, producing DOCs from their own parent or grandparent operations is a key source of savings. Integrators reported DOC costs from their own grandparent operations of Rs6-10 per chick, compared with costs of Rs10-15 per chick for other operations. In addition, market prices of DOCs are, reportedly, quite volatile depending on local supply and demand conditions. At times, market DOC prices can crash to as low as Rs3 and rise to as high as Rs16-18. Recently, hatcheries in some areas jointly agreed to destroy hatching eggs because of large surpluses of DOCs.

The parent and grandparent operations visited were run with strict standards of environmental control and sanitation to protect the health and productivity of the flocks. According to industry sources familiar with both Indian and U.S. practices, it is typical for Indian poultry breeding operations to achieve levels of performance, in terms of eggs per parent and hatching percentage, superior to those achieved in U.S. operations. Using Cobb 100 parents or grandparents, growers typically achieve about 170-180 eggs per parent with a hatching percentage of 90 percent or higher. These relatively high levels of productivity are attributed to the hardiness of the Cobb 100 breed, as well as higher labor inputs relative to U.S. operations.

**Feeding practices.** Growers tend to cite feed costs as the critical component of controlling and lowering production costs. Reducing feed costs includes steps to improve feed conversion, including innovations such as pelletization and automated feeding, as well as improvements in feed purchasing and logistics.

Poultry farmers have a strong understanding of the importance of balanced feed rations. They recognize corn and soybean meal as technically superior ingredients for broiler rations, with corn generally accounting for most of the energy in the feed ration and soybean meal providing most of the protein. Most operators, however, use substitutes for both the energy and protein ingredients in the ration based on changes in relative market prices. The most common corn substitutes for energy are broken rice, millet, and wheat (table 5). Fish meal, sunflower meal (decorticated), and peanut meal are the most common protein substitutes for soybean meal.

Given the key role of feed costs in overall costs of production, feed conversion rates (FCR) are a major concern for growers, most of whom have a clear understanding of their FCR, as well as the impacts of alternative ration ingredients on FCRs. Most operators use mash-type feeds, but a number are beginning to experiment with pelletized feeds. Although pelletized feeds are more expensive than mash feeds by Rs0.50-1.00 per kg, or about 5-10 percent, they result in less wastage, assure a more balanced ration for each bird, and lower FCR. Several operators that use pelletized feed report about a 0.1-kg improvement in the FCR.

The price volatility of local feeds, particularly corn, and the absence of futures markets to manage price risk make it difficult to control and predict feed prices. Some operators pursue a strategy of buying and storing ingredients when prices are low, but others do not because of the difficulty in accurately predicting price movements. Concerns with feed costs tend to be greatest in southern India, where both corn and soybean meal are not available locally and must be purchased from suppliers in central and northern India. Feed imports are normally not an economically viable option because of large national surpluses of soybean meal and a restrictive tariff-rate quota (TRQ) regime for corn imports (see feed trade policy section).

**Table 5—Major poultry ration ingredients in India**

| Energy | Protein | Other |
|---|---|---|
| Corn | Soybean meal | Soy oil |
| Broken rice | Fish meal | Sunflower oil |
| Pearl millet | Sunflower meal[1] | Minerals |
| Wheat | Peanut meal | |
| Sorghum | Rice bran | |
| Rice bran | Meat meal | |
| Shares: | | |
| 60-65 % | 30-35% | 5% |

[1]Decorticated.

Source: ERS field survey, August 2001.

Most poultry integrators include feed milling as one of their integrated enterprises. Most also indicate significant cost savings, as well as more consistent quality, from producing their own feed. A number of feed milling companies, threatened by integrated operations cutting into their customer base, have evolved into poultry integrators.

**Veterinary practices.** Poultry operators also appear to have a strong understanding of the steps needed to safeguard the health of their flocks. Most independent growers retain consultant veterinarians to monitor and address health problems in the flocks. Poultry integrators provide medicines and veterinary services as part of their package of inputs for contract growers. Diagnostic facilities and medicines are readily available. Outbreaks of flock-threatening diseases, though possible, are rare.

**Foreign direct investment in poultry inputs.** FDI in poultry production inputs is most common in the area of pharmaceuticals, as most of the companies operating in India are multinational corporations or Indian joint ventures with multinationals. Although some items are imported, most drugs and vaccines for poultry production are produced in India.

The major Indian feed companies are Indian owned. Two foreign companies, Japfa from Indonesia and CP from Thailand, now have feed operations in India, but they do not account for major market shares. Most poultry equipment, including feeders, waterers, and climatic controls, is produced by Indian-owned companies. Some equipment, however, is imported and some items are produced in joint ventures with foreign companies.

## Technical Performance and Production Costs by Region

Summary performance indicators, including days-to-market, weight, FCRs, and mortality rates and variable production costs for the operations visited, are shown in table 6. The results should be interpreted with caution because they are based on a small number of firms that may not represent overall regional or national averages. In particular, the sample is very small (1) in the East and is likely skewed toward larger integrated operators in the West. In general, however, the indicators suggest greater technical efficiency in

**Table 6—Summary of performance indicators and variable costs for poultry in India, by region**

| Variable | North | West | South | East |
|---|---|---|---|---|
| Harvest weight (kg/bird) | 1.83 | 1.68 | 1.89 | 1.50 |
| FCR (kg/kg) | 1.88 | 1.88 | 1.85 | 1.90 |
| Mortality rate (percent) | 4.3 | 3.9 | 3.9 | 3.9 |
| | | *Rs/kg, live harvest weight* | | |
| DOC cost | 6.72 | 6.14 | 4.35 | 6.67 |
| Feed | 16.13 | 15.96 | 16.58 | 17.10 |
| Mortality | 0.71 | 0.65 | 0.62 | 0.75 |
| Other[1] | 5.88 | 4.87 | 4.38 | 3.98 |
| Total variable costs | 29.44 | 27.63 | 25.93 | 28.50 |
| (US$/kg) | (0.62) | (0.59) | (0.55) | (0.60) |
| Feed share (percent) | 54.8 | 57.8 | 63.9 | 60.0 |
| Feed price (Rs/kg) | 8.58 | 8.55 | 8.97 | 9.00 |

[1]Includes medicines, labor, energy, grower fees, and overhead.

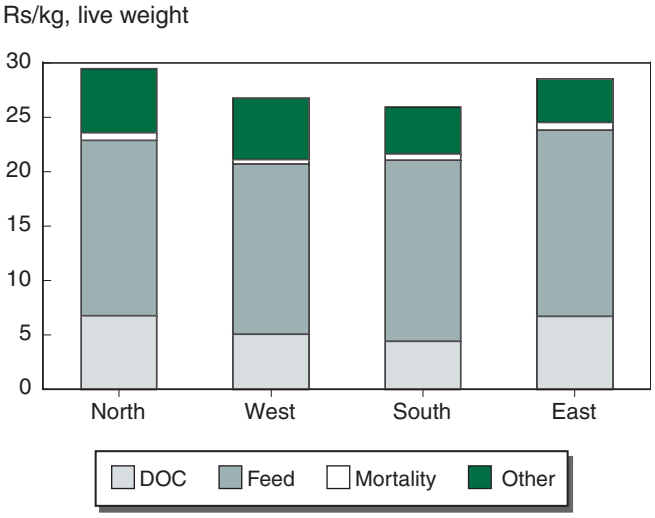
Source: ERS field study, August 2001.

the South and West, compared with the North and East. Findings also suggest greater technical efficiency in those operations employing automatic climate controls in their houses, regardless of region. Operations in the South, as well as the firm surveyed in the East, tend to achieve roughly equivalent or better technical performance than the other regions without having to use costly environmental controls (other than simple ceiling fans).

FCRs and days-to-market are generally higher in the North, at least in part because of higher market weights. Mortality rates are also highest in the North, where the extremes of hot and cold temperatures are most problematic. Growers in this region clearly face the greatest challenge from climatic conditions, which they cite as a key reason that their costs are higher than in the South. Northern Indian growers, however, have less difficulty with corn supplies because of local production.

**Variable production costs by region.** Average variable costs of production are lowest in the South, followed by the West, East, and North (fig. 5). However, the range of average variable production costs across regions, from Rs25.92 per kg to Rs29.44 per kg, is not very large. Feed is the largest component of costs, ranging from about 55 percent of total variable costs in the North to about 64 percent in the South. DOCs are the second largest cost component, ranging from 17 percent of variable costs in the South to about 23 percent in the North.

Figure 5
**Variable poultry production costs in India, by region**




Source: ERS field survey, August 2001.

- *South*. Variable production costs in the South average Rs25.92 per kg. Some of the larger integrators in the region reported costs below Rs25.00 per kg. The South has the lowest total costs despite facing the highest feed prices (both corn and soybean meal generally must be shipped from greater distances than in the other regions). DOC costs are lowest in the South, and mortality costs are also low relative to two other regions. The greater cost efficiency in the South likely stems both from favorable climate and better management by the integrated poultry operations. Relatively low energy costs for both heating and cooling hold down "other" costs in the South.
- *West*. Average variable costs in the sample of western region operations were Rs26.75 per kg, with this region having the lowest feed costs per kg of output and the lowest mortality costs. Producers in this region benefit from close proximity to Madhya Pradesh, which produces soybean meal and corn, and to Karnataka and Andhra Pradesh, which also produce corn. As noted earlier, however, all of the firms visited in this region were relatively large and well-managed integrated operators using climatic controls in their houses; hence, these findings may not be indicative of the region as a whole. "Other" costs are

relatively high in this region, in part due to the energy costs associated with operating climate controls.

- *East*. The eastern region had the third highest total for variable production costs, although the sample consists of only one, relatively large, integrated operator. Based on the data from this firm, this region has the highest feed costs, due to relatively high feed prices and FCR, as well as relatively high mortality and DOC costs.
- *North*. Average total variable production costs were highest in the sample of northern India producers, at Rs29.44 per kg. The benefits of relatively low feed prices in this region are offset by relatively high FCRs, DOC costs, mortality rates, and energy costs. To some extent, performance and costs are affected by the climatic extremes in this region. The absence of integrated poultry operations probably also affects costs, particularly for DOCs.

**Fixed production costs by region.** Data were collected on fixed costs of production, including housing, equipment, and, where applicable, environmental controls (table 7 and fig. 6). As expected, given differences in climate and production practices, there are sizable regional differences in fixed costs of production. Fixed costs tend to be lowest in the South and the East and highest in the West and North. In both the South and East, the favorable climate permits relatively low housing costs, automatic climate controls are generally unnecessary, and most producers use lower cost manual feeding and watering equipment.

By contrast, costs of both housing and equipment are significantly higher in the North and, at least for the operations visited, in the West. On a square-foot basis, housing and equipment costs in the West and North are two to three times higher than for typical producers in the South or East. With interest rates on bank borrowing for poultry operations of about 15 percent, according to most respondents, the differences in fixed costs can translate into significant differences in interest costs across the regions. Assuming a 15-percent interest rate, financing of 100 percent of construction costs, and six flocks per year per house, interest costs are Rs2.96-4.72 per square foot per flock in the North and West, and Rs1.65-1.72 in the South and East.

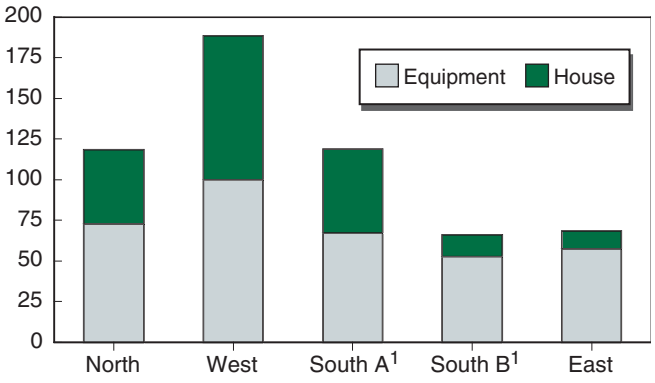
**Table 7—Summary of fixed costs of production for poultry in India, by region**

| Variable | North | West | South A[1] | South B[1] | East |
|---|---|---|---|---|---|
| | | | *Rs/sq. ft.* | | |
| House | 72.92 | 100.00 | 67.13 | 52.83 | 57.50 |
| Equipment | 45.43 | 88.61 | 51.53 | 13.15 | 11.11 |
| Total | 118.35 | 188.61 | 118.66 | 65.98 | 68.61 |
| | | | *Rs/sq. ft./flock* | | |
| Memo: | | | | | |
| Interest cost[2] | 2.96 | 4.72 | 2.97 | 1.65 | 1.72 |

[1]South A includes all respondents; South B excludes one, high-cost respondent.
[2]Assuming a 15-percent interest rate and six flocks per year.

Source: ERS field study, August 2001.

Figure 6
**Fixed poultry production costs in India, by region**




[1]South A includes all respondents; South B excludes one high-cost respondent.

Source: ERS field survey, August 2001.

Although estimates of land costs are not available across all regions, industry sources indicate that land costs are highest in the North (Punjab, Haryana, western Uttar Pradesh), where farm land is more likely to be irrigated and more productive for crop farming. In the Punjab region, farmers quoted land prices ranging from of Rs150,000 to 1,200,000 ($3,100-$25,000) per acre, depending on location.

Overall, the data collected suggest that lower fixed costs may tend to hold down poultry costs and prices and favor industry expansion in the South and East. However, because it is not feasible to ship large numbers of live birds across regions, producers in the South and East will not be able to exploit this advantage until there is a larger market for processed chilled or frozen poultry (see section on marketing). The relatively high fixed costs in the North and the West may also tend to restrict the participation of smaller growers in industry expansion in this region. While the integrated operations in the South and East tend to enlist both small and large growers, growers in the West and North may have to be larger firms with greater financial resources to invest.

## India's Production Costs Relative to Other Countries

To assess the relative competitiveness of Indian poultry production, Indian variable production cost and farm price data can be compared with data for other countries, including the United States, Brazil, and several Asian countries (tables D-1 and D-2). The Indian cost data comprise costs of day-old-chicks (DOC), feed, mortality, medicines, labor, and power reported on the basis of a kilogram of live-weight production, a common industry approach for computing variable costs. Data for other countries are those reported by USDA's Foreign Agricultural Service in annual "attache reports" on the poultry industry in each country. Although the cost accounting methods may vary across countries, it is likely that all the estimates include the key cost items—DOCs, feed, and mortality—which generally account for 80-85 percent of the variable costs of poultry production. Thus, although accounting methods may vary, the data should still be useful for comparison purposes.

The comparisons suggest that, while Brazil is the lowest cost producer, production costs in the southern, western, and eastern regions of India are very competitive with those in other countries, including the United States. Poultry costs in these Indian regions appear to be competitive with those in Thailand, a major exporter of poultry meat, and significantly lower than those in East Asia and other parts of Southeast Asia.

Data that would permit more detailed comparisons across countries are not available, so it is unclear how India compares on key productivity measures and major itemized costs. Given the dominant role of feed costs in the total variable costs of poultry meat production, it is likely that feed prices and feed use efficiency are important factors in India's apparent competitiveness. The two other relatively low-cost producers among the countries compared, Brazil and the United States, are, like India, large producers of soybeans and corn. Significant local production of both corn and soybean meal allow producers to benefit from relatively low transport and handling costs, and to avoid the costs of tariffs on imported feeds.

As the least developed among the countries compared in tables D-1 and D-2, India also has the least developed poultry sector, with a relatively small share of production from operations that use the most advanced technology. Indian poultry producers likely benefit from lower labor costs but may also pay relatively high real interest rates for operating and investment capital.

**Table D-1—Broiler variable costs of production by country**

| Country | 1999 | 2000 | 2001 |
|---|---|---|---|
| | | *$/kg, liveweight* | |
| Argentina | -- | 0.93 | -- |
| Brazil | 0.59 | 0.47 | 0.38 |
| Malaysia | 0.74 | 0.72 | -- |
| Philippines | -- | 0.86 | 0.94 |
| South Korea | 0.91 | 0.85 | -- |
| Taiwan | -- | 1.03 | -- |
| Thailand | 0.74 | 0.65 | 0.61 |
| United States | 0.54 | 0.56 | 0.56 |
| India: | | | |
| North | -- | -- | 0.62 |
| West | -- | -- | 0.59 |
| South | -- | -- | 0.55 |
| East | -- | -- | 0.60 |

-- = Not available.

Sources: Foreign Agricultural Service, USDA, various attache reports; *Poultry Yearbook,* Economic Research Service, USDA.

**Table D-2—Broiler farm gate prices by country**

| Country | 1999 | 2000 | 2001 |
|---|---|---|---|
| | | *$/kg, liveweight* | |
| Brazil | 0.44 | 0.50 | 0.48 |
| Indonesia | 0.94 | 0.79 | 0.74 |
| Malaysia | 0.83 | 0.83 | -- |
| Philippines | 1.34 | 1.17 | 0.78 |
| South Korea | 1.02 | 1.05 | -- |
| Taiwan | 1.18 | 1.08 | 1.03 |
| Thailand | 0.71 | 0.64 | 0.68 |
| United States | 0.82 | 0.76 | 0.87 |
| India: | | | |
| North | -- | -- | 0.84 |
| West | -- | -- | 0.48 |
| South | -- | -- | 0.52 |
| East | -- | -- | 0.66 |

-- = Not available.

Sources: Foreign Agricultural Service, USDA, various attache reports; *Poultry Yearbook,* Economic Research Service, USDA.

# Poultry Marketing and Prices

Most poultry meat in India is marketed to consumers in the form of live birds, with only a small share of output now marketed as chilled, frozen, or further processed products. The costs of moving live birds, including transport, shrinkage, and mortality costs, severely limit interregional movements. As a result, Indian poultry markets are regional, rather than national, in scope and there is limited potential for low-cost producers to market their product in higher cost regions. The limited information on costs and market price behavior collected for this study suggests that the presence of poultry integrators in a region has a significant impact on the returns received by poultry producers and the margins between producer and consumer prices. For example, retail prices and producer-retail margins were found to be significantly higher in the northern region, where poultry integrators are least active.

## Live-Bird Preference

The Indian broiler sector operates almost completely as a live-bird market, with poultry retailed as live birds and slaughtered for customers in retail shops. This practice is in accordance both with the lack of cold chain facilities, which limits capacity to market chilled or frozen products, and with consumer preference. Consumers have more confidence in the quality of fresh poultry meat that is slaughtered in their presence; frozen or chilled meat may have problems that can only be detected when it is thawed. Even when refrigeration is available, consumers lack confidence in chilled or frozen meat because of the unreliability of electrical power. The preference for fresh meat also extends to the belief that it is superior in taste and texture.

Poor sanitary conditions are common in India's retail poultry shops. In general, however, consumers and merchants share a belief that there is minimal health risk because the Indian style of cooking kills bacteria that could otherwise lead to food poisoning or disease. Most Indian meat preparations are well cooked, and some locally used spices are reportedly effective in killing foodborne bacteria. Aside from a recent campaign to improve sanitary conditions in poultry shops in New Delhi, there is no evidence that consumers or public health officials are greatly concerned with current practices. The move to license and inspect poultry slaughter within Delhi appears to have been motivated more by the urgings of the nascent poultry processing industry than by any documented public health concern associated with the quality of the product or the disposal of slaughter waste.

The dominance of the live-bird market restricts the movement of poultry because of the high transport, mortality, and shrinkage costs associated with moving live birds over India's poor roads. In particular, the live-bird preference severely limits movement of poultry from low-cost producing areas, particularly in southern and western India, to higher cost areas, such as northern India. In a market where poultry consumers are sensitive to price, this limitation can slow the growth in both consumption and production of poultry.

The consumer preference for live birds also restricts the potential for poultry imports, since imports would have to be frozen or chilled. Although there is some demand for frozen or chilled poultry products by institutions (hotels, fast food restaurant chains) and, to a lesser extent, high-end urban consumers, this small segment of demand is currently met by the small domestic processing sector.

## Processed Poultry Demand

Processed poultry products, including chilled or frozen poultry, as well as further processed items, currently account for a small share of urban household consumption and a negligible share of rural consumption. Chilled whole birds and parts can be found in markets and higher end shops in major cities and are also consumed in institutional settings, including restaurants and hotels. Frozen birds and parts are more difficult to find at the retail level but can be found in shops in major cities, and are also marketed by processors directly to hotels and restaurants. Frozen, further processed items, such as heat-and-serve dishes, can be found in high-end shops in the major cities.

It is difficult to determine the exact size of the chilled bird market. The Ghazipur market near Delhi, the largest poultry market in India, provides about 40 percent of the birds consumed in Delhi, and about 60 percent of those birds are dressed in a nearby facility.

The remainder of Delhi's poultry demand is supplied by smaller markets, where a somewhat smaller share of birds is sold in dressed form. With these rough numbers, dressed, chilled birds may account for 25-35 percent of consumption in Delhi, with most of this attributed to institutional customers. None of the other major urban centers has a large central market from which similar estimates can be taken. However, it is reasonable to assume that this share might be a little higher in such cities as Mumbai and Bangalore, where incomes are higher, and somewhat lower in Calcutta, Chennai, and Hyderabad, where incomes are lower.

The size of the frozen poultry market can, perhaps, be more accurately measured because of the relatively few firms involved in this industry segment. Dressed and frozen products are produced by about 12 firms operating semi- or fully mechanized dressing plants and freezing facilities. Based on information from three of the firms, plus estimates included in the USAPEEC study, frozen poultry products produced and consumed annually in India total about 12,000 tons, or about 1-1½ percent of total consumption, depending on the estimate of total consumption used.

The live-bird market will likely continue to dominate in India for the next few years. Institutional demand for chilled and frozen birds will continue to expand, but movement by household consumers to chilled or frozen products is likely to be slow. Chilled meat is more acceptable to consumers than frozen meat, and growth in consumption of chilled meat may help facilitate the transition toward a frozen bird market. Most of the poultry integrators in southern, western, and eastern India are already marketing dressed and chilled products and have plans to expand sales to both institutional and retail customers.

Current and future sources of growth in the institutional segment include hotels, restaurants, and fast food establishments, including McDonald's, Pizza Hut, Dominos, and many indigenously developed fast food brands. In the retail segment, growth is likely to be fostered by the emergence of a number of new approaches by poultry integrators, including the establishment of integrator-owned or franchised chilled/frozen poultry shops and sales counters in existing food shops, and home delivery services for chilled/frozen poultry products. The recent emergence of supermarkets, now mostly in southern India, is also likely to support growth in the retailing of chilled/frozen poultry.

## Poultry Processing

Traditional manual poultry processing still accounts for roughly 98 percent of all consumption in India. The traditional sector, as defined here, consists of manual dressing of birds, either in bulk by wholesalers or individually in retail shops. The Ghazipur wholesale market near Delhi may have the largest such dressing facility in the country, manually dressing roughly 60,000 birds daily. A similar, though smaller, facility exists near the Crawford market in Mumbai and in other urban market areas around India. No data exist with which to reliably estimate the share of consumption processed manually by wholesalers, but, as indicated earlier, processing may account for 25-35 percent of total consumption. Most of the remaining 65-75 percent of poultry consumption is dressed manually in retail shops or by consumers.

The traditional poultry dressing "facilities," whether at the wholesale or retail level, are completely manual, with no apparent sanitary measures taken for either the dressing floor or the workers. Although local health regulations exist, there is no evidence that any licensing or inspection regulations are effectively enforced. The Ghazipur facility near Delhi has no refrigeration facilities and dressed birds are stored in piles in the open until loaded into "refrigerated" vehicles for transport. Refrigeration for transport may consist of anything from a piece of ice on the back of a bicycle or scooter rickshaw to a mechanically refrigerated van. Refrigeration facilities for dressed birds do, however, exist in the Crawford market in Mumbai, as well as in higher end wholesale and retail markets in urban areas.

In the Ghazipur market, the cost of dressing is Rs0.50 (about 1 U.S. cent) per bird. At the Crawford market in Mumbai, dressing cost is Rs0.50-1.00 (about 1-2 U.S. cents) per bird.

The modern poultry processing sector consists of 10-12 firms that, altogether, process about 12,000 tons of poultry, or 1-2 percent of consumption, annually. The plants are all operated by poultry integrators and are located in or near major urban areas, including Mumbai, Calcutta, Hyderabad, Bangalore, and Coimbatore. These firms operate semi- or fully automatic plants mostly using imported equipment. Conditions in each of the three plants visited during the study appeared quite hygienic, including monitoring of employee health, water supplies, sanitary conditions,

and refrigeration facilities. One plant was the exclusive supplier to McDonald's franchises in India and, hence, able to meet its standards. Another plant meets standards for exporting to Dubai and other Middle East markets, and currently exports about 20 percent of its output. The third facility is considering trying to get certification to export to the U.S. market.

All of the modern facilities visited for the study report great difficulty in marketing their product because of the limited consumer acceptance and marketing infrastructure for chilled and frozen products. The facilities operate well below capacity and, at best, cover variable costs of processing, with none claiming to make any contribution to fixed costs. The operators included in the study estimate their variable costs of processing at Rs4-6 (8-12 U.S. cents) per bird. Estimates of fixed costs are not available. The tariff on imported processing equipment has recently been reduced from 57 to 30 percent.

Although many processing plants use imported equipment, FDI in poultry processing is limited to one recently completed plant in Coimbatore that was developed using foreign investment from Saudi Arabia.

## Farm Price Determination

Producer price formation for poultry varies from region to region. In the South, the integrators play a large role in setting daily prices, while in the West, Mumbai wholesale traders continue to have the upper hand in fixing prices. In the North, producer prices are set based on daily auctions at the large Ghazipur market near Delhi. In general, following the pattern of costs of production, producer prices of live birds at the time of the survey in August 2001 were lowest in the South and West, and highest in the North (fig. 7).

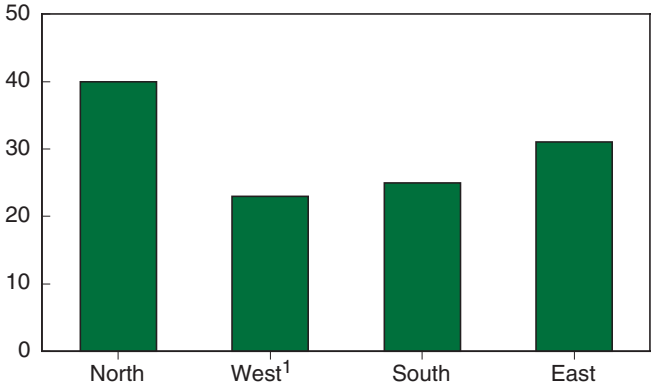
- *South*. In Tamil Nadu, which includes the major poultry production area of Coimbatore, farm price formation is facilitated by the Broiler Coordination Committee (BCC). The BCC has about 26 members, including integrators and large independent growers, that together account for about 95 percent of Tamil Nadu's poultry output. Because of the cost and difficulty of assembling large numbers of live birds for auction, the BCC provides an institutional framework through which market forces can operate. Each member has an understanding of the demand conditions prevailing within its market area, the volume it is attempting to sell, and the production costs. Based on this market information, members place their votes for a live-bird price by telephone or by FAX every Monday and Thursday. Under the BCC voting system, majority rules.

  The BCC producer price then becomes the benchmark for setting producer, wholesale, and retail prices for markets in the southern region, including Chennai, Tamil Nadu, Kerala, and, to a lesser extent, Bangalore. For example, one operator in Coimbatore sets its wholesale price as the BCC price plus Rs1 per kg, and the local retail price is generally the BCC price plus Rs8-9 per kg. This margin accounts for transport, shrinkage, and mortality costs, plus margins for the wholesaler and retailer. In the more distant Chennai market, the live-bird wholesale price is usually the Coimbatore price plus about Rs12 per kg to cover these costs and margins.

  The BCC also occasionally provides a mechanism for regulating supplies when the regional market faces oversupply conditions. In 2000, when excess supplies were pushing market prices below the cost of production, BCC members agreed to bring 10 percent of their hatching eggs to a common location to be destroyed. However, this mechanism has only worked when prices actually crash. With generally poor market information, it has proved difficult to forecast market conditions, or to convince BCC members of an impending oversupply situation. There is no evidence that the BCC engages in monopoly pricing, judging from the relatively low live-bird prices, retail prices, and margins in Coimbatore, compared with other regions. Monopoly

Figure 7
**Average producer prices for poultry in India, by region**

Rs/kg, live weight




[1]West region prices were unusually low due to oversupply conditions at the time of the survey.

Source: ERS field survey, August 2001.

pricing seems to be discouraged by the strong price sensitivity of poultry demand.

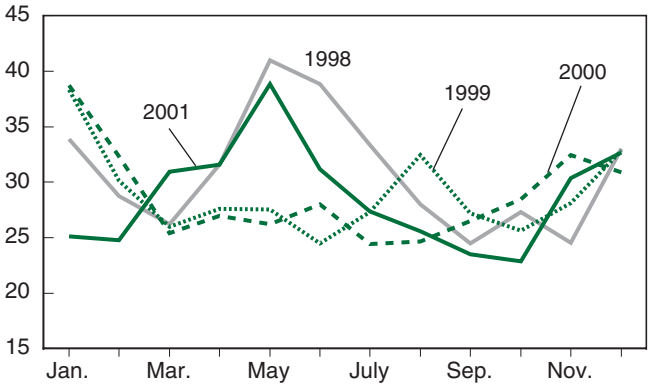
In Bangalore, integrated growers now also appear to have more influence over poultry marketing. In the past, independent growers often sold on credit, with wholesalers often delaying payment. Now, with the integrated growers having more influence, it is a cash market and volumes have increased as producer-retail margins have been reduced. The Coimbatore BCC price is now the reference price used by the Karnataka Hatcheries Association (KHA) to set the Bangalore live-bird price. Sellers are allowed to bargain within an Rs3 range of the price fixed by the KHA.

- *West*. In the Mumbai region, the producer price formation process begins with a daily rate set and published by an influential group of Mumbai wholesalers. The published price is the reference price off which producer and wholesale prices are set for nearby areas, including the major producing areas of Pune and Nashik. Presumably, these wholesalers set the daily price based on their reading of supply and demand conditions, but there is no transparency to the process. It is unclear how the entry of the integrators will affect this system. It is likely that, as they account for a rising share of supplies, the integrators will gain more influence over Mumbai wholesale (and retail) pricing. However, the high cost of establishing a sufficient presence in Mumbai retail markets may make this process more difficult than in the South.
- *East*. In contrast to the other regions visited, the Calcutta region does not appear to have a centralized price discovery mechanism, either in the form of a large central market or a group of traders. Market prices appear to be fairly volatile. The largest single player in the market, an integrator, does not appear to be large enough to exert price leadership.
- *North*. The northern region would appear to be the closest to having an open-market mechanism for setting regional wholesale and producer prices. The Ghazipur market near Delhi handles about 100,000 birds per day, about 40 percent of total Delhi consumption. The live birds are sold in batches at concurrent auctions involving market agents and producers. The remaining Delhi supplies are provided by smaller nearby markets that use the Ghazipur price as a benchmark. Prices in more distant regional markets in Punjab and Haryana also reflect Ghazipur prices. As the overall Delhi market expands, however, the Ghazipur market's share of market volume appears to be steadily declining. Producers opting to use smaller, closer markets cite the time and transport costs of using Ghazipur, along with a desire to evade the market fees and commission agent fees in the formal market.

The available data also indicate significant variability in monthly producer prices within each of the regional markets (figs. 8 and 9). This variability is to be expected due to the constraints on moving live birds long distances to address oversupply or shortage conditions across the regional markets. This price variability appears to be a key incentive for individual producers to enlist with poultry integrators who pay contractually fixed margins and assume all marketing risk. Producers, however, maintain responsibility for

Figure 8
**Monthly live-bird selling rates in India, Coimbatore market**

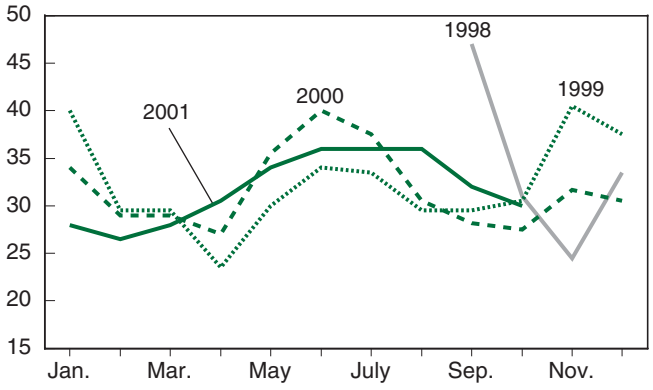
Rs/kg, live weight




Source: ERS, from Indian industry sources.

Figure 9
**Monthly live-bird selling rates in India, Delhi market**

Rs/kg, live weight




Source: ERS, from Indian industry sources.

achieving minimum production standards, including weight-gain efficiency and mortality rates.

## Farmer Compensation Under Integration

Under integration, farmers are largely insulated from the volatility in producer prices in the regional live-bird markets. In the southern and western regions, the standard grower's contract pays the grower a flat rate per live-weight kg of harvested bird, plus a potential performance bonus (or penalty). The integrator provides the DOCs, feed, medicine, veterinary services, and management guidance and is also responsible for removing and marketing the mature birds. The farmer provides the house and equipment to the integrator's specification, power, fuel, labor, and day-to-day management. Bonuses are most commonly awarded for exceeding contractual performance benchmarks for mortality and FCR.

- *South*. In the southern region, typical grower contracts pay farmers Rs2.20 per kg of harvested bird, based on an FCR of 2.0 and mortality of 4.0 percent, plus up to Rs0.50 per kg in incentives for lower FCR or mortality. For example, if a farmer achieves the harvest weight with a 1.75 FCR, the payment can reach Rs2.70 per kg. On average, farmers receive about Rs2.50 per bird. Farmer costs for power, labor, and other items not borne by the integrators are reported to be about Rs0.80 per kg, implying a return of about Rs1.70 per kg to apply against their fixed costs.
- *West*. In the western region, where integration is a newer development and costs appear somewhat higher than in the southern region, contracting terms seem to be more generous than in the South. One integrator in the region offers Rs3 per kg of live weight, based on an FCR of 2.0 and mortality of 4.0 percent, plus incentives.
- *East*. In the Calcutta area, different contracting arrangements are used, apparently due to difficulties in getting local farmers to provide proper management and quality control. The major integrator in this region only rents houses from local farmers or landlords, with the integrator then providing all equipment, labor, management, and variable inputs, with the exception of electricity and water. Rental rates paid by the integrator work out to about Rs3 per kg of live weight, implying somewhat higher grower returns than in the South or West.[12]

Farmers have the option of entering into contracts with a competing integrator, or of not participating in contract growing. In the South, where contract growing is well established, integrators claim that there is a high degree of loyalty and little switching by contract growers. In the West, contract production is a more recent development, and farmers are more aggressive about switching to another integrator and integrators are more aggressive in attracting new growers. Contract loyalty in the South stems, at least in part, from the experience of growers with market prices that held below costs of production during much of 2000 and 2001 and created strong incentives to shift to contract growing. In the South, producers appear to prefer contract growing, with fixed and assured returns regardless of swings in market prices and all marketing risk transferred to the integrator.

Although farmers have an incentive to renege on their contracts when prices rise above the rate of return provided by the integrator, the integrators appear to be effective in keeping market prices and margins low. Integrators in the South, West, and East report few instances of growers reneging on their contracts. By contrast, a lack of contract compliance by growers has been a major deterrent to contract growing in the North.

## Regional Variation in Retail Prices and Margins

The available data indicate significant regional variation in retail prices, with higher prices in the North than in the other regions (table 8). The relatively low retail prices reported for Mumbai in the West are probably not typical for most of the year, since these prices were observed during a religious festival when demand was slack and major suppliers were engaged in intense price competition. Respondents indicated that Rs60 per kg is a more typical Mumbai retail price for a dressed bird.

The retail prices in the North, including Delhi and Punjab, can be more than twice those in the South and West. These price differentials help to explain why per

[12] Although reported contract rates are the same in the East and West, growers in the West tend to incur higher variable costs for operating environmental controls, implying that grower returns may be somewhat higher in the East.

**`Table 8—Retail prices of poultry in India, dressed-weight basis**

| Region | Location | Description | Price |
|---|---|---|---|
| | | | *Rs/kg* |
| Whole birds: | | | |
| North | Delhi | W/O head, feet, skin & giblets | 90.00 |
| | Haryana | W/O head, feet, skin & giblets | 75.00 |
| | Ludhiana | W/O head, feet, skin & giblets | 90.00 |
| West | Mumbai | W/O head, feet; w/ skin & giblets | 44.87 |
| | Mumbai | W/ head, feet, skin & giblets | 38.00 |
| | Mumbai* | W/O head, feet; w/ skin & giblets; frozen | 75.00 |
| South | Bangalore* | W/O head, feet; w/ skin & giblets; chilled | 69.00 |
| | Hyderabad* | W/O head, feet; w/ skin & giblets; frozen | 52.00 |
| | Coimbatore | W/O head, feet; w/ skin & giblets | 46.42 |
| East | Calcutta* | W/O head, feet; w/ skin & giblets; chilled | 50.00 |
| Parts: | | | |
| North | Haryana | Drumsticks | 120.00 |
| | | Boneless breasts | 150.00 |
| West | Mumbai | Legs, breasts | 75.00 |
| | | Boneless | 100.00 |
| | Mumbai* | Legs w/ thighs | 110.00 |
| | | Breasts | 110.00 |
| | | Boneless | 170.00 |
| East | Calcutta | Leg quarters | 100.00 |

* Automatic processing, in frozen consumer packs.

Source: ERS field survey, August 2001.

capita consumption of poultry meat in the South is, reportedly, higher than in the North despite lower incomes in this region relative to the North.

The retail price data for poultry parts, collected from generally high-end shops in urban centers, are fairly sparse and inconclusive in terms of regional differences in prices. The data, however, show no evidence of a strong difference between prices for light- and dark-meat portions.

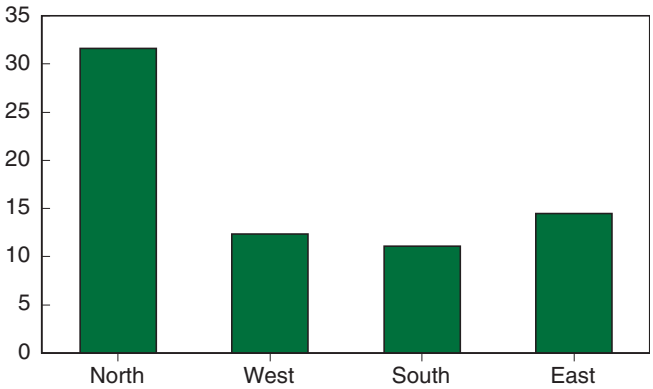
## Integration Leads to Lower Costs and Margins

The data collected on producer and retail prices indicate significantly lower marketing margins in the West, East, and, particularly, the South, compared with the North (fig. 10). Lower retail prices in the South appear to be due largely to the presence of poultry integrators who, in addition to reducing production costs, have sharply reduced marketing margins between producer and retail prices. Several factors appear to contribute to the reduced margins and retail prices. First, the process of integration has created regional oversupply conditions that have forced down retail prices and squeezed trader margins. Second, the integrators have

Figure 10

**Average producer-retail margins for poultry in India, by region**

Rs/kg, live weight




Source: ERS field survey, August 2001.

often supplanted traditional wholesalers and also established their own retail presence to squeeze the margins traditionally taken by many small wholesalers and retailers. This strategy, at least in part, reflects an effort by the integrators to exploit the high price elasticity of demand for poultry meat and increase profits by reducing prices and changing the sector from a high-margin, low-volume business, to a low-margin, high-volume business. Third, in order to expand operations and market share, integrators have likely pursued a strategy of low margins and market prices to help enlist and maintain the loyalty of contract growers.

Upwards of 75 percent of production in the South is now reported to be integrated, much more than in other regions. In Tamil Nadu, poultry integrators established their own retail shops, where they priced poultry meat substantially lower than other outlets. Their objective was not necessarily to move a high volume of poultry through their retail shops but to exercise price leadership, discipline other wholesalers and retailers, bring about substantial reductions in the farm-wholesale margin, and reduce consumer prices.

With the entry of integrators in the western region, some of whom are also establishing a retail presence, marketing margins that have historically been under the control of the established wholesale traders are likely to come under pressure. Margins were, reportedly, unusually low—close to those observed in southern India—in August 2001. Although low margins were at least partly due to the observance of a religious festival during this period, the aggressive expansion and marketing of the new entrants into the poultry integration business in the region was also a factor and may portend future developments. The integrators, with increased activity in cutrate retailing of live and branded processed poultry, appear to be providing some competition for established retailers in Mumbai. However, the high property and establishment costs for retail poultry shops, and for modern supermarkets that might offer branded poultry products, may lead to slower marketing success for the integrators in Mumbai than in the South.

In the eastern region, there is one large integrator serving the Calcutta market, a number of smaller nonintegrated producers, and no major central wholesale market. Although the integrated operator appeared to keep its producer-retail margins relatively low, it is not clear what impact this has on the rest of the market. The integrator faces little direct price competition for its product and follows a strategy of maintaining a constant retail price for months at a time, only changing it when necessitated by a large movement in producer prices. The marketing strategy of the integrator, which operates a growing chain of retail outlets for processed birds and parts as well as being a wholesaler, is to provide its product at a stable and "reasonable" price.

In the Delhi market, producer-retail price spreads have not been reduced by competition and appear to be relatively large. Retail prices appear not to move down, even when producer prices decline in the Ghazipur market. The Delhi market has the largest producer-retail margins and the highest retail prices of any of the major markets for which data are available. Retail prices in the Delhi market, Rs80-90 per kg during August 2001, reportedly remain fixed for long periods regardless of daily changes in wholesale or producer prices. Although Delhi has the largest, and perhaps the most openly competitive market for setting producer prices, solidarity among local traders and retail merchants appears to keep retail prices and margins up.

## Poultry Trade Policy and Import Potential

Consistent with its Uruguay Round market access commitments, India eliminated its quantitative restrictions on poultry meat imports in April 2001. Imports of poultry meat and products, as well as poultry grandparent breeding stock, are now subject to tariffs ranging from 40 percent for grandparent stock, to 108 percent for poultry meat, to 141 percent for processed products (table 9). Despite these policy changes, phytosanitary regulations and clearance procedures applicable to poultry meat remain poorly defined and a deterrent to imports.

Tariff levels, along with the poorly defined regulatory barriers, provide significant protection to the poultry industry. When domestic corn supplies are tight, however, this protection is at least partially offset by the impacts of corn import restrictions on feed costs. With feed accounting for a large share of poultry production costs, the TRQ regime for corn can, potentially, impose significant costs on the industry (see section on poultry feed supply and demand).

Although tariff and regulatory barriers restrict poultry imports, Indian consumer preferences and lack of cold chain facilities also constrain poultry imports. Most

**Table 9—Import policy for poultry and feed ingredients in India**

| HTS code | Commodity | Trade policy | Tariff[1] |
|---|---|---|---|
| 207 | Poultry meat | Free | 108.00 |
| 16.01 | Sausages (including poultry) | Free | 141.28 |
| 16.02 | Prepared/preserved poultry meat | Free | 141.28 |
| 407 | Eggs (table/hatching) | Free | 40.40 |
| 408 | Egg yolks | Free | 40.40 |
| 10511 | Poultry grandparent stock | Free | 40.40 |

HTS = harmonized tariff schedule.
[1]Inclusive of special and additional tariffs, as applicable.

Source: *India Poultry and Products Annual 2001*, Gain Report No. IN1045, Foreign Agricultural Service, USDA.

Indian consumers prefer freshly slaughtered birds, as opposed to chilled and, particularly, frozen poultry. Additionally, poor transport infrastructure and a lack of cold chain facilities currently limit the feasibility of handling significant volumes of chilled or frozen product. At present, the market for frozen poultry is limited to a relatively small number of institutional and high-end urban customers. Although the Indian market for frozen poultry can be expected to expand, it is not likely to provide significant trade opportunities in the near future. The current market for chilled products, among both institutional and urban retail consumers, appears to be larger than the frozen market. If chilled products can be supplied at a competitive price, market opportunities may expand significantly.

In some cases, U.S. poultry exporters have been able to take advantage of relatively weak U.S. demand and prices for dark-meat poultry portions by selling them to foreign markets, such as China and Japan, where dark meat is preferred to white meat. Indian consumers also generally state a preference for dark meat but, at least according to the sparse available price data, this preference is not reflected in noticeable price premiums for dark meat. As a result, at least with the high tariff applying equally to both dark- and white-meat portions, there does not appear to be an opportunity for imports of lower priced dark-meat portions to be price competitive in India.

Finally, based on market prices observed in southern, western, and eastern India, it does not appear that domestic costs and prices for whole birds differ significantly from U.S. prices. It is unlikely that imports of whole birds can be price competitive with domestic birds, even if the tariff were significantly lower, and it is unclear that imported parts would have a clear price advantage over domestic products. Whole-bird production costs and retail prices in southern India, where production costs and marketing margins are lowest, are roughly in line with U.S. prices. While production costs and market prices are higher in other regions, increased activity by integrators is likely to lower these costs over time, most immediately in the western region around Mumbai.

At present, India has no restrictions on FDI in the poultry industry, hence investment opportunities in poultry production and marketing may be stronger than opportunities for trade in poultry or feed. So far, there are only relatively small amounts of FDI in poultry feeds, production equipment, and processing, and none in poultry breeding or integration. Market price volatility, uncertainty on feed availability, poor power and transport infrastructure, and high taxes on processed food are key disincentives for foreign investment.

# Poultry Feed Supply and Demand

Feed is the single largest cost item in poultry production, accounting for 55-64 percent of variable costs in India, depending on the region (table 6). According to industry sources, domestically produced corn (energy) and soybean meal (protein) are the dominant feed ingredients in broiler rations. Nearly all of India's feed demand is met from indigenously produced feeds. The continued growth of poultry production, however, could eventually outstrip gains in feed production, particularly if poultry output continues to expand at its current rapid rate.

Statistics on feed use, either in general or by the poultry industry in particular, are not available from government sources. The Compound Livestock Feed Manufacturers Association (CLFMA) provides some data on compound feed production, but these member-supplied data cover only a portion of total feed production and use. As a result, estimates of feed use must be pieced together based on the judgment of industry sources. USDA provides the most up-to-date, long-term series of estimates of feed use in India, based on government and industry information and expert judgment.[13] USDA, however, does not provide estimates of feed use by animal type.

## Feed Composition

Corn and soybean meal are the major feeds used in the broiler industry, but feed composition varies somewhat by region and season. A ration of corn and soybean meal is recognized as technically superior for raising broilers, but other ingredients are sometimes substituted based on availability and price (table 5).[14] Regional feeding practices follow:

- *South*. The larger southern integrators report using a broiler ration that, on average, contains 60-65 percent corn, 28-30 percent soybean meal, and 2-3 percent oil. Most integrators report productivity losses when ingredients are substituted for corn or soybean meal. Although the ration can contain up to 20 percent wheat, depending on relative prices, this substitution necessitates the addition of energy in the form of oil. Other substitutes for corn may be rice bran, sorghum, millet, or broken rice. When the price of soy rises, limited substitutions for soy meal include peanut meal, sunflower meal (decorticated), and fish meal; but substitution of rapeseed meal is limited to no more than 3-5 percent. The preferred oil is corn oil, but sunflower and soybean oils are also used. Palm oil is also a substitute but is not as digestible as the other oils.
- *West*. The integrated operators in this region are more likely to use strictly a corn and soybean meal ration. One source indicated that rice polish is sometimes substituted into the ration, but this substitution had the impact of raising the FCR.
- *East*. The large integrator in this region generally does not substitute for soybean meal in the protein portion of the ration. While this integrator's ration typically included 55-60 percent corn, rice polish, sorghum, or feed grade wheat (5-10 percent) may be substituted for corn depending on the least-cost combination.
- *North*. In the Haryana-Punjab region, the typical feed composition includes 50-60 percent corn, 25 percent soybean meal, and 5 percent fish or meat meal. Reportedly, feed millers and producers substitute other ingredients into the ration, including wheat, rice polish, broken rice, and millet, based on shifts in relative prices. In this region, where producers are not integrated operations, it is common for feed millers to sell a concentrate feed consisting of protein (soybean meal, meat meal, fishmeal, etc.) and minerals, with the individual poultry producers then adding the energy component in the form of corn or other cereal.

Based on the field survey, the integrators, who receive direct benefits from higher levels of feed efficiency among their growers, are most likely to adhere to a corn and soybean meal ration, unless there is a significant swing in relative prices in favor of a substitute ingredient. In contrast, feed millers, who sell their product to independent growers, are more likely to substitute for corn or soybean meal in response to price changes so that they can either maintain a constant selling price for their feed products or reduce feed prices when final product prices fall.

[13] FAO also reports data on feed use in India, but the FAOSTAT database reports average corn feed use of only 197,000 tons for 1998-2000, compared with more than 4.5 million tons in the USDA PS&D database. The FAO data appear too low to be credible.

[14] By way of comparison, U.S. broiler feed rations generally contain 68 percent corn and 26 percent soybean meal, according to an ERS model for poultry costs and returns.

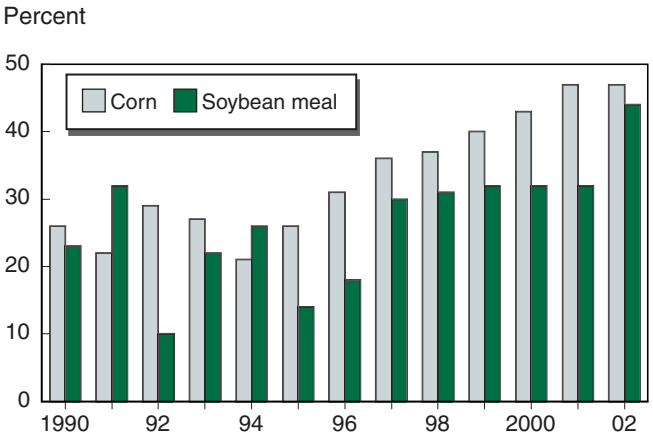
Current feeding practices suggest that the role of corn and soybean meal in broiler rations will increase with the further spread of integrated poultry operations. Substitute energy feeds that could become more important in the event of shortages of corn include wheat, rice (broken and polish), sorghum, and millet. Other proteins that could become more important if shortages of soybean meal emerge are rapeseed meal, sunflower meal, fishmeal, and meat meal. But, although India is a large producer of rapeseed and peanut meals, only small amounts of the former can be used in broiler rations, and use of the latter is limited due to concerns with aflatoxin, which can be prevalent in Indian peanut meal.

## Feed Production and Consumption Trends

In the absence of data on feed use in India from GOI or other sources, trends in supply and demand for the key broiler feeds, corn and soy meal, are based on USDA data. The USDA data series employs GOI crop production estimates, with the data on other variables, including trade, human consumption, and feed use, based on industry estimates and judgment. Because data on feed use by various animal product enterprises, including poultry production, are not available, the assessment is based on overall supply and feed use trends. According to these data, recent trends in corn and soybean production and feed use indicate that feed use accounts for a growing share of production (fig. 11).

**Production and feed use of corn.** Growth in Indian corn production, although somewhat slower in the 1990s than in the 1980s, has accelerated since the mid-1990s (table 10 and fig. 12). Recent production gains have resulted from growth in both area and yields, although yields remain quite low by world standards. Corn production also varies significantly year-to-year because most production is on rainfed land without assured supplies of moisture. The consumption data show a similar pattern, with relatively strong growth in total corn use since the mid-1990s. According to USDA estimates, corn feed use has grown much faster than nonfeed uses (including food and industrial uses), with the nonfeed total actually showing a decline for most of the period since the early 1970s. Growth in feed use of about 14 percent annually during the last half of the 1990s is comparable to industry estimates of the expansion in broiler output, and much greater than recent growth in corn production. With the rapid growth in estimated feed use, feed now accounts for more than 42 percent of total corn use in India, and, if recent trends continue, this share will increase.

Figure 11
**Feed-use share of domestic production in India**




Source: USDA PS&D database, January 2003.

The effect of rising feed demand on domestic corn prices and potential import levels will be determined by production trends, as well as trends in food and industrial use of corn. Until now, rising feed use has been accommodated by gains in production and static or declining food and industrial use. Estimates by P. Kumar indicate that coarse grains as an aggregate are an inferior good for food use with an expenditure elasticity of food demand in the range of -.10 to -.20. While these estimates suggest that per capita food use of coarse grains will continue to decline, it is unclear to what extent they apply to corn food use. According to some industry sources, in certain areas of India, particularly in Rajasthan, corn is the preferred staple grain and food use is likely to remain at current levels.

In general, industry sources, including those in the South, West, and East, express more concern about the availability and price of corn than about any other feed ingredient. Corn trade has, historically, been quite low, although both concessional and commercial imports increased slightly in the late 1990s. These increases in imports, however small, led to a growth rate in corn consumption that, for the first time since at least 1960, exceeded that of total production.

In the longer term, domestic corn production in India may expand significantly. India has a large area devoted to corn production, and average yields of about 1.8 tons per hectare are well below those in many other countries, including the United States (8.0 tons/ha.), China (4.4 tons/ha.), and Thailand (3.2

**Table 10—Trends in corn supply and use in India**

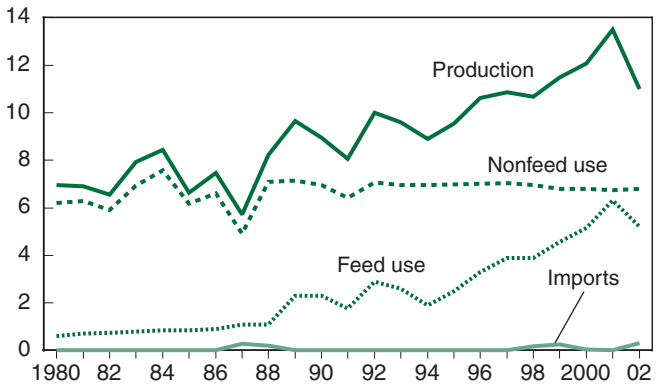
| Year | Area | Yield | Production | Imports | Consumption | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Total | Nonfeed | Feed | Feed share |
| | *1,000 ha.* | *Tons/ha.* | | | *1,000 tons* | | | *Percent* |
| 1969-71 | 5,794 | 1.05 | 6,087 | 18 | 6,405 | 6,246 | 158 | 2.5 |
| 1979-81 | 5,887 | 1.10 | 6,486 | 9 | 6,521 | 5,921 | 600 | 9.2 |
| 1989-91 | 5,893 | 1.51 | 8,891 | 0 | 8,956 | 6,839 | 2,117 | 23.6 |
| 1994-96 | 6,121 | 1.58 | 9,675 | 0 | 9,553 | 6,987 | 2,567 | 26.9 |
| 1999-2001 | 6,461 | 1.81 | 11,679 | 133 | 11,717 | 6,783 | 4,933 | 42.1 |
| | | | | *Growth rates (percent)* | | | | |
| 1970-80 | 0.2 | 0.5 | 0.6 | -6.9 | 0.2 | -0.5 | 14.3 | -- |
| 1980-90 | 0.0 | 3.2 | 3.2 | -100.0 | 3.2 | 1.5 | 13.4 | -- |
| 1990-2000 | 0.9 | 1.8 | 2.8 | -- | 2.7 | -0.1 | 8.8 | -- |
| 1995-2000 | 1.1 | 2.7 | 3.8 | -- | 4.2 | -0.6 | 14.0 | -- |

-- = Not applicable.

Source: Computed from USDA PS&D database.

Figure 12

**Supply and use of corn in India**




Source: USDA PS&D database; January 2003.

tons/ha.). Most corn is produced on unirrigated land using traditional varieties, with only about 30 percent of area sown to high-yielding varieties. The low level of technology employed is, at least in part, likely due to the traditionally low level of effective demand for corn, which has resulted in weak prices for corn relative to other crops. Reportedly, improved technology is available for use in India, including improved traditional and hybrid varieties and plant protection measures that could significantly boost corn yields. In addition to promoting new technology, the GOI may also opt to establish a more supportive price policy for corn producers. With the GOI now struggling with large surpluses and high price supports for wheat and rice, it may begin to shift more price and nonprice support to other crops, including corn and other feed grains.

**Production and feed use of soybeans and meal.** Soybean production expanded rapidly following its introduction to central India in the late 1960s and early 1970s, with growth driven primarily by gains in area planted (table 11 and fig. 13). Although chronically low yields have grown somewhat, growth in both area and production have slowed steadily since the 1970s. Future gains in soybean production will likely be increasingly dependent on improvements in yields, which may be difficult to achieve in the major rainfed production zones of Madhya Pradesh and Maharashtra to the west.

With no trade in soybeans, and most soybeans crushed for meal and oil, the pattern of growth in soybean meal production has closely matched that of soybeans. But while output of soybeans and meal has slowed since the early 1970s, growth in estimated consumption of soybean meal, and particularly feed use, has increased. According to USDA estimates, annual growth in feed use of soybean meal was about 12 percent during the 1990s, rising to more than 20 percent in the late 1990s.

With feed use of domestic soybean meal now growing significantly faster than production, India's traditionally large exportable surplus of soybean meal is under pressure from domestic demand. After expanding more than 25 percent annually during the 1980s, growth in Indian exports stalled at about 2.2 million tons in the late 1990s. This surplus should serve domestic feed requirements for the foreseeable future. In the longer term, however, growth in feed demand could create pressure for imports of soybeans and/or soybean meal, particularly if the recent slowdown in soybean production continues.

**Table 11—Trends in soybean and soybean meal supply and use in India**

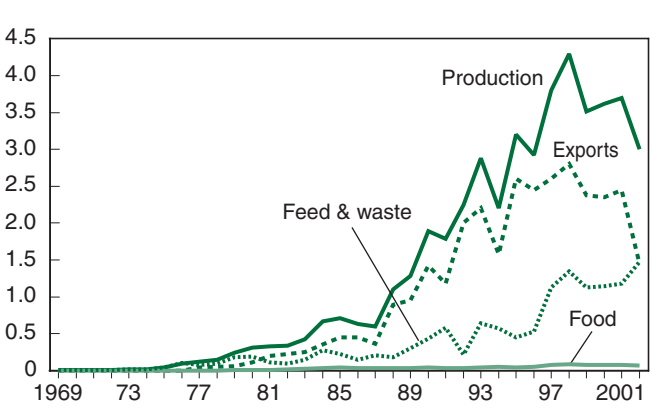
| Year | Soybeans | | | Soybean meal | | | | |
|---|---|---|---|---|---|---|---|---|
| | Area | Yield | Production | Production | Exports | Consumption | | |
| | | | | | | Total | Food | Feed |
| | *1,000 ha.* | *Tons/ha.* | | *1,000 tons* | | | | |
| 1969-71 | 29 | 0.56 | 16 | 6 | 0 | 6 | 0 | 6 |
| 1979-81 | 541 | 0.79 | 420 | 291 | 122 | 169 | 8 | 161 |
| 1989-91 | 2,667 | 0.87 | 2,300 | 1,653 | 1,183 | 470 | 33 | 437 |
| 1994-96 | 4,614 | 0.85 | 3,937 | 2,773 | 2,210 | 563 | 47 | 517 |
| 1999-2001 | 5,748 | 0.93 | 5,350 | 3,572 | 2,220 | 1,375 | 70 | 1,305 |
| | | | | *Growth rates (percent)* | | | | |
| 1970-80 | 34.1 | 3.5 | 38.4 | 46.6 | -- | 38.9 | -- | 38.2 |
| 1980-90 | 17.3 | 1.0 | 18.5 | 19.0 | 25.5 | 10.8 | 15.8 | 10.5 |
| 1990-2000 | 8.0 | 0.7 | 8.8 | 8.0 | 6.5 | 11.3 | 7.8 | 11.6 |
| 1995-2000 | 4.5 | 1.8 | 6.3 | 5.2 | 0.1 | 19.5 | 8.6 | 20.4 |

-- = Not applicable.

Source: Computed from USDA PS&D database.

Figure 13

**Supply and use of soybean meal in India**




Source: USDA PS&D database; January 2003.

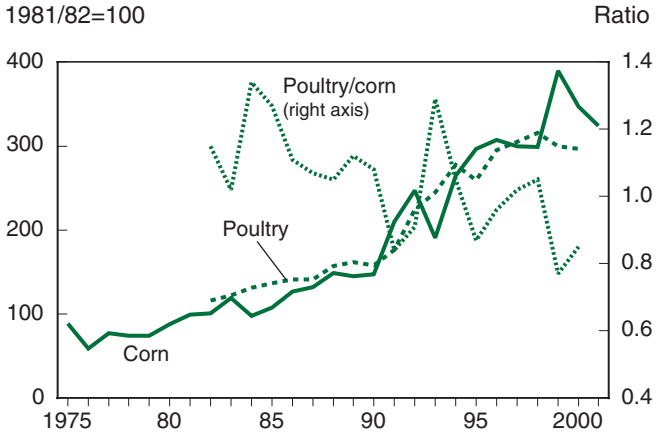
## Feed Price Trends

Limited data are available for corn prices, consisting of annual average wholesale prices for markets in three key producing states: Bihar (East), Karnataka (South and West), and Uttar Pradesh (North). These data indicate significant variability in the average corn price in these three regional markets, as well as significant variability in the ratio between corn and poultry prices (fig. 14). Industry sources also report considerable regional and seasonal variation in corn prices in the various producing areas. Unlike soybean meal, corn has not been traded heavily and corn prices in India can deviate significantly both above and below world prices (see subsection on feed trade policy). Again, poultry producers most distant from local production centers in Bihar, Uttar Pradesh, Madhya Pradesh, and Karnataka, including producers in Coimbatore in southern India, are most likely to face higher corn prices.

For soybean meal, with no impediments to exports and exports still accounting for more than 60 percent of annual production, domestic prices near production and export centers are closely aligned with world prices. However, poultry producers located a significant distance from production centers in Madhya Pradesh and Maharashtra in central India, such as those in Coimbatore in southern India, face somewhat higher prices due to transport and handling costs. As long as exports remain unrestricted and comprise a significant share of production, it is likely that domestic soybean meal prices will remain aligned with world prices.

Figure 14

**Trends in poultry and corn prices in India**




Source: *Agricultural Prices in India*, Ministry of Agriculture, GOI, various issues.

## Feed Trade Policy

With the removal of quantitative restrictions on most imports as a result of the Uruguay Round Agreement on Agriculture, imports of most feeds and ingredients are unrestricted and subject only to import duties (table 12). Imports of corn for feed use are now administered by a TRQ regime that was introduced in June 2000. Under the TRQ, the first 400,000 tons of imports enter at a duty of 15 percent, with above-quota imports subject to a 50-percent duty. By agreement, the TRQ was raised 50,000 tons annually, to a maximum of 500,000 tons in 2003. Importers of corn under the TRQ are to be given quota allotments by the Exim Facilitation Committee within the Office of the Director General Foreign Trade (DGFT) in the Ministry of Commerce. Imports of sorghum can be conducted by an agency appointed by the government, subject to a duty of 50 percent.

The current TRQ regime for corn replaced a policy under which corn was imported at a zero tariff but was subject to ad hoc government decisions on whether corn could be imported for feed or industrial (starch) use. Although some significant quantities of corn were imported under the previous policy, virtually no corn has been commercially imported since the TRQ was implemented. For most of the period since 2002, imports have not been viable because domestic prices have been below world prices, inclusive of the tariff and transport costs (table 13). TRQ administration, which has made if difficult for importers to obtain quotas at opportune periods of the marketing year, has also impeded corn imports.

Oil meal and feed concentrates can be imported without quantitative restriction, subject to tariffs of 35-40 percent. Imports of oil meals and concentrates remain negligible because India has a large exportable surplus of oil meals, and internal prices are generally near or below world prices.

**Table 12—Import policy for feed ingredients in India**

| HTS code | Commodity | Trade policy[1] | Tariff[2] |
|---|---|---|---|
| 100590 | Corn, for feed | Free;TRQ[3] | 15.00/50.00 |
| 100700 | Sorghum | Canalized | 50.00 |
| 2306 | Oilmeals | Free | 40.40 |
| 230120 | Fish meal | Free | 35.00 |
| 230990 02 | Concentrates for compound feeds | Free | 40.40 |

HTS = harmonized tariff schedule.
[1]Canalized and TRQ items require import license.
[2]Inclusive of special and additional tariffs, as applicable.
[3]TRQ is 400,000 tons with in-quota tariff rate of 15 percent and above-quota tariff of 50 percent.

Source: *India Poultry and Products Annual 2001*, Gain Report No. IN1045, Foreign Agricultural Service, USDA.

**Table 13—Domestic and import parity prices of corn in India**

| Item | Unit | 1996/97 | 1997/98 | 1998/99 | 1999/2000 | 2000/01 |
|---|---|---|---|---|---|---|
| Domestic price: | | | | | | |
| Wholesale price[1] | Rs/ton | 4,572 | 4,042 | 5,699 | 5,463 | 4,627 |
| | $/ton | 127 | 101 | 133 | 124 | 99 |
| Import parity: | | | | | | |
| U.S., fob [2] | $/ton | 118 | 107 | 94 | 88 | 90 |
| Freight & handling | $/ton | 23 | 17 | 16 | 23 | 22 |
| Import duty[3] | $/ton | 0 | 0 | 0 | 0 | 13 |
| Import price, cif + duty | $/ton | 141 | 124 | 109 | 110 | 125 |
| | Rs/ton | 5,074 | 4,978 | 4,680 | 4,865 | 5,866 |
| Freight & handling to mill | Rs/ton | 800 | 800 | 800 | 800 | 800 |
| Import price, cif mill | Rs/ton | 5,874 | 5,778 | 5,480 | 5,665 | 6,666 |
| | $/ton | 164 | 144 | 128 | 128 | 142 |
| Domestic-import parity | Rs/ton | -1,302 | -1,737 | 219 | -203 | -2,039 |
| | $/ton | -36 | -43 | 5 | -5 | -44 |
| Memo items: | | | | | | |
| Exchange rate | Rs/$ | 35.86 | 40.04 | 42.80 | 44.15 | 46.85 |
| Corn imports | 1,000 tons | 0 | 1 | 175 | 250 | 50 |

fob = free on board. cif = cost, insurance, freight.
[1]Average wholesale price in Karnataka, Bihar, and Uttar Pradesh.
[2]U.S. No. 2, Yellow, fob U.S. Gulf ports.
[3]Zero duty until June 2000, 15 percent in-quota tariff thereafter.

Sources: *Agricultural Prices in India*, Ministry of Agriculture, GOI; *International Financial Statistics*, International Monetary Fund; USDA.

As identified earlier in this report, several key factors are driving the recent growth of the Indian poultry sector. First, consumer demand for poultry is rising, driven by both income growth and changes in prices of poultry meat relative to other goods. Second, the structure of India's poultry market is changing. In particular, vertical integration of poultry production and marketing has lowered costs of production, marketing margins, and consumer prices of poultry meat. The future pace of vertical integration in the industry will likely affect the pace at which consumers shift from a preference for live birds to a processed (chilled or frozen) products, a shift that will enable poultry integrators to expand their market reach and scale of operations. Finally, feed availability and prices have a central role in determining costs of production and consumer prices. Addressing this factor entails assessing the potential for competitive domestic production of feeds, the impact of other sources of domestic demand for feeds, and policies affecting trade in feed ingredients.

Using a simple economic model, this section evaluates the likely role of each of these factors in the future growth in supply and demand for poultry and feeds in India. Many issues, including poor data, the uncertain dynamics of industry restructuring, and uncertain domestic and trade policies, prevent projecting the prospects for India's poultry and feed sectors with certainty. However, the analysis of the role of these major factors is intended to help identify key technical, economic, and policy variables affecting poultry sector development (table 14).

## Income Growth

Income growth is a principal force in the expansion of India's poultry industry. To isolate the impact of rising per capita incomes, supply and demand for poultry and feeds are projected under the assumption that incomes are the only driver of poultry demand. Market structure and technical efficiency in production remain as they were in 2001, and the current TRQ regime (with the quota rising to 500,000 tons in 2003 and remaining fixed thereafter) remains in place. The results, summarized in table 15 and figures 15-20 (more details in appendix 2.4), indicate that, with 4.0 percent annual growth in per capita incomes, poultry production and consumption increase 66 percent to 2.3 million tons by 2010. But with no change in market structure or technical efficiency, and with corn imports constrained by the TRQ, poultry costs of production and retail prices rise in real terms. Egg production and consumption expand more slowly than poultry, and with a sharp increase in real prices. Increased costs and prices for poultry and eggs are due to sharply higher real domestic prices for corn. Although corn output increases, imports are constrained at the 0.5-million-ton quota toward the end of the projection period, leading to higher domestic prices and slowed growth of production and consumption of poultry meat and, particularly, eggs. Growth in soybean meal exports is initially slowed by gains in domestic use, but then accelerates when constraints on corn imports begin to slow growth in poultry and egg output.

Income growth boosts demand and supply of poultry and eggs, but the analysis also suggests that higher costs associated with constraints on feed trade can lead

**Table 14—Major Indian poultry sector issues and analytical assumptions**

| Issue/assumption | PCGDP growth | Industry structure | | Trade policy for corn | Soybean growth |
|---|---|---|---|---|---|
| | | Integration[1] | Efficiency (FCR) | | |
| | *Percent* | | | | *Percent* |
| Income growth | 4.00 | No change | No change | TRQ | 2.70 |
| Integration | 4.00 | 75% integrated | 1.79[2] | TRQ | 2.70 |
| Free corn trade | 4.00 | No change | No change | Unrestricted | 2.70 |
| Integration & free corn trade | 4.00 | 75% integrated | 1.79[2] | Unrestricted | 2.70 |

PCGDP = Per capita gross domestic product.
[1]Integration includes changes in technical efficiency (FCR) and margins for inputs and products.
[2]FCR for poultry decreases from 1.88 in 2001 to 1.79 in 2010.

Source: ERS, USDA.

## Framework for Analyzing India's Poultry and Feed Sectors

The analytical framework incorporates supply and demand relationships for poultry meat and the two major feed ingredients, corn and soybean meal. Supply and demand relationships for eggs are also included because eggs are the other principal source of feed demand for corn and soybean meal. Poultry and egg demand are specified as functions of income and own prices. It is assumed that trade in poultry and eggs will remain negligible in the analysis, so production of each is made equal to demand. Poultry meat prices are related to costs and efficiencies in production and marketing, including costs of feed, day-old-chicks (DOC), and other costs, the profit margins for feed and DOCs, and farmer and farm-to-retail price margins. Egg prices are specified more simply as a function of feed and other costs, plus a farm-to-retail margin.

Area and yield of corn and soybeans are explained by trends and lagged own prices. Corn demand consists of food demand, still the largest segment of corn use, starch demand, and feed demand. In the absence of reliable income and price parameters, corn food and starch demand are each projected using historical trends. Corn feed use is based on levels of poultry and egg production and fixed-ration shares. Soybean meal supply is derived from soybean production using fixed crush and extraction rates. Soybean meal demand consists of feed use based on levels of poultry and egg output and fixed-ration shares.

A key feature of the model is that the specification of corn trade and prices is flexible, depending on the trade regime and relationship between domestic and world prices. When domestic prices remain below import prices (world price plus transport and tariff), trade is zero and domestic corn prices equilibrate domestic supply and demand. When domestic prices move above import prices, corn is imported subject to tariff and quota restrictions and the domestic corn price is set by the import price. For soybean meal, since India is a significant exporter, the domestic soybean meal price is set by the world price (including appropriate margins), and exports are the residual between domestic production and feed demand.

A more complete description of the characteristics of the India poultry-feed model is provided in appendix 2.1. Model equations and variable descriptions are provided in appendix 2.2 and model data and parameters are described in appendix 2.3.

to higher real product prices that slow growth. Interestingly, in this example, the impacts of constrained feed supplies are more significant for eggs than for poultry. This is because poultry meat has a higher income elasticity of demand than eggs and is able to bid corn supplies away from egg production as incomes rise.

The results are sensitive to the assumed rate of per capita income growth. The impacts of faster (slower) income growth are, predictably, faster (slower) growth in production and consumption of products, prices, feed use, and feed import demand. With slower demand growth, the quota on corn imports is less of a constraint on the poultry and egg sectors. But with higher growth, the quota imposes its impacts earlier and more severely. Larger and smaller income- and own-price elasticities of demand for poultry meat and eggs have similar impacts on the results, but experiments within a range of plus or minus 0.3 for the elasticities did not alter the results significantly. Importantly, however, the relative impact of growth on the poultry meat and egg sectors is affected by the differential between the income elasticities used for these products.

### Poultry Integration

Poultry integration in India is analyzed by simulating the impacts of 75 percent integration of poultry meat production across the country by 2010. Partial, as opposed to full, integration is studied because full integration may be an unrealistic assumption in a country now dominated by small-scale agriculture and regional disparities in infrastructure and development. In addition, full integration by 2010 would likely entail unrealistically rapid progress in the acceptance of chilled and frozen poultry meat. If we assume that consumer preferences and cold chain limitations will impede widespread use of chilled and frozen meat, then the marketing constraints imposed by retailing of live birds may also slow the progress of vertical integration.

**Table 15—Selected results of India poultry-feed sector analysis**

| Variable | Change over base year in 2010 | | | | Difference from income growth scenario in 2010 | | |
|---|---|---|---|---|---|---|---|
| | Income growth | Integration | Free corn trade | Integ. and free trade | Integration | Free corn trade | Integ. and free trade |
| | | | | *Percent* | | | |
| Poultry: | | | | | | | |
| Production and consumption | 66.2 | 98.5 | 84.4 | 122.2 | 19.4 | 11.0 | 33.7 |
| Producer price | 31.8 | 22.8 | 14.9 | 0.9 | -6.8 | -12.8 | -23.5 |
| Retail price | 19.4 | 1.2 | 9.1 | -12.2 | -15.3 | -8.6 | -26.5 |
| Farm-retail margin | 0.0 | -32.7 | 0.0 | -32.7 | -32.7 | 0.0 | -32.7 |
| Eggs: | | | | | | | |
| Production and consumption | 16.8 | 9.8 | 36.5 | 36.5 | -6.1 | 16.9 | 16.9 |
| Retail price | 36.1 | 43.2 | 16.4 | 16.4 | 5.2 | -14.5 | -14.5 |
| Corn: | | | | | | | |
| Production | 22.6 | 24.8 | 19.4 | 19.5 | 1.8 | -2.6 | -2.6 |
| Wholesale price | 145.7 | 177.1 | 58.3 | 58.3 | 12.8 | -35.6 | -35.6 |
| Feed use | 36.5 | 41.7 | 55.6 | 66.8 | 3.8 | 14.0 | 22.2 |
| Poultry | 66.2 | 89.8 | 84.4 | 112.4 | 14.2 | 11.0 | 27.8 |
| Imports | -- | -- | -- | -- | 0.0 | 224.0 | 317.6 |
| (2010 level, mil. tons) | 0.5 | 0.5 | 1.6 | 2.1 | 0.5 | 1.6 | 2.1 |
| Soybean meal: | | | | | | | |
| Consumption | 39.9 | 47.2 | 59.0 | 72.1 | 5.2 | 13.6 | 23.0 |
| Exports | 20.5 | 16.6 | 10.4 | 3.4 | -3.2 | -8.4 | -14.2 |

Note: More complete results are reported in appendix table 2.4.
-- = Not applicable.

Source: ERS India poultry-feed model.

The impacts of poultry integration, simulated assuming the same 4-percent per capita income growth and trade regime of the income growth scenario, include significantly faster expansion of production and consumption of poultry meat than in the reference scenario, along with smaller increases in real costs and prices. Improved technical efficiency and smaller margins on DOCs and feed inputs limit the rise in production costs and, together with a smaller retail margin, lead to lower retail poultry prices (fig. 17) than with income growth alone.[15] However, with the corn TRQ remaining in effect, corn imports are constrained and domestic corn prices rise and even more corn feed is bid away from egg production. As a result, egg production and consumption are significantly lower (fig. 16), and real prices higher (fig. 18), than with income growth alone. Impacts on egg trade are not evaluated in the analytical framework. The large increases in real domestic egg prices that occur in the integration (and the income growth) scenario would likely reduce egg exports, but egg imports may continue to be constrained by the 40-percent tariff.

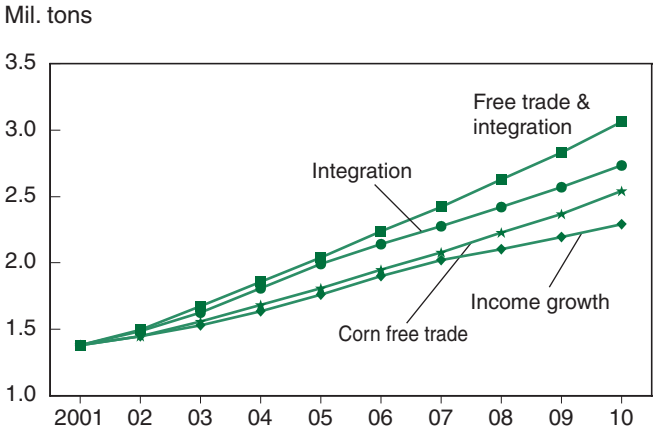
The process of integration helps reduce poultry production costs by increasing technical efficiency and eliminating the margins on feed and DOCs that nonintegrated producers must pay outside suppliers (fig. 21). However, in the analysis, these efficiency gains are mostly offset by higher corn prices when the TRQ restricts imports and domestic corn prices rise. Impacts of integration on poultry retail prices are more significant because of the reduction in the traditionally large farm-retail margins in India (fig. 22). Significant reductions in this margin have, so far, been associated with the establishment and influence of integrated producers in southern Indian markets.

With integration, growth in poultry and feed demand is faster than if income growth alone is driving the sector, and corn imports rise to the 0.5-million-ton TRQ sooner in the projection period (fig. 19).

[15] The impacts of vertical integration are simulated by adjusting the technical efficiency (FCR) parameter and the size of the three key margins affected by integration: the margins on feed, DOCs, and retailing (see appendix 2.3). The approach used assumes that the current integrated operations reflect the average levels of technical and marketing efficiency that can be achieved nationally. Implicitly, it is expected that additional future gains in efficiency by some integrators, say, in the South and West, will balance inherent relative inefficiencies in others, particularly in the North.

Figure 15

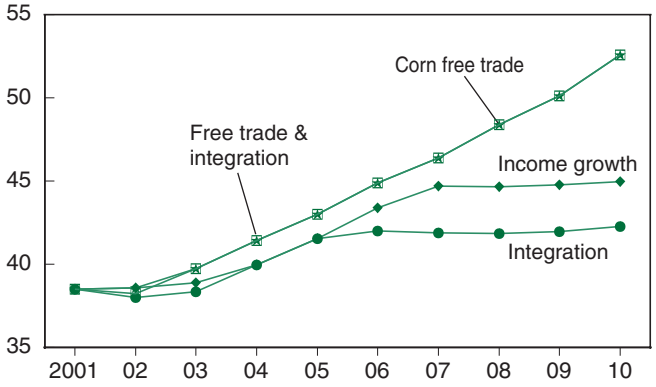
**Poultry production and consumption under alternative scenarios**




Source: ERS India poultry-feed model.

Figure 16

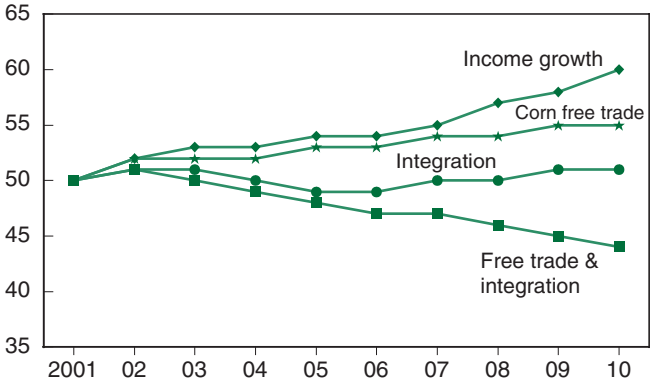
**Egg production and consumption under alternative scenarios**




Source: ERS India poultry-feed model.

Figure 17

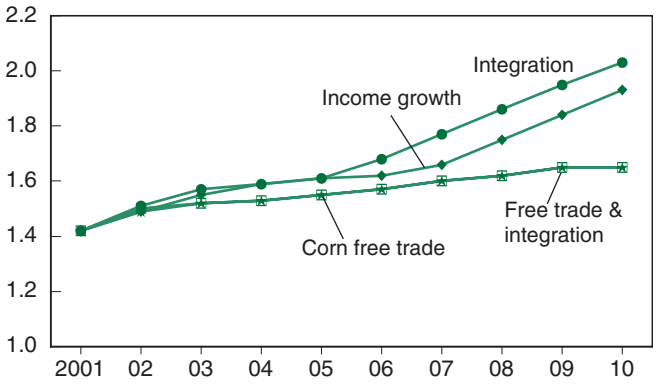
**Poultry retail prices under alternative scenarios**




Source: ERS India poultry-feed model.

Figure 18

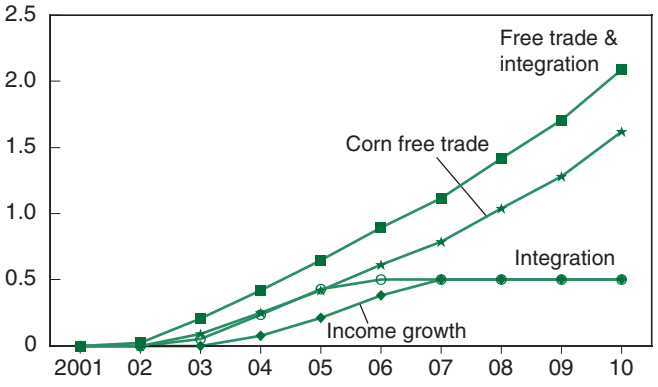
**Egg retail prices under alternative scenarios**




Source: ERS India poultry-feed model.

Figure 19

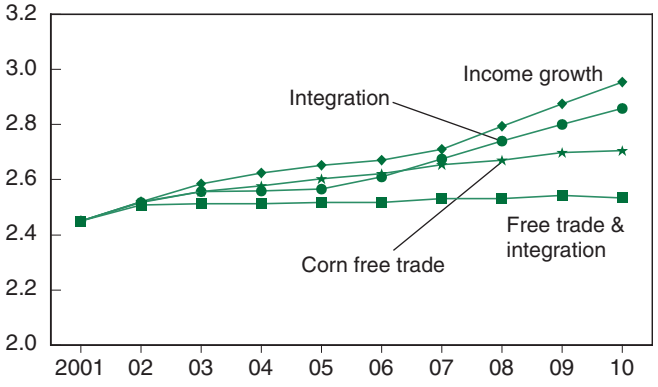
**Corn imports under alternative scenarios**




Source: ERS India poultry-feed model.

Figure 20

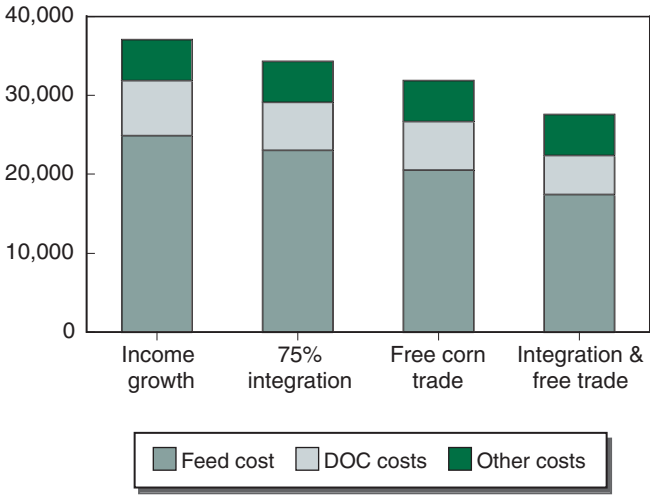
**Soybean meal exports under alternative scenarios**




Source: ERS India poultry-feed model.

Figure 21
**Poultry costs of production by scenario**

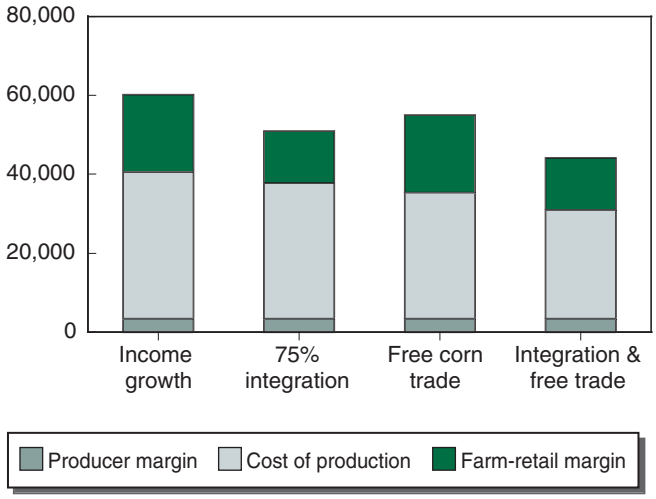
Rs/ton, live weight in 2010




Source: ERS India poultry-feed model.

Figure 22
**Poultry retail prices by scenario**

Rs/ton, live weight in 2010




Source: ERS India poultry-feed model.

Although domestic corn production increases in response to higher domestic prices, real corn prices are sharply higher than in the income growth scenario. For poultry meat, the impact of higher corn prices on costs and prices is more than offset by the efficiency gains associated with integration. The egg industry, however, experiences higher costs, and reduced production and consumption, when the poultry meat sector becomes more efficient under integration. Soybean meal exports decline marginally, compared with the income growth-only scenario (fig. 20), as increased poultry feed demand is partially offset by reduced demand from egg producers.

## Corn Trade Liberalization

Elimination of all tariff and quota restrictions on Indian corn imports would potentially reduce feed prices for poultry and egg producers by allowing corn to be imported freely at the world price. With full liberalization (zero tariff and no quota beginning in 2002) of corn trade, and assuming income growth of 4 percent per capita and no further market integration, poultry production and consumption rise faster than when income growth alone drives the sector (fig. 15). The impacts of corn free trade on sector growth are, however, not as significant as integration. Lower corn prices associated with free trade lead to a relatively large reduction in poultry production costs but, in the absence of further integration, farm-retail margins and retail prices for poultry remain relatively high and there are smaller gains in poultry consumption and production. Perhaps the key impact of corn free trade is that, with corn readily available at the world price, egg production costs and retail prices are kept in check (fig. 18), and egg production (fig. 16) and consumption are sharply higher than when trade restrictions are in place.

With free trade limiting the increase in domestic corn prices, growth in corn output is slower than when trade is restricted, but the loss in corn production is relatively small (about 3 percent). Corn imports rise to 1.6 million tons by 2010, mostly because of increased feed demand rather than lower corn production (fig. 19). With corn free trade leading to higher poultry and egg feed use, soybean meal exports are lower than when corn imports are restricted.

The analysis of corn free trade demonstrates that the availability and price of a major feed ingredient, namely corn, can have a significant impact on growth in production and feed demand by the poultry and egg sectors. These results can, however, be influenced by analytical assumptions regarding such factors as the amount of substitution between feeds, substitution between feed and nonfeed uses of corn, and the growth in domestic corn production. These issues are examined below:

- *Feed substitution.* This analysis assumes that both corn and soybean meal maintain fixed shares in poultry and egg rations that do not change with rela-

tive prices. These assumptions could lead the analysis to overstate the impacts on demand for corn and soybean meal, but two factors suggest that the assumptions are appropriate. First, the assumed ration shares for poultry (55 percent for corn and 20 percent for soybean meal) are significantly below the averages (60 percent and 29 percent) provided by integrated producers in the field survey. The assumptions for egg producers are also below those provided by informed sources. Thus, some scope for substitution is already built into the assumptions. Second, the integrated producers contacted during the field survey stated a strong preference for maintaining corn and soybean meal rations regardless of the price of competing feeds.[16]

- *Nonfeed use of corn.* By using fixed trends to project corn food use, the analysis does not account for the possibility that rising corn feed demand can be met by domestic corn that is bid away from food use rather than imports. However, to address this possibility, the assumed rate of decline in food use is set at -0.8 percent per year, faster than the observed rate for 1995-2002.
- *Corn production.* Faster growth in domestic corn output could also moderate domestic price increases, help meet feed demand, and reduce import needs. With the assumptions used, corn production responds to trends and prices, rising 2.3 percent annually in the income growth scenario, 2.5 percent in the integration scenario, and 2.0 percent in the scenarios involving corn free trade. These rates are slower than actual growth of about 2.8 percent annually between 1990 and 2001 but seem reasonable for what might be sustained under predominantly rainfed conditions.

## Integration and Corn Trade Liberalization

Income growth, integration, and corn free trade each have significant impacts on India's poultry sector growth, and, jointly, their impact is even more significant. When the impacts of 4-percent per capita income growth, 75-percent integration of the poultry industry, and corn free trade are combined, poultry meat production and consumption are substantially higher, and production costs and prices substantially lower, than when the changes are introduced separately. In addition, as in the corn free trade scenario, the availability of corn at world prices prevents the adverse impacts on the egg sector associated with income growth and poultry integration, allowing relatively large increases in egg production and consumption and low prices.

With relatively high levels of both poultry meat and egg production, feed use of corn and soybean meal is higher than when the changes are introduced separately. For corn, high feed demands combined with a smaller increase in domestic production when domestic prices are linked directly to world prices, pushes corn imports to about 2.1 million tons in 2010, highest of any of the scenarios. Higher domestic demand limits soybean meal net exports to 2.5 million tons in 2010, the lowest of the scenarios.

The results confirm that economic growth, industry restructuring in the form of vertical integration, and trade policy on key inputs can combine to have a major impact on domestic supply, demand, and prices in India's poultry industry. Economic growth is an important driver of industry expansion, but the pace and extent of vertical integration and the cost and availability of key inputs are at least as important.

The model used in the analysis does not provide estimates of the overall impacts of the scenarios on producer and consumer welfare within the sector, or for India's economy as a whole. It appears clear, however, that the cost-reducing impacts of the process of vertical integration and of providing low-cost feeds carry significant benefits for poultry meat consumers in the form of increased availability at lower prices. Consumers of eggs, while potentially facing significantly higher prices as a side effect of the process of poultry integration in the presence of corn trade restrictions, also benefit from lower prices and increased availability when corn trade restrictions are eased. Similarly, consumers of corn for food or in the starch industry face higher prices as a side effect of poultry integration, unless corn trade restrictions are also eased.

Impacts on producers of poultry, eggs, and corn are more ambiguous. Poultry producers and traders may

[16] Perhaps the key factor that could force a change in established substitution patterns would be a GOI decision to begin releasing some of its large surpluses of wheat and rice, which include significant amounts of damaged grain, for domestic feed use. This grain would have to be heavily subsidized to be comparable in price to corn and, so far, the GOI has not released stocks for feed use, in part because of concern with undermining market prices and extending subsidies to feed millers. However, the wheat and rice surplus is very large relative to total feed use and the release of relatively small amounts could easily meet any feed shortages for the foreseeable future.

earn smaller margins in an integrated industry but may also benefit from increased scale and, in the case of contract growers, reduced risk and greater access to technology and credit. Egg producers, while potentially losing when vertical integration of poultry meat production raises feed costs, would also gain if corn trade barriers were lifted. Domestic corn producers would tend to benefit from increased demand, prices, and output associated with income growth and poultry integration but face lower prices and slower output growth if corn trade barriers are eased.

Thus, the combination of vertical integration and corn free trade that appears to yield the maximum benefits to consumers of poultry, eggs, and corn, and also supports expansion of poultry and egg production, carries the potential for at least partially offsetting losses to corn producers. Avoiding any adverse impacts would require India's corn producers to adopt new technology that would permit their production to be competitive with imports, or to shift some portion of their land to a more competitive crop. In this event, the process of poultry industry expansion and integration would appear to carry potential gains for all producers and consumers.

# Conclusions

Rapid growth in the Indian poultry industry is being driven by a combination of rising incomes, a young and urbanizing population, and declining real poultry prices. The expanding role and influence of poultry integrators, primarily in southern and western India, have been key factors in both boosting production and reducing prices. The integrators appear to have helped increase production efficiency and significantly reduce marketing margins and consumer prices. The pace at which integrated poultry operations spread in the West, East, and North will be a key to the future expansion of India's poultry industry.

The pace of transition from a live-bird market to a chilled/frozen product market will likely be a factor in the future expansion of poultry sector integration. At present, live-bird sales dominate the market, limiting the scope for exploiting regional comparative advantages in production within the country, and for using storage, domestic movements, and international trade to stabilize supplies and prices. A shift away from live-bird sales to mechanical and more hygienic processing may also have public health benefits, although there is little evidence that current practices create health problems.

Available data on production costs and prices in India and other countries suggest that India is an internationally competitive producer of poultry meat. Producer prices of whole birds in India, while higher than in Brazil, compare favorably with those in the United States and in other Asian countries. In this regard, Indian producers have generally benefited from improved poultry management practices and, particularly, ready local supplies of corn and soybean meal at internationally competitive prices.

If recent trends in poultry and egg production are sustained, growth in feed demand, primarily corn and soybean meal, is likely to outpace gains in domestic production. For corn, variable domestic production, expanding feed use, and tariff and quota restrictions on corn imports could combine to constrain growth in both the poultry and egg industries, raise consumer prices, and slow consumption. For soybean meal, the Indian poultry and egg industries benefit from local surpluses and ready availability, but rising internal demand is likely to erode exports.

The expansion of the poultry industry opens a new set of policy issues to be addressed by the government, ranging from public health issues, to tradeoffs between poultry producers, feed producers, and consumers, to appropriate tariff and nontariff policies for imports of poultry and industry inputs. Although the traditional policy priority has been to promote self-reliance, it is unclear how future policy will weigh the competing interests of, among others, poultry and egg producers, consumers, and feed producers.

At present, analysis of developments in India's poultry sector is made difficult by the poor availability of reliable and timely official data on such variables as production, consumption, feed use, and production and marketing costs. If the Indian poultry industry is expanding as rapidly as industry sources indicate, poultry will quickly become an important component of both farm income and urban and middle-class diets. The consequent expansion of demand for poultry inputs, particularly feeds, may soon pressure local supplies, providing opportunities for production or trade in these products. The implications of this growth are likely to create demand for better data and information to support public and private sector decisionmaking.

The analysis in this study suggests that the process of poultry sector integration yields substantial potential benefits for the sector and, particularly, consumers of poultry meat. However, when shortages of feed emerge, there are likely to be significant adverse effects on producers and consumers of poultry meat and, particularly, eggs. Although domestic corn producers may gain from higher prices associated with import restrictions, these gains must be weighed against losses to producers and consumers of poultry meat and eggs, as well as to the potential international competitiveness of Indian poultry production. Development and adoption of technology for competitive domestic feed production would allow all producers and consumers to benefit from poultry sector expansion.

Expansion of the poultry industry in India creates potential trade and investment opportunities for U.S. agriculture. Although the potential for poultry meat imports appears limited, growth in demand for corn and soybean meal will likely outstrip gains in local production, creating demand for corn imports and reduced exports of soybean meal. Corn import policy

and productivity gains in these crops will help determine the size of the trade impacts. Although foreign direct investment has not been significant so far, India's fast-growing, competitive, and potentially large industry offers investment opportunities in such activities as breeding, medicines, feed, and equipment, as well as integration and processing. Foreign investment in these activities is permitted but is constrained by market and policy uncertainty and poor infrastructure.

Developments in the Indian market carry potentially useful lessons for understanding the emergence of poultry markets in other developing countries. Income growth and indigenous meat demand preferences are obviously key elements in gauging potential. But cost-reducing integration of production and marketing activities can also be important in spurring demand and output. Finally, availability of corn and soybean meal at competitive prices, either through local production or imports, is a key to growth and competitiveness.

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**Appendix 1.1—Growth rates of meat production, consumption and trade, by global region[1]**

| Country | Poultry | | | Bovine | | | Pork | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 |
| | | | | | *Growth rates* | | | | |
| **Production** | | | | | | | | | |
| World | 5.8 | 4.6 | 5.3 | 1.9 | 1.6 | 0.7 | 3.6 | 3.0 | 2.8 |
| Developed countries | 5.1 | 3.5 | 2.4 | 1.5 | 0.9 | -1.5 | 2.7 | 1.1 | -0.1 |
| United States | 3.7 | 5.0 | 4.5 | 0.0 | 0.4 | 1.5 | 1.5 | -0.2 | 2.2 |
| Transition markets | 7.7 | 2.6 | -5.3 | 2.2 | 1.9 | -7.2 | 2.4 | 1.5 | -4.9 |
| Developing countries | 7.5 | 6.9 | 9.1 | 2.7 | 2.8 | 3.7 | 5.6 | 6.0 | 5.6 |
| Asia developed | 8.6 | 2.2 | -0.6 | 4.5 | 2.8 | -0.2 | 7.1 | 0.7 | -2.1 |
| Asia developing | 6.3 | 8.2 | 9.7 | 2.8 | 4.8 | 6.4 | 5.8 | 7.1 | 5.8 |
| South Asia | 3.4 | 9.6 | 6.3 | 2.4 | 3.8 | 2.2 | 4.0 | 4.7 | 3.3 |
| China | 5.4 | 8.8 | 13.5 | 5.2 | 14.8 | 16.0 | 6.3 | 7.3 | 6.0 |
| East & Southeast Asia | 6.5 | 7.4 | 5.9 | 3.0 | 1.8 | 3.2 | 3.6 | 6.2 | 4.0 |
| Near East | 9.0 | 7.6 | 5.3 | 3.3 | 2.7 | 3.2 | 2.5 | 6.4 | 5.7 |
| Latin America & Caribbean | 9.9 | 5.5 | 9.0 | 2.7 | 2.2 | 2.1 | 4.9 | -0.7 | 3.9 |
| Africa developing | 5.6 | 6.0 | 4.6 | 2.2 | 1.3 | 2.4 | 3.5 | 6.1 | 2.5 |
| **Imports** | | | | | | | | | |
| World | 11.6 | 5.3 | 12.1 | 4.2 | 3.4 | 2.1 | 3.9 | 4.8 | 6.7 |
| Developed countries | 6.0 | 7.7 | 10.2 | 3.2 | 2.8 | 1.8 | 3.9 | 4.5 | 5.9 |
| United States | -0.7 | -- | 13.0 | 1.9 | 1.2 | 2.4 | 0.6 | 5.6 | -0.2 |
| Transition markets | 11.3 | 1.2 | 19.0 | 13.1 | 2.3 | 1.7 | 3.3 | 6.0 | 7.0 |
| Developing countries | 25.7 | 2.2 | 14.9 | 12.8 | 5.9 | 3.3 | 5.2 | 10.1 | 13.4 |
| Asia developed | 15.5 | 14.9 | 9.1 | 11.5 | 9.1 | 7.0 | 17.9 | 9.9 | 10.1 |
| Asia developing | 28.3 | 1.6 | 16.2 | 16.3 | 8.1 | 2.7 | 6.0 | 12.9 | 13.8 |
| South Asia | 26.6 | 11.4 | 15.9 | -4.1 | 26.5 | 1.3 | -20.2 | 24.4 | 13.1 |
| China | 9.0 | 15.0 | 23.4 | 8.2 | 10.6 | 4.8 | 5.2 | 12.4 | 12.4 |
| East & Southeast Asia | 16.6 | 12.0 | 22.7 | 8.9 | 13.6 | 7.6 | 13.0 | 18.0 | 18.6 |
| Near East | 40.1 | -3.8 | 5.5 | 26.2 | 4.1 | -1.4 | 5.4 | 4.5 | 6.8 |
| Latin America & Caribbean | 19.0 | 5.7 | 13.9 | 9.5 | 5.7 | 6.9 | 5.9 | 7.7 | 13.7 |
| Africa developing | 32.0 | 0.2 | 6.7 | 14.6 | 3.2 | 0.3 | 1.2 | 8.2 | 9.8 |

*See footnote at end of table.*

*--Continued*

**Appendix 1.1—Growth rates of meat production, consumption and trade, by global region[1]--Continued**

| Country | Poultry | | | Bovine | | | Pork | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 |
| | *Growth rates* | | | | | | | | |
| **Exports** | | | | | | | | | |
| World | 11.6 | 5.4 | 13.1 | 4.8 | 3.1 | 2.0 | 4.1 | 5.2 | 6.0 |
| Developed countries | 9.8 | 4.6 | 12.1 | 7.3 | 3.4 | 2.4 | 4.3 | 4.5 | 6.4 |
| United States | 17.9 | 6.2 | 18.2 | 15.6 | 18.8 | 8.8 | 8.3 | 1.1 | 18.9 |
| Transition markets | 7.4 | 0.3 | 2.3 | 2.3 | -5.4 | 3.0 | 3.7 | 0.5 | 2.0 |
| Developing countries | 34.0 | 8.7 | 16.0 | -0.1 | 2.4 | 0.9 | 0.5 | 13.5 | 2.3 |
| Asia developed | 39.1 | -2.8 | -4.8 | 5.0 | 17.4 | -6.4 | 6.1 | 27.8 | 8.9 |
| Asia developing | 19.4 | 13.6 | 20.0 | 20.9 | 15.5 | -0.3 | 0.6 | 13.3 | -2.4 |
| South Asia | -13.6 | 35.5 | 8.6 | -- | 5.2 | 12.9 | -1.5 | 22.5 | 19.9 |
| China | 12.8 | 11.2 | 27.5 | 20.3 | 29.5 | -10.9 | 0.5 | 12.8 | -8.1 |
| East & Southeast Asia | -- | 22.2 | 9.1 | 9.8 | 0.9 | 3.0 | 11.3 | 31.7 | 22.3 |
| Near East | 45.0 | -0.9 | 6.7 | 0.6 | 25.3 | 2.3 | 10.4 | 3.1 | 37.5 |
| Latin America & Caribbean | -- | 5.7 | 11.4 | -0.5 | 0.8 | 0.9 | 0.7 | 19.2 | 29.2 |
| Africa developing | 2.3 | 19.9 | 7.0 | -2.4 | -3.7 | 4.9 | -13.1 | -10.2 | 40.9 |
| **Consumption** | | | | | | | | | |
| World | 5.7 | 4.7 | 5.1 | 1.8 | 1.6 | 0.7 | 3.7 | 3.0 | 2.9 |
| Developed countries | 4.8 | 3.6 | 1.9 | 1.2 | 0.8 | -1.7 | 2.9 | 1.0 | -0.1 |
| United States | 3.2 | 5.0 | 3.1 | 0.1 | 0.1 | 1.1 | 1.4 | 0.1 | 1.6 |
| Transition markets | 7.9 | 2.6 | -2.9 | 2.6 | 2.2 | -6.7 | 3.1 | 1.5 | -4.1 |
| Developing countries | 7.8 | 6.5 | 9.1 | 3.2 | 2.9 | 4.0 | 5.7 | 6.0 | 5.7 |
| Asia developed | 8.7 | 3.6 | 1.7 | 5.8 | 5.5 | 2.6 | 7.8 | 2.0 | 1.5 |
| Asia developing | 7.2 | 7.5 | 9.8 | 3.1 | 4.7 | 6.4 | 5.9 | 7.1 | 5.9 |
| South Asia | 3.5 | 9.6 | 6.3 | 2.2 | 3.8 | 1.9 | 4.0 | 4.7 | 3.3 |
| China | 5.4 | 9.0 | 13.6 | 5.1 | 12.9 | 17.5 | 6.4 | 7.2 | 6.2 |
| East & Southeast Asia | 6.3 | 6.9 | 5.9 | 3.1 | 2.8 | 3.9 | 3.6 | 6.2 | 4.0 |
| Near East | 12.9 | 5.0 | 5.0 | 5.1 | 3.2 | 2.2 | 2.8 | 6.0 | 5.0 |
| Latin America & Caribbean | 9.3 | 5.4 | 9.1 | 3.3 | 2.2 | 2.6 | 4.9 | -0.5 | 4.0 |
| Africa developing | 6.5 | 5.5 | 4.7 | 3.0 | 1.7 | 2.2 | 3.5 | 6.2 | 2.8 |

*See footnote at end of table.*

*--Continued*

**Appendix 1.1—Growth rates of meat production, consumption and trade, by global region[1]--Continued**

| Country | Mutton & goat | | | Fish | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 |
| | | | | | *Growth rates* | | | | |
| **Production** | | | | | | | | | |
| World | 0.7 | 2.8 | 1.6 | 1.4 | 3.2 | 2.4 | 2.4 | 2.9 | 2.6 |
| Developed countries | -0.7 | 1.5 | -2.1 | 1.6 | 0.6 | -2.7 | 1.9 | 1.0 | -0.4 |
| United States | -5.4 | 1.2 | -4.1 | 3.1 | 4.3 | -1.0 | 1.4 | 2.2 | 2.2 |
| Transition markets | -1.1 | 1.4 | -6.2 | 3.1 | 0.7 | -7.6 | 2.3 | 0.6 | -5.6 |
| Developing countries | 2.3 | 3.8 | 3.8 | 1.2 | 5.6 | 5.0 | 3.3 | 5.3 | 5.2 |
| Asia developed | -1.6 | 4.6 | 0.2 | 1.7 | -0.2 | -5.8 | 2.3 | -0.6 | -3.7 |
| Asia developing | 3.1 | 4.6 | 4.5 | 4.2 | 5.7 | 7.1 | 4.6 | 6.4 | 6.3 |
| South Asia | 3.2 | 4.2 | 1.4 | 2.7 | 4.3 | 4.2 | 2.8 | 4.6 | 3.1 |
| China | 7.2 | 9.4 | 10.1 | 3.1 | 10.3 | 11.8 | 5.1 | 8.8 | 8.5 |
| East & Southeast Asia | 3.8 | 2.8 | -0.2 | 5.1 | 3.2 | 1.7 | 4.6 | 3.9 | 2.5 |
| Near East | 2.0 | 1.9 | 2.6 | 7.3 | 3.9 | 5.3 | 5.1 | 3.6 | 4.2 |
| Latin America & Caribbean | -2.2 | 1.3 | -0.8 | -3.1 | 5.6 | -0.3 | 1.5 | 3.7 | 2.9 |
| Africa developing | 2.7 | 2.8 | 3.0 | 1.6 | 4.3 | 2.8 | 2.2 | 3.5 | 2.8 |
| **Imports** | | | | | | | | | |
| World | 1.2 | 0.2 | 0.5 | 0.6 | 5.4 | 2.0 | 1.7 | 4.8 | 3.3 |
| Developed countries | -1.8 | 0.6 | 0.2 | -0.8 | 4.6 | 2.0 | 0.2 | 4.4 | 2.9 |
| United States | -8.1 | 2.3 | 11.3 | -0.6 | 3.0 | 1.9 | -0.9 | 2.6 | 2.6 |
| Transition markets | 25.2 | -1.2 | -22.5 | -0.8 | 0.7 | 4.3 | 1.4 | 0.1 | 6.6 |
| Developing countries | 16.6 | -0.6 | 1.3 | 6.2 | 7.4 | 1.9 | 8.4 | 6.1 | 4.1 |
| Asia developed | -2.6 | -3.6 | -7.8 | 7.2 | 8.7 | 3.1 | 7.1 | 10.1 | 3.9 |
| Asia developing | 22.2 | -2.8 | -0.8 | 8.9 | 13.4 | 1.8 | 12.7 | 10.2 | 4.0 |
| South Asia | 8.0 | 35.7 | 17.6 | -8.3 | 9.5 | 12.4 | -7.9 | 13.7 | 8.7 |
| China | 17.6 | 9.1 | 9.6 | 11.6 | 17.9 | 0.3 | 13.1 | 15.5 | 3.6 |
| East & Southeast Asia | 19.6 | 2.1 | -3.7 | 4.5 | 11.2 | 3.5 | 5.2 | 11.8 | 5.1 |
| Near East | 21.6 | -4.7 | -2.9 | 22.1 | 1.9 | 5.8 | 26.3 | -1.3 | 3.6 |
| Latin America & Caribbean | -6.8 | 13.3 | 9.8 | -0.2 | -2.3 | 3.8 | 0.0 | 1.0 | 6.7 |
| Africa developing | 7.3 | -2.0 | 0.6 | 10.8 | 0.3 | 1.8 | 12.2 | -1.5 | 3.0 |

*See footnote at end of table.*

*--Continued*

**Appendix 1.1—Growth rates of meat production, consumption and trade, by global region[1]--Continued**

| Country | Mutton & goat | | | Fish | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 | 1970-80 | 1980-90 | 1990-99 |
| | *Growth rates* | | | | | | | | |
| **Exports** | | | | | | | | | |
| World | 1.6 | 0.0 | 0.8 | -0.6 | 4.8 | 2.2 | 1.0 | 4.3 | 3.7 |
| Developed countries | 1.5 | 0.0 | 1.4 | 2.7 | 2.3 | 3.1 | 3.4 | 3.1 | 4.3 |
| United States | 0.0 | 19.2 | -5.4 | 16.7 | 10.7 | -2.5 | 16.0 | 9.2 | 7.4 |
| Transition markets | 12.2 | -1.4 | -10.5 | 4.2 | 4.4 | 6.4 | 3.4 | 1.9 | 4.7 |
| Developing countries | 3.1 | -0.4 | -5.7 | -3.8 | 7.7 | 1.4 | -2.2 | 6.4 | 2.9 |
| Asia developed | -- | -- | -- | 1.9 | 0.7 | -13.9 | 2.1 | -3.3 | -11.4 |
| Asia developing | 11.0 | -1.2 | -9.2 | 10.8 | 6.3 | 5.9 | 8.0 | 7.9 | 5.7 |
| South Asia | -- | 3.1 | 4.9 | 1.4 | 5.6 | 6.1 | 1.8 | 7.1 | 6.8 |
| China | 31.2 | 0.9 | 2.4 | 9.1 | 10.9 | 7.9 | 5.8 | 11.8 | 7.1 |
| East & Southeast Asia | 7.9 | -2.2 | -22.3 | 14.6 | 4.6 | 4.5 | 11.1 | 6.0 | 4.3 |
| Near East | 12.6 | -1.6 | -5.3 | -0.4 | 4.3 | 4.1 | 5.9 | 0.8 | 2.8 |
| Latin America & Caribbean | -4.1 | 0.8 | -4.7 | -6.6 | 8.4 | -1.1 | -4.1 | 5.9 | 1.2 |
| Africa developing | -0.3 | 10.7 | 16.4 | -3.9 | 5.5 | 6.0 | -4.5 | 5.2 | 4.9 |
| **Consumption** | | | | | | | | | |
| World | 0.7 | 2.7 | 1.7 | 2.6 | 3.3 | 3.2 | 2.8 | 2.9 | 2.8 |
| Developed countries | -1.3 | 1.3 | -2.5 | 1.6 | 1.7 | -0.5 | 1.8 | 1.3 | -0.1 |
| United States | -5.7 | 1.1 | -1.3 | 2.6 | 3.5 | 1.2 | 1.1 | 1.9 | 1.7 |
| Transition markets | -0.4 | 1.2 | -6.7 | 2.2 | -0.1 | -5.4 | 2.5 | 0.5 | -4.4 |
| Developing countries | 2.7 | 3.7 | 3.8 | 3.8 | 4.8 | 5.7 | 4.5 | 5.0 | 5.5 |
| Asia developed | -2.5 | -3.1 | -6.9 | 1.5 | 1.4 | -0.5 | 2.3 | 1.8 | 0.5 |
| Asia developing | 3.7 | 4.3 | 4.4 | 3.2 | 5.8 | 6.8 | 4.5 | 6.3 | 6.2 |
| South Asia | 3.1 | 4.2 | 1.4 | 2.2 | 3.9 | 4.4 | 2.6 | 4.4 | 3.0 |
| China | 7.2 | 9.5 | 10.1 | 2.8 | 9.8 | 10.3 | 5.2 | 8.5 | 8.1 |
| East & Southeast Asia | 4.2 | 3.4 | 0.4 | 3.5 | 3.5 | 2.4 | 3.8 | 4.2 | 3.0 |
| Near East | 3.1 | 1.3 | 2.3 | 8.3 | 3.9 | 5.8 | 7.1 | 2.8 | 3.9 |
| Latin America & Caribbean | -2.3 | 1.7 | 0.3 | 5.5 | 1.7 | 1.0 | 4.6 | 2.5 | 4.1 |
| Africa developing | 2.7 | 2.9 | 2.9 | 5.4 | 2.6 | 2.0 | 4.4 | 2.4 | 2.7 |

[1]Compound annual growth rates between 3-year averages centered on the years indicated.

Source: FAOSTAT database, August 2002.

**Appendix table 1.2—Alternative estimates of broiler meat production and consumption in India**

| Year | Production | | | | Imports | Exports | Consumption[5] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | USDA[1] | FAO[2] | USAPEEC[3] | Industry average[4] | USDA[1] | USDA[1] | USDA[1] | FAO | USAPEEC | Industry average |
| | | | | | *1,000 tons* | | | | | |
| 1980 | 213 | 113 | -- | -- | 0 | 0 | 213 | 113 | -- | -- |
| 1981 | 215 | 120 | -- | -- | 0 | 0 | 215 | 120 | -- | -- |
| 1982 | 230 | 130 | -- | -- | 0 | 0 | 230 | 130 | -- | -- |
| 1983 | 235 | 137 | -- | -- | 0 | 0 | 235 | 137 | -- | -- |
| 1984 | 240 | 150 | -- | -- | 0 | 0 | 240 | 150 | -- | -- |
| 1985 | 251 | 161 | -- | -- | 0 | 0 | 251 | 161 | -- | -- |
| 1986 | 257 | 180 | -- | -- | 0 | 0 | 257 | 180 | -- | -- |
| 1987 | 263 | 194 | -- | -- | 0 | 0 | 263 | 194 | -- | -- |
| 1988 | 330 | 225 | -- | -- | 0 | 0 | 330 | 225 | -- | -- |
| 1989 | 380 | 289 | -- | -- | 0 | 0 | 380 | 289 | -- | -- |
| 1990 | 380 | 342 | 410 | -- | 0 | 0 | 380 | 342 | 410 | -- |
| 1991 | 420 | 360 | 440 | -- | 0 | 0 | 420 | 360 | 440 | -- |
| 1992 | 520 | 405 | 430 | -- | 0 | 0 | 520 | 405 | 430 | -- |
| 1993 | 560 | 454 | 455 | -- | 0 | 0 | 560 | 454 | 455 | -- |
| 1994 | 507 | 468 | 507 | -- | 0 | 0 | 507 | 468 | 507 | -- |
| 1995 | 578 | 479 | 580 | -- | 0 | 0 | 578 | 479 | 580 | -- |
| 1996 | 665 | 479 | 660 | -- | 0 | 0 | 665 | 479 | 660 | -- |
| 1997 | 596 | 527 | 630 | 596 | 0 | 0 | 596 | 527 | 630 | 596 |
| 1998 | 710 | 540 | 730 | 710 | 0 | 0 | 710 | 540 | 730 | 710 |
| 1999 | 820 | 559 | 800 | 820 | 0 | 0 | 820 | 559 | 800 | 820 |
| 2000 | 1,080 | 575 | -- | 911 | 0 | 0 | 1,080 | 575 | -- | 911 |
| 2001 | 1,250 | 595 | -- | 1,034 | 0 | 1 | 1,249 | 594 | -- | 1,033 |
| 2002 | 1,400 | 595 | -- | -- | 0 | 2 | 1,398 | 593 | -- | -- |
| 2003 | 1,500 | -- | -- | -- | 0 | 5 | 1,495 | -- | -- | -- |
| Growth rates: | | | | | | | | | | |
| 1980-90 | 6.0 | 11.7 | -- | -- | -- | -- | 6.0 | 11.7 | -- | -- |
| 1990-2000 | 11.0 | 5.3 | 7.7 | -- | -- | -- | 11.0 | 5.3 | 6.1 | -- |
| 1990-96 | 9.8 | 5.8 | 8.3 | -- | -- | -- | 9.8 | 5.8 | 5.9 | -- |
| 1997-2002 | 18.6 | 2.5 | -- | 14.8 | -- | -- | 18.6 | 2.4 | -- | 14.8 |

-- = Not available.

[1]USDA PS&D database, January 2003.

[2]FAOSTAT database, January 2003.

[3]U.S.A. Poultry and Egg Export Council; reported to be derived from Annual Reports-Department of Animal Husbandry. & Dairy, GOI, and FAO data.

[4]Average of production estimates provided by three industry sources during August 2001 ERS field study.

[5]All consumption estimates calculated using USDA trade data and assuming zero stocks.

**Appendix table 1.3—Regionwise estimates of population and net state domestic product in India**

| Region and state | Population, 2001 | | Net state domestic product, 1999/2000 | | | |
|---|---|---|---|---|---|---|
| | 2001 | Urban share | Total | Per capita | | |
| | *Millions* | *Percent* | *Rs billion* | *Rs* | *Dollars* | *Rank* |
| **North** | | | | | | |
| Chandigarh (UT) | 0.9 | 89.8 | 40.6 | 45,065 | 1,003 | 1 |
| Delhi (UT) | 13.8 | 93.0 | 490.4 | 35,580 | 792 | 2 |
| Haryana | 21.1 | 29.0 | 416.3 | 19,744 | 439 | 6 |
| Himachal Pradesh | 6.1 | 9.8 | 99.7 | 16,407 | 365 | 10 |
| Jammu & Kashmir | 10.1 | 24.9 | 121.5 | 12,064 | 268 | 18 |
| Punjab | 24.3 | 33.9 | 549.6 | 22,627 | 504 | 4 |
| Rajasthan | 56.5 | 23.4 | 666.5 | 11,801 | 263 | 20 |
| Uttar Pradesh & Uttaranchal | 174.5 | 21.0 | 1,646.3 | 9,433 | 210 | 23 |
| Total | 307.2 | 26.4 | 4,030.8 | 13,121 | 292 | -- |
| (National share, percent) | 0.3 | | 0.3 | | | |
| **East** | | | | | | |
| Arunachal Pradesh | 1.1 | 5.5 | 15.3 | 14,050 | 313 | 15 |
| Assam | 26.6 | 12.7 | 250.5 | 9,404 | 209 | 24 |
| Bihar & Jharkhand | 109.8 | 13.4 | 627.6 | 5,716 | 127 | 26 |
| Manipur | 2.4 | 23.9 | 25.5 | 10,692 | 238 | 21 |
| Meghalaya | 2.3 | 19.6 | 28.1 | 12,168 | 271 | 17 |
| Mizoram | 0.9 | 49.5 | -- | -- | -- | -- |
| Nagaland | 2.0 | 17.7 | -- | -- | -- | -- |
| Orissa | 36.7 | 15.0 | 327.3 | 8,916 | 198 | 25 |
| Sikkim | 0.5 | 11.1 | 7.4 | 13,617 | 303 | 16 |
| Tripura | 3.2 | 17.0 | 38.1 | 11,949 | 266 | 19 |
| West Bengal | 80.2 | 28.0 | 1,223.3 | 15,249 | 339 | 13 |
| Total | 265.8 | 18.3 | 2,543.1 | 9,674 | 215 | |
| (National share, percent) | 26.0 | | 18.0 | | | |
| **West** | | | | | | |
| Dadara & Nagar Haveli (UT) | 0.2 | 22.9 | -- | -- | -- | -- |
| Daman & Diu (UT) | 0.2 | 36.3 | -- | -- | -- | -- |
| Goa | 1.3 | 49.8 | -- | -- | -- | -- |
| Gujarat | 50.6 | 37.4 | 893.2 | 17,653 | 393 | 9 |
| Madhya Pradesh & Chhatisgarh | 81.2 | 25.0 | 863.9 | 10,641 | 237 | 22 |
| Maharashtra | 96.8 | 42.4 | 2,122.2 | 21,934 | 488 | 5 |
| Total | 230.3 | 35.2 | 3,879.2 | 16,974 | 378 | |
| (National share, percent) | 22.0 | | 27.0 | | | |
| **South** | | | | | | |
| Andaman & Nicobar (UT) | 0.4 | 32.7 | -- | -- | -- | -- |
| Andhra Pradesh | 75.7 | 27.1 | 1,105.3 | 14,595 | 325 | 14 |
| Karnataka | 52.7 | 34.0 | 846.9 | 16,059 | 357 | 12 |
| Kerala | 31.8 | 26.0 | 587.0 | 18,438 | 410 | 8 |
| Lakshadweep (UT) | 0.1 | 44.5 | -- | -- | -- | -- |
| Pondicherry (UT) | 1.0 | 66.6 | 31.8 | 32,696 | 728 | 3 |
| Tamil Nadu | 62.1 | 43.9 | 1,178.3 | 18,970 | 422 | 7 |
| Total | 223.8 | 33.4 | 3,749.2 | 16,784 | 374 | |
| (National share, percent) | 22.0 | | 26.0 | | | |
| **Total** | 1,027.0 | 27.8 | 14,202.4 | 13,891 | 309 | |

-- = Not available. UT = Union territory.

Note: Population and net state domestic product data are the most recent available. Net domestic product underestimates income as measured by gross national product, but is the only available statewise income measure.

Source: *Economic Survey*, 2001/02, Ministry of Finance, Government of India, 2002.

**Appendix table 1.4—Supply and use of corn in India**

| Year | Area | Yield | Production | Imports | Exports | Consumption | | | Ending stocks | October/September trade | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Total | Nonfeed | Feed | | Imports | From U.S. | Exports |
| | *1,000 ha.* | *Tons/ha.* | *1,000 tons* | | | | | | | | | |
| 1980 | 6,005 | 1.16 | 6,957 | 10 | 10 | 6,807 | 6,207 | 600 | 500 | 10 | 10 | 10 |
| 1981 | 5,935 | 1.16 | 6,897 | 0 | 10 | 6,987 | 6,287 | 700 | 400 | 0 | 0 | 20 |
| 1982 | 5,720 | 1.14 | 6,549 | 0 | 0 | 6,649 | 5,899 | 750 | 300 | 5 | 5 | 0 |
| 1983 | 5,859 | 1.35 | 7,922 | 0 | 5 | 7,717 | 6,917 | 800 | 500 | 0 | 0 | 5 |
| 1984 | 5,800 | 1.46 | 8,442 | 0 | 6 | 8,436 | 7,586 | 850 | 500 | 0 | 0 | 6 |
| 1985 | 5,797 | 1.15 | 6,643 | 0 | 5 | 7,038 | 6,188 | 850 | 100 | 0 | 0 | 5 |
| 1986 | 5,873 | 1.27 | 7,457 | 0 | 5 | 7,502 | 6,602 | 900 | 50 | 0 | 0 | 5 |
| 1987 | 5,561 | 1.03 | 5,721 | 275 | 0 | 5,996 | 4,917 | 1,079 | 50 | 304 | 200 | 0 |
| 1988 | 5,897 | 1.40 | 8,229 | 200 | 0 | 8,179 | 7,079 | 1,100 | 300 | 200 | 200 | 0 |
| 1989 | 5,915 | 1.63 | 9,651 | 0 | 0 | 9,451 | 7,151 | 2,300 | 500 | 0 | 0 | 0 |
| 1990 | 5,904 | 1.52 | 8,962 | 0 | 1 | 9,261 | 6,961 | 2,300 | 200 | 0 | 0 | 1 |
| 1991 | 5,860 | 1.38 | 8,060 | 0 | 4 | 8,156 | 6,406 | 1,750 | 100 | 0 | 0 | 4 |
| 1992 | 5,963 | 1.68 | 9,992 | 1 | 28 | 9,965 | 7,065 | 2,900 | 100 | 1 | 1 | 28 |
| 1993 | 5,995 | 1.60 | 9,600 | 0 | 36 | 9,564 | 6,964 | 2,600 | 100 | 0 | 0 | 36 |
| 1994 | 6,135 | 1.45 | 8,884 | 1 | 17 | 8,868 | 6,968 | 1,900 | 100 | 1 | 0 | 17 |
| 1995 | 5,979 | 1.59 | 9,530 | 0 | 42 | 9,488 | 6,988 | 2,500 | 100 | 0 | 0 | 42 |
| 1996 | 6,248 | 1.70 | 10,612 | 0 | 8 | 10,304 | 7,004 | 3,300 | 400 | 0 | 0 | 8 |
| 1997 | 6,305 | 1.72 | 10,852 | 1 | 7 | 10,946 | 7,046 | 3,900 | 300 | 1 | 0 | 7 |
| 1998 | 6,080 | 1.76 | 10,680 | 175 | 2 | 10,853 | 6,953 | 3,900 | 300 | 175 | 85 | 2 |
| 1999 | 6,427 | 1.78 | 11,470 | 250 | 17 | 11,350 | 6,800 | 4,550 | 653 | 250 | 0 | 13 |
| 2000 | 6,557 | 1.84 | 12,068 | 50 | 95 | 11,950 | 6,800 | 5,150 | 726 | 50 | 0 | 92 |
| 2001 | 6,870 | 1.97 | 13,510 | 10 | 25 | 13,050 | 6,750 | 6,300 | 1,171 | 10 | 0 | 25 |
| 2002 | 6,200 | 1.77 | 11,000 | 300 | 50 | 12,000 | 6,800 | 5,200 | 421 | 300 | 0 | 50 |

Source: USDA PS&D database; January 2003.

**Appendix table 1.5—Supply and use of soybeans in India**

| Year | Area | Yield | Production | Imports | | Exports | Consumption | | | | Ending stocks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | From U.S. | | Total | Crush | Food | Other[1] | |
| | *1,000 ha.* | *Tons/ha* | ---------- | ---------- | ---------- | ---------- | *1,000 tons* | ---------- | ---------- | ---------- | |
| 1980 | 600 | 0.74 | 442 | 0 | 0 | 0 | 442 | 383 | 15 | 44 | 0 |
| 1981 | 622 | 0.75 | 467 | 0 | 0 | 0 | 467 | 405 | 15 | 47 | 0 |
| 1982 | 770 | 0.64 | 491 | 0 | 0 | 0 | 491 | 421 | 20 | 50 | 0 |
| 1983 | 836 | 0.73 | 614 | 0 | 0 | 0 | 614 | 528 | 25 | 61 | 0 |
| 1984 | 1,243 | 0.77 | 955 | 0 | 0 | 0 | 955 | 829 | 30 | 96 | 0 |
| 1985 | 1,340 | 0.76 | 1,020 | 0 | 0 | 0 | 1,020 | 890 | 30 | 100 | 0 |
| 1986 | 1,527 | 0.58 | 891 | 21 | 0 | 0 | 912 | 787 | 35 | 90 | 0 |
| 1987 | 1,543 | 0.58 | 898 | 25 | 25 | 0 | 923 | 750 | 30 | 143 | 0 |
| 1988 | 1,734 | 0.89 | 1,547 | 0 | 0 | 0 | 1,547 | 1,372 | 25 | 150 | 0 |
| 1989 | 2,253 | 0.80 | 1,806 | 0 | 0 | 0 | 1,806 | 1,606 | 30 | 170 | 0 |
| 1990 | 2,564 | 1.01 | 2,602 | 0 | 0 | 0 | 2,602 | 2,362 | 40 | 200 | 0 |
| 1991 | 3,185 | 0.78 | 2,492 | 0 | 0 | 0 | 2,492 | 2,232 | 40 | 220 | 0 |
| 1992 | 3,627 | 0.86 | 3,106 | 0 | 0 | 0 | 3,106 | 2,810 | 50 | 246 | 0 |
| 1993 | 4,250 | 0.94 | 4,000 | 0 | 0 | 0 | 4,000 | 3,600 | 50 | 350 | 0 |
| 1994 | 4,025 | 0.80 | 3,236 | 55 | 55 | 0 | 3,175 | 2,750 | 50 | 375 | 116 |
| 1995 | 4,817 | 0.93 | 4,476 | 0 | 0 | 0 | 4,476 | 4,046 | 50 | 380 | 116 |
| 1996 | 5,000 | 0.82 | 4,100 | 0 | 0 | 0 | 4,100 | 3,650 | 50 | 400 | 116 |
| 1997 | 5,600 | 0.96 | 5,350 | 0 | 0 | 0 | 5,410 | 4,770 | 80 | 560 | 56 |
| 1998 | 6,350 | 0.94 | 6,000 | 0 | 0 | 0 | 6,056 | 5,400 | 100 | 556 | 0 |
| 1999 | 5,645 | 0.92 | 5,200 | 0 | 0 | 0 | 5,160 | 4,400 | 200 | 560 | 40 |
| 2000 | 5,800 | 0.91 | 5,250 | 0 | 0 | 0 | 5,265 | 4,525 | 200 | 540 | 25 |
| 2001 | 6,000 | 0.90 | 5,400 | 0 | 0 | 0 | 5,400 | 4,629 | 202 | 569 | 25 |
| 2002 | 5,600 | 0.89 | 5,000 | 0 | 0 | 0 | 5,005 | 4,265 | 190 | 550 | 20 |

[1]Feed, seed, and waste.

Source: USDA PS&D database; January 2003.

**Appendix table 1.6—Supply and use of soybean meal in India**

| Year | Crush | Extraction rate | Production | Imports | | Exports | Consumption | | | Ending stocks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total | From U.S. | | Total | Food | Feed & waste | |
| | *1,000 tons* | *Percent* | *1,000 tons* | | | | | | | |
| 1980 | 383 | 0.80 | 306 | 0 | 0 | 107 | 199 | 7 | 192 | 0 |
| 1981 | 405 | 0.80 | 324 | 0 | 0 | 200 | 124 | 10 | 114 | 0 |
| 1982 | 421 | 0.80 | 337 | 0 | 0 | 225 | 112 | 15 | 97 | 0 |
| 1983 | 528 | 0.80 | 422 | 0 | 0 | 250 | 172 | 25 | 147 | 0 |
| 1984 | 829 | 0.80 | 663 | 0 | 0 | 350 | 313 | 35 | 278 | 0 |
| 1985 | 890 | 0.80 | 712 | 0 | 0 | 450 | 262 | 40 | 222 | 0 |
| 1986 | 787 | 0.80 | 628 | 0 | 0 | 450 | 178 | 30 | 148 | 0 |
| 1987 | 750 | 0.80 | 600 | 0 | 0 | 360 | 240 | 30 | 210 | 0 |
| 1988 | 1,372 | 0.80 | 1,100 | 0 | 0 | 890 | 210 | 30 | 180 | 0 |
| 1989 | 1,606 | 0.80 | 1,285 | 0 | 0 | 950 | 335 | 30 | 305 | 0 |
| 1990 | 2,362 | 0.80 | 1,890 | 0 | 0 | 1,420 | 470 | 40 | 430 | 0 |
| 1991 | 2,232 | 0.80 | 1,785 | 0 | 0 | 1,180 | 605 | 30 | 575 | 0 |
| 1992 | 2,810 | 0.80 | 2,250 | 0 | 0 | 2,005 | 245 | 30 | 215 | 0 |
| 1993 | 3,600 | 0.80 | 2,880 | 0 | 0 | 2,200 | 680 | 40 | 640 | 0 |
| 1994 | 2,750 | 0.80 | 2,200 | 0 | 0 | 1,580 | 620 | 50 | 570 | 0 |
| 1995 | 4,046 | 0.79 | 3,200 | 0 | 0 | 2,600 | 490 | 40 | 450 | 110 |
| 1996 | 3,650 | 0.80 | 2,920 | 0 | 0 | 2,450 | 580 | 50 | 530 | 0 |
| 1997 | 4,770 | 0.80 | 3,800 | 0 | 0 | 2,600 | 1,200 | 74 | 1,126 | 0 |
| 1998 | 5,400 | 0.80 | 4,295 | 0 | 0 | 2,800 | 1,425 | 84 | 1,341 | 70 |
| 1999 | 4,400 | 0.80 | 3,515 | 0 | 0 | 2,375 | 1,210 | 80 | 1,130 | 0 |
| 2000 | 4,525 | 0.80 | 3,614 | 0 | 0 | 2,350 | 1,224 | 79 | 1,145 | 40 |
| 2001 | 4,629 | 0.80 | 3,700 | 0 | 0 | 2,450 | 1,255 | 80 | 1,175 | 35 |
| 2002 | 4,265 | 0.80 | 3,405 | 0 | 0 | 1,800 | 1,595 | 90 | 1,505 | 45 |

Source: USDA PS&D database; January 2003.

# Appendix 2.1—India Poultry-Feed Model: Characteristics

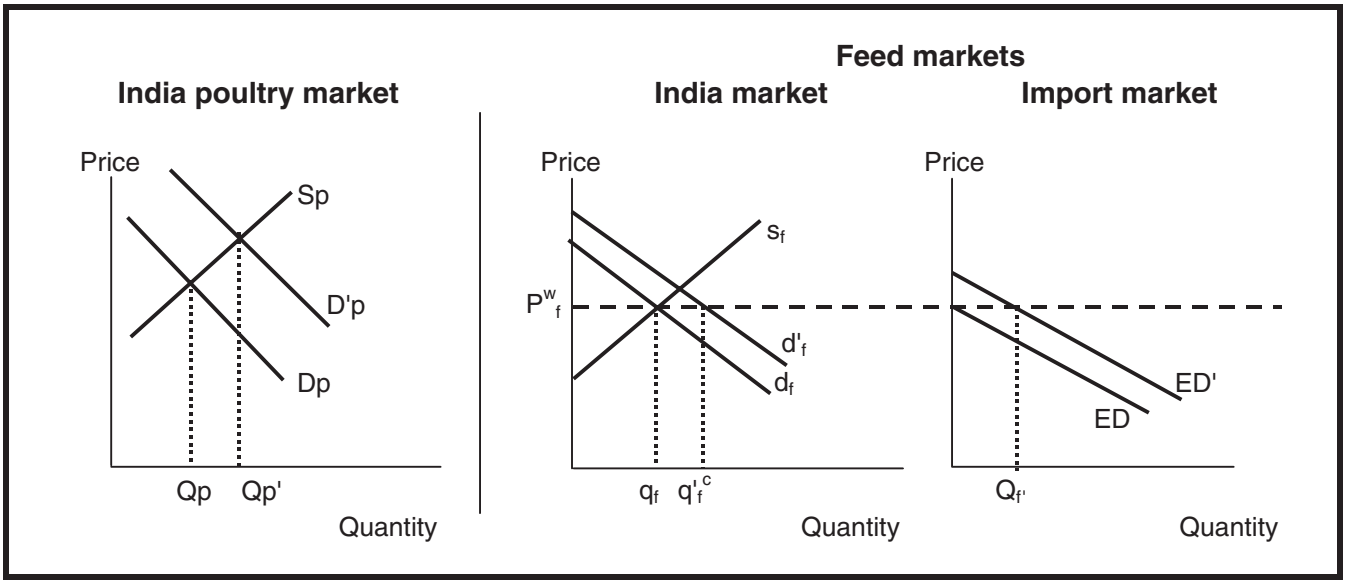
The India Poultry-Feed Model used for this study permits analysis of the impacts of the key forces shaping the growth of the poultry industry on major variables, including the production, consumption, and prices of poultry meat, eggs, corn, and soybean meal. The impact of income growth is depicted in fig. A, where higher incomes shift demand in the poultry (and egg) market outward toward $D'_p$, leading to an outward shift in feed demand in the India market to $d'_f$. In the import market, in the absence of trade restrictions, the excess demand schedule also shifts outward to ED', creating a situation where feed imports of $Q_f$' occur at the world price ($P^W_f$). The extent to which imports can occur at the world price hinges on the relationship between the domestic price and the world price and on the presence of trade restrictions. In the case of a feed that is exported (excess supply), such as soybean meal in India, the effect would be to reduce exports, rather than induce imports, with the domestic price set by the world market price.

The impacts of vertical integration captured in the framework are shown in fig. B. Vertical integration is leading to both production efficiencies associated with improved technology and marketing efficiencies observed in the form of lower costs for key inputs (DOCs, feed) and smaller margins between farmers and consumers. These efficiencies are captured in an outward shift in the poultry supply curve in the India market to $S'_p$. As drawn, the gains in production and marketing efficiency lead to higher levels of production and consumption ($Q_p$') at a lower price ($P_P$') in the poultry market. This can occur because, as increased poultry output shifts feed demand outward ($d'_f$) in the India market, the shift in excess demand (ED') in the import market is met at a world price ($P^W_f$) that is near the prevailing domestic price. With a world price that is above the domestic price, or trade restrictions that raise the import price above the world price, a smaller quantity of feed imports would occur at a higher price, raising the cost of poultry (and egg) production. As a result, poultry (and egg) supply and demand would shift back toward $Q_p$ and price upward toward $P_P$. As in the case above, the impact of vertical integration on an exported feed, such as soybean meal in the case of India, would be to reduce excess supplies (exports), with the domestic price continuing to be set by the world price.

The impacts of both income growth and vertical integration are potentially influenced by trade policies for feeds. For India, the corn TRQ regime imposes a 15-percent tariff for within-quota (450,000 tons in 2002) imports and a 50-percent tariff for any imports above the quota. The impacts of this policy in the model are

Figure A

**Effects of income growth**



depicted in fig. C. In the India market, d represents the total demand for corn, aggregated across the various uses. With no tariffs or other trade restrictions, markets are in equilibrium with a domestic price equal to the world price of $P_c^F$. As drawn, domestic consumption at this price is $q_c$, which exceeds domestic production of $q_p$ leading to imports of $q_e$ on the excess demand (ED) and supply (ES) schedules in the import market. In the large country case, the importing country would face an upward sloping excess supply curve (ES). In the case of the India model, however, it is assumed that any imports would not be large enough to affect the world price, so the relevant ES curve is actually the same as the flat dotted line at $P_c^F$.

India's ad valorem tariff (t) has the effect of rotating the excess demand curve from ED to ED(1-t), reducing imports from $q_e$ to $q_t$, as well as raising the price and reducing the quantity consumed in the India market (not shown). Impacts on the poultry and egg markets would include higher costs and prices, and smaller quantities produced and consumed. With both

Figure B

**Effects of poultry integration**

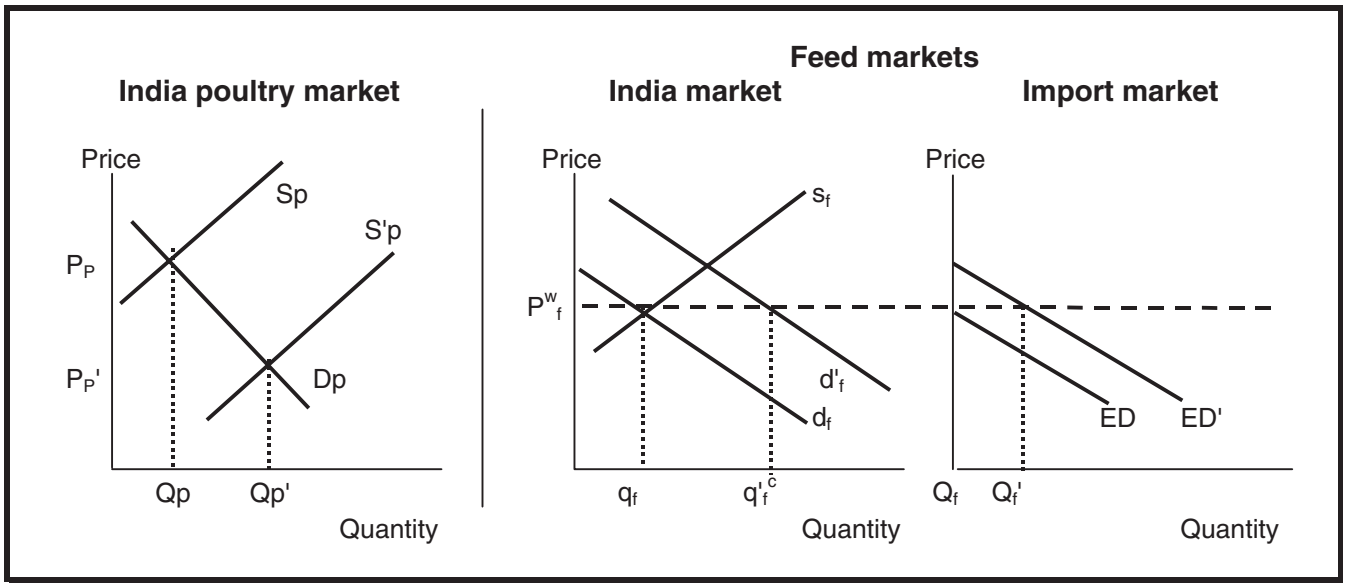
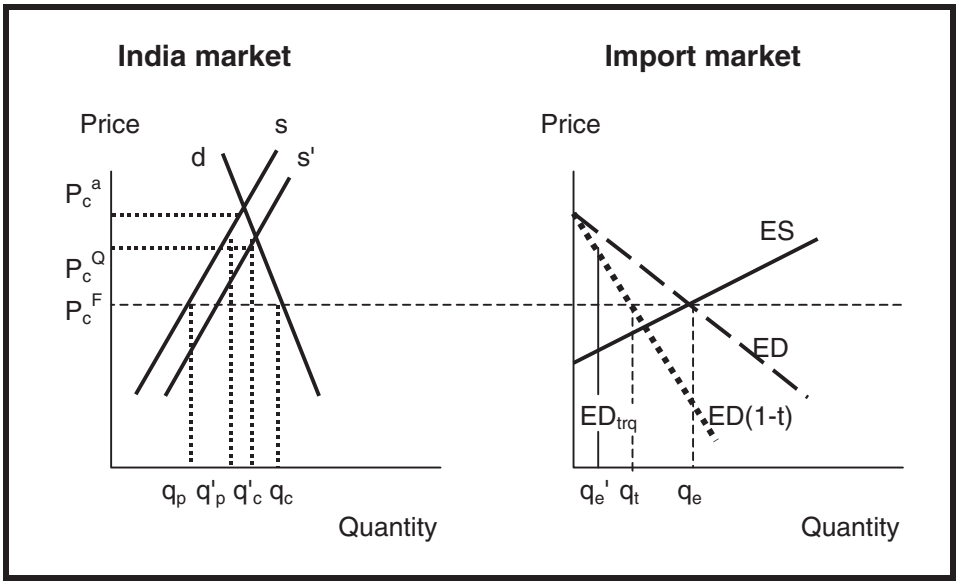



Figure C

**Effects of a corn import quota**



a tariff and a quota of $q_e$' (equal to 450,000 tons in 2002) imposed on imports, the excess demand curve is shifted from ED(1-t) to $ED_{trq}$, which is the same as ED(1-t) until it hits the quota $q_e$' and imports can no longer respond to price (a vertical line).[1] If the quota is large enough, that is to the right of $q_t$, the quota would be inoperative and imports would be the same as under the tariff-only regime. As drawn, however, the quota is binding, restricting imports below $q_t$. With this, domestic market prices and quantities for feed are determined from the intersection of d and s', where s' is the domestic supply including the quota imports (left panel). With the restrictive quota, the domestic corn price rises to $P_c^Q$, domestic consumption falls to $q'_c$ and domestic production rises to $q'_p$. Hence, although the TRQ permits domestic prices of corn to be lower than under a trade ban (autarky, $P_c^a$), prices remain higher, and consumption lower, than would be the case with free trade.[2] As before, higher corn prices translate into higher poultry and egg prices, and smaller quantities are consumed and produced.

## Limitations of the Framework

The analytical framework captures the major economic relationships in the poultry meat and feed sectors, but omits several aspects of potential significance to the results. First, by omitting poultry and egg trade, the framework assumes that trade in these items will remain inconsequential. Significant poultry imports seem unlikely in the medium term due to the limited market for frozen poultry, the high tariff, and relatively low internal market prices. Poultry exports may be more plausible, but are not accounted for in the analysis. India currently exports a relatively small share (less than 1 percent) of its egg production, and it seems likely that the huge internal market, rather than exports, will remain the key driver of the industry.

The framework includes only two products (poultry meat and eggs) and two feeds (corn and soybean meal) and, following Abbott et al. (2000) does not allow for substitution between products or feeds. In the case of the products, both egg and poultry demand are fairly responsive to changes in income and their own price, and it is likely that these income and own-price effects are more dominant than cross price relationships with other foods in driving demand. In the feed markets, available information suggests that integrated poultry meat producers prefer not to substitute for corn or soybean meal in their rations, but that independent growers and egg producers are more likely to substitute alternative ingredients based on price. To the extent that price-based substitution leads to average corn or soybean meal ration shares lower (higher) than those assumed in the analysis, impacts on domestic feed prices and trade are over (under) estimated in the framework. Similarly, by basing nonfeed (starch, food use) demand for corn on historical trends, the model does not build in price-based substitution between feed and nonfeed uses. To the extent that nonfeed uses deviate significantly from trend due to changes in prices, these effects are not captured.

The model, as specified, does not incorporate potential changes in world prices resulting from changes in India's trade of corn or soybean meal. Since India's trade in these commodities remains small relative to world trade in the various scenarios analyzed, this assumption is unlikely to affect the results significantly.

Finally, the validity of analyses conducted using the framework hinges on the reliability of the data, technical relationships, and economic parameters employed. Due to the limited availability of reliable industry data, it is difficult to be completely confident of the data and parameters used. In an attempt to address this problem, a range of estimates for key input data and parameters are used in the analysis to test the validity of the results.

[1] Also not shown is the distinction between the in-quota and above-quota tariffs. The shift to a 50-percent tariff for imports of 450,000-500,000 MT would rotate further the excess demand curve in the above-quota region, leading to a kinked excess demand curve.

[2] Note: Figure C is not drawn to scale.

# Appendix 2.2—India Poultry-Feed Model: Equations and Variable List

**Model Equations[1]**

**Poultry Block (PL)**

| | | | |
|---|---|---|---|
| 1) | PLDemand | = | $\mathbf{PL^1}$***PCGDP +** $\mathbf{PL^2}$*****$PLPrice_R$ **+ constant** |
| 2) | $PLDemand_D$ | = | PLDemand * **PLDresspercent** |
| 3) | PLProd | = | PLDemand |
| 4) | $PLProd_D$ | = | PLProd * **PLDresspercent** |
| 5) | $PLFeeduse_T$ | = | PLProd * **PLFCR** |
| 6) | $PLFeeduse_{CO}$ | = | $PLFeeduse_T$ * $\mathbf{PLRS_{CO}}$ |
| 7) | $PLFeeduse_{SM}$ | = | $PLFeeduse_T$ * $\mathbf{PLRS_{SM}}$ |

**Egg Block (EG)**

| | | | |
|---|---|---|---|
| 8) | EGDemand | = | $\mathbf{EG^1}$***PCGDP +** $\mathbf{EG^2}$*****$EGPrice_R$ **+ constant** |
| 9) | EGProd | = | EGDemand |
| 10) | $EGFeeduse_T$ | = | EGProd * **EGFCR** |
| 11) | $EGFeeduse_{CO}$ | = | $EGFeeduse_T$ * $\mathbf{EGRS_{CO}}$ |
| 12) | $EGFeeduse_{SM}$ | = | $EGFeeduse_T$ * $\mathbf{EGRS_{SM}}$ |

**Corn Block (CO)**

| | | | |
|---|---|---|---|
| 13) | COProd | = | COArea * COYield |
| 14) | COArea | = | $\mathbf{CO^1}$*$COArea_{t-1}$ + $\mathbf{CO^2}$*****$\sum_{i=1}^{5} COPrice_{F,\,t-i}$ **+ constant** |
| 15) | COYield | = | $\mathbf{CO^3}$*****$COPrice_{F,t-1}$ + $\mathbf{CO^4}$***** $COYield_{t-1}$ **+ constant** |
| 16) | $CODemand_{FD}$ | = | $CODemand_{FD,t-1}$ *** Trend** |
| 17) | $CODemand_{ST}$ | = | $CODemand_{ST,t-1}$ *** Trend** |
| 18) | $CODemand_{SW}$ | = | COProd *** Seedwastepercent**$_{CO}$ |
| 19) | $CODemand_T$ | = | $CODemand_{FD}$ + $CODemand_{ST}$ + $CODDemand_{SW}$ + $PLFeeduse_{CO}$ + $EGFeeduse_{CO}$ |
| 20) | CONetimports | = | $CODemand_T$ – COProd |

**Soybean and Meal Block**

| | | | |
|---|---|---|---|
| 21) | SBProd | = | SBArea * SBYield |
| 22) | SBArea | = | $SBArea_{t-1}$ * **Trend** |
| 23) | SBYield | = | $SBYield_{t-1}$ * **Trend** |
| 24) | SBCrush | = | SBProd * **SBCrushshare** |
| 25) | SMProd | = | SBCrush * **SMExtractionrate** |
| 26) | $SMDemand_T$ | = | $PLFeeduse_{SM}$ + $EGFeeduse_{SM}$ |
| 27) | SMNetexports | = | SMProd - $SMDemand_T$ |

[1]Variables in boldface are exogenous.

**Poultry Price Block**

28) $PLPrice_F$ = PLCOP + **$PLMargin_F$**
29) $PLPrice_R$ = $PLPrice_F$ + **$PLMargin_{FR}$**
30) PLCOP = PLFeedcost + PLDOCcost + PLOthercost
31) PLFeedcost = **PLFCR *** ($COPrice_W$***$PLRS_{CO}$** + $SMPrice_W$***$PLRS_{SM}$** + $OFCost_{PL}$) + **PLFeedmargin**
32) PLDOCCOP = **PLDOCcostfactor *** (**$PLRS_{CO}$***$COPrice_W$ + **$PLRS_{SM}$*** $SMPrice_W$ + $OFCost_{PL}$ + PLFeedmargin) + PLDOCOthercost
33) PLDOCcost = PLDOCCOP + PLDOCMargin
34) PLDOCOthercost = $PLDOCOthercost_{t-1}$ * **Trend**
35) PLOthercost = $PLOthercost_{t-1}$ * **Trend**
36) $OFCost_{PL}$ = $OFCost_{PLt-1}$ * **Trend**

**Egg Price Block**

37) $EGPrice_R$ = $COPrice_W$***$EGRS_{CO}$** + $SMPrice_W$***$EGRS_{SM}$** + EGOthercost + **$EGMargin_{FR}$**
38) EGOthercost = $EGOthercost_{t-1}$ * Trend

**Corn Price Block**

39) $COPrice_F$ = $COPrice_W$ - **$COMargin_{FW}$**
40) $COPrice_W$ = Free Trade: MIN{$COPrice_A$, **$COPrice_B$** + **$COHandling_{BF}$**}
= TRQ—Quota Not Operative: MIN{$COPrice_A$, **$COPrice_B$** * (1+ **COTariff**)+ **$COHandling_{BF}$**}
where, $COTariff = COTariff_{IQ}$ within quota
$COTariff = COTariff_{AQ}$ above quota
= TRQ—Quota Operative:[2] $COPrice_Q$

**Soybean Meal Price Block**

41) SMPriceW = $SMPrice_B$– $SMHandling_{BW}$

[2]When quota is operative, corn price is formed in manner consistent with Figure C.

## Variable List

| Variable | Description | Unit |
|---|---|---|
| COArea | Corn area harvested | 1,000 ha. |
| CODemand | Corn demand | 1,000 tons |
| **COHandling** | Corn handling costs | Rs/ton |
| **COMargin** | Corn marketing margin | Rs/ton |
| CONetimports | Corn net imports | 1,000 tons |
| COPrice | Corn price | Rs/ton |
| COProd | Corn production | 1,000 tons |
| **COTariff** | Corn tariff (ad valorem) | Percent |
| **COTRQ** | Corn tariff rate quota | 1,000 tons |
| COYield | Corn yield | Tons/ha. |
| EGDemand | Egg demand | Million eggs |
| **EGFCR** | Egg feed conversion rate | Kg/egg |
| EGFeeduse | Egg feed use | 1,000 tons |
| **EGMargin** | Egg marketing margin | Rs/egg |
| **EGOthercost** | Egg other costs of production | Rs/egg |
| EGPrice | Egg price | Rs/egg |
| EGProd | Egg production | Million eggs |
| **EGRS** | Egg feed ingredient ration share | Percent |
| $OFCost_{PL}$ | Cost of feed ingredients other than corn and soybean meal | Rs/ton |
| **PCGDP** | Real GDP per capita | Rs/capita |
| PLCOP | Poultry cost of production | Rs/ton, live wght |
| PLDemand | Poultry demand | 1,000 tons, live wght |
| **PLDresspercent** | Poultry meat dressing percentage | Percent |
| PLDOCCOP | Poultry DOC cost of production | Rs/ton, live wght |
| PLDOCcost | Poultry DOC cost | Rs/ton, live wght |
| **PLDOCcostfactor** | Factor for computing DOC costs | Ratio |
| **PLDOCmargin** | Poultry DOC marketing margin | Rs/ton, live wght |
| **PLFCR** | Poultry feed conversion rate | Feed/live wght production |
| PLFeedcost | Poultry feed cost | Rs/ton, live wght |
| **PLFeedmargin** | Poultry feed marketing margin | Rs/ton, live wght |
| PLFeeduse | Poultry feed use | 1,000 tons |
| **PLMargin** | Poultry marketing margin | Rs/ton |
| PLOthercost | Poultry grower other costs | Rs/ton, live wght |
| PLPrice | Poultry price | Rs/ton |
| PLProd | Poultry production | 1,000 tons |
| **PLRS** | Poultry feed ingredient ration share | Percent |
| Seedwastepercent | Seed and waste percent of production | Percent |
| SBArea | Soybean area harvested | 1,000 ha. |
| SBCrush | Soybean crush | 1,000 tons |
| **SBCrushshare** | Share of soybean production crushed | Percent |
| SBProd | Soybean production | 1,000 tons |
| SBYield | Soybean yield | Tons/ha. |
| SMDemand | Soybean meal demand | 1,000 tons |

| Variable | Description | Unit |
|---|---|---|
| **SMExtractionrate** | Soybean meal extraction rate | Percent |
| **SMHandling** | Soybean meal handling costs | Rs/ton |
| SMNetexports | Soybean meal net exports | 1,000 tons |
| SMProd | Soybean meal production | 1,000 tons |
| | | |
| Subscript A | Autarchy | |
| Subsript AQ | Above quota | |
| Subscript B | Border | |
| Subscript BF | Border farm | |
| Subscript BW | Border wholesale | |
| Subscript CO | Corn | |
| Subscript D | Dressed weight basis | |
| Subscript F | Farm | |
| Subscript FD | Food | |
| Subscript FR | Farm retail | |
| Subscript FW | Farm wholesale | |
| Subscript IQ | In quota | |
| Subscript OT | Other feed | |
| Subscript R | Retail | |
| Subscript SM | Soybean meal | |
| Subscript ST | Starch | |
| Subscript T | Total | |
| Subscript W | Wholesale | |
| Subscript SW | Seed and waste | |

Note: All prices are in 2001 Rs.

# Appendix 2.3—India Poultry-Feed Model: Model Data and Parameters

The data and parameters used in the analysis are based on firm-level data collected during field research, available literature, secondary data and, in several cases, expert judgment. The base year for the 10-year projections is 2001, and the data used for model variables are summarized in appendix table 2.3A, while economic parameters are summarized in appendix 2.3B. Key data sources are summarized below:

**Poultry supply and use.** Production (dressed weight basis) is based on industry average estimates in appendix table 1.2. Poultry trade and stocks are assumed to be negligible, so consumption is set equal to production. Conversion to live weight is based on a dressing rate of .75 typical for the Cobb 100 breed.

- *Egg supply and use*. Based on USDA estimates.
- *Feed supply and use.* Based on USDA estimates.
- *Poultry price, marketing margins, cost of production, and technical data.* These data are based on weighted regional average data collected during the 2001 ERS field survey. Regional weights (South .50, North: .20; West: .15, East: .15) are based on 2001 population data and expert judgment regarding per capita consumption by region. Price and margin data collected in the West and South region during the 2001 survey indicated negative producer margins and were judged to be atypically low due to seasonal and other factors. Based on re-interviews with several key sources, these data were revised to incorporate a more typical and sustainable producer margin of 5 percent. Technical and margin assumptions used to analyze the impacts of poultry integration are based on field survey data and analysts' judgment, and are summarized in appendix table 2.3C.
- *Feed price data.* Domestic corn prices are the average of wholesale prices for Bihar, Karnataka, and Uttar Pradesh published by the GOI. Domestic soybean meal prices are based on international prices, adjusted for estimated freight and handling costs. Projected world prices of corn and soybean meal, and the exchange rate for the rupee, are based on the 2002 USDA baseline projections.

Technical and economic parameters were based on findings from the field research, as well as expert judgment. In some cases, the choice of parameters was also motivated by the objective of replicating the base year (2001) levels of the endogenous variables. The initial choice of income elasticities of demand—1.7 for poultry and 1.25 for eggs—is higher than reported in table B-1 on page 7, but more consistent with the base period data. Also, it is reasonable that the preferences for poultry and eggs, and perhaps also dairy, may be relatively high in India due to weak preferences for some other products, including pork and beef.

The parameters for the corn area and yield equations result in supply elasticities of 0.04 and 0.28 in the short run and the long run, respectively, and are based on Kumar and Rosegrant (1993). Soybean area and yield growth rates of 1.7 percent and 1.0 percent, respectively, are taken from the USDA baseline projections.

**Appendix table 2.3A—Base values for India poultry-feed model**

| Variable | Unit[1] | Base value | Variable | Unit[1] | Base value |
|---|---|---|---|---|---|
| COArea | 1,000 ha. | 6,700 | PLDOCCOP | Rs/ton, live wght | 4,352 |
| $CODemand_F$ | 1,000 tons | 4,500 | PLDOCmargin | Rs/ton, live wght | 1,088 |
| $CODemand_{ST}$ | 1,000 tons | 1,100 | PLDresspercent | Percent | 75 |
| $CODemand_{SW}$ | 1,000 tons | 2,172 | PLFCR | Feed/live wght prod.[1] | 2.22 |
| $CODemand_T$ | 1,000 tons | 12,000 | PLFeedcost | Rs/ton, live wght | 16,633 |
| $COHandling_{BF}$ | Rs/ton | 800 | PLFeedmargin | Rs/ton, live wght | 1,533 |
| $COMargin_{FW}$ | Rs/ton | 1,334 | $PLFeeduse_{CO}$ | 1,000 tons | 1,686 |
| CONetimports | 1,000 tons | 0 | $PLFeeduse_{SM}$ | 1,000 tons | 613 |
| $COPrice_F$ | Rs/ton | 3,516 | $PLMargin_F$ | Rs/ton | 3,437 |
| $COPrice_W$ | Rs/ton | 4,850 | $PLMargin_{FR}$ | Rs/ton | 19,608 |
| COProd | 1,000 tons | 12,000 | PLOther | Rs/ton, live wght | 5,199 |
| $COTariff_{AQ}$ | Percent | 50 | $PLPrice_F$ | Rs/ton | 30,709 |
| $COTariffI_Q$ | Percent | 15 | $PLPrice_R$ | Rs/ton | 50,317 |
| $COTR_Q$ | 1,000 tons | 400 | $PLProd_L$ | 1,000 tons | 1,379 |
| COYield | Tons/ha. | 1.791 | $PLRS_{CO}$ | Percent | 55 |
| EGDemand | Million eggs | 38,511 | $PLRS_{SM}$ | Percent | 20 |
| EGFCR | Kgs/egg | 0.139 | $Seedwastepercent_{CO}$ | Percent | 18 |
| $EGFeeduse_{CO}$ | 1,000 tons | 2,543 | SBArea | 1,000 ha. | 6,000 |
| $EGFeeduse_{SM}$ | 1,000 tons | 696 | SBCrush | 1,000 tons | 4,759 |
| $EGMargin_{FR}$ | Rs/egg | 0.25 | SBCrushshare | Percent | 85 |
| $EGPrice_R$ | Rs/egg | 1.42 | SBProd | 1,000 tons | 5,600 |
| EGProd | Million eggs | 38,511 | SBYield | Tons/ha. | 0.933 |
| $EGRS_{CO}$ | Percent | 47.5 | $SMDemand_T$ | 1,000 tons | 1,309 |
| $EGRS_{SM}$ | Percent | 13.0 | SMExtractionrate | Percent | 79 |
| EGOthercost | Rs/egg | 0.150 | SMHandling | Rs/ton | 65 |
| $OFCost_{PL}$ | Rs/ton | 2,476 | SMNetexports | 1,000 tons | 2,451 |
| PCGDP | Rs /capita | 22,128 | $SMPrice_B$ | Rs/ton | 8,305 |
| PLCOP | Rs/ton, live wght | 27,272 | $SMPrice_W$ | Rs/ton | 8,240 |
| $PLDemand_L$ | 1,000 tons, live wght | 1,379 | SMProd | 1,000 tons | 3,760 |
| PLDOCcost | Rs/ton, live wght | 5,440 | | | |

[1]DOC plus grow-out.

Source: ERS field survey, August 2001.

**Appendix table 2.3B—Parameters and elasticities for India poultry-feed model**

| Equation & coefficient | Elasticity | Parameter |
|---|---|---|
| Poultry demand equation: | | |
| $PLPrice_R$ ($PL^1$) | -1.3 | -49 |
| PCGDP ($PL^2$) | 1.7 | 148 |
| Constant | -- | 0.544 |
| Poultry cost equations: | | |
| $PLDOCOthercost_{t-1}$ | -- | 1.00 |
| $PLOthercost_{t-1}$ | -- | 1.00 |
| $OFCostPL_{,t-1}$ | -- | 1.00 |
| Egg demand equation: | | |
| $EGPrice_R$ ($EG^1$) | -1.00 | -27,113 |
| PCGDP ($EG^2$) | 1.25 | 2.17 |
| Constant ($cZ_2$) | -- | 28.89 |
| Corn supply equations: | | |
| Area: | | |
| $COArea_{t-1}$ ($CO^1$) | 0.436 | 0.436 |
| $COPrice_{F,t-1}$ ($CO^2$) | 0.031 | 60 |
| Constant | -- | 3.67 |
| Yield: | | |
| $COPrice_F$ ($CO^3$) | 0.010 | 5.30E-06 |
| $COYield_{t-1}$ ($CO^4$) | -- | 1.005 |
| Corn demand equations: | | |
| $CODemand_{FD,t-1}$ | -- | 0.992 |
| $CODemand_{ST,t-1}$ | -- | 1.100 |
| Soybean and meal equations: | | |
| $SBArea_{t-1}$ | -- | 1.017 |
| $SBYield_{t-1}$ | -- | 1.010 |
| $SMDemand_{FD,t-1}$ | -- | 1.00 |

-- = Not applicable.

Source: ERS, USDA.

**Appendix table 2.3C—Technical parameter and margin adjustments for analysis of poultry integration**

| Parameter/margin | Unit | Base value | | 2010 value |
|---|---|---|---|---|
| | | Average producer | Integrated producers | |
| FCR (growout only) | Ratio | 1.88 | 1.75 | 1.79 |
| DOC margin | Rs/ton, live wght | 1,088 | 0 | 272 |
| Feed margin | Rs/ton, live wght | 1,533 | 0 | 383 |
| Farm-retail margin | Rs/ton, live wght | 19,608 | 11,060 | 13,197 |

Source: ERS, USDA.

**Appendix table 2.4—India poultry-feed model: Detailed results**

| Variable | Unit | Base year 2001 | Scenario projections for 2010 | | | | Change over base year in 2010 | | | | Change over reference in 2010 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Reference | 75% integration | Free corn trade | 75% int. & free trade | Reference | 75% integration | Free corn trade | 75% int. & free trade | 75% integration | Free corn trade | 75% int. & free trade |
| Poultry: | | | | | | | | | | | | | |
| Production | Mil. tons, live wt. | 1.4 | 2.3 | 2.7 | 2.5 | 3.1 | 66.2 | 98.5 | 84.4 | 122.2 | 19.4 | 11.0 | 33.7 |
| Producer price | Rs/ton, live wt. | 30,709 | 40,478 | 37,708 | 35,297 | 30,974 | 31.8 | 22.8 | 14.9 | 0.9 | -6.8 | -12.8 | -23.5 |
| Cost of production | Rs/ton, live wt. | 27,272 | 37,041 | 34,271 | 31,860 | 27,537 | 35.8 | 25.7 | 16.8 | 1.0 | -7.5 | -14.0 | -25.7 |
| FCR (grow-out) | Rs/ton, live wt. | 1.88 | 1.88 | 1.79 | 1.88 | 1.79 | 0.0 | -5.2 | 0.0 | -5.2 | -5.2 | 0.0 | -5.2 |
| Feed cost (grow-out) | Rs/ton, live wt. | 16,633 | 24,907 | 23,059 | 20,519 | 17,403 | 49.7 | 38.6 | 23.4 | 4.6 | -7.4 | -17.6 | -30.1 |
| Feed price | Rs/ton | 8,833 | 13,227 | 12,915 | 10,897 | 9,747 | 49.7 | 46.2 | 23.4 | 10.3 | -2.4 | -17.6 | -26.3 |
| DOC cost | Rs/ton, live wt. | 5,440 | 6,936 | 6,013 | 6,143 | 4,935 | 27.5 | 10.5 | 12.9 | -9.3 | -13.3 | -11.4 | -28.8 |
| Misc. cost | Rs/ton, live wt. | 5,199 | 5,199 | 5,199 | 5,199 | 5,199 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Consumption | Mil. tons, live wt. | 1.4 | 2.3 | 2.7 | 2.5 | 3.1 | 66.2 | 98.5 | 84.4 | 122.2 | 19.4 | 11.0 | 33.7 |
| Retail price | Rs/kg, live wt. | 50.3 | 60.1 | 50.9 | 54.9 | 44.2 | 19.4 | 1.2 | 9.1 | -12.2 | -15.3 | -8.6 | -26.5 |
| Farm-retail margin | Rs/ton, live wt. | 19,608 | 19,608 | 13,197 | 19,608 | 13,197 | 0.0 | -32.7 | 0.0 | -32.7 | -32.7 | 0.0 | -32.7 |
| Corn: | | | | | | | | | | | | | |
| Production | Million tons | 12.0 | 14.7 | 15.0 | 14.3 | 14.3 | 22.6 | 24.8 | 19.4 | 19.5 | 1.8 | -2.6 | -2.6 |
| Area | Million ha. | 6.7 | 6.9 | 6.9 | 6.8 | 6.8 | 2.7 | 3.4 | 1.7 | 1.7 | 0.7 | -1.0 | -1.0 |
| Yield | Tons/ha. | 1.79 | 2 | 2 | 2 | 2 | 19.4 | 20.7 | 17.5 | 17.5 | 1.1 | -1.6 | -1.6 |
| Wholesale price | Rs/ton | 4,850 | 11,915 | 13,437 | 7,678 | 7,678 | 145.7 | 177.1 | 58.3 | 58.3 | 12.8 | -35.6 | -35.6 |
| Consumption | Million tons | 12.0 | 15.2 | 15.5 | 16.0 | 16.4 | 26.8 | 29.0 | 33.0 | 36.9 | 1.7 | 4.9 | 8.0 |
| Feed use | Million tons | 4.2 | 5.8 | 6.0 | 6.6 | 7.1 | 36.5 | 41.7 | 55.6 | 66.8 | 3.8 | 14.0 | 22.2 |
| Poultry | Million tons | 1.7 | 2.8 | 3.2 | 3.1 | 3.6 | 66.2 | 89.8 | 84.4 | 112.4 | 14.2 | 11.0 | 27.8 |
| Eggs | Million tons | 2.5 | 3.0 | 2.8 | 3.5 | 3.5 | 16.8 | 9.8 | 36.5 | 36.5 | -6.1 | 16.9 | 16.9 |
| Food | Million tons | 4.5 | 4.2 | 4.2 | 4.2 | 4.2 | -7.0 | -7.0 | -7.0 | -7.0 | 0.0 | 0.0 | 0.0 |
| Starch | Million tons | 1.1 | 2.6 | 2.6 | 2.6 | 2.6 | 135.8 | 135.8 | 135.8 | 135.8 | 0.0 | 0.0 | 0.0 |
| Seed, waste, other | Million tons | 2.2 | 2.7 | 2.7 | 2.6 | 2.6 | 22.6 | 24.8 | 19.4 | 19.5 | 1.8 | -2.6 | -2.6 |
| Imports | Million tons | 0.0 | 0.5 | 0.5 | 1.6 | 2.1 | -- | -- | -- | -- | 0.0 | 224.0 | 317.6 |
| Soybean meal: | | | | | | | | | | | | | |
| Consumption | Million tons | 1.3 | 1.8 | 1.9 | 2.1 | 2.3 | 39.9 | 47.2 | 59.0 | 72.1 | 5.2 | 13.6 | 23.0 |
| Wholesale price | Rs/ton | 8,240 | 10,781 | 10,781 | 10,781 | 10,781 | 30.8 | 30.8 | 30.8 | 30.8 | 0.0 | 0.0 | 0.0 |
| Exports | Million tons | 2.5 | 3.0 | 2.9 | 2.7 | 2.5 | 20.5 | 16.6 | 10.4 | 3.4 | -3.2 | -8.4 | -14.2 |
| Eggs: | | | | | | | | | | | | | |
| Production | Billion eggs | 38.5 | 45.0 | 42.3 | 52.6 | 52.6 | 16.8 | 9.8 | 36.5 | 36.5 | -6.1 | 16.9 | 16.9 |
| Consumption | Billion eggs | 38.5 | 45.0 | 42.3 | 52.6 | 52.6 | 16.8 | 9.8 | 36.5 | 36.5 | -6.1 | 16.9 | 16.9 |
| Retail price | Rs/egg | 1.42 | 1.93 | 2.03 | 1.65 | 1.65 | 36.1 | 43.2 | 16.4 | 16.4 | 5.2 | -14.5 | -14.5 |

Source: ERS India poultry-feed model.