BABCOCK INSTITUTE DISCUSSION PAPER
NO. 2006-2

THE DAIRY SECTOR OF INDIA: A COUNTRY STUDY

The India Country Study Team

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The Babcock Institute for International Dairy Research and Development
is a joint program of the
University of Wisconsin-Madison College of Agricultural and Life Sciences
University of Wisconsin-Madison School of Veterinary Medicine
University of Wisconsin-Extension, Cooperative Extension

Funding for this study was provided by CSREES USDA Special Grant 02-34266-14583

ISBN 978-1-59215-101-9

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THE DAIRY SECTOR OF INDIA: A COUNTRY STUDY

Babcock Institute India Country Study Team[1]

INTRODUCTION

This is the third of a planned series of Babcock Institute reports on the dairy sectors of major dairy countries. These are comprehensive studies summarizing information relating to the competitiveness and likely future strategies of selected foreign dairy producers, processors, exporters and government agencies. This information is intended to help U.S. firms and policymakers develop strategies and policies to exploit exporting and foreign direct investment opportunities, and to respond appropriately to the actions of foreign dairy companies and foreign governments.

Oceania was selected as the first study region in 2004. Our observations and conclusions were reported in Babcock Institute Discussion Paper No. 2004-3, The Dairy Sectors of New Zealand and Australia: A Regional Study. Poland was the focus of the second study, reported in Babcock Institute Discussion Paper No. 2005-3, The Dairy Sector of Poland: A Country Study.

In 2006, we selected India as a study country. India offers a unique and challenging case study in dairying as it holds the world's second largest population and is the world's largest milk-producing country. The dairy sector is characterized by a smallholder production system of village-based production units often consisting of one to three milking animals. The majority of milk produced is consumed on the farms where it is produced or distributed through informal channels. More formal markets receive milk deliveries from millions of smallholders coordinated through an extensive cooperative structure. Competing private structures use similar methods for consolidating milk and maintaining a cold chain. India represents a vast potential market for dairy products, but has policies in place that encourage self-sufficiency and restrict dairy imports.

The multi-disciplinary team assembled to conduct this study was comprised of Louis E. Armentano, UW-Madison professor of Dairy Science (dairy production systems), William D. Dobson, UW-Madison emeritus professor of Agricultural and Applied Economics and Babcock Institute Agribusiness Economist (dairy trade and strategic behavior of agribusiness firms), Edward V. Jesse, UW-Madison professor of Agricultural and Applied Economics (dairy marketing and trade), Norman F. Olson, UW-Madison emeritus professor of Food Science (dairy processing) and Vijay Paul Sharma, Professor and Chairman, Centre for Management in Agriculture, Indian Institute of Management (Indian dairy institutions and policy).

The study team reviewed an extensive collection of government and academic reports, internet sites, and other information prior to a ten-day visit to India arranged by Professor Sharma. The team interviewed and heard presentations from dairy farmers, dairy processors, dairy trade association representatives, and government officials, and obtained pertinent data and other unpublished information.

A NOTE ON INDIAN TERMINOLOGY AND UNITS OF MEASUREMENT

While conventional western units of measurement are used in this report, readers accessing print or electronic references will find some uncommon nomenclature.

A traditional number system is used in India that expresses numbers in lakhs and crores. A lakh is equal to 100,000 and a crore is equal to 100 lakhs or 10,000,000. The use of hundreds in the lakh and crore number system means that large numbers are frequently expressed with commas in the 100 position instead of the 1,000 position.

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[1] The India study team members were Louis E. Armentano, William D. Dobson, Edward V. Jesse, Norman F. Olson, and Vijay P. Sharma. Jesse is the editor and corresponding author of this report.

For example, the number, 1,000,000, is commonly written as 10,00,000 to emphasize the number as equal to 10 lakhs. Larger numbers are often written in crores without any number separation (e.g., 17385 crores of rupees).

The term, quintal, is commonly used in India as a unit of mass. One quintal is equal to 100 kilograms or 0.10 metric tons.

The terms, Kharif and Rabi, refer to the monsoon (July–October) and non-monsoon cropping seasons, respectively. Cropping during the Rabi season is almost exclusively irrigated. Cropping data are often separately reported for Kharif and Rabi.

ACKNOWLEDGEMENTS

We are indebted to the University of Wisconsin-Madison Babcock Institute for Dairy Research and Development for providing financial support for this project.

We wish to express appreciation to the many India dairy industry experts we visited who gave generously of their time and provided excellent information to the team. Special thanks are due staff from the Indian Dairy Association, the National Dairy Research Institute, Nestle-India, the Gujarat Cooperative Milk Marketing Federation, and Chairman Patel and others from the National Dairy Development Board.

THE DAIRY SECTOR OF INDIA: A COUNTRY STUDY

Babcock Institute India Country Study Team

EXECUTIVE SUMMARY

Viewed through the eyes of Western dairy observers, dairying in India is not only unique, but also difficult to comprehend.

Dairying in India is an unusual combination of economic endeavors. Cows and buffalo are a source of family milk, employment, and income from milk and dung production, but not from meat production. Dung is used extensively as fuel, and what manure is not used for fuel is used for fertilizer. Because of their sacred status in Hindu theology, bull calves and non-productive dairy cows are not a food source and therefore are a liability, not the asset that they represent to dairy farmers in most other countries. Indian buffalo—more prevalent than dairy cows—are not sacred, but because of dietary preferences, buffalo meat is seldom eaten. Consequently, cull buffalo are no more valuable or less costly than cull cows.

Dairying in India is largely a by-product of crop production, resulting in low milk yields. Most of the feed for dairy animals comes from crop residues. An often-heard adage is, "Feed first the people and what remains to the cows and buffalo." Little green forage is fed to most of the dairy animals in India compared to other countries, and there is very little starch in the dairy animal diet. Much of the nutrition research conducted in India is focused on increasing the nutritive value of plant materials that are often discarded in Western countries. These dairy animal ration restrictions limit potential gains in milk yield.

Dairying in India is characterized by an extensive informal distribution system. While reliable published data verifying milk distribution are not available, there is evidence that nearly one-third of all milk produced is consumed on-farm. An estimated 70 percent of the remaining milk is sold in the unorganized sector, either as liquid milk or as home-produced dairy products such as dahi, paneer, butter, ghee and Indian sweets. About one-sixth of the Indian milk supply—approximately 16 million tons in 2005—is used for processing in commercial dairy plants, either as packaged fluid milk or manufactured products. Dairy products are perceived by Indian consumers as superior goods and are easy to sell. There would appear to be significant potential for increased demand as population and—especially—income grows. The volume of milk directed into the formal sector seems woefully inadequate to supply what will be a rapidly-growing market in higher-income areas.

Dairying in India is viewed from a national policy perspective less as a contributor to Gross national Product (GNP) than as a rural development initiative to provide a minimal income to tens of millions of rural residents. Consequently, there is strong resistance among national dairy leaders to increase dairy herd size, since this could reduce rural employment. There is equally strong resistance to subsidized dairy imports, which would compete for the relatively small market for domestically-produced manufactured dairy products from the commercial (formal) sector. The Indian dairy research and outreach structure has focused on generating a little bit more milk from a whole lot of cows. This is consistent with the national political view of dairying as a critical source of subsistence income for rural residents and a source of nutrition for the rural poor. That view may be appropriate, since rural areas have seen few benefits from the recent large rates of growth in India's GNP. At the same time, it raises questions about the ability of India to generate enough marketable surplus to remain self-sufficient in dairy products when consumers demand more and better-quality products.

Since dairying in India contributes to both social and economic goals, it would be presumptuous to draw conclusions about the dairy sector based only on economic criteria. Nonetheless, we offer the following observations:

National goals of food self-sufficiency dating to Indian independence in 1947 have been overachieved for wheat and rice. High price supports frequently generate surplus production. Arguably, too much scarce land is devoted to wheat and rice and at the same time, green fodder for dairy animals is in very short supply. Significant gains in

milk yields could be made with expanded production of forage and feed grains. Altering the incentive structure to decrease area planted to crops in surplus and increase area devoted to crops to support dairy production would seem to be a prudent policy choice.

Rural development efforts have focused on marginal gains in income, relying on multiplier effects combined with a high marginal propensity to consume. Small gains in farmer income from added milk production translate into small gains for merchants, service providers, landlords and others; small gains that translate into larger aggregate gains in income and employment at the village level. However, the added income appears to be doing little to alleviate poverty in rural areas and the quality of jobs created is not high. This raises the question of whether there is a better way to allow rural areas to gain a larger share of India's robust overall economic growth. In particular, we question the lack of government support for commercial dairying, which has the potential to create well-paying jobs in rural areas, not necessarily at the expense of small-holder dairy farmers.

India has shown impressive growth in milk production and related gains in per capita availability of milk despite large population increases, but most of the increased milk production has been consumed on the farms where it is produced or absorbed by the informal sector. As India's economy grows, it would appear logical to direct efforts not only to increasing milk production, but also to increasing the proportion of marketing within the formal sector.

India has stressed self-sufficiency in its basic food supply and uses world markets primarily as a balancing wheel for food grains and as a source of edible oils. Government policies have not considered the comparative advantage India appears to have in fluid milk. There may be benefits to channeling domestically produced milk to fluid and importing some manufactured dairy products to meet growing demand.

GENERAL BACKGROUND INFORMATION ON INDIA

This section consists of economic and other background information on India that will place in perspective findings related to the country's dairy industry. We emphasize the implications of economic reform measures undertaken by the Government of India for different sectors of the economy, including agriculture in general and the dairy industry in particular.

Geography and Population

India occupies 3.3 million square kilometers, an area slightly larger than one-third the size of the U.S. The country borders Bangladesh, Bhutan, Burma, China, Nepal and Pakistan. India's administrative divisions consist of 28 states and seven union territories.

India's major cities include Kolkata (formerly Calcutta), Mumbai (formerly Bombay), Delhi and Chennai (formerly Madras). Mumbai is India's largest city and port, and is often described as India's economic powerhouse and financial center. Thirty-six cities in India have populations exceeding one million [60]. The National Capital Territory of Delhi is the site of India's capital, New Delhi. In addition to these major economic centers, a host of other cities exhibit economic importance. For example, Bangalore and Hyderabad are famous high-tech centers. Firms in these two

FIGURE 1. State and National Borders of India

cities have capitalized on workers' computer skills and fluency in English to become strong international competitors in information technology. Ahmedabad in Gujarat is a home for part of India's large, internationally-competitive textile industry.

India has a population of about 1.1 billion people and (Table 1) about 70 percent of them live in rural areas (Figure 2). The population growth rate is higher in urban areas, but because of a much larger base, the number of rural residents continues to grow at a faster pace than urban residents. Moreover, the poverty rate in rural areas tends to be higher than in urban areas [32,39].

In terms of total population, India is second only to China (population 1.3 million) and has more than 3.6 times as many people as the U.S. Moreover, given India's faster population growth rate it will likely overtake China's population in the not-too-distant future. Specifically, if the different population growth rates (1.4 percent per year for India versus 0.6 percent per year for China) continue, India's population will exceed that of China before 2030 (Figure 3).

India faces population density pressures, with approximately 324 people per square kilometers of territory. This is nearly three times the population density for China and ten times the density for the U.S. (Table 1).

Political Economy

Gross Domestic Product (GDP) figures expressed in Purchasing Power Parity (PPP) for India, China and the U.S. show the relative size of the three economies. India's economy is only 46 percent as large as that of its neighbor-rival China and only about 28 percent as large as that of the U.S. Expressing GDPs in per capita PPP terms changes the relationship among the three countries in predictable ways. GDP per capita in PPP terms for India, with its large population, was US$3,100 in 2004, only about 8 percent of the U.S. figure and about 55 percent of the comparable figure for China.

The complexities involved in deriving PPP figures may introduce errors in the figures. Moreover, China's income and economic growth figures may overstate that country's actual numbers. Therefore, the GDP figures expressed in PPP terms in Table 1 should be regarded as approximate.

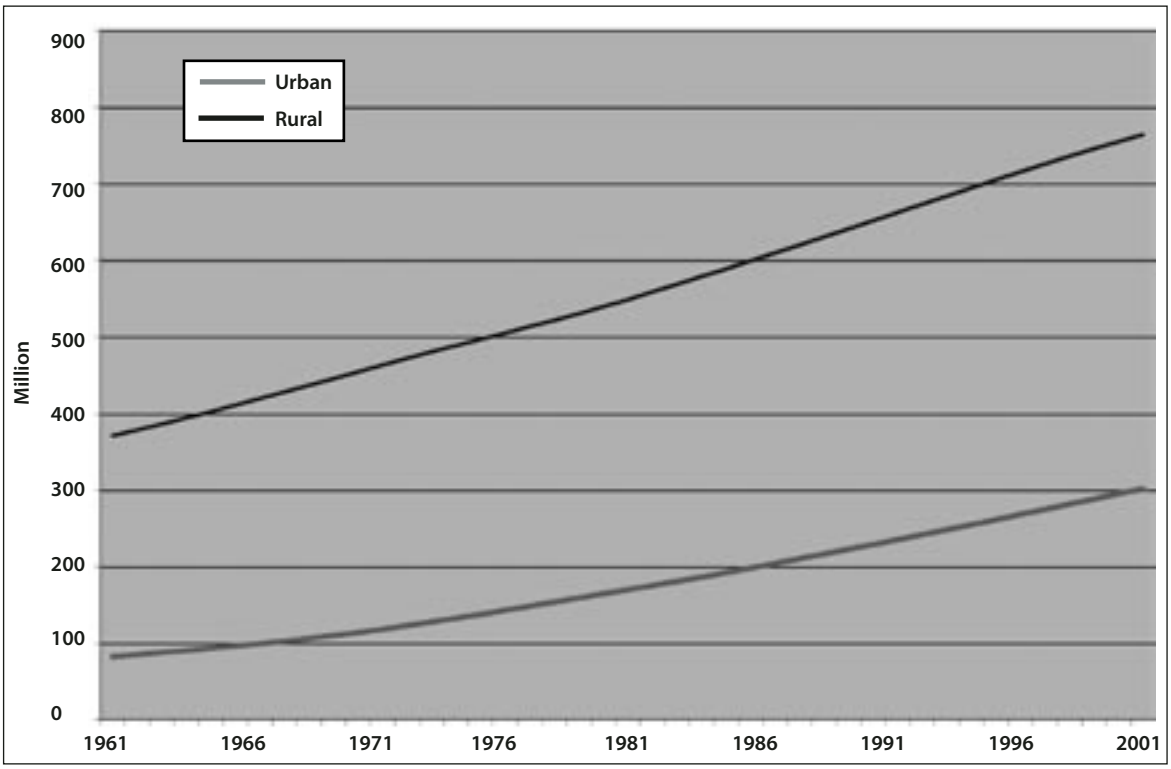
A phenomenon concealed in the aggregate population and income figures is the growth of a prosper-

TABLE 1. Selected Statistics for India with Comparison to China and the U.S.

	India	China	U.S.
1. Population (July 2005 est.)	1,080,264,388	1,306,313,812	295,734,134
2. Persons per Square Kilometer	329	136	31
3. Population Growth Rate (%)	1.4	0.58	0.92
4. GDP (PPP in U.S.$ Trillion)	3.319	7.262	11.75
5. GDP per Capita (PPP in U.S.$)	3,100	5,600	40,100
6. Real GDP Growth Rate (%)	7.5	9.5	3.5
7. Unemployment Rate (%)	9.2	20.0	5.5
8. Inflation Rate (%)	4.2	4.1	2.5
9. Literacy Rate (%)	59.5	90.9	97.0
10. Corruption Perception Index	2.8	3.4	7.5

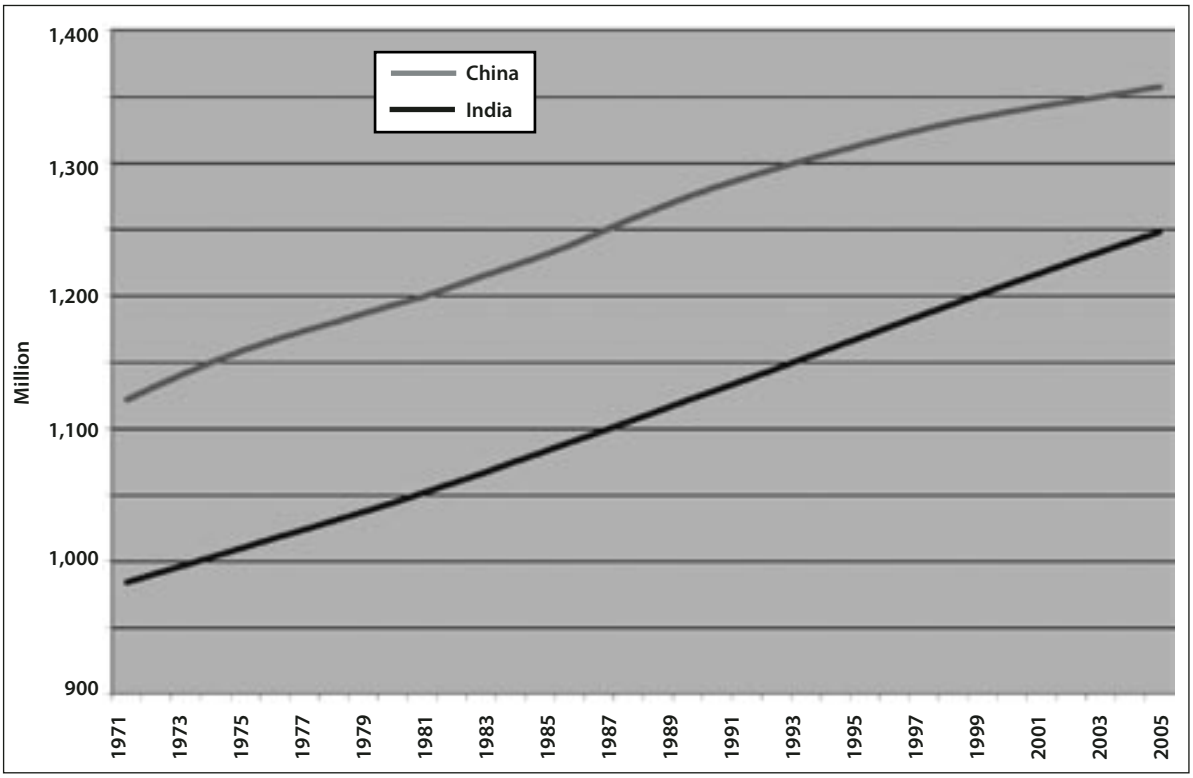
Sources: CIA for items 1,3,4,5,7,8 and 9 [90]. Item 2 was computed by the authors. Figures for India and China for item 6 were obtained from IMF and Global Insight [53, 38]. Item 10 is from Transparency International [89]. Items 1 and 2 represent 2005 figures. Items 3,4,5, and 7 represent 2004 figures. Item 6 consists of 2004-05 figures for India and China and a 2005 figure for the U.S. Item 9 consists of figures for 2003, 2002, and 1999 for India, China, and the U.S., respectively. Key for interpreting Corruption Perceptions Index: 10 = highly clean, 1 = highly corrupt.

FIGURE 2. India Population Growth: Rural versus Urban



Source: FAO [33].

FIGURE 3. Total Population, India and China



Source: ERS, USDA [28].

ous middle class in India. Middle-class households with buying power well above average are frequently thought to include 150–200 million consumers and constitute the fastest growing segment of the population [60, p. 2]. A *Wall Street Journal* estimate suggests that India's middle class may be as large as 260 to 300 million people [61].

India's real GDP growth rate in 2004–05 was a relatively high 7.5 percent. Furthermore, figures for the quarter ending September 30, 2005 show that India's real GDP growth rate was 8 percent for that quarter. While reportedly lower than China's real GDP growth rate, some analysts argue that official Chinese government figures are overstated, and that the two economies are growing at an equal pace. Both India and China have faster real GDP growth rates than the U.S. For a number of reasons—primarily its very large GDP base—it would be difficult for the mature U.S. economy to grow at rates similar to those recorded for India and China.

India's relatively low unemployment rate (compared to China) is potentially misleading. Since the figure fails to reflect the millions of marginally employed people in India's rural areas. While India's world class information technology and office service sector is a valuable asset for the country, it employs only about one million people [31, p. 25]. While pharmaceuticals constitute an additional, promising "sunrise" industry for India, that sector too, will absorb only a limited number of workers. India may need to expand its export-oriented manufacturing sectors to increase employment substantially in the future.

Inflation in India was at 4.2 percent in 2004. While this was higher than that of the U.S., such a rate is manageable.

India's literacy rate was a relatively low 59.5 percent in 2003, substantially lower than that of China and only about 60 percent of the U.S. figure. While India produces world-class graduates from its top technical schools, the low overall literacy rate is likely to constrain economic growth.

In 2004, India had a relatively unfavorable Corruption Perceptions Index of 2.8, placing the country at the top of the bottom third of the 145 countries evaluated by Transparency International (Table 1). Corruption in India manifests itself in the form of complex regulations, bribes, stock market scandals, and a legal system that is complex and confusing, making it difficult to settle contractual disputes. Indeed, one attorney familiar with India's legal system said that a rule of thumb when business disputes arise in India is to "arbitrate, don't litigate" [26].

The prevalence of corruption has probably limited foreign direct investment (FDI) in India. Inward FDI flows were only about US$5 billion in 2004 and have grown slowly in recent years [31, p. 26]. In contrast, China, had inflows of about US$60 billion in 2004, nearly 50 percent higher than the total for 2000.

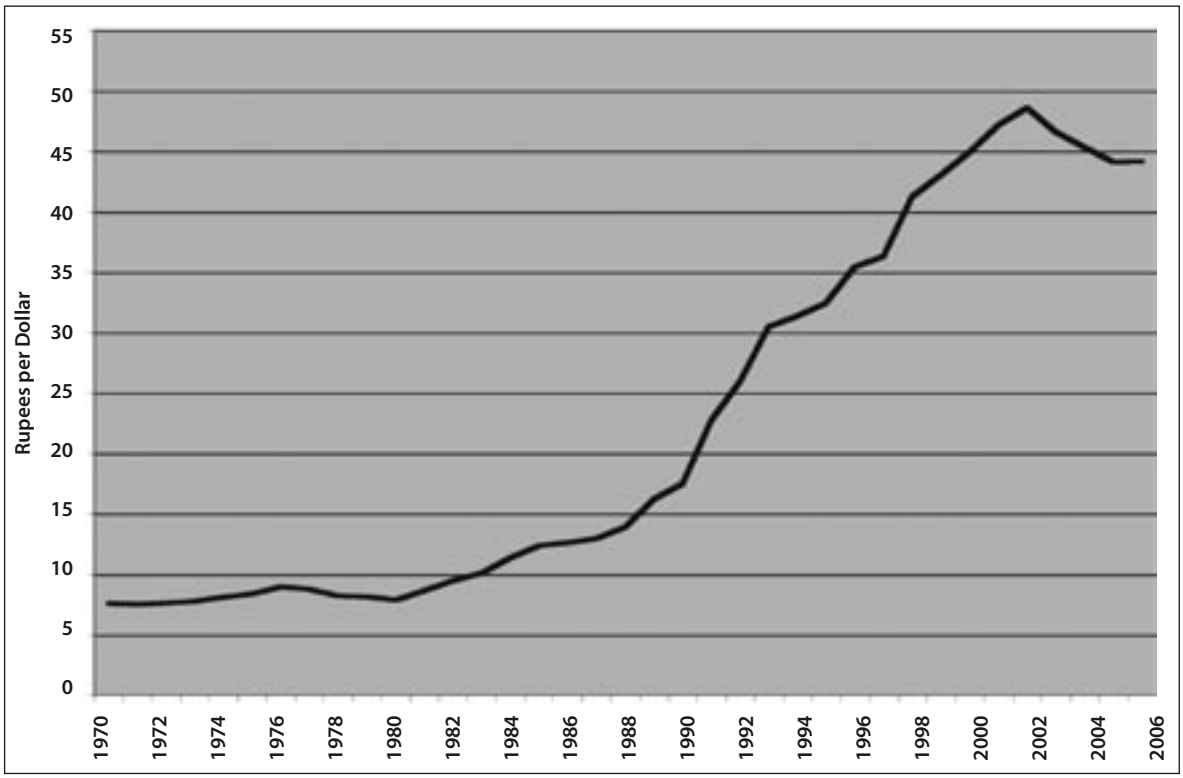
In its "Special Report, Reform in India," the *Economist* explains the relatively small amount of FDI in India as follows:

> *. . . India imposes caps on FDI in a host of economically important, or politically sensitive, sectors: insurance, aviation, coal mining, media and much else. Chief among these is retailing. Though franchise operations are allowed, foreign direct ownership is banned, which explains why even Delhi's smartest shopping areas are scruffy and chaotic places with limited stock [31, p 24].*

FDI in India is likely to increase substantially in the near future, at least in India's high-tech sector. For example, Microsoft, Intel and Cisco Systems have indicated that they will each invest more than US$1.0 billion in India's computer and internet industries in the next four to five years [9]. FDI may also increase to satisfy the demand of India's growing middle-class for cell phones, computers and autos, and to strengthen India's export-oriented textile and pharmaceutical industries.

Exchange Rates: India's rupee remained fairly stable from about 1970 to 1998 in relation to the U.S. dollar (Figure 4). However, the rupee declined rather sharply against the U.S. dollar during the 1990s and early 2000s, falling from about 17 rupees to the dollar at the beginning of the decade to 48.6 to the dollar in 2002. The decline in the value of the rupee beginning in the early 1990s reflected in part the devaluation of the rupee in 1991 to deal with a foreign exchange crisis. The weaker rupee, combined with reform measures adopted by the Government of India, facilitated an expansion of agricultural exports, and increased foreign exchange earnings. For example, the rupee value

FIGURE 4. Exchange Rate: Indian Rupees per $US



Source: [28], 2006 is estimated.

of India's agricultural exports increased by 30 percent and 14 percent from year-earlier levels in fiscal 1991 and 1992, respectively [28].

Under the managed float system installed by India's government in1991, the Reserve Bank of India allows a free flow of foreign exchange for trade in goods and services, but it regulates who may exchange rupees for other currencies for investment purposes, and the circumstances under which they may do so [10]. Specifically, the rules regulate currency conversion by foreign firms that want to invest in India and by Indians who want to invest overseas. In March 2006, Prime Minister Singh asked India's Finance Minister and officials of the Reserve Bank of India to develop a road map for making the rupee more freely convertible for investment purposes. The Prime Minister hopes that this step will help to foster the increases in FDI in India needed to hit a 9 percent real GDP growth target.

Evolution of India's Economy

India gained independence from Great Britain in 1947. The early years of independence were marked by turmoil associated with the partition of Pakistan. This turmoil has re-surfaced in recent years and creates risks for India's economy.

From the time of independence until the early 1990s, India's economy was characterized by extensive central planning and regulation of economic activity. The regulation included quantitative controls on imports and exports, making India one of the most closed economies in the world [28]. Although private firms existed in most areas of the economy, public sector enterprises dominated many sectors. Under this system, the economy registered relatively slow growth, accumulated large deficits, and operated with a chronically weak current account balance stemming from uncompetitive domestic industries.

Post-independence efforts to improve India's agricultural sector figured heavily in the evolution of India's economy. At the time of independence, agriculture and its associated sectors accounted for more than 70 percent of the country's employment and more than 50 percent of India's GDP. Moreover, agricultural development was a key to many of India's national goals such as reducing rural poverty, provid-

ing improved diets for citizens, supplying raw material for the textile industry and expanding exports. In the mid-1960s, the goal of self reliance was added to the list.

India's government used eight five-year plans in an effort to achieve these goals [28]. In a first phase (implemented mainly in the 1950s), agricultural growth was promoted by removing socioeconomic constraints through land reform, changing village power structure, reorganizing the rural poor into cooperatives and expanding citizen participation in planning. The origins of India's National Dairy Development Board (NDDB) and the well-known Gujarat Cooperative Milk Marketing Federation (discussed later) are traceable in part to these efforts.

A second phase (implemented mainly during the 1960s), was aimed at raising agricultural output, especially of food grains. Key to this phase was achieving self-sufficiency in food grain production and development of an adequate buffer stock. This phase morphed into a third phase, identified as the Green Revolution, which spanned the period from the late 1960s to the mid-1980s. The third phase relied on improved seeds, more water for irrigation, and improved quantities and qualities of fertilizer. The Green Revolution was successful in meeting the goals of self-sufficiency in food grain production and an adequate buffer stock by the end of the 1970s. In the 1990s, under the eighth five-year plan, there were continuing efforts to achieve self-sufficiency in food production and plans were established to generate surpluses of agricultural commodities for export. This five-year plan also aimed to spread the Green Revolution to more regions of the country with an emphasis on dry land farming.

Agricultural reforms carried out in the early 1990s coincided with reforms of other segments of the economy. In 1991–93, with Finance Minister Dr. Manmohan Singh serving as architect, the country introduced major reforms to industry, trade and exchange rate policy that led to India's emergence as a rapidly growing economy. The *Economist* describes the Singh-led reforms in these terms:

> *. . . The Rao (Congress party leader)/Singh government lasted five years, during which it smashed the "license raj" that had smothered the economy in regulation and condemned it to the sluggish "Hindu rate of growth," a term now happily consigned to history. That government started to privatize, opened India to foreign investment and began to deregulate the country's appalling infrastructure. Over the past six years, the ruling Bharatiya Janata Party (BJP) merely continued Congress's work, with plenty of backtracking along the way. [30, p. 9]*

As a result of these reforms, the balance of payments (balance of trade and capital flows with the rest of the world) have become robust [28]. Trade liberalization measures included a near elimination of quantitative import restrictions and state trading, a process completed in 2001. Tariff reductions have been substantial, although India retains relatively high bound and applied tariffs on some sensitive goods. With less restrictive trade, less domestic regulation, and rupee depreciation, Indian goods and service industries have become more competitive, leading to expanded two-way trade (imports plus exports) from under US$50 billion per year in the early 1990s to more than US$100 billion in the early 2000s.

These comments describe a fairly positive outlook for India's economy. This might be expected since the architect of the 1991–93 reforms, Dr. Manmohan Singh, became Prime Minister of the coalition government that was formed after India's 2004 parliamentary elections. However, important weaknesses still exist in India's economy:

> *. . . (India's) weaknesses are all too obvious, and are the reason why India on many counts still lags behind its neighbor-rival, China. India has lousy infrastructure, bumbling and burdensome regulation and restrictive labor laws. And economic reform now appears to be stalled in political recriminations. [31, p. 23]*

Laws and regulations pertaining to labor may also be a constraint to efficient development of India's economy. A key battleground on labor issues is a regulation preventing any company with more than one hundred employees from laying off people without approval from local labor boards [31, p. 24]. While this regulation protects unionized labor, it makes employers wary of taking on new staff, opening new factories or, in the case of small businesses, expanding beyond one hundred employees.

While labor laws and regulations may have some adverse effects, some analysts in India see substantial merit in the guarantee of employment for India's two hundred poorest districts. They suggest that the measure will provide badly-needed employment and bring about needed improvements in infrastructure in the rural areas. This may be one way of sharing the gains of strong economic growth that is occurring primarily in urban areas with India's rural population.

In summary, a mixed picture emerges regarding prospects for India's economy. The country has a growing middle class, world class technical schools, and growing, competitive high-tech and pharmaceutical sectors. However, it still has massive underemployment in rural and poor urban areas, unwarranted regulation, and inefficiencies in labor markets. As noted earlier, India will probably need to develop its export-oriented manufacturing sectors more fully to achieve full economic potential.

The Role of Agriculture in India's Economy

Reflecting the magnitude and density of its population, India is one of the most intensely cultivated countries in the world and a major world producer of most primary agricultural products.

Cropping intensity is illustrated in Table 2, which compares cropping patterns among several leading agricultural countries. The percentage of India's land base that is cultivatable is similar to the other countries, but a much larger percentage of it is used for annual or perennial crops. With less than half of its land suitable for agriculture, India crops almost as much land as the U.S. India's land devoted to arable and permanent crops exceeds that of China—which has 225 million more people—by fifteen million hectares.

India's share of world production of major crops and livestock products is shown in Table 3. In interpreting these numbers, keep in mind that India holds one-sixth of the world population, and that Indian agricultural trade is very limited.

Production of most meat products in India is quite low, reflecting the predominant vegetarian diet. Even egg production is considerably smaller than expected on the basis of population. Due to the extensive use of buffalo for milk production, India accounts for about two-thirds of the world's buffalo milk and nearly half of the world's buffalo meat output.

Cow milk production is less than buffalo milk production, and India's share of world cow milk output is less than one-half its population share. Combining milk from all species, India produces about 15 percent of the world supply.

India produces 10.5 percent of the world's cereal (food) grains, mostly wheat and rice. India is also a major producer of cotton and sugarcane, and accounts for two-thirds of world jute output. India's production of most other crops expressed as a percent of world production is less than India's share of world production. The exception is pulses (dry beans, lentils, and peas), again reflecting dietary preferences.

TABLE 2. Land Use Patterns, India Compared to Other Countries, 2003

	India	U.S.	China	Germany	Argentina
Total Land Area (Million Hectares)	297	916	933	35	274
Agricultural Land					
Million Hectares	181	409	555	17	129
Percent of Total Land	60.8%	44.7%	59.5%	48.7%	47.0%
Arable and Permanent Crops					
Million Hectares	170	176	155	12	29
Percent of Agricultural Land	93.9%	42.9%	27.9%	70.8%	22.4%
Percent of Total Land	57.1%	19.2%	16.6%	34.5%	10.6%

Source: FAO [33].

TABLE 3. India Crop and Livestock Production, 2005

	India	World	India as % of World
	Million MT		
Livestock Products			
Beef and Veal	1.5	60.2	2.5%
Buffalo Meat	1.5	3.2	47.1%
Poultry Meat	2.0	81.0	2.4%
Sheep and Goat Meat	0.7	13.0	5.5%
Eggs (Fresh)	2.5	64.4	3.9%
Cow Milk	38.5	529.8	7.3%
Buffalo Milk	50.7	77.1	65.8%
Goat Milk	2.7	12.4	21.7%
Milk, Total	91.9	629.2	14.6%
Crops			
Wheat	72.0	628.1	11.5%
Rice, Paddy	129.0	618.5	20.9%
Barley	1.5	137.3	1.1%
Maize	14.5	694.6	2.1%
Millet	9.0	27.4	32.9%
Sorghum	8.0	58.6	13.6%
All Cereal Crops	234.0	2,228.0	10.5%
Seed Cotton	7.5	67.3	11.1%
Cotton Lint	2.5	23.5	10.5%
Jute	1.9	2.9	66.4%
Sugarcane	232.3	1,289.8	18.0%
Fruit excl Melons, Total	47.0	509.1	9.2%
Oil crops Primary	9.0	137.6	6.6%
Pulses, Total	14.6	61.7	23.7%
Roots and Tubers, Total	32.6	711.7	4.6%
Tree nuts, Total	0.5	8.7	5.6%
Vegetables & Melons, Total	80.5	883.1	9.1%

Source: FAO [33].

Land areas devoted to crops and livestock units in India are larger as a proportion of world totals because of relatively low yields. For example, in 2005, FAO estimates show India rice yields at 3 metric tons (MT) per hectare compared the world average of 4MT. India's 2005 wheat yield was 2.7MT per hectare versus the world average of 2.9MT.

India's food and fiber comes from an estimated 116 million farmers who hold some land, and an unknown number of additional landless farmers who use land holdings in common [reported in 1995–96; latest estimates available, 42]. The distribution of holdings is shown in Figure 5.

Farms with less than one hectare of land represented 61.6 percent of total farms and 17.5 percent of land in farms. Farms larger than ten hectares controlled 15.1 percent of farmland. This extreme inequality in land distribution is due to fragmentation from split inheritances, state restrictions on foreign ownership (including residents of other states), and ceilings on the amount of land that individuals can hold.

Agriculture in India has shown strong growth, and self-sufficiency goals have been largely attained. Since independence, the annual growth rate in agricultural GDP has averaged about 3 percent. Annual changes have been highly variable due to the profound effect of monsoons on crop yields (Figure 6).

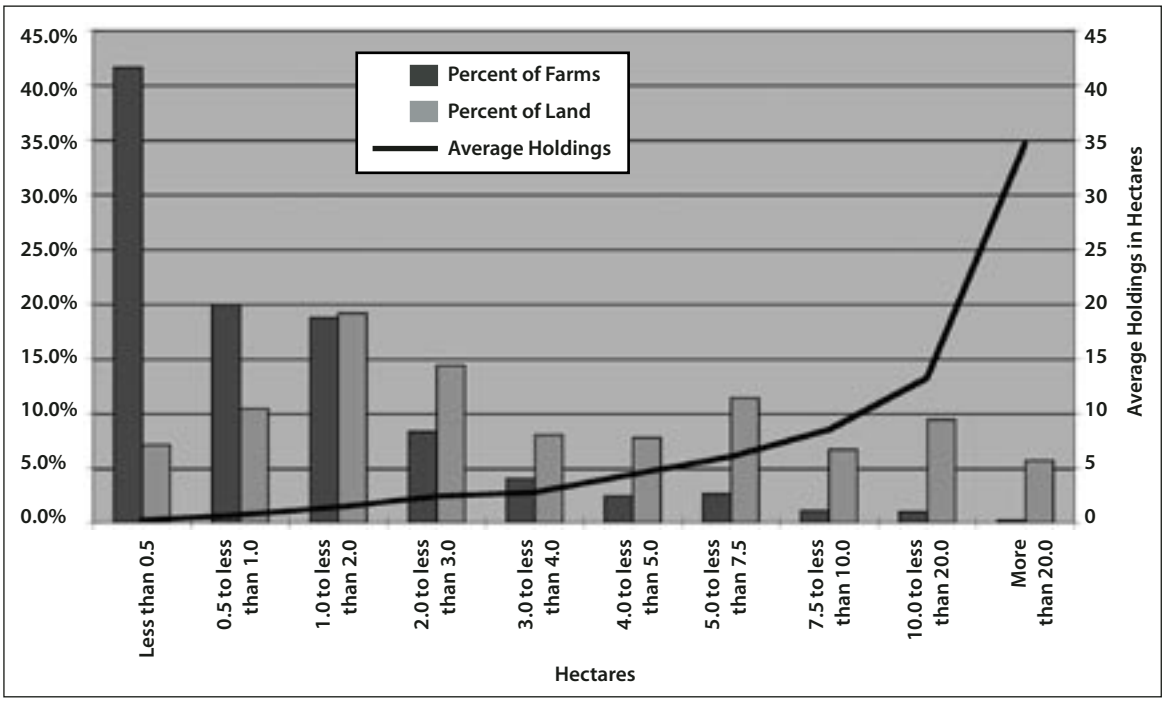
Because of productivity gains in agriculture and more robust economic growth in other sectors of the economy, the contributions of agriculture to India's overall employment and GDP have declined significantly since independence. In 2001, farmers and farm laborers represented about 23 percent of India's population and GDP from agriculture and allied sectors accounted for 24 percent of India's total GDP [39].

Yet agriculture remains a critical sector of the Indian economy. In major agricultural states, agricultural GDP accounts for 30 to 40 percent of total GDP. More importantly, the majority of the Indian population resides in rural areas that are heavily dependent on agriculture, even though most of these rural residents are not engaged in farming. The 2001 census indicated that only 31 percent of the population designated "rural" were cultivators or agricultural laborers [42].

Development of the Dairy Sector

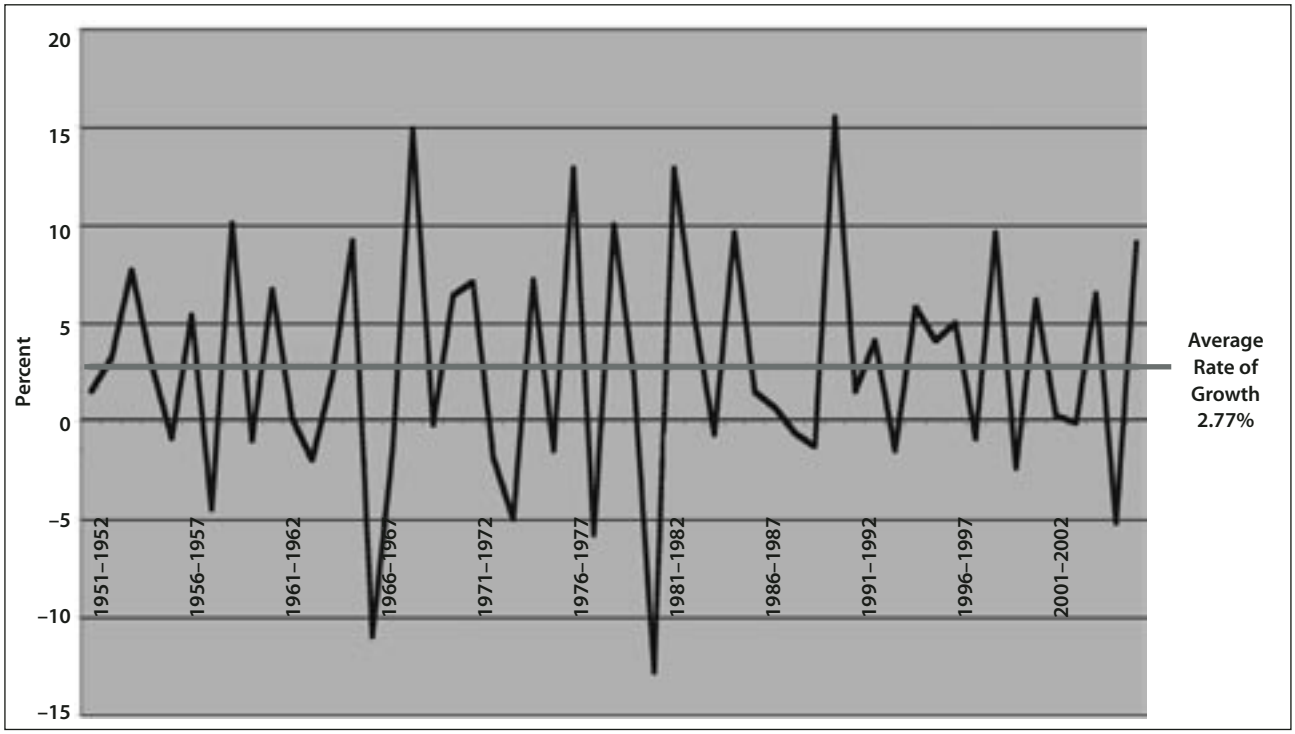
India's dairy industry was included in development measures implemented by the Indian government after independence. Modernization of the dairy industry became a priority with the initiation of India's first five-year plan in 1951 [8]. The government's goal was to provide hygienic milk to the country's growing urban population.

FIGURE 5. Distribution of Indian Farms by Size of Holdings, 1995–96



Source: Goverment of India [42].

FIGURE 6. Annual Rate of Growth in Agricultural GDP, 1993–94 Prices



Source: Goverment of India [42].

The foundation for development of India's dairy industry was the cooperative movement in the state of Gujarat. In 1952, the Kaira District Cooperative Milk Producers' Union (currently the Gujarat Cooperative Milk Marketing Federation) gained the right to supply the Bombay market with fluid milk. This assured market allowed the cooperative to grow rapidly but also provided a challenge in maintaining a cold chain and balancing milk production with fluid milk demand. The cooperative adopted a unique tiered system of milk collection and processing. Village cooperative societies collected and cooled milk from tens of thousands of small dairy farmers throughout the state. District unions consolidated society shipments and operated manufacturing plants to handle fluid surpluses. Marketing and coordination were at the state level. The cooperative adopted the Amul brand and developed nationwide brand recognition.

The tiered system ultimately became known as the Anand Model (for the location of the cooperative federation headquarters), and was promoted and financially supported by the Indian government through the NDDB, created in 1965.

In the late 1960s, Dr. V. Kurien (widely known as the father of India's modern dairy industry), designed the concept of Operation Flood and gained government support for its adoption. The purpose of Operation Flood was to create a white flood of milk throughout India by widely replicating and financially supporting the Anand Model. The first phase of Operation Flood was launched in 1970 under an agreement with the World Food Program. This agreement provided aid and financing in the form of 126,000 tons of skim milk powder and 42,000 tons of butter oil—surplus dairy products obtained from the then European Economic Community (EEC). In brief, the Operation Flood program carried out the following functions:

- Organized village dairy cooperatives.
- Created the physical and institutional infrastructure for milk procurement, processing, marketing and production enhancement services.
- Established dairies at India's major metropolitan centers—i.e., Bombay, Calcutta, Delhi and Madras.

The second phase of the program was implemented between 1981 and 1985. It incorporated state dairy development projects that had been undertaken with the assistance of the Indian Dairy Corporation, into one overall program. This effort was financed with US$150 million from the World Bank and commodity assistance from the EEC.

The third phase focused on making the cooperative efforts self-sustaining. Employing World Bank, EEC and the NDDB's internal resources, this phase expanded the production, processing, marketing and professional management capabilities of the dairy industry.

A Harvard Business School case study summarized how India's dairy industry had evolved from the late 1960s to the late 1990s as follows:

> *Through . . . Operation Flood, the NDDB had created, in India's 25 states, more than 70,000 village dairy cooperatives with ten million members. Operation Flood had helped increase India's milk output at a compounded annual growth rate (CAGR) of 4.7% since 1969 (up from a 0.7% CAGR from 1947 to 1969). . . . Operation Flood-inspired cooperatives had raised the incomes of millions of landless or marginal farmers who constituted the cooperatives' membership . . . Amul branded products had dominated the retail dairy sector in India for more than 30 years. Amul was India's most well-known food brand. The Gujarat Cooperative Milk Marketing Federation (GCMMF), India's largest food company with sales approaching Rupees (Rs.) 19 billion (US$500 million) in 1997–98, was the exclusive marketer of Amul-branded products. [88]*

Government involvement in shaping the growth and development of India's dairy industry appears to have been fairly successful. Prior to Operation Flood, low-cost, often-subsidized dairy imports entered India in a fashion that undercut domestic milk prices and discouraged development of the dairy industry. Under Operation Flood, EEC dairy surpluses were used to finance development of what turned out to be a growing, more efficient industry, an industry that eventually required less government help. In recent years, India has become largely self-sufficient in dairy products. Ironically, EEC dairy surpluses once dumped in India were used to promote industry development and implement an import substitution strategy for dairy products.

We now move to a more comprehensive discussion of the dairy sector within Indian agriculture, focusing on the production sector, the processing sector and relevant government policies.

THE INDIAN MILK PRODUCTION SECTOR

General Characteristics

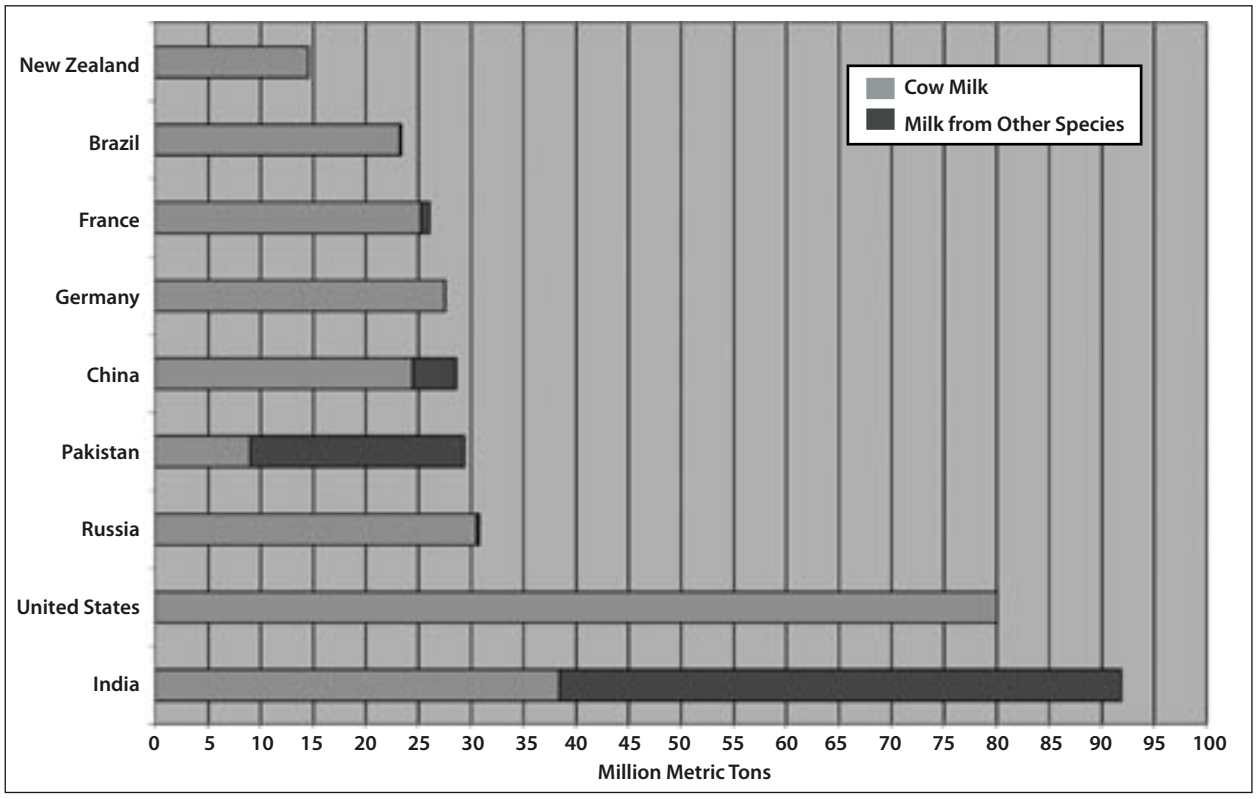
In 1998 India surpassed the U.S. to become the largest single milk producing country in the world. In 2005, Indian milk production represented 14.6 percent of world milk production, exceeding the combined production of the top five dairy countries in the EU-25 (Figure 7).

Milk production has grown steadily and rapidly over the last 25 years, from 50 million MT in 1979-80 to 92 million MT in 2004–05 (Figure 8). Growth in milk production has exceeded the growth in India's population, elevating per capita milk availability over the same period from 75 grams per day to more than 225 grams per day.

Milk production is primarily a supplementary occupation for small landholders or landless laborers. There are no official counts of dairy farms and estimates vary widely among sources. Best estimates indicate that approximately 70 million rural households (primarily small and marginal farmers and landless laborers) are engaged in milk production. The average herd size is about two milking animals, and average daily milk production per herd is about four liters.

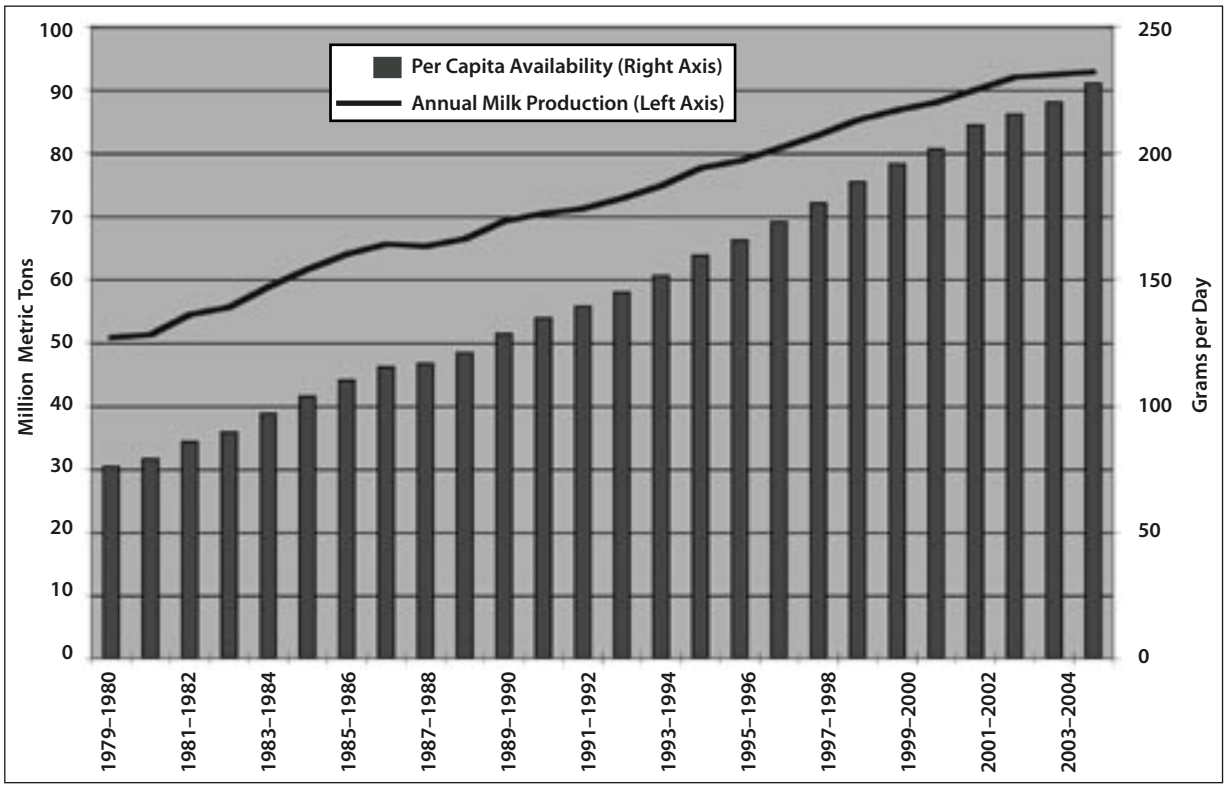
Dairying is practiced throughout India, but concentrated in the northwestern states where the climate is more temperate. The top five states account for more than half of current production (Figure 9). Major surplus producing states (percent of milk production more than twice the percentage of population) are Punjab

FIGURE 7. World Milk Production, All Species, 2005



Source: FAO [33].

FIGURE 8. Indian Milk Production, Total and per Capita



Source: Goverment of India [41].

and Haryana. West Bengal and Bihar are major milk deficit states (Table 4).

More than half of India's milk production comes from buffalo. The predominant buffalo breed is the Murrah, a river type buffalo that has been selected for milk production. Buffalo milk is preferred to cow's milk by consumers in many parts of India because of its relatively high butterfat content. The percent of total milk coming from buffalo has remained practically constant at about 55 percent since the early 1960s (Figure 10).

India's dairy cow population is a combination of indigenous cattle and those cross-bred (mostly Holsteins) with indigenous stock. Purebred dairy cows do not tolerate the heat and animal diseases prevalent in India. Crossbreeding increases milk production while preserving native heat tolerance and disease resistance. Milk production capacity is highest in cross breeds followed by buffalo and then native cattle (Table 5). The cow population has been growing at a considerably smaller rate than the buffalo population, but more rapid increases in cow milk yields from increasing adoption of cross-breeding have resulted in the relative shares of cow and buffalo milk remaining constant.

Milk Production Costs

On average, milk production costs in India are very low by international standards. A 2003 study commissioned by FAO's Pro-Poor Livestock Policy Initiative, provided a breakout of costs for four representative farms in the state of Haryana [46]. Total costs ranged from US$14 to US$24 per 100kg, equivalent to a range of US$6.35 to US$10.90 per hundredweight. The lowest cash costs of production and the highest opportunity costs were represented on a landless, two-buffalo farm.

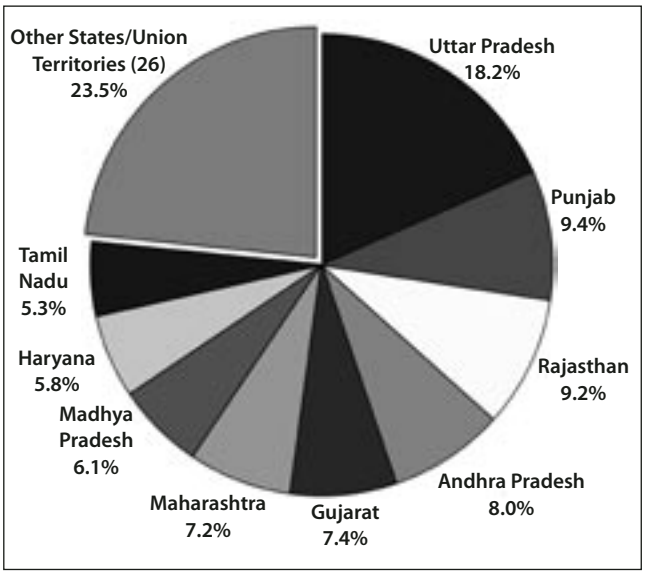
In its 2005 annual dairy report, the International Farm Comparison Network reported 2004 costs and returns for eleven Indian dairies in four states [63]. Cash costs less non-milk returns ranged from US$2.50 to US$15 per 100 kg (US$1.13 to US$6.80 per hundredweight). Total costs ranged from US$15 to US$23 per 100 kg (US$6.80 to US$10.43 per hundredweight).

TABLE 4. Indian Milk Production by State versus Population by State

State/Union Territory	2004 Milk Production		Percent of 2001 Population
	Million Tons	Percent of Total	
Uttar Pradesh	16,512	18.20%	16.17%
Punjab	8,554	9.43%	2.37%
Rajasthan	8,310	9.16%	5.50%
Andhra Pradesh	7,257	8.00%	7.37%
Gujarat	6,745	7.44%	4.93%
Maharashtra	6,567	7.24%	9.42%
Madhya Pradesh	5,506	6.07%	5.88%
Haryana	5,222	5.76%	2.05%
Tamil Nadu	4,784	5.27%	6.05%
Karnataka	3,917	4.32%	5.13%
West Bengal	3,790	4.18%	7.81%
Bihar	2,974	3.28%	8.07%
Kerala	2,025	2.23%	3.10%
Jammu & Kashmir	1,422	1.57%	0.98%
Jharkhand	1,330	1.47%	2.62%
Orissa	1,283	1.41%	3.57%
Uttaranchal	1,195	1.32%	0.83%
Himachal Pradesh	870	0.96%	0.59%
Chhattisgarh	831	0.92%	2.02%
Assam	739	0.81%	2.59%
Delhi	303	0.33%	1.34%
Tripura	86	0.09%	0.31%
Manipur	75	0.08%	0.23%
Meghalaya	71	0.08%	0.22%
Nagaland	69	0.08%	0.19%
Goa	57	0.06%	0.13%
Arunachal Pradesh	48	0.05%	0.11%
Sikkim	46	0.05%	0.05%
Chandigarh	43	0.05%	0.09%
Pondicherry	41	0.05%	0.09%
A&N Islands	24	0.03%	0.03%
Mizoram	16	0.02%	0.09%
Dadra & Nagar Haveli	4	0.00%	0.02%
Daman & Diu	1	0.00%	0.02%
Lakshadweep	1	0.00%	0.01%

Source: Goverment of India [41,42].

FIGURE 9. Indian Milk Production by State, 2004–05



Source: Goverment of India [41].

All but one of the eleven representative farms had herds of from two to six dairy animals (cows and/or buffalo).

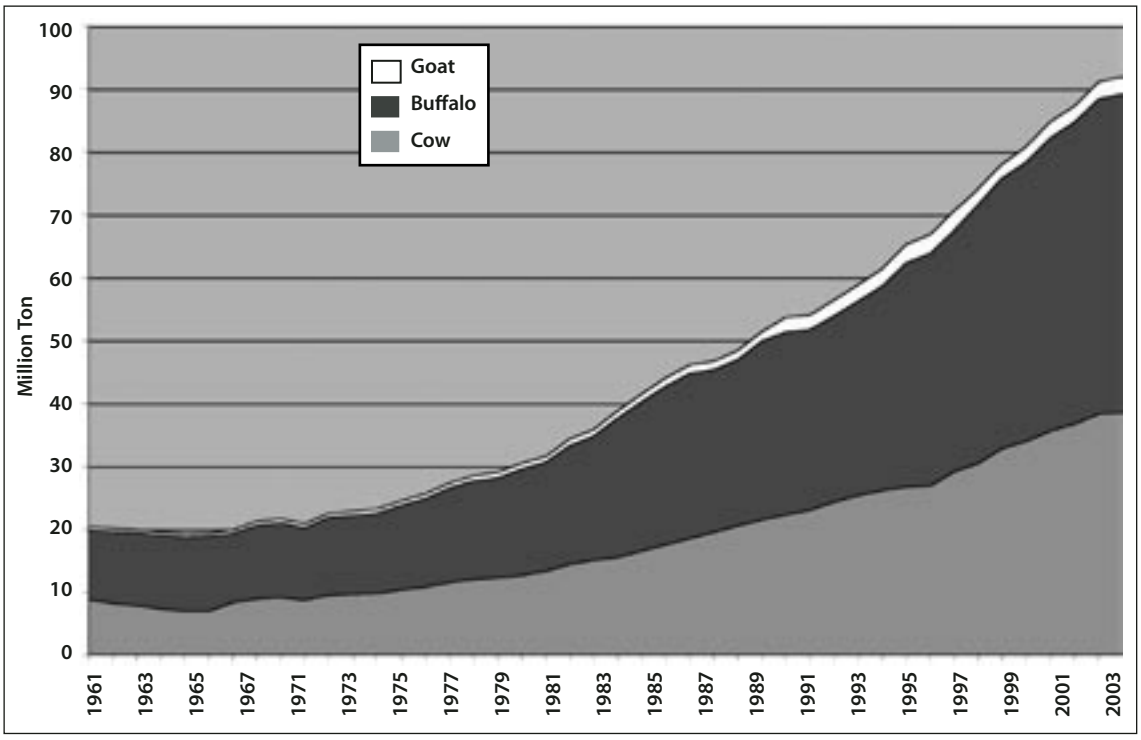
These are impressively low costs of production, compared to U.S. total costs (less non-milk returns) of about US$11.80 to US$13.60 per hundredweight. They result from very low labor costs (paid labor and opportunity costs for family and operator labor), feed costs, depreciation and opportunity cost for land. For example, labor costs for some of the smaller representative farms were reported at US$0.20 per hour. Land cost for some farms is zero. Indian dairy farmers' cash expenses and overhead costs are low enough to more than offset the negative effect of very low milk yields per animal on unit costs of production.

Data for Indian costs of milk production must be interpreted carefully. While they may accurately represent average costs under existing conditions, they do not likely reflect marginal costs, especially if ambitious expanded production goals are achieved and economic conditions in rural areas improve.

Milk Prices

Each cooperative and most private dairy firms set and move their milk price independently, based on the profitability of final product sales, local competition, and other factors. There is no systematic milk price

FIGURE 10. Indian Milk Production by Species



Source: FAO [33].

TABLE 5. Indian Dairy Animal Numbers and Milk Production, 2004–05

Type	Average Number of Animals in Prod. 1,000 Head	Total Milk Prod. 1,000 MT	Average Annual Milk Yield kg.
Non-Descript (Indigenous)	27,733	19,690	710
Exotic (Cross-Bred)	7,012	16,461	2,348
Buffalo	31,621	49,485	1,565
Totals/Average	66,366	85,636	1,290

Source: Goverment of India [41]. Does not include dairy goats.

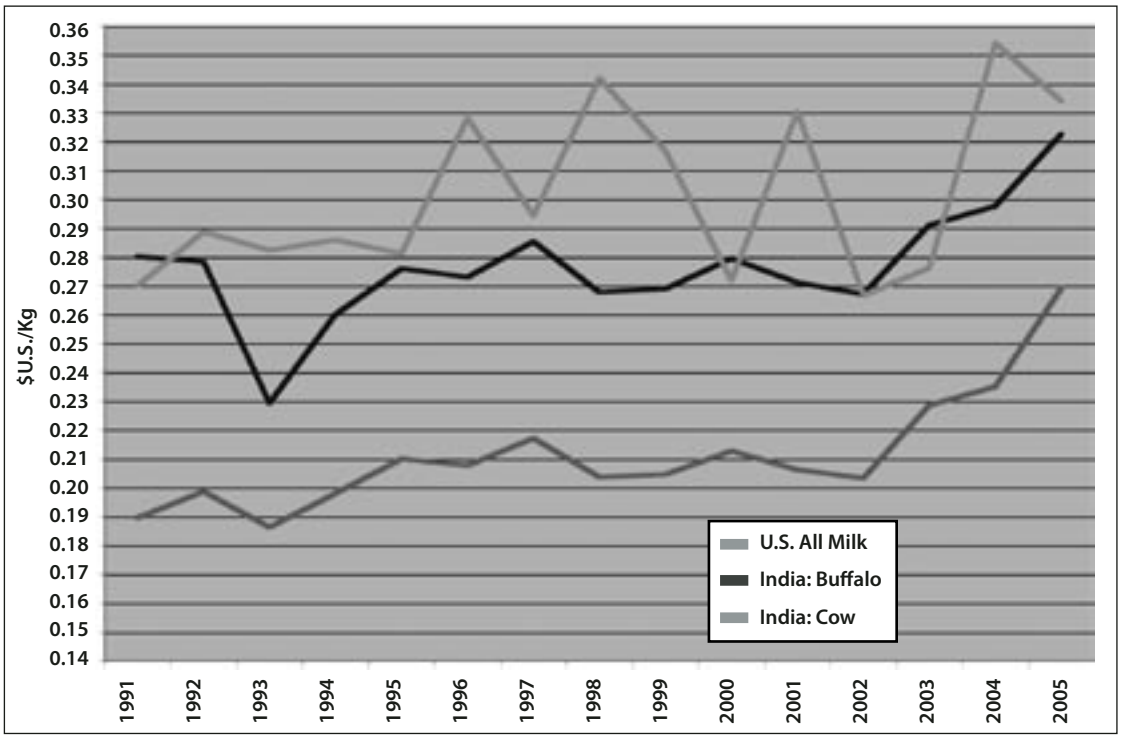
reporting, probably because of the wide variability in prices among and within milk plants, and the difficulty of obtaining reliable price data from thousands of separate reporting units.

FAO reports a country average time series of milk prices by species in which prices for both cow and buffalo milk have been gradually increasing, with significant gains since 2002 (Figure 11). The gap between buffalo and cow milk prices has been steady in percentage terms at about a 30 percent premium for buffalo milk. India cow milk prices between 1991 and 2005 averaged 70 percent of U.S. milk prices, and buffalo milk prices averaged 92 percent. Indian milk prices, as reported by FAO, were very stable compared to U.S. prices.

Supporting Infrastructure

In writing this report, the author's exposure to academic and research facilities was limited, but there appears to be a very good system set up for research, education and outreach. The linkage between outreach and research was evident, and was far superior to that observed in most developing countries and in many developed countries. Emphasis on translating research for users was evident at the National Dairy Research Institute (Karnal) and throughout the government institutions we visited. In addition, the "model village" concept at Karnal was a good example of outreach by demonstration, as well as an effective way to gather information on the needs and constraints faced by producers.

FIGURE 11. India Producer Milk Prices



Source: FAO, FAS [33,34].

Dairy Extension in India includes not only the provision of information, but also a very extensive delivery of services (e.g., artificial insemination, reproductive diagnosis, and animal health). In addition, cooperatives and some private milk handlers provide feed and services to farmers. This service orientation for dairy is very different than Extension in the U.S. and apparently different than crop-oriented extension in India.

The tenth five-year plan appears critical of the quality of linkage between research and production, and the NDDB appears similarly concerned. Several times the need for veterinarians to make "house calls" as opposed to villagers bringing the cows to the village veterinarian was stated as important. From the U.S. perspective, it is difficult to imagine providing a high level of professional veterinarian care to the doorstep of one- and two-animal herds. Certainly, training of AI technicians and others could help in spreading useful management techniques, but the task is daunting.

Marked increases in milk production in India will require increased use of feed grains or dedicated green forage production. Increased interactions among agronomists and animal nutritionists will be essential to the development of sustainable systems that meet the need for higher quality dairy diets. Research reports dealing with green fodder need to be clearly expressed in dry matter terms in order to be useful. Scientific abstracts and reports need to be more careful in reporting results quantitatively. Animal response, modern chemical analysis, mycotoxin screening of feeds and agronomic information on crops used should be included in animal nutrition research projects and reports.

Unique Aspects of Indian Dairy Sector

From a Western perspective, there are several unusual aspects of Indian dairying:

- The Hindu religion prohibits slaughtering of cows and eating beef. Bull calves and unproductive dairy cows are a disposal problem, rather than an additional income stream. This would seem to increase the benefits of promoting longevity in lactating cows and also the benefits of sexed offspring. Buffalo are not sacred, and finishing and slaughtering facilities exist in country. Buffalo meat is not commonly consumed and is primarily exported. Some cull

cattle are marketed in neighboring states and to Indian Muslims.

- Cattle are fed primarily on byproducts from crop production. Green forage (forages other than straw) occupies about 4 percent of India's arable cropland, and up to 10 percent in the northern plains states [6]. Concentrate feeds do not usually contain feed grains, but could include starch from rice and wheat milling, and molasses from sugar production. Green forages include berseem clover, oats, ryegrass and sorghum. Villages in some areas often have common pasture lands that are unimproved, unmanaged and probably overgrazed. Intensively managed grazing is not practiced, and labor for cut and carry feeding of forages is plentiful.
- Manure is a valuable resource for fuel and fertilizer. Much of the manure from dairies is formed into dung pies and dried for farm use or sale as a heating and cooking fuel. Presumably, the residual ash from burning is incorporated as fertilizer, although this was not confirmed. Manure that is not used for fuel is applied directly to cropland, reducing chemical fertilizer needs.
- There is considerable sensitivity to protecting the income earned by small-scale producers and resistance to larger-scale commercial dairy herds. This is manifested by a dairy research and extension support system targeted toward smallholders. Commercial dairy managers more commonly look to the internet for management information from other countries.

Constraints to Expanding Milk Production

The major limiting factors to increasing India's milk production are:

1. The available dairy feed supply cannot support significant increases in milk yield per dairy animal.
2. It is an immense challenge to improve the dairy management capability of about 70 million dairy farmers, many of whom are illiterate.
3. There is a mind set—perhaps a good and reasonable mind set—that the smallholder model must be maintained to alleviate rural poverty.

Intensive milk production systems involve a combination of adequate animal genetics and liberal allocation (25 kg DM/day) of high quality (30 percent NDF) diets. Reproductive regularity is also required. Excellent animal observation and intervention to maintain health, and concern and expenditures to ensure animal comfort (bedding, heat stress relief, etc.) are part of this package. Generally, animals are raised to maturity as quickly as possible without impairing future milk productivity, but less intensive young stock programs can be combined with more intensive milking herd programs.

Extensive milk production systems involve many more lower-producing animals to achieve the same level of production as intensive systems do. Feed quality can be poor, and body maintenance requirements relatively large, therefore large amounts of total feed are required. Typically, young stock are raised at such a low level of energy that lifetime productivity is delayed and daily production potential at maturity is reduced. Low quality or insufficient amounts of feed at certain times of the year are less troublesome for cows of lower genetic merit because they direct absorbed nutrients to their body maintenance at the expense of milk production. High genetic merit cows are bred to direct nutrients to milk at the expense of body condition on the premise that adequate quality feed will be available throughout the lactation and dry cycle to rebuild reserves. Without a consistent feed supply, body reserves are depleted, reproduction ceases and animal health is impaired.

Milk production systems differ according to the nature of inputs used and the management strategies employed, not necessarily according to herd size. In particular, the exclusive use of crop residue and byproduct feeds is not restricted to very small herds. Nor is using dedicated green forage production and whole feed grains only compatible with larger commercial farms that employ non-family labor.

A major challenge to expanding Indian milk production is improving cow management expertise in the vast number of dairy farmers in India. Training is made even more difficult because many of these farmers are

women, who have a lower literacy rate than their male counterparts.

It is apparent that the extension delivery services and models have been evaluated and organized to convey information as effectively as possible, but increasing management skills is a difficult goal to attain. Information is characterized by almost perfect economies of scale. The cost to provide/acquire knowledge that yields a small reduction in feed costs per animal is the same whether the knowledge is applied to a herd of one-hundred animals or two. But the value to the manager of the herd of two may well be less than the cost of attaining the knowledge.

Limited management expertise is being addressed in part by controlling or limiting management choices. For example the manager can decide how many kg of concentrate mixture to feed, but the mixture is predetermined (almost at the national level from some comments we heard). Training on basic cleanliness can be simplified because of the dominance of hand milking and the limited potential for massive cow-to-cow cross infection. Diagnosis and treatment of diseases can be left to the veterinarian.

Limitations of Byproduct-Based Dairy Systems

A search for specific peer-reviewed data on milk production by dairy cattle breeds or improved breeds of buffalo fed solely on untreated straw and cereal grain byproducts proved fruitless. Most production trials assumed some form of treatment of straw and usually some form of green forage. Some concentrate was almost always fed.

Using assumptions regarding the composition of wheat and rice straw, and other milling byproducts along with National Research Council nutritional requirements, we estimated the volume of milk that could be produced from these crop residues. Under peak wheat, rice, maize and sorghum production levels since 2000, crop residues would have supported less than half of India's current level of milk production.

It is obvious then, that much of India's current milk production must be based on use of a richer diet that increases dietary energy density to produce the amount of milk production estimated by Indian agencies. Green forages probably account for a majority of this. A web-based dairy budget from India for a 3000 liter/year milk cow suggested 5 kg/day dry fodder, 20 kg/day green fodder and 5 kg/day of concentrate, presumably on an as fed basis [44]. If the indicated green fodder was fresh green chop at 20 percent DM and the straw was 90 percent DM, then this diet is almost half green forage on a DM basis.

If feed is the principal limiting factor to milk production, then increases in milk production could come about only by:

1. Displacing food grains with feed grains and forages.
2. Feeding high starch or high sugar products to dairy animals.
3. Achieving a marked improvement in yields of green fodder and pasture.
4. Improving the nutritional quality of straw.

Items 1 and 2 imply a possible decrease in food grain production or imports of feed and/or food grains. These options seem unlikely given India's increasing population and the Indian government's focus on self-sufficiency in food. The tenth five-year plan addresses increased fodder production [40]. Less waste and better distribution of fodder is mentioned, but seems to apply mainly to straw and chaff. It may very well be that some grain straws are wasted because alone they do not even maintain an animal, and sufficient concentrate may not be available to combine with the straw. In some areas, like Punjab and Haryana, most of the wheat and rice stalks are burned in the field. Better management of shared marginal lands and forests as sources of pasture, browse and harvested forage are also mentioned. The idea of increased forage acreage is not cited as a source of growth, but improved productivity of forage production through improved seed and management is mentioned.

From a labor utilization standpoint, importation of grain to produce milk would certainly make more sense than importation of milk. India has a tremendous source of labor and female cows, and could increase milk production quickly in response to higher dietary quality and quantity. However, importing milk powder for domestic use, if required, may have advantages in transportation costs over grain imports, depending on the source. If world milk prices supported grain

imports into India to better feed the cattle and buffalo population, increased production could be expected.

Declining water tables in heavily irrigated areas may require that different cropping systems be developed to conserve water. If this water conservation strategy includes producing more and better-quality forages, then the benefit in increased milk and water conservation may be well worth the tradeoff of reduced grain production.

Even small improvements in the energy value of the diet will have marked returns at these low levels of production. Replacing half of the wheat straw with a mid-maturity legume-grass mixture would increase energy balance milk yield from 4 to 6 kg/day. This is calculated without an increase in feed intake, which is also likely to happen and would further increase milk yield. Cropping systems, either rotations or intercropping, may very well result in increased green forage availability without marked reduction in grain production. Stands of pure berseem were present in the Punjab area and appeared to be very intensively managed and crucial to the commercialized dairies there.

Items 3 and 4 above are more attractive than 1 and 2 because they would not affect grain production. Chemical treatment of straws has been a research area for almost one hundred years. Various techniques exist to treat straw. Again, even a modest increase in straw total digestible nutrients (TDN) could have a dramatic effect on milk yield in very high roughage diets.

Other potential areas of improvement could include the breeding of grain plants with better vegetative digestibility without sacrificing anti-lodging properties. In fact, water conservation cropping strategies and optimized breeding of grain crops to consider by-product quality are major areas where interdisciplinary research between agronomists and nutritionists will likely be very beneficial. Given the tremendous progress in grain production in India, it is likely that agronomy departments have focused on cereal production. Agronomists interested in providing feeds to dairy animals need to be in close proximity to dairy nutrition experts. Institutional structures that support this interaction should be encouraged.

Use of ionophores in the rations is another avenue to slightly increase energy availability. In low-energy rations, ionophores increase energy availability without decreasing feed intake. This appears to be a natural fit for this technology and has proven to be reasonably cost-effective in heifer-raising in the U.S.

Potential for Commercial Farms

The Anand Model, described in the previous section, has been successful not only in developing a widespread smallholder milk collection system, but also in providing dairy services (e.g., veterinary, artificial insemination, outreach education) and mixed feed to farmers. Private dairy companies that procure milk in India usually adopt most of the elements of the Anand model, partly for competitive reasons and partly because the model has proven to be an effective means of getting very small quantities of milk from a very large number of farmers while maintaining a cold stream.

For example, Nestle, which operates a large manufacturing facility near Moga in the state of Punjab, operates several collection/consolidation stations comparable to those owned by village cooperative societies, and provides veterinary and insemination services at no cost except for drugs and semen. The company employs outreach specialists and arranges free training programs on dairy husbandry and milk quality. It sells mixed feed to farmers at cost.

Nestles' farmer-patrons are paid every two weeks instead of daily. All milk collected at receiving stations is transported to the factory—Nestle does not sell raw milk to village residents. The biggest distinction between Nestle and the Anand model is that Nestle actively encourages dairy farm growth. This is done principally by providing cooling tanks to farmers of sufficient size, and by providing technical assistance and other incentives such as incentive price to large producers. Many farmers in the Moga area who sell their milk to Nestle have expanded their operations to the point of being able to efficiently utilize milking parlors. Some have herds of more than fifty cows and are using feeding, breeding and management practices that generate milk yields several times the area average.

The NDDB views larger dairy operations, such as those promoted by some private sector units, with some skepticism because of their perceived effect on rural employment and income distribution. If the demand for milk is finite and India's large rural population con-

tinues to be isolated from the rapid economic growth occurring in some urban areas, then this criticism has merit. A one-hundred cow herd would produce at least as much milk as fifty two-cow herds, and any displaced dairy farmers would lose income that could not be restored from alternative employment. But the demand for milk is not stagnant and will likely grow rapidly, so there is room for co-existence of commercial and smallholder producers. Indeed, larger farms may be necessary if India wishes to remain (more or less) self-sufficient in milk production.

Summary Observations: Dairy Production Sector

India produces more than 90 million tons of milk annually from a herd (cows and buffalo) numbering more than 70 million under the control of an estimated 70 million farmers. The U.S., by comparison, produces 80 million tons of milk annually from 9 million cows in about 65,000 herds.

Crop residues represent the major feed source for India's dairy herd. Green fodder and concentrate feeds are in limited supply because of the Indian government's emphasis on self-sufficiency in rice and wheat. The composition of the dairy ration constrains milk yields, but small improvements in the quality or quantity of the ration applied to the large number of dairy animals in India would generate large gains in total milk production.

Because of inexpensive feeds and low opportunity costs for labor, the average cost of producing milk in India is very low by world standards despite low yields per animal. However, the marginal cost of production could be considerably higher if demand increases rapidly and India retains its policy of promoting domestic production to meet internal consumption.

Meeting the educational and service needs of Indian dairy farmers is a challenge due to sheer numbers and relatively low literacy rates in rural areas. Both cooperatives and private dairy firms play a major role in dairy education and in providing feeds and services.

PROCESSING SECTOR

General Description

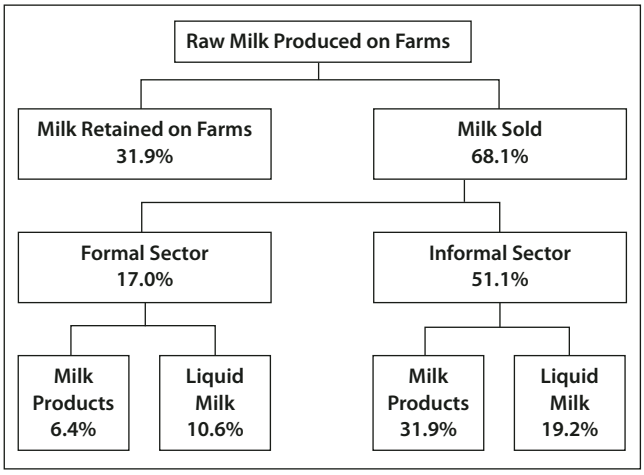
Dairying historically has been an unorganized activity in India [85]. The present status of dairy processing is the result of demographics, traditions, religion, and infrastructure limitations.

A primary characteristic of milk processing and distribution in India is the dominance of the informal sector. About 32 percent of the milk produced is retained on the farm for food and feed [71]. The amount retained on farms varies among states and is influenced by the size of the herds. Of the 68 percent leaving the farm, approximately 75 percent of that milk goes to the unorganized or informal sector and the remaining 25 percent is handled by the formal sector (Figure 12).

Approximately 44 percent of the milk leaving farms is sold as liquid milk and 56 percent is converted into products, which are usually sold fresh [71]. The relative amounts of milk from the informal and formal sectors that are converted into various products are shown in Figure 13. Percentages are calculated on the basis of total milk produced on the farms, including the 32 percent retained on the farms. It is estimated that the amount of milk produced is sufficient to satisfy domestic demand, but there are no public data on production of milk products in India [95].

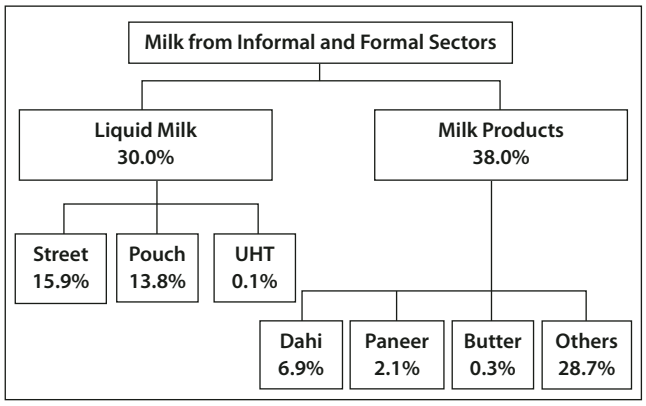
The large informal sector exists partly because consumers have been unwilling to pay the additional costs

FIGURE 12. Disposition of Indian Milk Production, 2005



Adapted from Nestle [72].

FIGURE 13. Major Milk and Milk Product Categories, 2005



Adapted from Nestle [72].
Street milk is milk that is dispensed in bulk to consumers; pouch is milk sold in plastic bags, and UHT is milk sold in cartons as long-life milk.

of pasteurization and packaging, which can raise retail prices by more than 100 percent. Moreover, consumers often regard raw milk and traditional products obtained from reliable vendors to be of better quality than formally processed dairy products [85].

In the informal sector, raw milk may be sold directly to the consumer by the farmer or the farmer may sell the milk to a "milkman" who re-sells it to consumers or to a creamery. The creamery also sells to consumers, but may sell to sweet shops (Halwaiis) and restaurants as well. The informal sector encompasses the marketing of raw milk and traditional products such as locally manufactured ghee, fresh cheese and sweets. This sector is quite well organized, with a complex net of market agents. It may also be relatively formal, with market agents paying municipal fees and having vendor licenses. The Indian government has generally adopted a laissez-faire approach to the informal sector and has allowed it to expand with demand and to serve both small farmers and resource-poor consumers [85]

The formal sector is relatively new in historical terms, and consists of western-style dairy processing based on pasteurization, although adapted to the Indian market in terms of products. In 2002 the formal sector consisted of 678 dairy plants registered under the Milk and Milk Products Order (MMPO) and has grown rapidly during the last decade. The number of registered milk-processing plants under the MMPO is shown in Table 6. Ranking of the top twelve states is according to total number of plants.

TABLE 6. Number of Dairy Plants Registered under Milk and Milk Products Order, March 31, 2002

States/Union Territories	Cooperative		Private		Others		Total	
	No.	Capacity*	No.	Capacity	No.	Capacity	No.	Capacity
Uttar Pradesh	32	2,286	180	10,841	0	0	212	13,127
Maharashtra	35	4,206	68	5,575	38	3,395	141	13,476
Haryana	5	400	37	4,590	2	130	44	5,120
Punjab	13	1,630	31	3,805	0	0	44	5,435
Tamil Nadu	25	4,365	16	871	0	0	41	5,236
Karnataka	14	1,908	19	1,110	1	400	34	3,418
Rajastan	14	1,337	17	1,597	0	0	31	2,934
Andhra Pradesh	13	2,905	15	1,443	1	200	29	4,548
Gujarat	17	6,280	3	690	7	670	27	7,640
Kerala	11	765	7	238	2	35	20	1,038
Madhya Pradesh	10	1,250	4	1,100	2	20	16	2,370
Delhi	0	0	0	0	8	6,500	8	6,500
Total—All States/Territories	212	28,394	403	32,415	63	12,170	678	72,979

*Capacity is given in thousands of liters/day and is the total capacity within each category and state. Data show ranking by plant numbers of the top 12 states/territories. Adapted from FAO [85].

The average capacity for cooperative milk processing plants in all states was 133,900 liters per day compared to 80,400 liters per day for the private plants. The high average capacity of 193,200 liters per day for "other" plants was influenced greatly by the large plants in Delhi. The number of processing plants and the amount of processing capacity generally correlates with the milk production of the state. There are some exceptions to general trends. For example, milk production in Uttar Pradesh is about 2.7 times greater than in Maharashtra, but the processing capacities are equivalent. Also, the average processing capacity in Gujarat is higher than other states, and the average capacity for plants in Kerala is lower. The presence of the large Gujarat Milk Marketing Federation is a major reason for the high capacity per plant in the State of Gujarat.

Milk Procurement and Processing

About 110,000 dairy cooperative village societies, involving about 12 million farmer members, had been organized by 2003–04 to supply milk to processing firms and directly to consumers. Until the early 1990s, milk processing was mainly reserved for the cooperative sector through licensing. As part of domestic economic reforms and commitments to the WTO, the Indian dairy sector was liberalized in a phased manner starting in 1991. The government removed all restrictions on setting up new milk-processing capacity in March 2002.

Following partial decontrol of the dairy sector in the early 1990s, many private sector processors entered the market and established milk-processing facilities, mostly in milk surplus areas. Some of the private sector plants also adopted the Anand model by creating informal contracts with local farmers and providing various inputs and services to the farmers. Nestle made large investments in its milkshed to improve productivity levels and the quality of raw milk. However, a large proportion of private dairy plants depend on contractors and subcontractors to meet their raw material requirement [85].

Estimates of milk production indicate sufficiency for current domestic consumption levels. However, the Department of Animal Husbandry, Dairying and Fisheries of the Government of India is implementing a number of initiatives to increase milk production to meet anticipated future demand. These initiatives include [95]:

- National Project for Cattle and Buffalo Breeding
- Livestock Health and Disease Control
- Fodder Development Scheme
- Intensive Dairy Development Project
- Assistance to Cooperatives
- Assistance to States for Feed and Fodder Development
- Strengthening Infrastructure for Quality and Clean Milk Production.

Major Processing Organizations

Based on 1999–2000 sales, the largest Indian dairy companies and cooperatives were: Gujarat Cooperative Milk Marketing Federation (GCMMF), Mother Dairy, Nestle India, Hindustan Lever, Ltd., Britannia, Andhra Pradesh Dairy Development Cooperative Federation (APDDCF), Hatsun Agro and Vadial [81]. Two other firms—Dynamix Dairy Industries, Ltd. and Heritage Foods (India), Ltd.—have grown rapidly since 2000 and may have sales that exceed those of the top ten firms in 1999–2000. The GCMMF dominates the processing sector, and has about three times the sales of its nearest competitor.

GCMMF. The evolution of GCMMF dates back to 1946, when farmers in the Kaira District in Gujarat organized into a union of cooperatives to counter low milk prices in the Bombay Milk Scheme [88]. The Kaira District Cooperative Milk Producers' Union adopted the brand name Amul in 1955. The milk unions in Gujarat organized GCMMF in 1974 and selected Amul as their brand name to market the cooperative's milk products outside the State of Gujarat. The term, Amul, will be used hereafter to refer to GCMMF.

Daily milk collection has increased from 247 liters in 1946 to 5.9 million liters in 2005. This milk is supplied by 2.4 million members organized into 11,615 village cooperatives [4]. The milk is tested for composition, cooled and transported to twelve district milk unions located in the State of Gujarat. Some of the raw

milk is sold directly to consumers, but most is shipped to 24 processing operations.

Amul introduced whole and skim milk powders, butter and ghee to the Indian market in 1955. Today Amul distributes a wide range of products throughout India, and exports to a number of countries. Products are sold under the Amul or Sagar brand names. Product lines include cheese (eight product lines), ethnic sweets (six lines), UHT milk (seven lines), ghee (three lines), infant milk (three lines), milk powders (four lines), sweetened condensed milk (one line), fluid/market milk (six lines), curd products (four lines), ice cream (seven categories, multiple flavors and product sizes and styles), chocolate and confectionery (two lines), milk drinks (two lines), and one line of health beverage [2].

Sales of packaged products have risen substantially. Revenue from these products increased 11.8 percent between fiscal years 2003–04 and 2004–05. Sales of pasteurized milk in pouches increased by 36 percent and sales of UHT milk grew by 23 percent, albeit from a small base. Pasteurized milk pouches are the largest contributor to Amul's total turnover [4]. Amul is a market leader in ice cream, and the turnover for this product has increased 10 percent. Sales of cheese, including cheese spreads and cheese for pizza, increased by 21 percent from a fairly small base. Total sales revenue was slightly more than 29 billion rupees (approximately US$670 million) in 2004–05 [11]. Sales increased by 62 percent from 1994–95 to 2004–05 [2].

Distribution of products by Amul is complex with 47 sales offices link to more than 3,000 wholesalers and more than 500,000 shops. Plans are underway to expand the infrastructure of distribution, with initial focus on smaller Indian cities. It is felt that the purchasing power of the upper-middle class in these smaller cities offers increased markets, especially for value-added products. Plans call for a major expansion of retail outlets for ice cream. There is also active consideration of retailing fresh and frozen vegetables, and fruits and fruit products in the cooperative's extensive distribution system [14]. An example of expansion into new products is the recent introduction of a whey-based energy sports drink [74]. It is possible to purchase 75 items on-line from Amul's Cyber Store [2]. Direct retailing throughout India by a chain of franchisee operating "Amul Utterly Delicious" parlors is being planned. Amul presently has nine such parlors in various Indian cities that are operated by the cooperative or by wholesalers. Amul is considering collaboration with cooperatives in other states by offering their expertise in processing and marketing of dairy products [2].

The export market is also part of Amul's present focus, with the anticipation of increased sales in the future. Export sales were slightly more than 1 billion rupees (US$22 million) in 2004–05 [11]. The cooperative is planning for export sales of about 2 billion rupees (US$44 million) in this fiscal year by marketing consumer products to areas that have large populations of non-resident Indians and by exporting commodities to neighboring countries in West Asia, Africa, Afghanistan, Singapore and, especially, China [57]. Customers in the U.S. can order five products online through the Cyber Store [2]. Amul has been marketing processed cheese, ghee, Nutramul (malted milk food), and Gulab Jamuns and Shrikhand (sweets) to more than 1,000 ethnic Indian grocery stores in the U.S. through Kanan Dairy. An agreement was signed with Wal-Mart to stock products under the Amul label [56]. Further diversification of the organization is illustrated by their manufacturing and marketing of packaging film [51].

Mother Dairy. This cooperative was established in 1974 under the Operation Flood Program as the marketing arm of the NDDB and to create marketing joint ventures with cooperative dairy federations in the states [65, 22]. It is based in New Delhi and had a turn-over of US$150 million in 2003–04. Products marketed include fluid milk, UHT milks, flavored milks, ice cream, dairy whitener, cheeses, butter, and Indian products such as dahi, lassi and ghee. It operates kiosks where consumers can purchase one-half liter pouches of pasteurized milk and a limited selection of dairy products manufactured by the cooperative. Loose pasteurized milk, purchased with a token, is dispensed into the consumer's milk container from a spigot built into the side of the kiosk [5]. Competition in the Delhi market has intensified over the past several years with GCMMF, Britannia and Paras Dairy penetrating the market [75]. GCMMF started selling fresh milk in 2004 after a non-compete agreement lapsed. In 2004 Paras Dairy made plans to place milk vend-

ing machines in fast-moving consumer goods outlets throughout Delhi.

A major restructuring of Mother Dairy was initiated in 2000 [12, 22]. Mother Dairy Fruit and Vegetable Private, Ltd. was formed by a merger of Mother Dairy Foods with a NDDB subsidiary, Mother Dairy Fruit and Vegetable, Ltd. Product manufacturing (dairy, and fruit and vegetable) is carried out by Mother Dairy Foods Processing and Mother Dairy is responsible for marketing products throughout India. The company's dairy plant processes 1.3 million liters of milk per day, and products are marketed through 636 shops owned by the company and 6500 retail outlets in and around Delhi. Horticultural products are processed in a plant located in Delhi and marketed through 263 Fruit and Vegetable Shops owned by the company and 20,000 retail outlets in various areas of India [67].

National distribution of milk products such as curd, ice cream, lassi, butter and ghee was announced in 2005 [12]. Fluid milk will continue to be marketed only in Delhi, Mumbai and Hyderabad. Dairy products and fruit and vegetable products are exported globally, from a marketing office established in the Netherlands [65].

Nestle. Nestle India, a subsidiary of Nestle S.A. Switzerland, was incorporated as a separate company in 1959. It is one of the leading companies in the Indian Food sector and is among the "Top Wealth Creators in India" [48]. Milk products comprise a major portion of the company's total products, including beverages, culinary products, and chocolate and confectioneries [50]. A milk processing facility was built near Moga in the state of Punjab in 1961 [72]. Initially the company adopted a cooperative approach to secure milk but converted to a contract system. This was done to increase milk production and procurement by providing inputs and services to the farmers.

Nestle has dominated the weaning foods market with its Cerelac and Nestum brands. It also markets infant milk powder, sold as Lactogen and Nestogen brands, and Milkmaid, a popular sweetened condensed milk. Nestle's dairy whiteners have also gained market share [50]. A major effort was made in the early part of this decade to secure a larger share of the Indian dairy market [62]. Butter, curd, UHT and flavored milks, flavored dahi and lassi in cartons were introduced with large investments in diversification and creation of a distribution infrastructure [13]. Many of these products are in low-margin, high-volume businesses. Manufacturing of many of the products was contracted to other dairy firms.

Recently, Nestle has consolidated its dairy product portfolio [83]. Butter was withdrawn from the market, other products are being evaluated, and new products have been introduced, such as raita (yogurt combined with selected ingredients like cucumbers). The company sees opportunities in "away-from-home" products since it possesses skills in vending and marketing consumer products. Product introductions in their culinary division, mainly noodle and soup products, have been well-received.

Hindustan Lever, Ltd. This subsidiary of the Anglo-Dutch Unilever has been in India since 1888. It is India's largest consumer goods company and markets home and personal care goods, beverages and foods including Kwality Wall's ice cream [17]. Like Nestle, Hindustan Lever revised their marketing strategy between 2000 and 2004 [47]. A number of lines, such as adhesives, nickel catalyst, seeds, fats and oils, and mushrooms were sold. It appears that the core brands to be emphasized will target upper-middle and upper-class households. Ice cream should remain a core product for the company, but this will depend upon future emphasis on personal care products which account for approximately two-thirds of the total sales. Revenue from ice cream sales for the quarter ending March 2006 increased 30 percent over that of the previous year, but revenue from ice cream still accounted for only 1 percent of total corporate sales [15].

Britannia Industries, Ltd. Britannia was incorporated as Britannia Biscuits Company, Ltd. in 1918. It was subsequently acquired by, or merged with, a number of firms including multinationals like Nabisco and Danone [49]. Bakery products are the dominant product line for this corporation, with dairy products accounting for a small fraction of sales. There was a 50 percent increase in the volume of dairy products from 2000 to 2001. Products included flavored lassi, flavored milks, cheese, dairy whitener, butter and ghee. Manufacture of these products had been outsourced to processors in several states.

Britannia announced a joint venture with Fonterra, New Zealand, in October 2001 [59]. The dairy division was to be transferred to the joint venture with Britannia and Fonterra each holding 49 percent of the capital base. The joint venture, was predicted to have both positive and negative impacts on Britannia. Association with Fonterra would bring access to technology at every stage of milk production and processing, as well as experience in value-added products. The approval by the Indian Foreign Investment Promotion Board indicated that the joint venture would establish manufacturing facilities and would not be involved in trading, except at the wholesale level. The remaining divisions in Britannia would lose the dairy product business that was quite profitable in 2000–02. Another development influencing Britannia is the intention of Danone to set up its wholly-owned subsidiary in India, which received approval from the Foreign Investment Promotion Board. Danone and the Japanese firm Yakult have established a new company, Yakult Danone Private, Ltd. to market probiotic products [20].

Significant restructuring of the product portfolio of the joint venture occurred recently when the number of brands was reduced from 133 to less than 100 and emphasis was placed on 16 to 17 "power brands" [73]. This was prompted by loss of sales to competitors such as Mother Dairy, Amul and Paras. Paras is a 45-year-old dairy firm that procures milk in Uttar Pradesh and is the second largest milk distributor in Delhi [87]. It has a wide range of products including bactofuged consumer milks, mozzarella cheese and demineralized whey. Another indication of a shift in market focus of the Britannia-Fonterra venture is illustrated by the recent introduction of a high-calcium, non-fat milk powder that targets the upper and upper-middle class, health-conscious older population.

Hatsun Agro Product, Ltd. This Chennai-based private dairy firm, the largest private firm in India, intends to expand its branded milk sales in the domestic market. It also aims to increase products for export through a larger milk ingredients unit [7]. Milk powder, frozen cream, butter and anhydrous milk fat were exported to 23 countries. Export revenues climbed from 34 million rupees (US$0.8 million) in 2004 to 590 million rupees (US$13 million) in 2005. The company has a processing capacity of more than sixty metric tons per day which is augmented by a new 22-metric ton milk powder plant. There are also plans to export UHT milk [76].

Domestic market products include fluid milk, ice cream, butter and ghee. Milk sales are increasing and its brands are market leaders in the states near Chennai. Expansion northeastward is planned to the near-by state of Andhra Pradesh. Franchised distribution centers are being opened to strengthen milk marketing, especially in Chennai [7]. Ice cream accounts for 10 percent of sales, with more than seventy flavors being offered and more being added. Plans were made in 2003 to set up an ice cream novelties manufacturing unit [55].

Vadilal Industries, Ltd. (VIL). VIL has one division that produces and markets ice cream, and a second division handling fruits, vegetables and ready-to-serve Indian foods [92]. It has one of the largest refrigerator/freezer distribution networks in India with 250 distributors and 15,000 retailers. VIL markets bulk ice cream and novelties.

Dynamix Dairy Industries, Ltd. Dynamix Dairy Industries was created in 1995 in Baramati near Bombay in the state of Maharashtra. The company claims a processing capacity of 500,000 liters of cows milk per day, producing cheese, butter, ghee, dairy whitener, SMP, WMP, lactose, casein, whey protein concentrate, whey powder, baby food and UHT products [27]. Lactose and whey protein concentrate are produced in technical collaboration with Whey Systems, U.S. and Valio, Finland.

Dynamix has bulk cooling stations in more than 110 villages. The company uses a demonstration dairy farm to help educate milk producers in clean milk production, regulated feeding, disease control and genetic improvement of cows. Like cooperatives and other private dairies, Dynamix supplies its producers field services to its producers that include artificial insemination, vaccination and veterinary care.

Heritage Foods (India), Ltd. Heritage Foods began operations in 1992. The company was promoted by the former Chief Minister of Andhra Pradesh and benefited from the 1991 Government of India Industrial Policy. Heritage Foods procures, processes and dis-

tributes milk and dairy products in Andhra Pradesh, Karnataka and Tamil Nadu [58]. Its primary product is fluid milk, but it also produces curd, ghee, buttermilk, flavored milk, SMP and dairy whitener.

Heritage acquires milk from about 50,000 farms in 3,000 villages and provides a full set of inputs and services to its producers. The company's 2005 turnover was an estimated US$65 million. Recently, Heritage announced plans to enter the food retailing business as the principal shareholder of a joint venture [80].

Processing and Product Technologies

Technology development is accomplished primarily by federal agencies, the NDDB, and some cooperatives and private companies. Technical support is also secured through educational institutions by the training of dairy food scientists, and from basic and applied research.

National Dairy Research Institute (NDRI), Karnal. Established in 1923, NDRI is the largest governmental research and development organization serving the dairy processing industry [70]. Five divisions, Dairy Technology, Dairy Engineering, Dairy Chemistry, Dairy Microbiology, and Dairy Economics, Statistics and Management are staffed with 95 scientists/technical officers.

The Dairy Technology group concentrates on development of improved processes for traditional (indigenous) Indian dairy products. This is in anticipation of the movement of processing from the informal sector to the formal sector because of increased marketing to urban consumers. Developmental emphasis is on continuous processing, heat processes to increase storage stability, reduced fat products, dry (reconstitutable) mixes, use of dairy proteins (whey protein concentrates) that will be produced from increased cheese manufacturing, and the use of membrane technologies.

Improved equipment for continuous production of traditional products is emphasized in the Dairy Engineering division. Improved methods of detecting milk contaminants, enhancing nutrition of dairy products, whey fractionation, and use of vegetable fat in cheese are areas of interest in Dairy Chemistry. Biopreservatives, probiotics, defined strain bacterial starters for some traditional dairy foods, recombinant buffalo chymosin, and improved fermented whey beverages are some of the projects in Dairy Microbiology. Technology transfer includes improvement of the processes for traditional products that would assist the informal sector somewhat but are aimed at the formal sector.

NDRI facilitates technology transfer through a Consultancy Unit. A compendium of transferable technologies was published in 2002 [69]. The technologies cited reflect the research emphases above and include improved traditional products as well as products that are emerging on the Indian market, such as mozzarella and cheddar cheeses, and new processes such as membrane separation technologies.

National Dairy Development Board (NDDB) processing. As part of its functions, NDDB provides technical assistance in product/process development and equipment design to its partner cooperatives [68]. Technologies that have been developed and reportedly used by the cooperatives encompass indigenous dairy products, Western-style products, and packaging.

The developed products and processes appear to be designed for more extensive distribution systems than the traditional or informal sectors and to enhance the export market. Examples include continuous and mechanized processes for indigenous products, dehydrated and heat-stabilized indigenous products, dry ice-cream mix, dairy whitener and ice cream novelties. Mozzarella cheese technology transfer is a response to the increased pizza market. The choice of technology transfer of emmental cheese would suggest the preference by Indians for a milder flavored cheese and one that would appeal to the upper-income market.

Coincidental to the process/product development, NDDB has designed equipment for continuous and mechanized production and packaging of indigenous products. Of particular interest is continuous Gulabuamun (sweets) portioning, forming, frying and sugar syrup soaking equipment, as well as equipment for pressing and dicing paneer. A wholly-owned subsidiary, IDMC Ltd., has carried out a number of projects relating to milk processing and has recently installed a polyfilm manufacturing plant [66].

Educational Institutions. There are eleven dairy science colleges in India that offer courses leading to a Bachelor of Technology degree in Dairy Technology or a Bachelor of Science degree in Dairy Technology [84]. Of these, National Dairy Research Institute (Karnal and Bangalore) and the Sheth MC College of Dairy Science (Anand) are designated as centers of excellence. Karnal and Anand have modern commercial dairies funded by the NDDB. An automated dairy plant having a capacity of one-hundred thousand liters, named Vidya Dairy, became operational at the Dairy Science College, Anand in 1994. All operations in this dairy are carried out by students under the supervision of dairy staff and teachers.

As in the U.S., the bachelor's degree course is generally a four-year program. There are also diploma level courses offered by the Dairy Science Institute (Aaray, Mumbai), Allahabad Agricultural Institute, and the State Institute of Dairying (Haringhata, West Bengal). NDRI (Bangalore) offers a two-year National Dairy Diploma course.

Master's degree courses in dairy science and dairy technology are offered by seventeen institutions, which include several agricultural colleges plus colleges of veterinary science and animal husbandry. Postgraduate programs are offered in dairy chemistry and dairy microbiology. A quality control program is also offered by Dairy Science Colleges at Karnal and Anand. In the Indian Institute of Technology (Kharagpur), dairy engineering is offered as part of the Bachelor of Technology Honors degree in agricultural and food engineering and Masters of Technology degree in dairy and food engineering, as well as a doctorate degree in dairy engineering and dairy technology. Six universities have introduced doctorate level courses.

Milk and Product Distribution

Past and Present Systems. As indicated earlier, sale and distribution of fluid milk may occur directly from the farm, from milk collection stations, or through local distributors. The remaining milk is cooled, transported to processing plants and converted into market (fluid) milk and milk products that are distributed by a variety of means. Loose or bulk pasteurized milk is dispensed to the consumer in the Mother Dairy kiosks. Each dairy cooperative has its own channels for distributing milk and other products. Private dairy companies distribute products through local shops because refrigerated distribution channels are sparse [5]. As indicated in the discussion of the major dairy organizations, initiatives are beginning to enlarge their markets into other states. Larger cooperatives are beginning to expand through their own and franchised market outlets.

The principal outlet for the popular traditional sweets made from condensed milk is sweetshops or halwais. These are located in the markets of virtually every city and are generally subject to government oversight. A limited number of dairy outlets are located in newly-built shopping centers in the upper-middle and upper class sections of cities like New Delhi, Mumbai and Bangalore. Fashioned after Western-style stores, they handle Indian dairy products and imported items such as cheeses from a number of European and Oceanic countries. Specialized food outlets that cater to more affluent Indians are emerging in the suburbs of larger cities.

Future Trends. Emergence of a more affluent segment of the Indian population, albeit small as a percentage of total population but large in numbers, seems to be prompting a shift to more value-added dairy products [5]. Packaged market milk is gaining in popularity compared to "loose" milk. Markets for UHT and flavored milks are growing, but are still niche markets. It must be remembered, however, that a niche market of 0.1 percent of the Indian population is about 1.1 to 1.2 million persons.

Traditional Indian dairy products such as paneer and dairy-based sweets, with longer shelf-life, are being marketed as branded products by cooperative and private companies. Markets for butter, ghee and ice cream are competitive markets and are dominated by a few firms that have the manufacturing and merchandizing capabilities to compete in these markets. It would seem difficult to enter these markets without offering innovative products. For example, a Dutch company, Royal Numico, sold its low-margin, start-up operation in dairy and baby food to concentrate on high-margin nutrition products [19].

An assessment by RaboBank concluded that multinationals in the Indian dairy market have focused on premium products presently produced in small quantities [5]. With the exception of Nestle, multination-

als have followed this path because of the difficulty in procuring milk in large quantities. In spite of these market shifts, Western-style products and marketing have had little impact on the total Indian society because 85 percent of total milk production is marketed directly to the consumer. About 65 percent of the total milk is consumed as unpasteurized—two-thirds in the rural areas where the milk is produced and one-third in urban areas [97].

In spite of a dispersed market, a competitive climate, and the present uncertainty about the nature and rate of change of dairy product marketing and consumption in India, a number a foreign investments have been made in recent years. Of particular interest are two firms located in Wisconsin. Schreiber Foods, Green Bay, recently acquired 51 percent of Dynamic Dairy Industries, Ltd., which produces a broad range of products including processed cheese [21]. The expertise of Schreiber Foods in processing, packaging and marketing of processed cheese slices is an asset in sales to the growing number of fast food outlets in India. Erie Foods, with a minor stake in Dynamics, adds expertise in manufacturing caseinates and whey protein concentrates, and in extracting minor components from whey. Another U.S. firm, Keller Whey Systems located in Minnesota, is involved in the lactose and whey systems of Dynamix [27]. A plan to build a cheese plant to produce and market buffalo milk mozzarella cheese in the U.S. is part of a collaboration between Winona Foods, Green Bay and Himalya International [64]. The management of Winona Foods has experience in producing Mozzarella cheese and will be assisted by Dr. N. Gandhi, Jeneil Biotech Inc, a Wisconsin firm. Buffalo milk will be sourced directly from U.S. farmers.

Summary Observations: Processing and Marketing

Most Indians will continue to eat a core meal of ethnic staples, which includes cereals, pulses, vegetables and presumably milk and milk products. An area with potential is development is snacks, since most Indians are not likely to switch to processed foods for their core meal. At the same time, changes in life style for a segment of the Indian population (urbanization, increased income, commuting and more working adults) will provide inroads for processed foods [96].

The informal sector with direct marketing of milk to the consumer will continue to dominate the Indian dairy scene for some time because of the dietary and food preparation habits of Indians. Distribution of milk and milk products through small stores will also dominate in the near future, even though the number of supermarkets is increasing. Cooperatives and companies recognize the importance of localized marketing have been setting up chains of small convenience shops. The transportation infrastructure is a constraint to more efficient distribution and marketing of milk and milk products in many parts of India.

The Indian dairy industry has made substantial advances in development of the dairy processing infrastructure, with construction of modern plants, use of mechanization and automation, and the development of distribution centers. Training in the basic sciences and dairy technology has aided in the modernization of the industry and will continue to do so if the institutions are properly funded and structured.

Cooperatives partnering with the NDDB provide a national system for products, especially milk and commodity dairy products. Most of the larger dairy firms have initiated similar expansion into promising distant markets. Private companies have varying degrees of penetration into the dairy markets, with Nestle appearing to have a significant role. Some of these firms have a long history in the Indian market. Foreign companies have been able to partner with existing Indian dairy firms. The more recent entries have brought unique features into the processing area and/or the ability to access a particular market niche, either in India or its export market.

MARKETING AND TRADE ISSUES

In this section, we will analyze the drivers of change that will affect future purchases of dairy products in India and implications of demand growth for India's international trade in dairy products.

This section builds on the description and analysis of the structure of India's dairy industry appearing earlier in the paper. Thus, we assume familiarity with the relative importance of cooperatives, investor-owned

firms (IOF), and the government, the role of Amul, the status of the large informal sector and the smaller formal dairy processing sector, and India's dairy product mix.

Major drivers of change relate closely to the Three A's of dairy marketing: *Acceptability, Affordability* and *Availability.*

Acceptability of Dairy Products

Milk and dairy products are widely accepted in India, partly because dairy products have cultural significance in the Indian diet. A large percentage of the population is lacto-vegetarian and dairy products represent an important source of protein. In addition, dairy products are often products of choice when increases in consumer incomes permit additional purchases.

B.M. Vyas, Managing Director of the GCMMF, puts the acceptability issue in these terms: "In the Indian consumer's mind, milk and dairy products are premium foods" [94]. He added that the widespread acceptability of dairy products and India's huge market simplify dairy marketing in India, making marketing a less challenging task than keeping skilled personnel for his operations.

While dairy products undoubtedly are now widely regarded as premium foods in India, it may become more difficult for dairy products to keep this status when more people enter the middle and upper income groups. It seems likely that middle and upper income consumers would not be satisfied with the short shelf-life (2–4 days) of milk sold by processors in the formal sector in parts of India. The widespread practice of boiling milk—even some pasteurized milk sold by the formal sector—to kill harmful organisms might also become a source of dissatisfaction. The formal dairy processing sector will benefit if it can capitalize on the demands of upper and middle income people for convenience, hygiene and quality.

Affordability of Dairy Products

The affordability of dairy products varies widely across India. Middle and upper income consumers—possibly as many as 450 million people in the future—will have the power to purchase desired quantities of dairy products. However, the remainder of the population, including many people living in rural areas, will be subject to important income constraints.

Price and income elasticities are useful for predicting approximate changes in future consumer purchases of dairy products in India. The price elasticity of demand estimates reported in Table 7 differ substantially in size. The differences may reflect differences in the time period used to estimate the elasticities, variation in the products involved in the estimation, different estimation techniques, or other factors. While the price elasticity of demand estimates in the table differ, they indicate that milk and dairy products have an elastic demand in India and that rural consumers are more price responsive than urban consumers. The elastic price elasticity of demand estimates for India stand in sharp contrast to the generally more inelastic price elasticity of demand figures (less than 1.0 in absolute terms for most dairy products and especially low for fluid milk) for U.S. dairy products.

The theoretical implication of these high-demand elasticity estimates is that total industry revenue could be increased by lowering milk prices. This is unreasonable in light of the already very low farm milk prices in India, especially in rural areas. We suspect that the high price elasticity of demand estimates are the result of comparing consumption and price data across non-homogeneous markets. For example, high rates of milk

TABLE 7. Selected Price and Income Elasticities for India's Dairy Products

Elasticity Characteristics	Price or Income Elasticity
Price Elasticity of Demand for Milk [23]	
Rural Areas	–2.99
Urban Areas	–2.77
Price Elasticity of Demand for Milk and Milk Products [25]	
Rural Areas	–1.65
Urban Areas	–1.15
Income Elasticity of Demand for Milk [23]	
Rural Areas	1.36
Urban Areas	1.07
Income Elasticity of Demand for Milk and Milk Products	0.60

Source: Roadmap Group [82].

consumption in markets with low milk prices may be associated with factors other than price, such as availability and cultural preferences.

There are other complexities involved in pricing dairy products in India that are undoubtedly disguised within the gross price elasticity of demand estimates. One such complexity is the reportedly weak link between milk prices and milk quality. Among other things, this means that milk is not a homogeneous product in India and discussion of pricing should take into account quality differences. The link between price and quality presumably will be strengthened by the demands of increasingly affluent consumers for better milk and dairy product quality.

Availability of Dairy Products

The income elasticity of demand estimates in Table 7 suggest that milk and dairy product consumption is highly responsive to increases in income. While the income elasticities in the table differ, it is possible to draw rough implications about future milk and dairy product purchase patterns from the figures.

In the background section of this paper, we noted that the Indian population has been growing at a rate of 1.4 percent annually and real GDP has shown an annual growth of 7.5 percent. Combined with the NDDB Roadmap income elasticity of 0.6, these growth rates indicate an annual growth in dairy product consumption of 5.9 percent. Weighting the income elasticity estimates by the percentages of population in rural India (70 percent) and urban India (30 percent) yields an income elasticity of 1.27 [23]. This elasticity and the population and income figures used in the previous example predict an annual increase in dairy product consumption of 10.9 percent in India.

These crude forecasts of increases in dairy product purchases suggest that strong demand for India's dairy products will prevail in the future. Moreover, the forecasts suggest that India's domestic dairy industry will be challenged to internally provide the milk supply necessary to keep up with projected domestic purchases. In short, increasing supply by significantly more than recent 4.0 to 5.0 percent annual gains is not a sure bet, nor is the likelihood of milk production increases entering the formal distribution channels. This obviously raises questions about the need for dairy imports to augment domestic dairy product supplies—a complex question discussed later.

As in many parts of the world, India's dairy industry will witness increases in demand for dairy products from the food service industry, the ingredients market and the away-from-home food consumption businesses. Improved milk quality would likely increase the importance of these sources of milk and dairy product demand in India.

Enhancing the Acceptability and Availability of Dairy Products

The NDDB and Nestle (India) have taken steps to enhance the acceptability and availability of dairy products to India's consumers. Presumably the actions would be representative of those taken by other Indian dairy firms to achieve similar objectives.

NDDB Initiatives. As part of its Perspective 2010 Program in 2004–05, the NDDB continued to implement strategies relating to (a) cooperative business development, (b) productivity, (c) quality, and (d) improved use of information for commercial decision making. The cooperative business development and quality improvement strategies have important implications for increasing the acceptability and availability of milk and dairy products.

Under the cooperative business development initiative, the NDDB put effort into tapping the potential of indigenous milk products. The Board described the rationale and impact of this initiative as follows:

> *Recognizing the popularity and market potential of indigenous milk products, NDDB has developed technologies to manufacture paneer, dahi and other fermented products. The introduction of semi-mechanized production lines and improved packaging systems has considerably increased product quality and shelf life. Cooperatives have introduced several of these products. The steady growth over the last few years has led to dairy cooperatives' annual production of approximately 70,000 MT of indigenous fermented products. [66, p. 11]*

This product differentiation and quality improvement initiative has increased the production of indigenous fermented products by India's dairy cooperatives

from about 26.6 thousand MT in 1990–2000 to the 70 thousand MT figure noted above (a 163 percent increase). The NDDB also has worked with dairy cooperatives to develop new dairy desserts, including low-calorie varieties.

Implementation of the NDDB's quality improvement strategies included the following initiatives affecting cooperative societies under the Board's clean milk production program, which covers nearly 32,000 villages [66, p. 19]:

- Acquisition of 794 milk coolers.
- Acquisition of 8,558 automatic milk collection units.
- Installation of 31,890 electronic milk testers.

These changes were augmented by a US$7 million Government of India program for "Strengthening Infrastructure for Quality and Clean Milk Production," which helped cooperative milk unions to install more bulk milk coolers.

Other quality improvement initiatives included the addition of 50,000 stainless steel cans, increased emphasis on maintaining cold chains, and proper retail milk and dairy product storage. The addition of stainless steel cans is potentially important. Such cans are more effective for maintaining milk quality early in the marketing chain than the plastic gerry cans used in some developing countries for transporting milk from the farm to cooling stations or purchase points.

Nestle's Initiatives. Nestle is known world wide for its emphasis on product differentiation as a strategy for increasing the acceptability and profitability of its products. Nestle's dairy strategies in India are no exception. Selling branded products made from high-quality raw milk is part of the company's strategy in India.

Nestle is attempting to move toward European standards in terms of the quality of raw milk that the company purchases. To obtain higher quality raw product, Nestle has placed more than 600 bulk milk cooling tanks on the farms that supply its Punjab dairy plant, allowing more of the farms that supply Nestle's plant to cool milk to temperatures that will limit the growth of bacteria within two to three hours of milking.

Nestle pays volume premiums to farmers who produce large quantities of milk. The size of the quantity premiums is unclear, however, the study team witnessed noteworthy expansion initiatives on some Punjab farms that supply Nestle. When finished with the expansion, some of these farms will resemble those commonly found in Western Europe and the U.S. Presumably the volume premiums paid by Nestle provide part of the incentive for farm modernization and expansion activities.

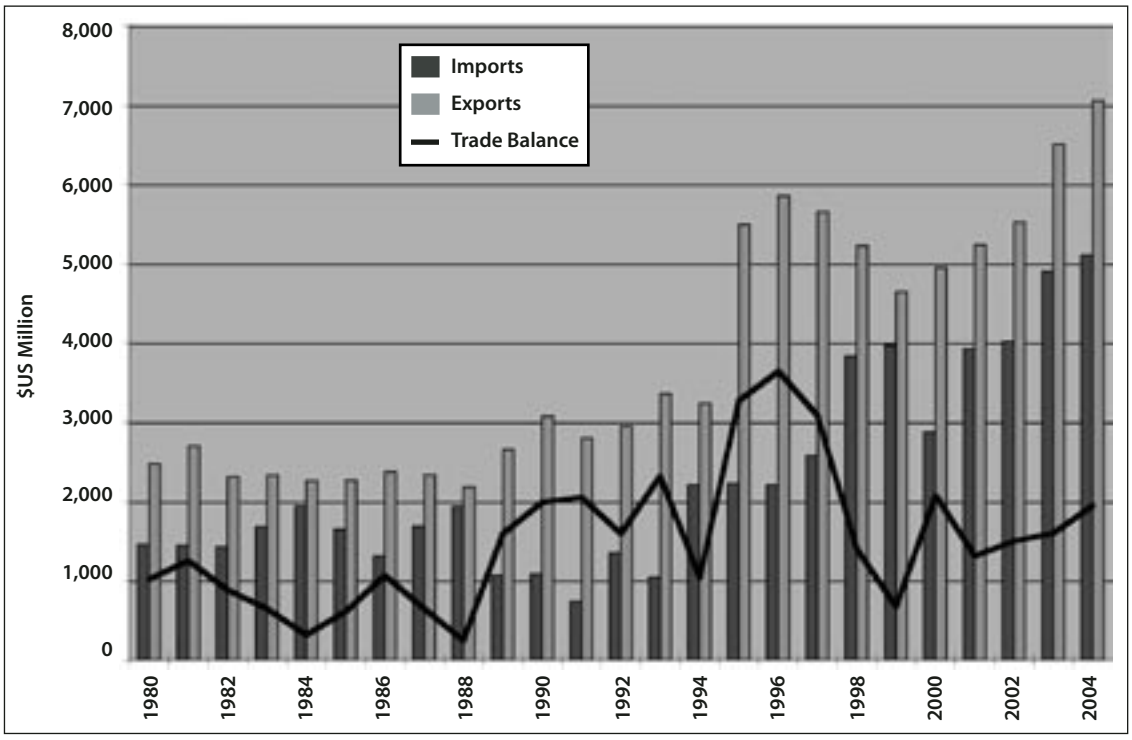
While Nestle is regarded as a formidable competitor in world markets, the firm has encountered significant challenges in India's dairy markets. This has led Nestle to rationalize its dairy portfolio, including a withdrawal from the butter market and from certain other specialized, fermented product markets [29]. Nestle's sales of UHT milk have also failed to meet company expectations. Nestle believes that it has a competitive advantage for serving the away-from-home market, including sales through vending machines [29].

In many respects, the product differentiation and quality improvement strategies pushed by the NDDB and Nestle are familiar. Variations of these strategies are found in the dairy industries of other countries, especially in those where incomes of sizeable groups of consumers are rising. However, there is one important difference. In India, it is unclear how consumers define dairy product quality. This ambiguity is reflected in the fact that prices for milk sold in the formal and informal markets are essentially the same in many locations. Many consumers boil all milk, including pasteurized milk, suggesting that in their minds all milk is pretty much the same. As noted earlier, this perception may change as consumers gain income and appreciation for the difference in the quality of products.

India's Agricultural Trade

Since becoming a member of the WTO on January 1, 1995, India has substantially increased international trade in agricultural products (Figure 14), but Indian agricultural trade remains small, both by world standards and in comparison to trade in other goods and services. The latest available FAO data (2004) show agricultural exports of US$7.1 billion and imports of US$5.1 billion [33]. By comparison, China recorded

FIGURE 14. India Agricultural Trade



Source: FAO, [33].

agricultural exports of US$17.3 billion and imports of US$32.8 billion in 2004. In 2004–05 (April-March), agricultural imports represented 3.5 percent of total India imports and agricultural exports were 10 percent of total exports. India's agricultural trade balance has been positive since 1980 and was in excess of US$3 billion in the first three years after joining the WTO.

India's agricultural imports are dominated by vegetable oils, mainly palm and soybean oil. Edible oil imports averaged about two-thirds of total agricultural imports in 2003–04 and 2004–05 (April-March) [42]. Imports of pulses and raw cashew nuts each added about 10 percent. Agricultural exports are more varied and less concentrated than imports. Wheat, rice, and oil meals have recently topped the list of exports. Exports of wheat and rice are sensitive to the Indian government's domestic procurement and feeding program.

India's Dairy Trade

Dairy trade is a small part of India's small agricultural trade portfolio. In 2004, India had dairy exports of US$78 million and imports valued at US$11 million [33]. Exports were record high in 2004, buttressed by large exports of casein. Together with SMP, WMP and butter/ghee comprised 94 percent of 2004 dairy export value (Figure 15).

India's dairy imports consist mainly of butter/ghee, some hard cheeses, and dry whey products. Butter/ghee imports were one-fifth of exports (Figure 16).

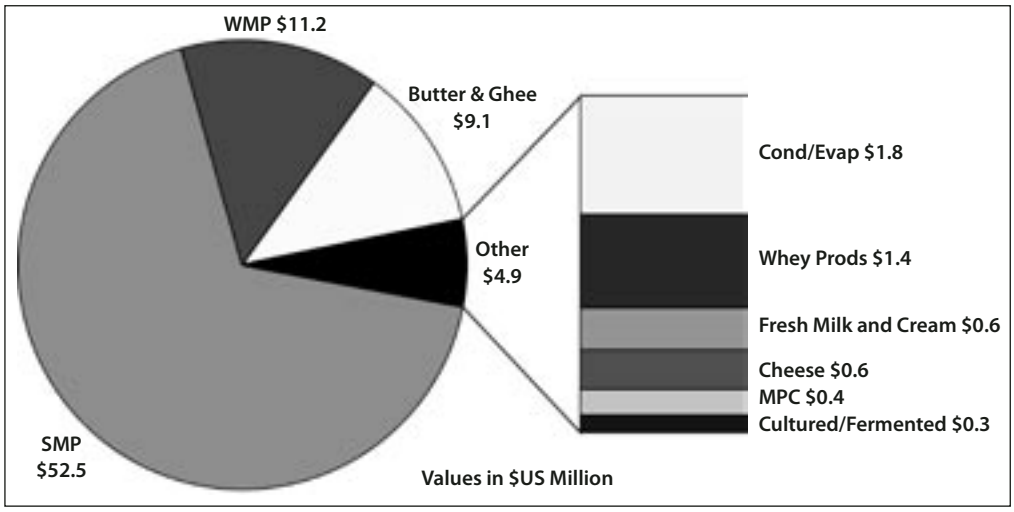
Both imports and exports are highly variable from year to year. India's dairy trade balance has ranged from US$30 million to US$65 million between 1989 and 2004 (Figure 17).

India's very small volume of dairy product imports is due partly to restricted market access through import tariffs and partly to sanitary requirements for some products [35]. In 2001, India removed all quantitative restrictions on agricultural imports.

U.S.-India Dairy Trade

U.S.-India dairy trade is small and decidedly one-sided (Figure 18). In 2005, the U.S. exported less than US$3 million in dairy products to India and imported

FIGURE 15. India Dairy Exports, 2004



Source: FAO, [33].

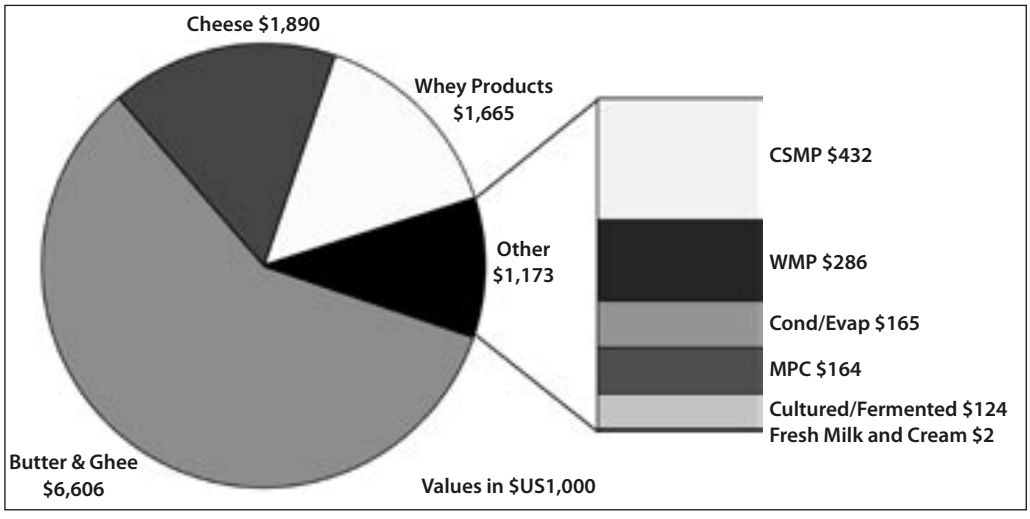
US$60 million. Nearly all of the U.S. dairy imports from India in 2005 were in the form of casein and caseinates. Casein imports totaled US$53 million, and India was the third largest supplier of casein, behind Ireland and New Zealand. The value of casein imports from India nearly doubled between 2004 and 2005.

Most U.S. dairy products are restricted from India by sanitary/health certification rules adopted in 2004. Among other things, these rules prohibit imports of dairy products derived from animals administered supplemental recombinant Bovine Somatatropin (rBST or BGH) or subjected to estrogenic treatment. Since these products are widely used in the U.S., most exporters cannot meet these standards [35].

In pessimistically summarizing dairy trade opportunities for the U.S., USDA's Foreign Agricultural Service noted in 2005 that:

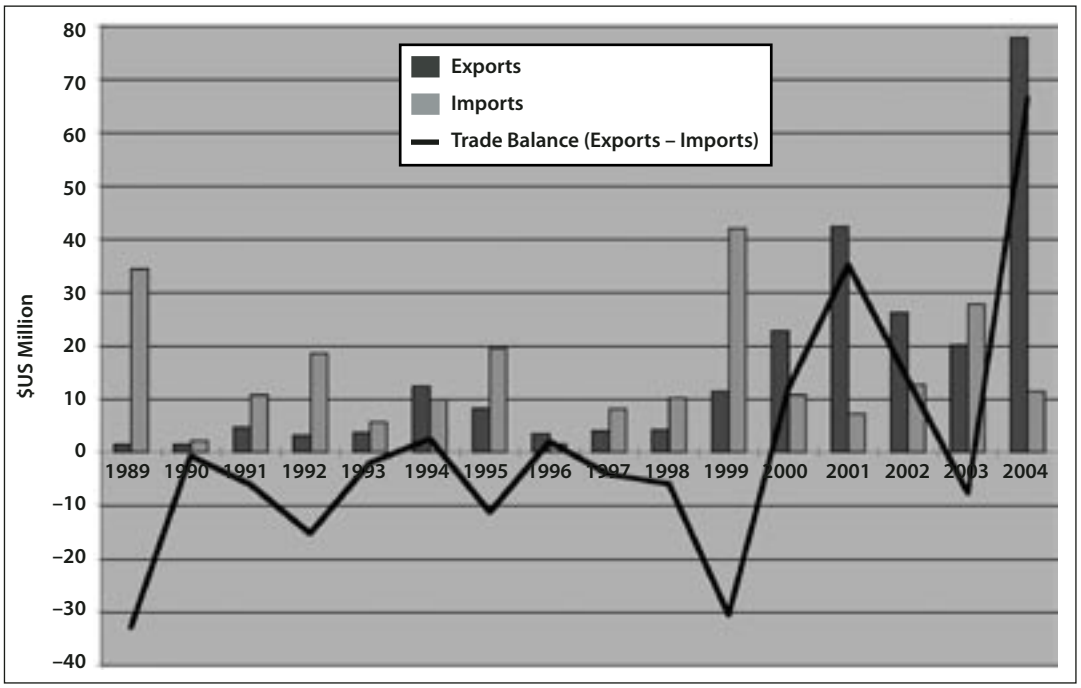
> *. . . the current GOI sanitary conditions effectively restrict imports from all countries except for a few EU member countries that are able to certify to these conditions. Australia and New Zealand have a cost advantage over the United States due to their geographical proximity [37].*

FIGURE 16. India Dairy Imports, 2004



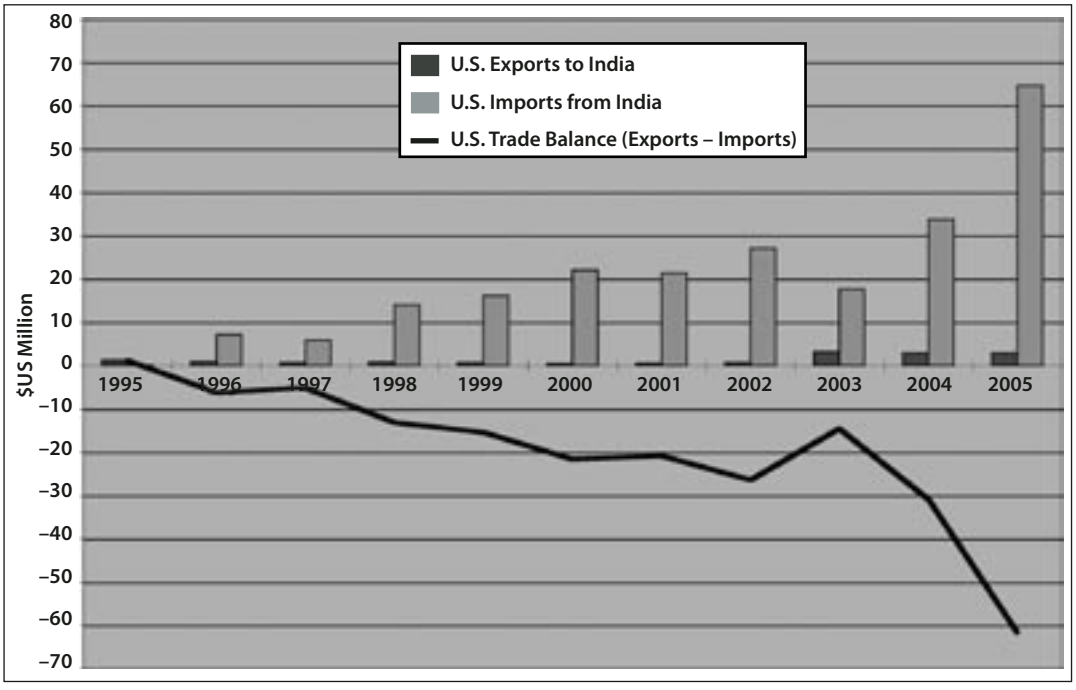
Source: FAo, [33].

FIGURE 17. India Dairy Trade Balance



Source: FAO, [33].

FIGURE 18. India Balance of Trade in Dairy Products



Source: USDA, FAS [34].

India Dairy Trade Prospects

Dairy imports are a contentious issue in India. While government policy generally supports more open trade, dairy interests are strongly opposed to allowing greater access to imports. Some of this opposition seems to reflect a misunderstanding of India's current dairy trade balance or, perhaps a general negative perception regarding possible benefits of trade:

> *Cheap dairy products' imports from the West, which grant high subsidies to their farmers, are flooding the Indian markets and are threatening the domestic industry's existence.*
>
> *The country's dairy industry and farming community have been at the receiving end of the influx of cheap dairy products imported from the developed countries after India removed quantitative restrictions from April 1, 2001, under the World Trade Organization (WTO) regime. [79]*

Opposition also comes from those concerned about the impact of more open trade on the fate of rural residents and rural communities:

> *. . . I would like to mention a subject that greatly concerns the NDDB. The subject that concerns me, that concerns all dairymen in India is the evolution of the rules of international trade. We are concerned that the way these rules are developed poses a serious threat to smallholder dairying. . . . Today the World Trade Organization would prefer never to see another Operation Flood with its limits on imports. In fact, probably every country represented at this workshop has agreed to allow free trade in milk and milk products and probably most countries represented at the workshop have low tariffs on dairy commodities, far lower than in the European Union and North America. This is despite the fact that none of the countries represented at this workshop can afford to subsidize milk production and dairy commodity exports to the massive extent done in Europe and North America. And while the Uruguay Round did result in agreements to reduce such subsidies the effect was tokenism and not substantive. [78]*

While charges of vast quantities of subsidized dairy imports into India (except possibly in 1999–2000) are unfounded, the fear is real if current WTO negotiations fail to yield an elimination of export subsidies and require India to allow greater market access. But absent export subsidies, it is hard to imagine profit-seeking exporters being able to compete with India's low-cost internal production.

The Government of India and many agricultural trade groups have expressed a strong interest in maintaining self-sufficiency in dairy and other agricultural products. However, India may experience pressures to import more dairy products in the future if demand for dairy products unfolds strongly in response to increases in population and incomes.

Alternatively, if strong internal demand for dairy products fails to materialize, India, as the largest milk producer in the world, may feel pressures to export dairy products. For example, if India's real GDP growth should moderate to 4.5 percent, and assuming an income elasticity of demand of 0.6 percent and population increases of 1.4 percent year, then domestic dairy product purchases in India might increase at only about 4.1 percent per year. Under such a scenario, projected domestic supplies of dairy products could put strong downward pressure on prices and increase the incentives of dairy firms to export.

Which firms would export? Which dairy products would the firms export? What would be the destination of the exports?

The GCMMF would likely be an important exporter. The Federation reported dairy exports of rupees 1.15 billion (about US$25.6 million) in 2004–05, which represented a trebling of export value from year-earlier levels. In value terms, the Federation's dairy exports represented about a third of India's total dairy exports in 2004–05. However, the study team was told that the Federation's dairy exports represented about 50 percent of India's total dairy exports.

The Federation said the reasons for the increase in the organization's dairy exports in 2004–05 and the export products involved were as follows:

> *The reduced subsidies of the EU have given us excellent opportunities for export of SMP and WMP. We have shown that if a level playing field is granted, Indian dairy products would be successful in the global market. We have also grown by 40 percent in consumer pack exports and consolidated our exports of UHT, milk, ghee and paneer in particular. [45, p. 12]*

The GCMMF reports that its dairy exports reach some 24 country markets across the globe. While there is little detail on the relative importance of the different markets, the Federation obviously has "beachheads" that could be expanded if it becomes profitable for the organization to substantially expand dairy exports.

Nestle of India reported to the study group that it exported relatively small amounts of dairy products. It is unclear which firms account for the one-half to two-thirds of the dairy exports not accounted for by the GCMMF.

Summary Observations: Marketing and Trade

India's dairy marketing and processing firms face generally favorable demand prospects. Indeed, the industry may be challenged to produce enough milk and dairy products to satisfy prospective demand. Improving the price-quality link remains a challenge. The formal market sector cannot expect to make large inroads into the large informal market sector if consumers regard product from the two sectors as largely interchangeable and, at least in some locations, are unwilling to pay a price premium for formal market products. Finally, the import-export situation in India remains uncertain. If milk production keeps up with prospective demand, expect India to continue to remain approximately self-sufficient in milk and dairy products.

GOVERNMENT POLICIES AFFECTING DAIRY

General Agricultural Policies

Since its independence in 1947, a primary goal of Indian agricultural policy has been food self-sufficiency. This goal has been pursued through direct and indirect support for the farming sector to reduce cash costs of production and through setting minimum prices for food crops that stabilize and enhance revenue.

Direct support includes input subsidies for production inputs and services with the largest subsidies going for fertilizers and irrigation. Fertilizer subsidies go to both farmers and fertilizer manufacturers and are made available to farmers at fixed prices below market prices. For imported fertilizer, the difference between the import cost and the fixed price is subsidized. For fertilizers produced domestically, manufacturers are paid a subsidy representing their economic costs of manufacturing and distributing fertilizers. The total fertilizer subsidy in 2005–06 is estimated at US$3.7 billion [42].

Irrigation is subsidized in two ways: (1) through charging less than market rates for electrical power used for pumping groundwater, and (2) through public investment in surface water distribution systems and covering distribution costs. Power and water subsidies were estimated to be $6.4 billion in 2003–04 [36].

Minimum procurement prices apply to a large number of crops. For rice and wheat, the primary food crops, the minimum prices serve as intervention prices. That is, the government purchases these commodities for storage and distribution under the Indian Public Distribution System, which supplies foodstuffs at subsidized prices to the poor. Since the government accepts all rice and wheat offered at the announced support prices, purchases vary according to crop size and private sector demand.

Good crops and reduced consumption in the late 1990s led to large government purchases and a buildup of government rice and wheat stocks. The Indian government was forced to subsidize exports in order to reduce stocks to a manageable level. Later, stocks were depleted and in 2006, the government needed to import wheat in order to meet its distribution needs.

Indirect forms of government support for farmers include agricultural research and outreach, underwriting crop insurance, and financial and institutional support for cooperatives, including farm credit cooperatives.

Direct support in the form of subsidies and minimum prices is limited to the crop sector of Indian agriculture. Livestock and dairy are not directly supported, but receive some indirect support through induced pro-

duction of crops that yield by-products and residues for feeding to livestock. At the same time, subsidies and price guarantees for specific crops restrict the area devoted to other unsupported crops, notably fodder.

More generally, current agricultural supports have been criticized for "locking in" crop production patterns that are becoming increasingly separated from domestic consumption patterns [36,32]. Expanding consumer incomes in areas with strong economic growth has increased demand for horticultural crops, poultry and dairy products, and edible oils. Current support policies provide little incentives for shifting production to higher-demand products.

Subsidies have also been criticized for causing mining of groundwater and for restricting private investment in agriculture. In separate reports, the International Food Policy Research Institute concluded that:

> *. . . uncontrolled exploitation of groundwater has led to serious depletion of the water table in many parts of the country. Overexploitation is encouraged by the policy of massive underpricing of electricity for agricultural use, with a few states having made electricity for farmers completely free. [1, p. 18]*

> *Today input subsidies, together with food subsidies, amount to roughly five to six times the public investment in agriculture. With a burgeoning subsidy bill and shrinking public investment, the growth impetus for agriculture has been declining. Private investment in agriculture has been increasing, yet it has not fully compensated for the loss from falling public investment. [93, p. 2]*

The 2004 Indian national elections resulted in a new coalition government (United Progressive Alliance, or UPA) led by the Indian National Congress Party. The UPA-selected Prime Minister, Dr. Manmohan Singh, recently noted in an interview:

> *The future direction of policy clearly has to recognize that we are no longer in an era of chronic shortage, and that our emphasis now has to be on providing rapid growth in agriculture-based livelihoods. For this we would need to correct the various distortions that have crept into our policy framework both in terms of geographical focus as well as incentives to specific crops. It is necessary for us to create conditions whereby farmers can respond to market signals in deciding what and how much they produce and to whom they sell. [52, p. 4]*

Prime Minister Singh's remarks suggest the possibility of meaningful reform of agricultural policies. But agricultural reform is not an easy task in India because of the involvement of states—states must agree to and implement policies recommended and funded by the central government. Given the diversity of agriculture among states, acrimony is more likely than harmony.

Dairy Policies

Economic conditions existing in India in the decade following independence created an environment that gave rise to unique policies and institutions that shaped the development of the country's dairy industry. In the 1950s and 1960s, India was one of the largest dairy importing countries in the world. For example, India's commercial imports of milk powder peaked at more than 50,000MT in 1963–64. This contrasts sharply with the zero milk powder imports recorded by India in 2005.

The large number of dairy imports in the 1960s stunted development of India's dairy industry causing milk production in the country to plateau at about 20 to 22 million metric tons per year in that decade. This happened partly because it was often cheaper for India's domestic firms to import milk powder and butter or butter oil and make reconstituted milk rather than buy milk from India's farmers.

This situation concerned India's policymakers who reasoned that an expanding domestic dairy industry would be a good vehicle for promoting employment and rural development. Moreover, government officials and persons in the dairy industry recognized that India's population growth, urbanization, income growth, the high income elasticity of demand for dairy products, and changes in consumption habits, all might support profitable expansion of the country's dairy industry. Hence, the government of India embarked on an import substitution policy that would produce near self-sufficiency in dairy products. Initially, this policy was basically a dairy cooperative development initiative.

Government Support for Operation Flood

As noted earlier, the vehicles for moving India to near self-sufficiency in milk production were the NDDB and the three-stage Operation Flood program. The NDDB was created in 1965 in response to the then Prime Minister Sh. Lal Bahadur Shastri's call to replicate the Anand model in many other places in India. Specifically, the Prime Minister in a letter to State Chief Ministers described his vision as follows:

> *We envisage a large program of cooperative dairies during the Fourth Plan and this will, no doubt, be based on the Anand model. If we can transplant the spirit of Anand in many other places, it will also result in rapidly transforming the socio-economic conditions of the rural areas. [67]*

Government support for cooperatives under Operation Flood included public investments in milk processing facilities and marketing infrastructure that would be operated by cooperatives. Government assistance was channeled to India's dairy cooperatives in part because of government officials' apparent mistrust of private dairy firms. Cooperatives argued that proprietary firms would buy mostly from big milk producers, pushing out the smallholders. Proprietary middlemen were also criticized on grounds they were rent seekers who received monopolistic profits for services rendered. The latter argument is still being offered today. Indeed, Verghese Kurien in the 2004–05 Annual Report of the GCMMF commented as follows about proprietary firms and middlemen:

> *Starting with Polson, it (Amul) has decimated the evil presence of rent-seeking middlemen from the dairy business in India. [45, p. 14]*

While Kurien undoubtedly appreciated the support of the Government of India for putting Operation Flood on a firm footing, he also distrusted government involvement in business, distrust which he expressed as follows:

> *. . . when the government enters business, the citizens of India get cheated. The greatest repercussions of the government entering into business is that instead of safeguarding people from vested interests, they themselves become the vested interest. [24]*

Kurien also successfully opposed using dairy cooperatives or the NDDB as a place for parking temporarily unemployed government officials.

The successes of Operation Flood and the emergence of India's modern dairy industry from this initiative reflect the impacts of sound management concepts. This is suggested in comments made by Kurien in a speech to the GCMMF:

> (Product Differentiation Strategy) *I have always been a firm believer of the dictum, "Brand is power." A cooperative without a brand can never aspire to survive—let alone thrive—while marketing commodities in today's competitive environment. . . .*
>
> (Rural Employment Strategy) *Thus, even were outsourcing and information technology to reach our rural poor, they can never offer our country a sustainable competitive advantage, leaving us vulnerable to massive disruption should the business move on to other countries where skilled labor is less costly. . . . I therefore put forward my case that cooperative dairying on the Amul Pattern forms a source of assured employment and a sustainable basis for competitive advantage for India. [45, pp. 5 and 7]*

In addition to financial support, the Government of India sharply limited commercial dairy imports from the early years of Operation Flood until the early 1990s. This action was justified in part as protection for an infant industry. The permitted dairy imports were channeled through the NDDB as the exclusive importing agency.

The Lifting of Restrictions on India's Domestic Dairy Industry

India's dairy sector was regulated and protected through restrictions on imports and exports of dairy products and domestic regulations until the early 1990s. The industry became progressively more liberalized after 1991 as a result of changes that culminated in the repeal of certain licensing requirements and changes in the Milk and Milk Products Order (MMPO) to reform India's dairy economy. Among the restrictive measures contained in the MMPO that were eventually

eliminated was one that specified the milksheds from which dairy processors could procure milk.

The reforms adopted for the domestic dairy industry coincided with changes that opened India's dairy industry to limited amounts of international competition. The Government of India reasoned that it would be illogical to retain restrictive domestic regulations while partially opening India's dairy industry to international competition.

Prior to the 1990s, milk procurement, processing and supply to urban consumers was primarily in the hands of cooperatives. The entry of most big proprietary firms into the processing sector was restricted through licensing. As part of broader economic reforms introduced in 1991, licensing of dairy industry firms ended and the industry was opened to private competition. Private investment, foreign capital and new technologies were allowed. In part these changes reflected a desire on the part of the Government of India to increase the production of value-added (differentiated) dairy products.

Within a year after the 1991 reforms, more than 100 new private sector dairy plants were set up in India's dairy industry. Unfortunately, some of the new private plants sold adulterated and contaminated milk products to consumers. In response to this development, the government brought back a licensing system under the MMPO of 1992. This order required the state regulation of dairy plants producing 10,000 to 75,000 liters of milk per day or manufacturing of milk products containing 500 to 3,750 tons of milk solids per year. Plants producing more than 75,000 liters of milk per day or handling more than 3,750 tons of milk solids per year had to be registered with the central government.

The 1992 MMPO defined "milksheds" to refer to the region from which the marketable surplus of milk was to find its way to a processing plant. The edict in the 1992 MMPO relating to milksheds was implemented by state or central government Registering Authorities.

The Government of India amended the MMPO of 1992 to permit efficiencies to be introduced and to facilitate faster growth of the dairy industry. The MMPO was amended in 2001 to require compulsory registration only for larger dairy plants that processed more than 20,000 liters pay day. The MMPO was last amended in 2002 with the following changes [87]:

- Restrictions on setting up new milk processing capacity were eliminated. However, plants processing 200,000 liters or more of milk per day or 10,000 or more metric tons of milk solids per year were required to register with an appropriate state government or union territory government.
- The time required for granting registration certificates was reduced from 90 to 45 days.
- The practice of assigning milksheds by the Registering Authorities was eliminated.
- Dairy processing establishments were required to conform to specified sanitary, hygienic and food safety measures.

Among the most significant changes was the elimination of the specification of milksheds by the Registering Authorities. The defining of milksheds had introduced inefficiencies into milk procurement and artificially limited the amount of milk that certain milk processors could secure. Most private companies applauded the end of the milkshed definition. Some of them were able to substantially expand their procurement area.

Trade Policies

Policies aimed at self-sufficiency in milk and dairy product production were strongly in evidence during Operation Flood. However, India has since become the biggest milk producer in the world. India has low milk production costs, and its large population is likely to exhibit a strong demand for dairy products. Hence, questions relating to how India's dairy industry might change its relationship to international markets can be raised: In the future, will India continue to be largely self-sufficient in milk and dairy products? A dairy importer? A dairy exporter?

Given the rapid growth of population in India, the high rates of income growth, and the relatively high income elasticity of demand for dairy products in the country, it is likely that demand for dairy products will grow strongly for the foreseeable future. Moreover, India's dairy industry does not have extensive expe-

rience in exporting dairy products in a world market environment, which many in India's dairy industry characterize as being distorted by export subsidies, protective tariffs and domestic price support programs. Therefore, it is reasonable to suppose that India's dairy trade policies will focus heavily on seeing that the domestic market is protected and served mostly by domestic firms.

However, India's dairy industry will engage in limited amounts of exporting. Dairy processors will export small amounts of SMP to sell seasonal milk surpluses. Casein and caseinates may also be viable exports and firms in the industry may continue to export UHT milk. The amount of India's dairy exports will depend partly on whether the country's dairy industry can deal successfully with product quality problems, which have limited exports in the past.

While India's government will pursue policies to protect the country's dairy industry from what many describe as unfair foreign competition, India—as a member of the WTO—must abide by the trading practices the country agreed to under the Uruguay Round WTO Agreement. It has done so by converting nontariff barriers to tariffs and by ending the practice of channeling milk imports through the NDDB. Use of the NDDB as the channeling authority, in essence, gave it a monopoly dairy importing authority. If continued, this practice might have drawn challenges from trading partners.

India's tariffs on imports of dairy products might be characterized as moderate (Table 8). Furthermore, the applied tariffs are in several cases substantially lower than the WTO bound tariffs.

The tariffs in Table 8 for NDM and WMP are anomalous. India had agreed to a zero bound tariff for milk powders under the Uruguay Round WTO agreement. Later India renegotiated the zero bound tariffs for these products with the U.S., Australia and the EU under Article XXVIII of the GATT. However, the renegotiation took several months to complete, creating concerns within the industry. It is not clear why India's negotiators agreed to the zero bound tariffs for milk powders in the first place. It may have been reasoned that as a low-cost producer of milk powders, had little to fear from imports of such products.

TABLE 8. Applied and Bound Tariffs for India's Dairy Products

	Tariffs		
Product	**1995–96**	**2003–04**	**WTO Bound Tariffs**
Liquid Milk	40%	35%	100%
SMP	0	15	60
WMP	0	15	60
Yogurt/Buttermilk	40	35	150
Whey Powder	40	35	40
Butter	40	46	40
Dairy Spreads	40	46	40
Cheese & Curd	40	35	40

Source: [16].

India is likely to insist upon being permitted to designate a number of dairy products as special products in the agricultural trade negotiations. This action will allow the country to limit market access via the continuation of restrictive tariffs for certain dairy products and not expand market access as much as will be required of countries such as the U.S., EU and Japan under the Doha Round. Use of the special product designation to promote rural employment and development is consistent with provisions of the July 2004 WTO Framework for Modalities for completing the Doha Round negotiations. Moreover, India undoubtedly has the clout needed to obtain special product status for certain dairy products, since it is a leader of the Group of 20 developing countries (G-20) that has achieved noteworthy results in the Doha Round.[2] The G-20 has made it clear that their negotiating bloc—not just the U.S. and EU—must be satisfied with the agricultural provisions of the new trade agreement before the Doha Round will be completed.

[2] The Group of 20, also variously known as G21,G22 and G20+, is a bloc of developing nations established on August 20, 2003. Proposals advanced by the Group of 20 first emerged in September 2003 at the Cancun, Mexico WTO Trade Ministerial Meetings. In March 2006, the membership of the Group of 20 consisted of the following countries: Argentina, Bolivia, Brazil, Chile, China, Cuba, Egypt, Guatemala, India, Indonesia, Mexico, Nigeria, Pakistan, Paraguay, Philippines, South Africa, Tanzania, Thailand, Uruguay, Venezuela and Zimbabwe.

While India is likely to pursue policies that limit imports of dairy products for the foreseeable future, scenarios can be constructed that would change this result. A NDDB Road Map Group developed a plan under which India's domestic milk production would rise from 91 million metric tons per year to about 170 million metric tons per year by 2021 or 2022. The approximately 5 percent per year increase in milk production embodied in this plan would be achieved by increasing the productivity of the existing number of dairy animals. If milk production increases as specified in the plan and demand for dairy products exhibits recent trends in the future, then most of India's domestic requirements for dairy products under this scenario could be met by domestic producers.

However, different scenarios are possible. For example, a Nestle official described for the study team a high economic growth scenario under which an additional 200 million people in India would enter markets to purchase at least two meals per day. He said that under this scenario India would import more of almost everything, including dairy products. It is beyond the scope of this study to assess whether the latter scenario is likely to materialize. However, it would be imprudent to entirely rule out the possibility of a high economic growth scenario that would carry with it substantially greater dairy imports by India.

Summary Observations: India's Dairy Policies

Many policies affecting India's dairy industry, particularly Operation Flood, must be regarded as successful. India's dairy policies helped to facilitate cooperative development and rural employment-development objectives. These policies may continue to be successful, especially if productivity on India's small dairy farms can be improved. However, if productivity on the small farms languishes, India's policymakers may find that the country will need to import more dairy products to satisfy India's burgeoning demand. Such a development would not necessarily require India to abandon the import substitution—self-sufficiency policies pursued for the dairy industry since the 1970s. To avoid the consequences of any stagnating productivity on the smaller farms, India's policymakers might find it useful to help foster growth of some larger farms (or at least not discourage growth of such farms) where productivity may be greater to ensure that most of the demand for dairy products can be satisfied by domestic producers. Potential exporters of dairy products to India will find it useful to monitor the decisions of India's policymakers with regard to dairy self-sufficiency issues.

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