# 18 From Plate to Plow: Agricultural Diversification in India

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The sustained growth of India's GDP at 5 to 6 percent per annum and of its per capita income at about 3.5 percent per annum over the past two decades has brought about major changes in consumption patterns across the country. Preference is shifting from basic staples toward high-value agriculture such as fruits, vegetables, and dairy, poultry, and fishery products. The dietary mix and flavor are changing fast on the plates and palates of Indian consumers.

Interestingly, this change is happening not only in the upper-income brackets of the Indian population but even below the so-called poverty line. For example, the National Sample Survey Organization (NSSO) estimates that the per capita consumption of cereals by people below the poverty line declined by 10 percent over the period 1983 to 1999–2000. On the other hand, their consumption of milk increased by 30 percent, of vegetables by 50 percent, of fruits by 63 percent, and of meat, eggs, and fish by 100 percent over the same period (Table 18.1). These percentage changes in the consumption of high-value agricultural products in the poorest segments of the population point to a silent revolution.

This revolution is also reflected in the rapidly rising exports of high-value agriculture, especially fruits and fish, during the past two decades (Figure 18.1). Given the perishable and high-value nature of these commodities, the growth in their export has strong implications not only for producers but for financiers, processors, exporters, and the retail chain industry, too. It also has repercussions for the institutional innovations that are emerging to link the plate to the plow—efforts to link changing consumer preferences and rising exports of high-value agriculture to the production decisions of the growers.

What could be driving this silent revolution? Besides rising incomes, changes in relative prices between cereals and high-value agricultural products, increasing urbanization and infrastructure, and more open trade policies are behind this changing scene (Kumar and Mathur 1996; Joshi et al. 2002; Kumar and Mruthyunjaya 2002).

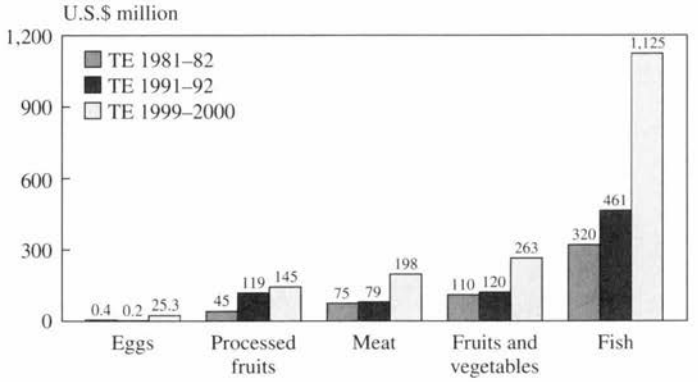
Changing relative prices are resulting from a mix of technology impacts as well as changing demand pressures. While the green revolution (wheat and

**TABLE 18.1** Annual per capita consumption of various commodities in India, by income group and urbanization of setting, 1983 and 1999–2000 (kilograms)

| | 1983 | | | | 1999–2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Lower-income group | Upper-income group | Rural | Urban | Lower-income group | Upper-income group | Rural | Urban |
| Cereals | 147.1 | 194.3 | 181.5 | 141.7 | 132.4 | 154.6 | 157.3 | 131.1 |
| Pulses | 7.6 | 17.7 | 11.1 | 12.4 | 6.9 | 16.6 | 11.2 | 14.7 |
| Edible oils | 2.6 | 7.3 | 3.5 | 6.1 | 4.6 | 13.7 | 8.4 | 13.3 |
| Vegetables | 36.0 | 65.2 | 46.0 | 50.9 | 53.9 | 90.8 | 74.3 | 79.1 |
| Fruits | 1.6 | 6.4 | 2.8 | 46.2 | 4.2 | 18.2 | 9.6 | 35.6 |
| Milk | 15.7 | 89.7 | 37.0 | 55.5 | 20.5 | 117.2 | 63.3 | 90.7 |
| Meat, eggs, and fish | 1.9 | 4.8 | 3.9 | 1.4 | 3.8 | 10.6 | 6.7 | 9.5 |

SOURCE: Kumar and Mruthyunjaya (2002).

**FIGURE 18.1** Indian exports of nontraditional crops, 1980s and 1990s




SOURCE: Joshi et al. (2002).

rice) technology was running out of steam in the 1980s, technological and marketing boosts were given to dairy products, fruits, vegetables, poultry, fish, and so on. Thus, this high-value segment of agriculture, within and outside the crop sector, started increasing its share. Sizable changes took place within the crop sector, with the share of foodgrains, the hallmark of food security, giving way to high-value nonfoodgrains. From the triennium ending (TE) 1981–82 to TE 1998–99, the share of foodgrains in the value of the output of the crop sector fell from 48 percent to 40 percent, while in terms of area it fell from 70 percent to 65 percent over the same period (Joshi et al. 2002).

By the end of the 1990s, surpluses of cereals and storage costs were rising rapidly and putting greater pressure on the farming community and policymakers to explore possibilities for a more remunerative and viable alternative production mix. Diversification of agriculture in favor of noncereals and high-value commodities such as fruits, vegetables, milk, meat, eggs, fish, and so on continues to offer such an alternative. These commodities are also emerging as promising sources of income augmentation, employment generation, poverty alleviation, and export promotion (Jha 1996; Chand 1996; Vyas 1996; Delgado and Siamwalla 1999; Ryan and Spencer 2001; Joshi et al. 2002).

Therefore, it is important to diagnose the production-consumption linkages in the context of agricultural diversification. This requires identification of the driving forces that alter the production portfolio and the consumption basket.

It is important to understand how the production portfolio is being transformed in response to changes in the consumption basket, in a scenario where smallholders dominate Indian agriculture and the majority of consumers live in rural areas. The available evidence shows that the primary production centers of high-value commodities are largely concentrated with smallholders. There

is also evidence to show that small farm holders are relatively more efficient in producing these commodities (Jha 2001). Unfortunately, due to their tiny amounts of marketable surplus and lack of access to appropriate markets and information, their transaction costs are too high. This does not permit them to take full advantage of the changing scenario in domestic consumption patterns and rising exports of high-value products. Therefore, it is imperative to establish strong and cost-effective linkages between plow and plate and to examine the role of innovative institutional arrangements for integrating production and consumption.

In the first section of this chapter, we trace the nature of agricultural diversification in some detail, then examine what is driving that trend. Thereafter we probe consumption patterns and review the types of institutional arrangements that are emerging between growers and processors or exporters in some selected segments of Indian agriculture. In the final section we highlight some policy implications.

## Agricultural Diversification in India

### *Our Approach*

We make a shift from the usual definitions of agricultural diversification to a definition that emphasizes movement of resources from a low-value commodity mix (mainly foodgrains) to a high-value commodity mix (vegetables, fruits, livestock, fishery products, and so on).[1] The information we use is collated from three ongoing studies on (1) constraints and opportunities related to agricultural diversification in south Asia, (2) diversification in food baskets, and (3) innovative institutions for accelerating diversification on small farms. Our analysis covers the decades of the 1980s and 1990s. A comparison between the two decades is expected to provide some useful insight into the implications of economic reform for agricultural diversification and the consumption basket.

### *The Nature, Speed, and Determinants of Diversification*

Those promoting agricultural diversification in India are gradually choosing to emphasize high-value crops and livestock activities that augment incomes rather than resorting to a coping strategy to manage risk and uncertainty. Crops, livestock, fisheries, and forestry constitute the core subsectors of agriculture. The crop subsector is the principal source of income in agriculture, followed by the livestock sector (Joshi et al. 2002). There is strong synergy in the crop and livestock subsectors, which are complementary to one another. The fishery subsector is prominent in the coastal areas, forestry in the hilly regions.

1. The usual definitions are (1) shift of resources from farm to nonfarm activities and (2) use of resources in a larger mix of diverse and complementary activities within agriculture.

The share of the crop subsector in the agricultural GDP marginally declined during the 1980s (from about 76.25 percent in TE 1981–82 to 73.65 percent in TE 1990–91), then slowly recovered during the 1990s (rising to 74.91 percent in TE 1998–99) (Joshi et al. 2002). This happened due to the normal monsoon rains during most of the 1990s and the greater emphasis on and higher level of production of horticultural crops. On the other hand, there was an increase in the share of the livestock subsector during the 1980s, from about 18 percent in TE 1981–82 to 23 percent in TE 1990–91. Later, though the value of livestock during the 1990s nearly doubled, its share in the sector remained stagnant at 23 percent. This was because the value of the larger crop subsector increased relatively higher than that of the livestock subsector and hence masked the latter's performance. The same was true for the fishery subsector, the value of which swelled by about 50 percent during the 1990s, though its share in agricultural GDP declined marginally, to about 1 percent in TE 1998–99 from 1.35 percent in TE 1990–91.

DIVERSIFICATION WITHIN THE CROP SUBSECTOR. The trends show that nonfoodgrain crops have gradually replaced foodgrain crops, with the area of the former increasing from about 30 percent of the total crop area in TE 1981–82 to 35 percent in TE 1998–99. This trend was more pronounced in terms of value—from about 52 percent to 60 percent (Joshi et al. 2002). Coarse cereals were mainly replaced by nonfoodgrain crops such as oilseeds, fruits, vegetables, spices, and sugarcane.

Cereals continued to dominate the foodgrain crops and accounted for more than half (53 percent) of the gross cropped area in TE 1999–2000, compared to 59 percent in TE 1981–82. Crop diversity within the cereal sector declined during the past two decades, much faster during the 1990s than in the 1980s. The sown area and production of rice, wheat, and maize increased, while the sown area of barley, millet, and sorghum decreased rapidly. The expansion of the area sown in wheat and rice was mainly on account of the availability and large-scale adoption of remunerative and stable technologies as well as favorable and assured government policies on the prices and procurement of these crops. Maize, on the other hand, emerged as an important crop mainly to meet the requirements of the booming poultry sector. The availability of improved maize hybrids, the flexibility of the maize growing season, and the diverse uses of maize were responsible for its area expansion. The crop is also finding niches in nontraditional areas (e.g., the southern part of India) and seasons (e.g., there is now winter maize). Noncereals, including pulses, were gradually moving toward nontraditional areas, too, and silently increasing.

A swift diversification of agriculture was noted in favor of oilseeds, vegetables, and fruits. Oilseed production jumped remarkably, from 18 million tons (mt) in TE 1981–82 to 30 mt in TE 1991–92, and touched 40 mt in TE 1999–2000. The annual compound growth rate of oilseed production was quite impressive, at 5.35 percent during the 1980s, which slowed down to 2.31 percent

in the 1990s (Table 18.2). The sown area and production of the majority of oilseed crops increased substantially during 1980s, while in the 1990s only soybeans, coconuts, rapeseed, and seed cotton gained in area, and groundnuts, sunflower seed, and linseed lost. The remarkable success in oilseeds was a result of the Technology Mission on Oilseeds (TMO) launched by the Indian government in 1986 to meet domestic demand and control imports of edible oils. The mission encompasses a blend of improved technologies and favorable policies to augment production. Despite the acclaimed success of oilseed production, the country is not globally competitive in the edible oils sector and faces a severe threat to its domestic oilseed producers, so the tariffs on edible oils had to be raised from 15 percent to more than 70 percent during recent years. Sustaining the success of the TMO will depend on how well technical efficiencies can be increased at the production and processing levels.

During the past two decades, the sown area and production of vegetables increased considerably, with the subsector diversifying toward new areas, new crops, and new seasons. India is the second-largest producer of vegetables, next to China. Output grew at an annual rate of 2.53 percent during the 1980s, then slowed to 1.99 percent per annum in the 1990s. Yield increase contributed significantly to higher levels of production in the 1980s, while area expansion was important in the 1990s. The vegetables sector is becoming strong in the urban peripheries and emerging as an important source of income augmentation for small farm holders in water-scarce regions due to the massive subsidies extended by the government on water-saving devices (e.g., sprinkler and drip systems). In addition, the watershed programs gave high priority to vegetable production to enhance the efficiency of conservation of the scarce water in the rain-fed areas.

Fruit production (both fresh and dry) is gaining importance. Production grew at an annual rate of 6.3 percent during the 1990s, rising from about 3 percent in the previous decade (Table 18.2). A large share (approximately 60–65 percent) of increased fruit production in both decades was realized through productivity gains. Indian *desheri* and *alfonso* mangos have an excellent export market. Mango production increased by 67 percent in the 1990s, as did the production of bananas, oranges, grapes, apples, papayas, and pineapples. Dry fruits and spices also gained over the past two decades. Higher fruit production was a result of the changing diet of the high-income group and, on the supply side, of the government's initiatives in food processing. During the mid-1980s, a new ministry on food processing was set up to strengthen agroprocessing, reduce postharvest losses, and enhance value addition. Private sector participation in fruit processing is growing, though slowly.

In summary, during the 1980s, oilseeds, fruits, and vegetables performed impressively in all regions of India. While the TMO resorted to high levels of protection to encourage the expansion of oilseed production, the government opted for the establishment of the National Horticultural Board in 1984 to promote the integrated development of horticulture by coordinating, stimulating,

**TABLE 18.2** Temporal changes in area and annual compound growth rates of area, production, and yield of major commodity groups in India, 1981–82 to 1999–2000

| Commodity group | Average area (in thousands of hectares) in triennium ending | | | Annual compound growth rates (percent) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1981–90 | | | 1991–2000 | | |
| | 1981–82 | 1991–92 | 1999–2000 | Area | Output | Yield | Area | Output | Yield |
| Cereals | 104,350 | 102,279 | 101,190 | –0.20 | 3.32 | 3.53 | 0.20 | 2.22 | 2.01 |
| Pulses | 22,780 | 23,817 | 23,442 | 0.08 | 2.50 | 2.42 | 0.08 | 0.66 | 0.58 |
| Oilseeds | 26,675 | 33,004 | 37,471 | 1.79 | 5.35 | 3.50 | 0.94 | 2.31 | 1.36 |
| Vegetables | 5,064 | 5,738 | 6,767 | 0.41 | 2.53 | 1.09 | 1.48 | 1.99 | –0.50 |
| Fruits | 2,239 | 2,638 | 3,567 | 1.04 | 2.98 | 1.92 | 2.38 | 6.30 | 3.83 |
| Spices | 1,627 | 1,848 | 2,142 | 1.45 | 5.13 | 3.64 | 0.55 | 2.73 | 2.17 |
| Fiber crops | 1,354 | 777 | 800 | –7.43 | 0.53 | 8.61 | 0.87 | 0.91 | 0.04 |
| Dry fruits | 646 | 766 | 1,030 | 1.59 | 3.87 | 2.24 | 3.87 | 4.52 | 0.63 |
| Miscellaneous | 11,762 | 13,470 | 14,084 | 1.39 | | | 0.59 | | |

SOURCE: Joshi et al. (2002).

NOTE: Blank cells indicate that data are unavailable.

and sustaining the production and processing of fruits and vegetables. To further promote the horticulture sector for domestic and global markets, adequate attention must be given to the development of infrastructure and effective quality control.

DIVERSIFICATION WITHIN THE LIVESTOCK SUBSECTOR. The livestock subsector is also growing rapidly. Its share in the total value of agricultural output is progressively rising (Birthal and Parthasarathy 2002). Milk accounted for around 68 percent of the total value of livestock products during the past two decades (Joshi et al. 2002). The remaining 32 percent of livestock products is distributed over several items, such as meat, poultry, wool, and so on. Milk production more than doubled, from 33 mt to 71 mt over TE 1981–82 to TE 1998–99, with an annual compound growth rate of about 4.62 percent. The growth rate of milk production was much higher, at 5.23 percent in the 1980s than in the 1990s (3.46 percent). Such a breakthrough was aided by the Operation Flood Program, which was launched to accelerate the progress and rapid development of the dairy sector.

The meat and poultry subsectors registered good performance, increasing from a low of 0.80 mt in TE 1982–83 to 2.73 mt in TE 1991–92 and finally to 4.41 mt in TE 1998–99, with an annual compound growth rate of about 5.81 percent in the 1980s vis-à-vis 3.90 percent in the 1990s. Meat's share in the value of livestock grew from 6.6 percent in 1982–83 to 8.4 percent in 1989–99 (Birthal and Parthasarathy 2002). The large increase in meat production over the 1980s was due partly to the severe drought in 1987 in most parts of the country. An acute shortage of green and dry fodder forced the disposal of less productive animals at a large scale. Poultry, too, flourished during the 1980s, with its share in the value of livestock rising from 7.8 to 9.6 percent between 1982–83 and 1998–99 (Birthal and Parthasarathy 2002). The share of poultry and goat meat in the total value of meat production went up from 66 percent to 77 percent. Similarly, egg production increased by 8.46 percent annually in the 1980s as against 4.60 percent annually in the 1990s. Unlike the dairy sector, the poultry sector grew with the help of the private sector, which controls roughly 80 percent of total production.

The future of the livestock sector is quite promising, because it still has a huge potential to raise the production, consumption, and export of different livestock commodities. Meat production, for instance, is mostly confined to the unorganized sector and is just waiting for modern slaughter facilities and the development of cold chains to take off in a big way.

DIVERSIFICATION WITHIN THE FISHERY SUBSECTOR. The fishery subsector has seen a gradual shift from marine to inland fisheries. Traditionally, marine fisheries, accounting for more than 75 percent of the total production in 1960–61, used to dominate fish production. In recognition of the importance and potential of the fish sector in the inland areas, a greater impetus was accorded to inland fisheries. The share of marine fisheries in the sector's total production fell

to about 54 percent in TE 1999–2000, while that of inland fisheries rose to about 46 percent, from less than 25 percent in 1960–61. The annual compound growth rate of inland fisheries was higher, at 6.54 percent, in the 1990s than in the 1980s, when it was at 5.27 percent. Marine fish production, which performed poorly during the 1980s (0.12 percent), improved afterward (2.53 percent). The potential of inland fisheries is still higher, with well-spread locations of rivers, canals, and reservoirs.

The higher rate of growth in inland fisheries is mainly attributed to the overwhelming progress in aquaculture, in both fresh and brackish waters. The share of culture fisheries in the inland sector has gone up, from about 43 percent in 1984–85 to a high level of about 84 percent in 1994–95 (Kumar, Joshi, and Birthal 2001). The bulk of the growth in culture fisheries has come from freshwater aquaculture (Krishnan and Birthal 2000). There is good scope to expand the production of culture and other products in brackish-water areas, because only 10 percent of the available brackish-water areas (12 million ha) had been exploited by 1995–96 (IASRI 2001). The expansion of inland fisheries has also led to some negative externalities related to the degradation of arable lands due to salinity.

The remarkable progress in fisheries was the outcome of a well-knit strategy to augment production, enhance exports, and overcome the poverty of fishermen. Several production- and development-oriented programs were implemented in both marine and inland areas by the freshwater aquaculture, integrated coastal aquaculture, coastal marine fisheries, and fish farmers' development agencies established in freshwater areas and the brackish-water fish farmers' development agencies in brackish-water areas. For better infrastructure facilities, fisheries industrial estates were developed by grouping the fishing villages.

The future of the fisheries sector is bright with the opening up of the economy. There is a promising export market for both marine and inland fish and aquaculture products. In this context, sanitary and phytosanitary issues gain importance. There is a need to focus on quality control, modernize the crafts used in marine areas, and use the full potential of the inland fisheries.

*Determinants of Crop Diversification*

Several forces influence the nature and speed of agricultural diversification from staple food to high-value commodities. Earlier evidence suggests that the process of diversification out of staple food production is triggered by rapid technological change in agricultural production, improved rural infrastructure, and diversification in food demand patterns (Pingali and Rosegrant 1995). These are broadly classified as demand- and supply-side forces. The hypothesis in this study is that demand-side forces, including per capita income and urbanization, and supply-side forces, including infrastructure (markets and roads), technology (relative profitability and risk in different commodities), resource endowments

(water and labor), and socioeconomic variables (pressure on land and literacy rate), influence agricultural diversification.

The generalized least squares (GLS) technique with a fixed-effect model is applied to examine how different forces have influenced crop diversification in India. The analysis is based on the pooling of cross-section and time-series information from major states (19 out of 28) in India for the period from 1980–81 to 1998–99.[2] The GLS technique eliminates the effect of heteroscedasticity that arises due to cross-section data and the autocorrelation that results from time-series data. The following model is used to examine the determinants of diversification:

$$D_c = \text{f}(tech,\ infr,\ prof,\ know,\ dema,\ rain).$$

The variables are defined as follows. The dependent variable, $D_c$ is defined in two ways: (1) as the Simpson index of diversity in the crop sector ($SID_c$) and (2) as the index of the output values of horticultural commodities at constant prices, with 1980–81 used as the base year. The results for the latter were found to be statistically superior (Joshi et al. 2002) and are therefore used for discussion.

The independent variables are broadly grouped as follows: (1) technology related (*tech*), (2) infrastructure related (*infr*), (3) profitability related (*prof*), (4) resources and information related (*know*), (5) demand-side related (*dema*), and (6) climate related (*rain*). To capture their effect, a few proxy variables are used. For technology (*tech*), these include proportion of area sown in high-yielding varieties of foodgrain crops (percent), fertilizer use (kg per ha), proportion of gross irrigated area to gross cultivated area (percent), mechanization (number of tractors per 1,000 ha). For infrastructure (*infr*), the proxy variables are market density (number of markets per 1,000 ha of gross cropped area) and road length (square km per 1,000 ha of gross cropped area). The relative profitability of high-value enterprises with cereals and other crops is the proxy for the profitability-related variables (*prof*). Average size of landholding (ha) and the proportion of small landholders in total holdings are used as proxies for available resources and rural literacy (percent) for information-related variables (*know*). Urbanization (percent urban population) and per capita income (rupees per person) are used in the model as demand-side variables (*dema*). Annual rainfall (mm) is used to define the climate-related variable (*rain*) in the model.

Different combinations of independent variables have been tried to arrive at the best-fit equations. Both linear and double-log equations have been used and the best ones selected.

The study covers two decades divided into two periods—1980–81 to 1989–90 and 1990–91 to 1999–2000—for two reasons. First, historical evidence shows that the impact of the green revolution gradually faded during the 1980s.

2. Nineteen states in the country are categorized as major and the remaining nine states as small on the basis of geographical area, production, and population size.

**TABLE 18.3** Determinants of diversification in favor of horticultural commodities in India, 1980–81 to 1999–2000 (double-log estimates of generalized least squares)

| | Dependent variable: Index of gross value of horticultural commodities at 1980–81 prices | | |
|---|---|---|---|
| Explanatory variables | Equation 1 | Equation 2 | Equation 3 |
| Irrigation | –0.4575*** (0.0614) | –0.4697*** (0.0607) | –0.5073*** (0.0564) |
| Relative profitability | 0.3549*** (0.04450) | 0.3329*** (0.0411) | 0.3152*** (0.0441) |
| Roads | 0.2873*** (0.0664) | 0.2843*** (0.0665) | — |
| Markets | 0.1261* (0.0710) | 0.1870*** (0.0528) | — |
| Rural literacy | –0.7976*** (0.1458) | –0.8415*** (0.1419) | –0.5497*** (0.1389) |
| Small landholders | 1.1964*** (0.2283) | 1.2016*** (0.2285) | 1.6043*** (0.2002) |
| Urbanization | 0.1840 (0.1438) | — | 0.3050*** (0.1094) |
| Income | 0.4892*** (0.0668) | 0.5082*** (0.0652) | 0.4671*** (0.0686) |
| Rainfall | –0.0583 (0.0422) | –0.0712* (0.0411) | –0.0949** (0.425) |
| Time dummy: 1981–90 = 0; 1991–99 = 1 | 0.8944*** (0.0700) | 0.8839*** (0.0696) | 0.8960*** (0.0722) |
| R-square | 0.7735 | 0.7722 | 0.7572 |
| Adjusted R-square | 0.7642 | 0.7637 | 0.7490 |
| F-statistic | 82.82*** | 90.00*** | 91.40*** |

NOTES: The figures in parentheses are standard errors of the respective coefficients.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Second, the process of economic reforms started in the early 1990s, and India bound itself to the World Trade Organization commitments, which will impact agriculture. The data for the study were collected from various published sources, especially the national statistical bulletins (CMIE 2001).

To examine the forces influencing diversification in favor of high-value commodities, explanatory variables related to infrastructure development, technology adoption, relative profitability, resource endowments, and demand-side factors including urbanization and income level were studied. The double-log estimates of generalized least squares are given in Table 18.3.

To capture the effect of infrastructure development, two important variables, namely markets and roads, were included in the model. Both variables yield positive and significant influence on the diversification of the crop sector. Obviously, better markets and road networks induce diversification in favor of horticulture, because they result in low marketing costs and easy and quick disposal of commodities. They also reduce the risk of postharvest losses of perishable commodities.

Although technology was defined by area sown in high-yielding varieties of cereals, irrigated area, and extent of mechanization, irrigated area turned out to be the most significant and represented the technological advancement in the region. The regression coefficient of this variable shows a negative relationship with diversification, which means that crop diversification in favor of horticultural commodities is declining with increasing irrigated area.

This suggests that crop diversification is more pronounced in rain-fed areas, which are deprived of technological advancement in terms of irrigation. These areas are characterized by low levels of resource endowment but with abundant labor force and were bypassed during the green revolution.

The regression coefficient is significant and positive, because obviously the higher profit of horticultural commodities would induce farmers to diversify in their favor. The relative profitability of fruits is more than 8 times higher than that of cereals, while the corresponding figure for vegetables is 4.8. However, while high profits from horticultural crops encourage their cultivation, price and yield instability limit widespread cultivation. The high price variability of fruits and vegetables is due to poor vertical linkages between production, marketing, and processing. This calls for the development of appropriate institutional arrangements for minimizing the price uncertainty, and more rigorous work needs to be done in this area.

There is a positive relationship between the growth of horticultural commodities and the proportion of smallholders. This indicates that diversification in favor of horticultural products is mostly confined to the smallholders because it is labor intensive and generates a regular flow of income. However, absence of appropriate markets and increase in supply may adversely affect the prices and opportunities for higher income (Joshi et al. 2002).

Rainfall is another variable included in the model to assess the effect of climate on crop diversification. This variable is negative and highly significant, indicating that crop diversification is limited to higher-rainfall areas. Obviously, high-rainfall areas specialize in rice, while farmers in medium- and low-rainfall areas lean toward diversification to increase their income and minimize their risk. Demand-side factors such as urbanization and per capita income also have a positive and significant impact on crop diversification.

Our discussion suggests that assured markets and a good road network could stimulate agricultural diversification in favor of high-value crops because they help maximize profits and minimize the uncertainty of output prices. Encouraging appropriate institutional arrangements for better markets through cooperatives or contract farming would go a long way toward strengthening farm-firm linkages. The role of technology also cannot be ignored. The high-yielding and more stable genotypes of fruits and vegetables need to be propagated by the development of a strong seed sector.

## Diversification of Dietary Patterns

There are apprehensions that a shift in the crop portfolio from foodgrain to nonfoodgrain commodities may lead to an imbalance in dietary patterns and adversely affect food security from the nutritional point of view. However, the high-yielding nature of foodgrain crops has in fact improved availability, and production trends reveal that the per capita daily availability of foodgrains increased from 448.56 grams in TE 1981–82 to 475.4 grams in TE 1999–2000. Similarly, the per capita daily availability of milk increased substantially, from 128 grams in 1980–81 to 214 grams in 1999–2000 (India, Ministry of Agriculture, *Agricultural Statistics at a Glance,* 2002).

Income levels of consumers and urbanization are two important forces that influence dietary consumption patterns as well. Earlier studies have shown that diversification is strongly determined by these two demand forces (Joshi et al. 2002). As income increased and urbanization grew, diversification moved in favor of high-value commodities. Evidence from the consumption basket shows similar patterns across all income brackets.[3]

### *Consumption Patterns and Income*

The level of per capita consumption of all commodities is higher in the upper-income group than in the lower-income group (Table 18.1). Consumption of fruits, vegetables, milk, meat, eggs, and fish has increased in all the groups. Even in the lower-income group, consumption of these commodities has increased markedly. On the other hand, consumption of cereals declined during the past two decades in all income groups,[4] though the pace of decline of cereal consumption was faster in the upper-income group. For example, per capita consumption of cereals in the upper-income group declined from 194.3 kg in 1983 to 154.6 kg in 1999–2000. The corresponding figures for the lower-income group were 147 kg and 132 kg. Contrary to the trend for cereals, the per capita consumption of vegetables increased from 36 kg in 1983 to about 54 kg in 1999–2000, an increase of about 50 percent. Similarly, consumption of meat, eggs, and fish doubled, from 1.9 kg in 1983 to 3.8 kg in 1999–2000.

The bottom income group, however, consumed smaller quantities of high-value commodities, although their consumption of these commodities also increased. This is an indication that the consumption baskets of poor as well as rich consumers have changed, shifting in favor of noncereals. The diversification of consumption patterns was a combined result of three different forces: (1) income effect, (2) price effect, and (3) changes in tastes and preferences.

3. Those below the poverty line were classified as the lower (or bottom) income group, those above the poverty line but below 150 percent of the poverty line as the middle-income group, and those above 150 percent of the poverty line as the upper-income group.

4. This may be one of the reasons for the growing buffer stock of foodgrains in the late 1990s.

The fall in the relative prices of these commodities also contributed to the increase in their consumption (Kumar and Mruthyunjaya 2002).

*Consumption Patterns and Urbanization*

Another important factor that determines consumption patterns is urbanization. Earlier studies have shown that urbanization has strongly influenced the diversification of agricultural production. The urbanization-induced production of high-value commodities is rapidly increasing in the periurban areas (Parthasarthy et al. 2002). The level of consumption of high-value commodities, namely fruits, vegetables, milk, meat, eggs, and fish, has been much higher in the urban areas than in the rural areas. The share of cereals, pulses, and edible oils in total expenditures increased from 41 percent in 1983 to 51 percent in 1999–2000 in the urban areas. In rural areas their share in expenditures declined from 69 percent in 1983 to 61 percent in 1999–2000. The share of fruits, vegetables, milk, meat, eggs, and fish in total expenditures increased from 41 percent in 1983 to 49 percent in 1999–2000 in the urban areas. The corresponding increase in the rural areas was from 31 to 39 percent.

Per capita consumption of cereals has declined in both urban and rural areas, with the decline steeper in the latter. On the other hand, per capita consumption of milk, vegetables, meat, eggs, and fish increased sharply in both rural and urban areas. Per capita consumption of all commodities except cereals was higher in urban areas than in rural areas. The shift in consumption patterns in favor of high-value commodities did not have any adverse effect on calorie intake. Per capita calorie intake increased marginally in rural areas, from 2,205 in 1983 to 2,332 in 1999–2000, while the corresponding increase was quite substantial in urban areas, from 1,972 in 1983 to 2,440 in 1999–2000.

In sum, the evidence we have presented reveals that income and urbanization are influencing the diversification of dietary patterns in favor of nonfoodgrain commodities and therefore toward the diversification of agricultural production. A more favorable environment for diversification toward high-value commodities will not only ease the pressure of storing huge surpluses of rice and wheat but also accelerate the growth of the agricultural sector and agricultural incomes.

## Integration of Consumption and Production

Although the demand for noncereal commodities is growing fast, farmers, the majority of whom are smallholders, are constrained by high transaction costs resulting from (1) lack of access to markets, (2) limited marketable surplus, and (3) the perishable nature of their products. Due to the rising demand for high-value commodities, different forms of production-market integration are slowly emerging in the food supply chain. These include (1) spot or open market

transactions, (2) agricultural cooperatives, and (3) contract farming. The features of these modes of integration are now briefly discussed.

*The Spot Market*

Spot or open market transactions are traditional and common in developing countries where the level of market uncertainty is high. In this model, the prices are determined by the demand and supply of the commodity under transaction. In India, the concept of spot or open markets has been initiated in some states where producers and consumers transact business without any middlemen. Ryat Bazaar in Karnataka and Apana Bazaar in Andhra Pradesh are examples of spot or open markets for fruits and vegetables. These markets provide a forum in which producers can deal directly with consumers. However, the uncertainty of prices during excess supply periods and high transport costs still persist.

*The Cooperative Model*

The agricultural cooperative model has overcome the problems of spot markets. In this model a group of producers with common interests own and manage production and/or marketing to take advantage of economies of scale. Cooperatives enhance the bargaining power of the producers in input and output markets, and by integrating input and output markets, they tend to reduce transaction costs. In India, one of the most successful models of a cooperative is in the dairy sector, where the breakthrough is ascribed to the implementation of the Operation Flood Program through the National Dairy Development Board (NDDB), which developed a cooperative for procuring and marketing milk and milk products. Encouraged by the success of dairy cooperatives, the NDDB has diversified its product portfolio in recent years to include fruits, vegetables, oilseeds, and plantation crops, which are sold in cooperatives developed along the lines of dairy cooperatives. In 1985, the NDDB started under the banner of SAFAL to meet the growing demand for fruits and vegetables of the Delhi metropolitan area. This is one of the largest public sector undertakings in the marketing of fresh fruits and vegetables in the world. In 1996, the company established an ultramodern 100 percent export-oriented fruit processing unit in Mumbai. At present, there are 75 associations throughout the country with a membership of 15,000 growers selling about 200 tons of fruits and vegetables every day through its 275 retail outlets in and around Delhi. This model has most benefited the smallholders in remote areas where markets for fruits and vegetables were previously absent.

*Contract Farming*

The contract farming model is relatively new in India. In this model, farmers are contracted to produce the commodity desired by a firm. The firm controls the production process without owning or operating the farms, while the farms are assured procurement of the output at remunerative prices. India is witness-

ing a silent revolution in this form of mutually beneficial integration of farm, firm, and consumer.

One successful example of contract farming is the multinational company Nestlé India Limited. Nestlé entered into the dairy business in 1961 by collecting a mere 540 kg of milk from 180 farmers in four villages and setting up a milk plant at Moga in Punjab (National Dairy Development Board 2002). By 2002 the milk collection had grown to over 650 thousand kg/day from about 90,000 farmers in about 1,600 villages in Moga and the adjoining districts of Ferozpur, Faridkot, Muktsar, and Ludhiana in Punjab. The company's success resulted from developing effective backward and forward linkages. Most of the milk comes from the small dairy producers. The company provides free veterinary aid and extension, breeding services, information on fodder production techniques, and so on for quality production.

Another successful example of the integration of production and marketing is witnessed in the poultry sector. The poultry industry grew mainly due to the strong integration of poultry producers and firms. Several poultry firms have entered into contract farming for the production, marketing, processing, and export of eggs and broiler chickens. The most important ones are Saguna Hatcheries Limited and Venkateshwara Hatcheries Limited (VHL). The latter is the leading firm in the poultry sector and has been in operation since 1971. Initially the firm was engaged in the breeding of chicks, the production of vaccines, and their sale to poultry producers. Since the early 1990s, VHL has ventured into contract broiler farming in the major poultry-producing states of Andhra Pradesh, Karnataka, and Maharashtra. VHL has its own poultry breeding farm, feed plant, vaccine manufacturing unit, and research laboratory and has developed innovative approaches to reduce transaction costs and enhance production efficiency. The consequence of contract farming in the poultry sector has been a marked increase in the production of eggs and broilers in these states.

To sum up, the integration of production and marketing is critical for high-value commodities, because they are perishable and their markets are restricted. To expand the scale of production, integrating production and marketing through cooperatives or contract farming seems to be a prerequisite.

## Conclusion

India's agricultural production portfolio is gradually diversifying in favor of high-value commodities. In particular, the production of horticultural commodities, milk, meat, fish, and eggs has shown a remarkable increase during the past two decades. These commodities are well suited to the needs as well as the resources of small farm holders. Therefore, strengthening the horticulture, livestock, and fisheries subsectors would benefit them and significantly contribute to enhancing farm income, offering employment opportunities in rural areas, and meeting the food and nutritional needs of small farm holders.

The consumption basket is also diversifying in favor of high-value commodities in both rural and urban areas and across both rich and poor consumers. In the absence of appropriate integration of production, markets, and consumption, the potential of high-value commodities is yet to be fully exploited. Strengthening the integration of these three areas would promote the production of high-value commodities because of their growing demand.

To cater to the demand for these commodities in metropolitan cities, a few innovative institutional arrangements are gradually emerging in the form of cooperatives and contract farming, which benefit producers, firms, and consumers. Establishing strong farm-firm linkages strengthened both types of entities and gave them the opportunity to benefit from the expanding domestic and international markets. These kinds of arrangements need to be replicated so that more small farm holders can share the benefits of the growing markets for high-value commodities. This will have several macro-level benefits, including food management and diversification of agriculture.

In terms of policy implications, the following points are worth noting. First, greater attention needs to be given to the nongrain economy in terms of research and development (R&D) expenditure and investment in marketing, storage, and processing facilities. Although the share of the nongrain component in the total value of agriculture is already more than half, that component does not receive commensurate attention and resources. This distortion needs to be corrected.

Second, India has constrained its own potential by not changing the restrictive laws toward the development of a high-value chain in agriculture. Giving preference to cooperatives or public sector firms in the past restricted the entry of big players into the private sector. This needs to change if a revolution in the value addition process is to be unleashed. All legal impediments that restrict the entry of big private sector entities into marketing, storage, and processing facilities need to be lifted. Further, retail chain stores with foreign direct investments (FDIs) are still not permitted in accord with the recommendation of the latest government task force on FDIs.

Third, to ensure an efficient basis in the value addition process, it is necessary to withdraw the preferential treatment given to cooperatives and public sector concerns, often in the form of corporate tax exemptions, subsidized finance, and so on. This preferential treatment often drives out private sector investments. Further, major investments in retail chain stores, processing, and storage facilities would emerge if the legal environment was cleaned up and the private sector was provided with a level playing field vis-à-vis cooperatives and public sector concerns.

Fourth, it is essential to facilitate the emergence of vertical integration between farmers, processors, and retailers (farm–firm–fork linkages) in high-value agriculture. India must graduate from producing raw commodities to adding value and developing brand equity. A major role needs to be played by the pri-

vate sector, the sooner the better, although it is disheartening to see that it took 10 years to delicense the dairy and sugar industries. Many others in agro-processing are still waiting for delicensing, including those involved in the processing of groundnuts and mustard oilseeds, which are reserved for small-scale industries. To ensure food safety, laws need to be duly enforced and sanitary and phytosanitary standards adopted, and it would be desirable to promote large processing facilities with state-of-the-art technology.

All these policy changes are basically in line with the emerging demand-pull forces, and therefore are likely to be more sustainable. But they need to be supplemented by some policy changes on the supply side, too. First, the land-lease market should be freed and smaller cultivators helped to increase the sizes of their operational holdings. They are efficient producers, but their transaction costs need to be cut if Indian agriculture is to remain competitive internationally.

Second, investments will have to be stepped up in basic infrastructure, such as roads and power, where the private sector is still reluctant to enter. Government programs on highways and rural roads are laudable, but reform in the power sector is another story altogether. Major institutional and price reforms are required in the power sector to plug the leakages, raise efficiency, and generate surpluses to plow back into investments. The cold storage chain, often talked about as an important form of infrastructure for high-value agriculture, cannot be developed without reforming the power sector in rural areas.

Third, the level of R&D expenditure in India, at less than 0.5 percent of agricultural GDP, is way below the 1 percent level in most developing countries. In biotechnology research, the record is even worse. The country is losing out on a revolution in biotechnology that is waiting in the wings. If the government does not have ample resources for this, the private sector could be invited in on a large scale. For this purpose, the government should put in place for biosafety appropriate regulatory institutions that are transparent and time bound.

Fourth, the Indian agricultural credit scene is contradictory: commercial banks are saddled with excess liquidity, while farmers are still relying on informal sources of finance for almost 45 percent of their requirements and at much higher rates of interest than are offered by the commercial banks. High-value agriculture needs higher amounts of working capital and also has higher risks. While schemes like the *kisan* credit cards (Gulati and Narayanan 2002a) are a step in the right direction,[5] facilitating credit through processors, input dealers, and others who are vertically integrated with the farmers for the provi-

5. Under this scheme, established by the government in 1998–99, farmers are eligible for production credit in the amount of Rs. 5,000 or more issued against a *kisan* card, which is valid for three years but subject to an annual review. Credit limits are fixed depending on need related to crop production, operational holdings, cropping pattern, and scale of finance. By January 2001, over 13.4 million *kisan* cards had been issued to farmers by cooperatives and regional rural banks.

sion of critical inputs or for processing their produce could increase the credit flow to agriculture greatly. These dealers or processors could act as nonbanking financial intermediaries, able to obtain refinancing from the banking sector with a margin to cover the risk of default. Such a scheme could bring about a revolution in the financing of agriculture, provided the government facilitates the entry of such nonbanking financial institutions and frees up interest rates.