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# Can Horticulture Revitalise Agricultural Growth? 

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I<br>INTRODUCTION

Over the last one decade or so agricultural sector has come under stress. Agricultural growth has decelerated from 3.2 per cent during 1980/81 to 1995/96 to 1.9 per cent during 1996/97 to 2005/06, leading to a situation of agrarian distress in some parts of the country. Accelerating agricultural growth is thus a major policy challenge. To respond to this, there is a need to understand the past sources of growth by commodity, and their relative contribution to agricultural growth, inter alia. An improved understanding of the sources of growth would provide an empirical basis to guide and prioritise efforts and investment to speed up agricultural growth. In this paper, we identify different sources of growth and quantify their contribution to overall agricultural growth. Our emphasis is on the role of horticultural sector in speeding up agricultural growth. Demand for horticultural commodities is expanding rapidly (Ravi and Roy, 2006; Kumar et al., 2007), and we hypothesise that horticulture can make significant contribution towards accelerating agricultural growth.

Besides, quantifying the contribution of horticulture to agricultural growth, we also examine the implications of horticulture-led growth for small farmers. Horticultural crops have a strong potential to raise returns to land, labour and capital, and are labour-intensive, and thus are conjectured to be more pro-small farmers who have higher endowment of family labour in relation to land (Joshi et al., 2006a). However, it is often argued that small farmers may not benefit from horticulture-led growth because of greater barriers for them in transition from staple foodgrains towards high-value horticultural crops. Production of high-value agricultural commodities is capital, technology and information intensive and is more risky compared to staple food crops, while small farmers are resource constrained and risk averse. Further, a lack of access to markets is also a major limitation to small diversification towards high-value horticultural crops. Marketable surplus with small farmers is tiny, while local rural markets are thin, and selling in distant urban markets is costlier (Birthal et al., 2005; Birthal and Joshi, 2007; Singh, 2005).

In this paper we confine to quantification of growth sources within the crop sector, which accounts for about 70 per cent of the total value of output of agricultural sector. The paper is organised into five sections. The next section

[^0]describes data and methodology. Section III discusses the sources of agricultural growth focusing on the role of horticultural sector. Section IV examines cropping pattern on small vis-à-vis large farms as to know whether small farmers can benefit from horticulture-led growth. The concluding remarks are made in the final section.

II

ANALYTICAL APPROACH

## Data

Agricultural growth is an outcome of changes in cropped area, yield and prices. We examine the contribution of these sources to agricultural growth at the national level for the periods 1981/82 to 2004/05. We have divided this period into two parts: 1981/82 to 1995/96 and 1995/96 to 2004/05. There are two reasons for studying growth sources separately for these periods. First, the period 1981/82 to 1995/96 was a period of widespread adoption of agricultural technologies and hence a period of high agricultural growth. Second, agricultural sector started witnessing some major reforms markets and trade reforms (removal of quantitative restrictions on import, liberalisation of agricultural markets, etc.) from mid-1990s, implying some adjustment pressure on agriculture. Further, agricultural growth during the latter period also started decelerating. It is therefore conjectured that growth sources during these periods are likely to be different.

Data on area, production and yield were compiled from the Agricultural Statistics at a Glance - an annual publication of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. Prices of different commodities were derived implicitly dividing their value of output by production. The data on the value of output of different crops were compiled from the National Accounts Statistics published by the Central Statistical Organization, Ministry of Statistics and Programme Implementation, Government of India. The prices were computed for 1993-94 and were developed as a series of in real terms (at 1993-94 prices) using wholesale price indices published by the Office of the Economic Advisor, Ministry of Commerce and Industries, Government of India.

For testing the hypothesis whether small farmers can benefit from horticultureled growth, we have used information on cropping pattern by size group of land holdings from the Agriculture Census- a quinquennial publication of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

## Method of Decomposition of Growth ${ }^{1}$

A change in the gross income (value of output) from a single crop can be decomposed into changes in its area, yield, price, and a residual term representing interaction of these variables. A change in the value of the total crop production can
be similarly decomposed, except that there is a fourth source of growth that is, area reallocation or change in the crop mix.

We quantify the contribution of each of the above sources to agricultural growth using the method developed by Minot (2003). If $A_{i}$ is the area under crop $i, Y_{i}$ is its yield, $P_{i}$ is its price then the gross income $(R)$ from $n$ crops is:

$$
\begin{equation*}
\mathrm{R}=\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}} \tag{1}
\end{equation*}
$$

On expressing $\mathrm{A}_{i}$, as share of crop $i$ in the total cropped area, ai $=\mathrm{A}_{\mathrm{i}} \sum_{i} \mathrm{~A}_{\mathrm{i}}$ the equation (1) can be written as:

$$
\begin{equation*}
\mathrm{R}=\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{a}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}}\right)_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}} \tag{2}
\end{equation*}
$$

To measure the change in gross value of output we take total derivative of equation (2) yielding:

$$
\begin{equation*}
\mathrm{dR} \cong\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{a}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}}\right) \mathrm{d}\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}}\right)+\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}}\right) \mathrm{d}\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{a}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}}\right) \tag{3}
\end{equation*}
$$

Equation (3) is an approximation of the changes explained by area, yield and prices in the value of output, as it excludes the interaction term. The second term on the right-hand side of equation (3) can be further decomposed from a change in sums to the sum of changes, as follows:

$$
\begin{equation*}
\mathrm{dR} \cong\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{a}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}}\right) \mathrm{d}\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}}\right)+\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}} \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~d}\left(\mathrm{a}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}}\right) \tag{4}
\end{equation*}
$$

Further expansion of the second term in equation (4) gives the following expression:

$$
\begin{equation*}
\mathrm{dR} \cong\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{a}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{P}\right) \mathrm{d}\left(\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}}\right)+\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}} \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{a}_{\mathrm{i}} \mathrm{Y}_{\mathrm{i}} \mathrm{dP} \mathrm{P}_{\mathrm{i}}+\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}} \sum_{\mathrm{i}=1}^{\mathrm{n}}\left(\mathrm{a}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}} \mathrm{dY} \mathrm{Y}_{\mathrm{i}}\right)+\sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{~A}_{\mathrm{i}} \sum\left(\mathrm{Y}_{\mathrm{i}} \mathrm{P}_{\mathrm{i}} \mathrm{da}_{\mathrm{i}}\right) \tag{5}
\end{equation*}
$$

The first term on the right-hand side of equation 5 provides change in gross value of output due to change in total cropped area, which we term as area effect. The second term gives the effect of change in real prices (price effect), and the third term captures the effect of a change in yield (yield/technology effect). The fourth term quantifies the change in gross value of output due to change in land reallocation (diversification effect). If the fourth term is positive, it indicates a shift in area from
lower-value to higher-value crops. Dividing both sides of Equation 5 by the overall change in gross value of output ( $d R$ ) gives proportional contribution of each source to overall growth.

Each of the above growth sources has implications for agricultural development policy. If a lower share of growth is associated with area expansion, it may reflect limited scope for bringing additional area under cultivation in particular when land area is limited. If the substantial share of growth comes from price rise it may reflect changes in price policy or reduction in transportation cost. The price-driven growth however is unsustainable in the long-run. In either case, the implication is that in the long-run the growth must come from yield improvements and diversification of production portfolio from lower-value to higher-value crops. Policy implications of yield increases and diversification are not as obvious (Minot, 2003; Joshi et al., 2006b). Does a lower share of these in growth imply that there is under-investment in that type of growth or the economic conditions do not favour that type of growth so public investment should be correspondingly small? Drawing implications of these sources thus require additional assumptions about the investment in agricultural research and development, and the economic conditions.

Growth is time-variant, and thus the relative contributions of different growth sources would also vary over time, depending on the changes in economic conditions and agri-food policy. For example, if the economic conditions favour a shift in demand pattern towards high-value commodities, the policy should emphasise diversification of agriculture towards these commodities and provide infrastructure and policy support to sustain diversification.

SOURCES OF AGRICULTURAL GROWTH: ROLE OF HORTICULTURE

## Sources of Growth

Before proceeding to examine the role of horticulture in revitalising agricultural growth, we decompose the growth in the gross value of output during 1981/82 to $2004-05^{2}$ due to changes in cultivated area, yield, prices and diversification. For this purpose we have considered ten commodities/commodity groups, viz., rice, wheat, coarse cereals, pulses, oilseeds, sugarcane, cotton, fruits and vegetables, condiments and spices and beverages, which account for 91 per cent share in the total cropped area and 85 per cent share in the gross value of output of the crop sector.

Agriculture grew at an annual rate of 3.8 per cent (in real terms) during 1981/82 to 1995/96 (Table 1). The growth however decelerated to 2.1 per cent during 1995/96 to 2004/05. The results indicate that the growth sources have changed significantly over time. During 1981/82 to 1995/96 the yield increases accounted for 62 per cent of the growth, indicating that technology was the prime mover of agricultural growth during this period. Diversification from lower-value to higher value crops, price rise
and area expansion contributed 20, 12 and 6 per cent, respectively. During 1995/96 to 2004/05 though the technology remained an important source of growth, its share declined to 45 per cent. Diversification towards high-value crops with a share of 42 per cent emerged as the second largest source of growth. Since area is limited, share of area in growth declined, and share of prices also declined to 7 per cent.

These trends in growth sources are expected. The period 1981/82 to 1995/96 can be considered as the period of consolidation of gains of investment in agricultural research and development made during the green revolution period. During this period there was an increasing use of modern seeds, chemical fertilisers and electricity, which together contributed to the rapid rise in crop yields. ${ }^{3}$ For example, yield of both rice and wheat increased at an annual rate of around 2.8 per cent during 1981/82 to 1995/96. Later on, although crop yields continued to rise, it increased but at a diminishing rate; at less than 1 per cent a year. The deceleration in growth of agricultural productivity was a result of sluggish growth in inputs that contributed to growth during earlier period. Besides, other factors such as deterioration of soil health and depleting water table could also be held responsible for slow growth in recent years.

Despite, severe supply-side constraints, the contribution of technology to overall growth remained substantial. This implies there were also other factors responsible for slow growth in crop sector. Price policy was one of these. Real prices of most food and non-food agricultural commodities showed a positive trend during 1981/82 to $1995 / 96$; the real wholesale price index of food and non-food agricultural commodities grew at 0.75 and 0.68 per cent, respectively, which acted as a catalyst in higher growth in agriculture during this period. The price trends however reversed during the latter period. The real wholesale price index of food commodities declined at -0.31 per cent and that of non-food agricultural commodities at -0.95 per cent a year.

TABLE 1. CONTRIBUTION OF DIFFERENT SOURCES TO THE GROWTH OF CROP SECTOR

|  | (per cent) |  |
| :--- | ---: | ---: |
|  | Share in crop sector growth |  |
| Growth source | $1981 / 82$ to $1995 / 96$ | $1995 / 96$ to 2004/05 |
| (1) | $(2)$ | $(3)$ |
| Area | 6.1 | 4.2 |
| Yield | 61.9 | 44.6 |
| Price | 11.5 | 7.0 |
| Diversification | 19.5 | 42.4 |
| Interaction | 1.0 | 1.8 |
| Total | 100 | 100 |
| Per cent annual growth in the total value | 3.8 | 2.1 |
| of crop output |  |  |

## Contribution of Horticulture to Agricultural Growth

Horticultural sector including fruits, vegetables, condiments and spices with a share of about 6 per cent in the total cropped area contributed maximum ( 32 per cent) to the total value of crop production in TE 2004-05 (Table 2) with fruits and vegetables accounting for a major share in total crop production. During 1995/96 to 2004-05 the gross value of fruits and vegetables grew at an annual rate of 5.6 per cent, higher than the growth in the contribution of any other commodity. During 1981/82 to 1995/96 the growth in their contribution was one of the lowest ( 2.9 per cent).

TABLE 2. CONTRIBUTION OF DIFFERENT CROPS TO THE GROWTH OF CROP SECTOR


Notes: *Share in total value of output at 1993/94 prices and does not include value of by-products and kitchen garden.
$\dagger$ Growth in value of output of all crops after excluding other crops and by-products.
Agriculture growth decelerated significantly during 1995/96 to 2004/05, and would have decelerated further had the robust growth in fruits and vegetables not provided a cushion to it. Fruits and vegetables accounted for 64 per cent of the growth during 1995/96 to 2004/05, which was more than thrice their share during earlier period. In fact, during 1981/82 to 1995/96 the pattern of contribution of different commodities to overall growth was quite diversified. The share of fruits and vegetables in overall growth was about 21 per cent. Rice and wheat accounted for
about 30 per cent of the overall growth. Oilseeds with a share of 16 per cent was the other important source of growth. During the latter period the share of rice and wheat declined considerably.

Robust growth in horticulture was demand-led. Food basket underwent a significant change away from staple foodgrains towards high-value food products. The share of fruits and vegetables in urban food expenditure increased from 12 per cent in 1983 to 14.9 per cent in 1993/94 and further to 15.8 per cent in 2004/05 (Government of India, 2006). There was also a considerable rise in their share in rural food expenditure, from 9.3 per cent in 1983 to 12.4 per cent in 1993/94 and 14.5 per cent in 2004/05.

Demand-led growth in horticulture was supported by expanding public infrastructure (roads and markets), and a favourable policy environment for investment in food processing. Food processing industry was de-regulated in 1991, and the foreign direct investment (FDI) in food processing was gradually raised to 100 per cent. Also the food processing industry was accorded priority sector status for borrowing from institutional credit agencies. The Government of India has amended the Agricultural Produce Market Committee (APMC) Act in 2003 allowing establishment of private markets and direct transaction of food commodities between sellers and buyers (processors/marketing firms) outside the state-regulated agricultural markets through institutions such as contract farming or otherwise. The Government also provides numerous fiscal incentives to producers, processors and exporters. Besides, two other developments that also helped acceleration of horticultural growth include establishment of the National Horticulture Board in 1986 and launching of a Horticulture Mission in 2005.

Another important factor that needs to be discussed in the increasing importance of horticulture in agricultural growth is the profitability of horticultural crops vis-àvis other crops. Joshi et al. (2004) and Birthal et al. (2007) have shown that changes in relative profitability of horticultural crops vis-à-vis other crops is an important factor in farmers' decision regarding diversification towards these crops. The changing pattern of growth sources also confirms this. Deceleration in yield growth and decline in prices of cereals, pulses and oilseeds have motivated farmers to diversify towards horticultural crops that have a larger potential of returns to land, labour and capital. And, the expanding demand for horticultural products created an opportunity for farmers to grow horticultural crops.

Indian agriculture is dominated by small farmers. According to the Agricultural Census, in 2000/01 of the total 121 million land holdings 81.9 per cent were of less than or equal to 2 ha and had an average size of 0.59 ha . Although, horticulture has the potential of higher returns to land, it is often doubted that farmers cultivating such
tiny pieces of land may not diversify towards these crops because of numerous constraints in production and marketing and higher production and price risks associated with these.

An insight into 'whether small farmers can benefit from horticulture-led growth' can be gained by examining their cropping pattern and share in the total area under horticultural crops. Table 3 compares the cropping pattern on small vis-à-vis large farms, shows that as compared to others small farmers allocate a larger proportion of their area to horticultural crops. In 2000-01 they allocated 5.7 per cent of their total cropped area to horticultural crops, compared to 3.9 per cent by the large farmers. Further, over time the share of horticultural crops in their total cropped area increased but proportionately less than for others. This implies a rising tendency of diversification towards horticultural crops on large farms as well.

TABLE 3. CROPPING PATTERN ON SMALL VERSUS LARGE FARMS

| (per cent of gross cropped area) |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Farm size <br> (1) | Cereals (2) | Pulses <br> (3) | Oilseeds (4) | $\begin{aligned} & \text { Sugarcane } \\ & (5) \\ & \hline \end{aligned}$ | Cotton (6) | Fruits <br> (7) | $\begin{aligned} & \text { Vegetables } \\ & (8) \end{aligned}$ | Condiments and spices (9) | Other crops (10) | Total (11) |
| 1985-86 |  |  |  |  |  |  |  |  |  |  |
| Small $(\leq 2 \mathrm{ha})$ | 68.16 | 9.74 | 8.06 | 2.16 | 2.30 | 1.38 | 2.32 | 1.13 | 7.06 | 100 |
| Medium (2-4 ha) | 64.34 | 11.54 | 9.70 | 2.01 | 4.34 | 0.75 | 1.45 | 1.02 | 6.31 | 100 |
| Large $\text { (> } 4 \text { ha) }$ | 57.16 | 14.33 | 11.16 | 1.25 | 5.80 | 0.50 | 0.91 | 1.06 | 8.75 | 100 |
| All | 62.41 | 12.18 | 9.81 | 1.72 | 4.32 | 0.84 | 1.50 | 1.07 | 7.63 | 100 |
| 1995-96 |  |  |  |  |  |  |  |  |  |  |
| Small $(\leq 2 \mathrm{ha})$ | 64.42 | 8.90 | 10.07 | 2.60 | 3.64 | 1.60 | 2.53 | 1.24 | 7.55 | 100 |
| Medium (2-4 ha) | 58.12 | 10.47 | 13.27 | 2.45 | 6.07 | 1.28 | 1.58 | 1.21 | 7.14 | 100 |
| Large (>4 ha) | 50.72 | 12.72 | 15.41 | 1.53 | 6.30 | 1.02 | 0.90 | 1.21 | 11.07 | 100 |
| All | 57.77 | 10.71 | 12.84 | 2.16 | 5.22 | 1.30 | 1.69 | 1.22 | 8.77 | 100 |
| 2000-01 |  |  |  |  |  |  |  |  |  |  |
| Small $\text { ( } \leq 2 \mathrm{ha} \text { ) }$ | 64.83 | 8.28 | 10.09 | 3.15 | 3.79 | 1.59 | 2.92 | 1.16 | 7.10 | 100 |
| Medium (2-4 ha) | 57.58 | 10.36 | 13.95 | 3.04 | 6.43 | 1.39 | 1.67 | 1.18 | 6.07 | 100 |
| Large ( $>4 \mathrm{ha}$ ) | 52.10 | 11.61 | 14.78 | 1.85 | 6.64 | 1.14 | 1.49 | 1.27 | 10.60 | 100 |
| All | 58.65 | 9.94 | 12.65 | 2.67 | 5.42 | 1.39 | 2.12 | 1.20 | 8.08 | 100 |

Among horticultural crops, vegetables are more pronounced on small farms, while fruits, condiments and spices occupy a larger share on large farms. These differences are expected. Vegetables generate quick returns, requires less capital and more labour, which match the resource endowments of the small farmers. While, fruits and some condiments and spices require high start-up capital, and have a long
gestation period, the small farmers are capital constrained. Birthal et al. (2007) also found small farmers more diversified towards vegetables because of surplus labour and liquidity constraint.

Table 4 presents distribution of area under horticultural crops across different farm categories. Assuming identical productivity on all farm categories, in 2000-01 small farmers contributed 57 per cent to the total vegetable production, and 47 per cent to the total fruit production, which is higher than their share in the gross cropped area. In contrast, large farmers who shared 35 per cent of the gross cropped area contributed 25 per cent to the vegetable production and 29 per cent to the fruit production. If the productivity on small farms were to be higher, which is likely given the higher labour endowment with small farmers, their contribution could be an underestimate.

TABLE 4. DISTRIBUTION OF AREA UNDER HORTICULTURAL CROPS ACROSS FARM CATEGORIES

|  |  |  | (per cent) |  |
| :---: | :---: | :---: | :---: | :---: |
| (1) | Gross cropped area (2) | Fruits <br> (3) | Vegetables <br> (4) | Condiments and spices <br> (5) |
|  | 1985/86 |  |  |  |
| Small ( $\leq 2 \mathrm{ha}$ ) | 32.6 | 53.5 | 50.6 | 34.4 |
| Medium (2-4ha) | 23.2 | 20.5 | 22.5 | 22.1 |
| Large ( $>4$ ha) | 44.2 | 26.0 | 26.9 | 43.5 |
| All | 100.0 | 100.0 | 100.0 | 100.0 |
| 1995-96 |  |  |  |  |
| Small ( $\leq 2 \mathrm{ha}$ ) | 38.6 | 47.2 | 57.6 | 39.1 |
| Medium (2-4ha) | 23.9 | 23.4 | 22.4 | 23.7 |
| Large ( $>4$ ha) | 37.5 | 29.4 | 20.0 | 37.2 |
| All | 100.0 | 100.0 | 100.0 | 100.0 |
| 2000-01 |  |  |  |  |
| Small ( $\leq 2 \mathrm{ha}$ ) | 41.1 | 47.3 | 56.7 | 39.8 |
| Medium (2-4ha) | 24.0 | 24.1 | 18.8 | 23.4 |
| Large ( $>4$ ha) | 34.9 | 28.6 | 24.5 | 36.7 |
| All | 100.0 | 100.0 | 100.0 | 100.0 |

Though not so pronounced, the shares of different categories of farmers in the total area under horticultural crops underwent some change. Between 1985/86 and 1995/96, the share of small farmers in total vegetable area increased by 7 percentage points, but declined in fruit area by 6 percentage points. Large farmers, on the other hand, lost their share in vegetable area by 7 percentage points, but gained in case of fruits. However, no noticeable changes appear to have occurred between 1995/96 and 2000/01, except that large farmers regained their lost share in vegetable area.

The results clearly show that small farmers are capable of diversifying towards horticultural crops provided some of the production and marketing constraints which they may face in the process of transition are alleviated. However, an issue that has
attracted considerable attention in the agricultural policy debates is that excessive emphasis on small farm diversification towards high-value cash crops may adversely affect household food security. Data presented in Table 3 show that although compared to large farmers, small farmers allocate a larger area to horticultural crops; the share of foodgrain crops, particularly cereals in the gross cropped is also higher on small farms. This indicates that small farmers optimise their cropping pattern in a way that enables them to obtain higher income without adversely affecting their food security.

> V

## CONCLUSIONS AND POLICY IMPLICATIONS

The paper has analysed the sources of growth in Indian agriculture for the period 1981/82 to 2004-05 focusing on the role of horticultural crops in speeding up agricultural growth. Three important conclusions are drawn from this study. First, despite deceleration in its contribution, technology has remained an important source of growth in Indian agriculture. Second, diversification of agriculture towards horticultural crops has considerable potential to accelerate agricultural growth. Third, horticulture-led growth is an opportunity for small farmers to raise their income.

Some important implications that emerge from this study are: First, decline in the contribution of technology, especially when there is a deceleration in yield growth, is a major issue of concern. It however should not be construed that the yield potential has been fully tapped. There are a number of factors like, slow growth in input use, deterioration of soil health due to unbalanced application of fertilisers, low seed replacement rate, depleting water table, inefficiency in transfer of technology, etc., that can deter tapping yield potential. Evidence indicates that a considerable genetic potential of crop varieties developed by the national agricultural research system remain untapped due to such constraints. This implies a need for increasing the efficiency of technology and information transfer systems. Nonetheless, the role of agricultural research should not be undermined in sustaining agricultural growth.

Second, the factors underlying demand growth in horticultural products are robust and offer an opportunity to revitalise agricultural growth and augment income of the farmers through diversification of agriculture towards horticultural crops. However, horticultural growth may come under pressure unless supported by markets, infrastructure and policies. Pingali (2006) indicates that in this era of market liberalisation and globalisation the returns to diversification towards high-value commodities are conditional to investment in post-harvest technologies for processing, quality and food safety. It is therefore imperative to increase investment in public infrastructure (roads, markets, communication, electricity, etc.) and institutions that generate widespread benefits in terms of improving access to markets and reducing transaction costs, and induce private investment in agribusiness. Concerning the role of public infrastructure and agricultural research in agricultural
growth in India, Fan et al. (2007) conclude that investment in agricultural research and roads are the most important factors underlying agricultural growth and poverty reduction.

Third, price driven growth though would not be sustainable in the long-term, yet given the crucial role of prices in determining cropping pattern there is a need to maintain some parity prices of agricultural commodities as to minimise trade-off between production of staple food crops and high-value crops.

Finally, horticulture-led growth can make substantial contribution towards improving livelihood of small farmers provided they are appropriately supported by infrastructure and institutions that enhance their capacity to invest, and link them to markets cutting down transaction costs (Birthal and Joshi, 2007).

## NOTES

1. This section is drawn from Minot (2003) and Joshi et al. (2006b).
2. The year 2002-03 was dropped from the analysis due to an abrupt fall in the area under some important crops like rice. The gross cropped area declined from 190.2 million ha in 2001/02 to 176.7 million ha in 2002/03 and again recovered to 190.6 million ha in 2003/04.
3. During $1981 / 82$ to $1995 / 96$ per ha fertiliser consumption increased at an annual rate of 5.5 per cent and electricity consumption 13.2 per cent. The corresponding figures for 1995/96 to 2004/05 were 2.4, and -0.1 per cent, respectively.

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