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## **Total Factor Productivity in Horticultural Crops in Konkan Region of Maharashtra**

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### **Abstract**

The comparative picture of TFP growth by sub-period-wise has revealed that the magnitude of TFP growth varied from 1.3 per cent per annum during the 1990s to 6.2 per cent per annum during the 1980s. During the entire period under study (1981-2000), TFP has been found growing at the rate of 5.4 per cent per annum. The results present a divergent picture of horticultural growth in the Konkan region during the period under study. Investment on research has been the major source in TFP growth. The returns to horticultural research were high pay-off to the tune of IRR 119 per cent.

### **Introduction**

The agro-climatic conditions of the Konkan region in the Maharashtra state are favourable for horticultural crops. Therefore, this region has been the predominantly horticultural zone in the state. The state government has invested good amount of money to promote horticultural research and development so as to increase the horticultural production of the major horticultural crops in this region.

There have been several attempts to capture pay-off to agricultural research at the aggregate (all-India) level (Evenson and Jha, 1973; Rosegrant and Evenson, 1992; Kumar and Rosegrant, 1994; Evenson *et al.*, 1999) and at the state level (Bal and Kahlon, 1977; Kumar *et al.*, 1977; Jha and Kumar, 1998; Ananth (2004). However, such attempts at the agro-climatic zonal level and particularly for horticultural crops, have not been made so far. There is a need to understand whether horticultural research and development activities have contributed to the horticultural output in the region. The present study has found the trend in total factor productivity (TFP) of the horticultural

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sector and has quantified returns to investment on horticultural research and development. The study pertains to these major horticultural crops, viz. cashew, mango and coconut.

### Total Factor Productivity

The total factor productivity (TFP) implies an index of output per unit of total factor inputs, measures shift in output holding all inputs constant. Thus, TFP measures the amount of increase in total output which is not accounted for by the increase in total inputs. The time series data on the wholesale prices of horticultural crops are not available and hence the selling prices of horticultural crops at the University research stations were used to aggregate the outputs. Inputs included in the index were: human labour, manure, fertilizers and plant protection chemical. Inputs were aggregated using the factor shares on appropriate weights. Divisia-Tornqvist index was used for computing the TFP indices for crops (for details *see* Christensen, 1975, Diewert 1978; Surabhi and Lal, 2001; Kumar *et al.*, 2004a).

In order to assess the temporal performance of TFP of horticulture in the Konkan region, the compound growth rates of input, output and TFP indices were estimated for 20 years from 1981-82 to 2000-01 and for two periods, viz. Period I (1981-82 to 1990-91) and Period II (1991-92 to 2000-2001) to see whether significant swing has taken place in the TFP due to horticultural research and development policies. The results of the same have been presented in Table 1. A perusal of Table 1 reveals that over the entire period of study (1981 to 2000), TFP grew at the rate of 5.4 per cent per annum. During the same period, input index increased by 8.7 per cent per annum and output index by 14.6 per cent per annum. The higher increase in the output index than the input index has been due the fact that the rate of increase in output prices was more than input prices. However, sub-period-wise results were more revealing. The input index declined at the rate of 4.5 per cent per annum during Period I, while output index increased at the rate of 2.0 per cent per annum. The TFP index registered an impressive growth of 6.8 per cent during Period I.

During Period II, input and output indices witnessed an impressive growth; however, the TFP indices increased marginally. The input and output

**Table 1. Compound growth rates of input, output and TFP indices.**

Period	Input index	Output index	TFP index
1981-1990	-4.5	2.0	6.8
1991-2000	15.7	17.5	1.3
1981-2000	8.7	14.6	5.4

indices grew at the rate of 15.67 and 17.49 per cent per annum during Period II. The TFP registered a marginal growth of 1.30 per cent per annum during the 1990s. The higher growth rates of input and output indices were due to increase in the prices of inputs and outputs during the 1990s. It is surprising to note that though there has been a substantial positive growth in output and input indices, the resultant growth rate in TFP was very low. It was because high growth rate in output indices has out-weighed the effect of high growth rates in input indices and hence the growth rates in TFP were seen to be very low. However, several studies conducted at the national or state level on either specific crops or entire agriculture have reported the declining contribution of technology to the agricultural output growth.

The results present a divergent picture of horticultural growth in the Konkan region during the two periods under study. It was because during Period I, there was no expansion of acreage under horticultural crops; however, there was corresponding increase in output resulting in higher growth rate of TFP. During Period II, there was a simultaneous increase in input-use and output, resulting in a marginal increase in TFP. But, the overall picture shows a satisfactory growth in TFP, indicating thereby that there is a potential to improve in the coming years.

### **Time Lag for Investment on Horticultural Research and Development**

Horticultural research and development is a lengthy process and requires a time lag to yield results. The technology generated through horticultural research also needs to be taken to the farmers' fields which takes a reasonable time. The results of a technology are visible when it is adopted by a large number of farmers and can be measured through the increased horticultural production of the whole region under consideration. Therefore, to have an appropriate time lag in research ( $R_t$ ) and development ( $D_t$ ) expenditure and the resultant horticultural output ( $Y_t$ ), all the possible correlation coefficients were worked out between  $Y_t$  and  $R_{t-K}$ ,  $Y_t$  and  $D_{t-K}$  for different lag years values of  $K$ .

where,

$Y_t$  = Gross output during the 't'th year (Rs in lakh)

$R_t$  = Research expenditure during the 't'th year (Rs in lakh)

$D_t$  = Development expenditure during the 't'th year (Rs in lakh)

$t$  = Time period, and

$K = 0, 1, \dots, 10$  (years)

**Table 2. Correlation coefficients of horticultural output with horticultural research and development using different time lags**

Time lag	Correlation coefficient	
	Research expenditure	Development expenditure
Zero lag (K=0)	0.67	0.54
One-year lag (K-1)	0.79	0.83
Two-year lag (K-2)	0.81	0.78
Three-year lag (K-3)	0.80	0.87
Four-year lag (K-4)	0.85	0.95
Five-year lag (K-5)	0.92	0.96
Six-year lag (K-6)	0.96	0.98
Seven-year lag (K-7)	0.96	0.90
Eight-year lag (K-8)	0.96	0.82
Nine-year lag (K-9)	0.96	0.74
Ten-year lag (K-10)	0.96	0.63

Time lag with the highest correlation coefficient was considered and used for studying the further relationships. The investments on development and research on horticulture are given in Appendices I and II, respectively.

It is evident from Table 2 that the highest correlation coefficient (0.96) between horticultural output and investment on research was observed for the sixth year. This implied that the investment made in horticultural research in the current year pays returns after about six years. Thus, the hypothesis that ‘Horticultural research is a relatively lengthy process and requires a time lag to yield its benefits’ was found true.

The highest correlation coefficient (0.98) between investment on horticultural development and horticultural output was for the sixth year. Surprisingly, the time lag of investment on research and development of horticulture seems to be same. Obviously, the time lag of horticultural development and investment coincided with the average gestation period for the horticultural crops under study. The transfer of technology from “lab- to-land” requires some time period. But, the proportion of expenditure incurred on extension activities related to horticultural crops was only meagre as compared to the investment on horticultural development. It may also be mentioned here that a lion share of expenditure was made on activities like plantation of horticultural crops. It can be concluded that these horticultural development activities have made an impact on out-turn from horticultural crops after a time lag of six years.

**Sources of TFP in Horticulture**

Increase in production can be induced by research, development/extension and infrastructural facilities, etc. So as to take prudent public investment decisions, it is useful to understand the relative importance of these productivity-enhancing factors in determining the productivity growth. Therefore, the TFP growth was decomposed into its sources. The estimated parameters of decomposition model along with their contributions to TFP of the horticultural crops in the Konkan region have been presented in Table 3.

A perusal of Table 3 reveals that the investment made in research, irrigation development and horticultural development were the major sources of growth in TFP. The expenditure incurred by the government on irrigation and horticultural development has been found to have negative coefficients. This could be due to the fact that the expenditure made on the horticultural development had mainly resulted in area expansion. Similarly, mango and cashew had the major shares in the horticultural production in the Konkan region, which are predominantly grown as rainfed crops. Therefore, it could be concluded that though there was significant investment on irrigation development, it did not result into positive impact on TFP. Investment on research was the main source of TFP growth in the major horticultural crops in the Konkan region of Maharashtra.

**Rates of Return to Horticultural Research and Development**

In order to assess the determinants of total factor productivity (TFP), the TFP index was regressed on research and development investment per hectare of area and per year basis, which was trend variable. Using the elasticity of TFP with respect to research investment, we estimated the value of marginal product of research investment, using the following formula:

$$EVMP = b \times (V/I)$$

where, I = Investment, V = Value of production associated with TFP, and b = TFP elasticity of investment.

**Table 3. Sources of TFP in horticulture in the Konkan region: 2004-05**

Variables	Regression coefficient	SE (b)	't' cal.
Intercept	96.92		
Horticultural development expenditure	-0.00493	0.0006	8.15
Irrigation development expenditure	-0.00803	0.001	7.92
Horticultural research expenditure	0.2833	0.012	22.07
R <sup>2</sup>	0.99		

Following Kumar and Rosegrant (1994), the internal rate of return to horticultural research investment was computed to the tune of 119 per cent, which is much higher than those of crop (Evenson and Jha, 1973; Bal and Kahlon, 1977; Kumar and Rosegrant 1994), livestock (Kumar *et al.*, 1977) and fisheries (Kumar *et al.*, 2004b) in India. The result clearly implied that investment on horticultural research was highly profitable.

### Conclusions

The comparative picture of TFP growth by sub-period-wise has revealed that the magnitude of TFP growth varies from 1.30 per cent per annum during Period II (1991-92 to 2000-01) to 6.18 per cent per annum during Period I (1981-82 to 1990-91). During the entire period under study (1981-82 to 2000-01), the TFP has grown at the rate of 5.43 per cent per annum. The results present a divergent picture of horticultural growth in the Konkan region during the period under study. The horticultural research being a lengthy process requires time lag to yield its fruits. Similarly, plantation crops are characterized by long-gestation period, hence, investment made on research and development requires time to yield returns. The results have shown that there is a time lag of six years between investment on horticultural research and development and returns from it. Investment in research and development in horticultural crops has been found highly profitable.

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## Appendix I

### Investment in horticultural development

(Rs in lakhs)

Year	S'durg	Ratnagiri	Raigad	Thane	Konkan
1981-82	2.8	2.16	1.92	2.11	9.42
82-83	7.05	6.75	9.91	12.49	81.41
83-84	9.06	14.18	11.72	4.81	42.26
84-85	35.89	50.86	41.36	44.45	172.89
85-86	12.78	11.67	1302	19.9	1347.48
86-87	14.57	18.79	12.05	26.72	74.06
87-88	11.89	17.4	16.19	19.77	66.31
88-89	12.46	21.4	19.91	24.62	78.57
89-90	111.63	146.35	62.58	53.94	375.97
90-91	236.77	274.94	172.18	134.69	818.65
91-92	291.15	438.62	199.49	170.1	1102.07
92-93	435.4	515.67	255.89	307.42	1519.73
93-94	477.78	606.47	323.66	336.62	1766.03
94-95	469.65	790.48	377.87	400.84	2058.21
95-96	800.25	953.82	927.88	710.40	3407.98
96-97	498.25	725.02	761.14	688.59	2923.30
97-98	473.78	646.39	819.25	454.76	2656.19
98-99	803.83	1062.26	779.96	568.01	3648.89
99-2000	802.14	1258.39	942.8	1253.55	4892.58
2000-01	469.67	1157.16	728.51	484.55	3087.23

Source : Financial records from the office of Joint Director of Agriculture, Konkan Division, Thane



**Appendix II****Research Investment in Horticultural crops in Konkan region of Maharashtra**

(Rs in lakhs)

Year	Mango	Cashew	Coconut	Total
1975-76	5.63	3.01	2.44	11.08
76-77	5.9	3.41	3.3	12.61
77-78	6.31	3.46	4.46	14.23
78-79	6.61	6.43	3.67	16.71
79-80	7.11	4.06	8.18	19.35
80-81	7.91	4.88	4.19	16.98
81-82	8.43	4.9	4.47	17.8
82-83	8.6	4.97	8.14	21.71
83-84	8.73	5.2	5.02	18.95
84-85	9.69	6.88	5.61	22.18
85-86	9.87	6.99	14.5	31.36
86-87	19.36	9.05	7.28	35.69
87-88	20.27	14.88	9.61	44.76
88-89	21.24	17.73	11.45	50.42
89-90	27.31	13.85	11.54	52.7
90-91	41.1	27.7	13.11	81.91
91-92	44.37	12.71	12.42	69.5
92-93	45.51	10.81	9.52	65.84
93-94	44.58	14.92	10.78	70.28
94-95	67.79	3.23	12.27	83.29
95-96	58.385	19.13	13.84	91.35
96-97	48.76	18.9	20.79	88.45
97-98	70.66	20.89	17.53	109.08
98-99	86.83	22.56	17.83	127.22
99-2000	117.51	96.01	28.28	241.8
2000-01	144.02	44.05	31.93	220
2001-02	86.14	38.12	26.74	151.00
2002-03	116.65	34.77	28.77	180.19

*Source:* Financial records from different research stations working under D.B.S.Konkan Krishi Vidyapeeth Dpoli