

Cotton productivity in the districts of Maharashtra: (TFP) approach

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ABSTRACT : The analysis indicated that in most of the districts total factor productivity growth was positive indicating the sustainability of cotton production. In two districts total factor productivity growth was not significant. This indicated that cotton output growth is not sustainable in these two districts. Decadal growth rates indicated that during 2000-2008 total factor productivity growth was high in all the districts when compared with that of 1991-2001. Output growth can further be improved by improving the total factor productivity growth as well as input growth.

Key words : Cotton, Tornqvist Theil indices, total factor productivity

Total Factor Productivity (TFP) measures the changes in aggregate productivity considering all major inputs at a time. There are mainly two sources of production growth. One is increase in the quantity of inputs and the second is due to the improvement in quality of inputs as well as their application methods. This in turn is the output of research efforts made. TFP precisely estimates the growth rate in total output due to this source which is very important for sustainable growth in productivity in long run. As cotton production is highly location specific aggregate estimate are little useful to take decision at district levels. Hence in this study an attempt was made to analyze total factor productivity at district level. As Maharashtra ranks first in cotton area, the study was conducted in 10 major cotton growing districts.

MATERIALS AND METHODS

Data and selection of districts : Cotton is produced in 22 districts of Maharashtra. There are 11 districts in Maharashtra, which have more than 100000 ha cotton area and produce more than 100000 bales of cotton. These districts include, Akola, Amravati, Aurangabad, Beed, Buldhana, Jalna, Jalgoan, Nanded, Parbhani, Wardha and Yavatmal. All these districts were considered for the study except Jalgoan due to the non availability of the data. These 10 districts are contributing 75 per cent of cotton area and

56.5 per cent of cotton production of Maharashtra. The data on quantity of inputs used, output produced, their prices etc. were collected from the cost of cultivation schemes of Maratwada Agricultural University, Parbhani and Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola for the period from 1991-1992 to 2006-2007. The data has been analyzed using the following methodology

Compound growth rates : Compound growth rates were worked out for area, production and productivity of cotton, inputs used and their partial productivities for the period of study. Compound growth rates were worked out by fitting exponential function as given below:

$$X_t = ab^t$$

$$\log X_t = \log a + t \log b$$

$$\text{Compound growth rate (r)} = (\text{antilog } b - 1) \times 100$$

Where,

X_t = Value of the variable in the year 't'

t = time element which takes the value

1, 2, 3, n

a = constant

b = regression coefficient.

Total factor productivity : Earlier Laspyeres arithmetic indices were used most commonly to measure TFP. But most recent literature on TFP (Desai and Nambudri, 1997; Mittal and Lal, 2001) has advocated and employed Tornqvist Theil or translog index in their study

because of its superiority. Tornqvist-Theil index is a superlative index which is exact for the linear homogeneous translog production function. A further advantage of the Tornqvist-Theil index is that it accounts for changes in quality of inputs. Because current factor prices are used in constructing the weights, quality improvements in inputs are incorporated, to the extent that these are reflected in higher prices. The Tornqvist-Theil index provides consistent aggregation of inputs and outputs under the assumptions of competitive behavior, constant returns to scale, Hicks-neutral technical change, and input-output separability.

Expressed in logarithmic form, the Tornqvist-Theil index is given by the following equation

$$\ln (TFP_t / TFP_{t-1}) = \ln (Q_t / Q_{t-1}) - \frac{1}{2} \sum (C_{it} + C_{it-1}) \ln (X_{it} / X_{it-1})$$

Where;

Q_t = Output of cotton in year 't'

C_{it} = Share of input 'i' in total input cost

X_{it} = Input 'i' in year 't'

Specifying the index equal to 100 in base year and accumulating the measure based on above equation provides the TFP index. Inputs considered for constructing the indices includes human labour, bullock labour, machine labour, seed, manures, fertilizers (NPK), plant protection chemicals and rental value of land. Seed cotton was considered as only output as value of cotton stalks was negligible.

RESULTS AND DISCUSSION

Average area and production of cotton in last 5 years in the selected districts is given in Table 1. Among these 10 districts Yavatmal ranks first in cotton area (3.70 lakh ha) followed by Amravati (2.62 lakh ha) and Akola (2.25 lakh ha). In case of production also Yavatmal ranks first with (3.51 lakh bales) followed by Jalna (2.71 lakh bales) and Akola (2.43 lakh bales). But Jalna ranks first in cotton productivity with a productivity of (249 kg lint/ha). Similarly, Wardha and Parbhani ranked second and third with a productivity of 202 kg and 200 kg lint/ ha,

respectively.

Districtwise analysis of total factor productivity : Total input, output and total factor productivity indices were worked out for each district using Tornqvist-Theil indexing procedure. Compound growth rates of these indices were worked out and their significance were tested. The analysis was carried out for the period 1991-1992 to 2007-2008 as per the availability of the data. The period was divided into two sub periods first from 1991- 2001 and the second from 2001-2008. The results were presented in Tables 2 and 3.

Akola : Akola is one of the important cotton growing districts of Maharashtra. Total factor productivity indices showed a non significant growth during the period of analysis in this district. Output index showed a positive growth of 2.16 per cent/annum. This growth is mainly caused by the growth of inputs. It is not supported by the growth of total factor productivity. Hence it is not sustainable in the long run. Decadal analysis indicates that during first period (1991-2000) total factor productivity growth was not significant and input as well as output indices showed negative growth. But during the second period (2001-2008) output index and total factor productivity index showed

Table 1. Districtwise area, production and productivity of cotton in selected districts of Maharashtra (Average of 2002-2003 to 2006-2007)

S. No	District	Area (ha)	Production (bales*)	Productivity (kg/ha)
1.	Akola	224860	242540	183
2.	Amravati	262400	191720	124
3.	Aurangabad	209040	238280	194
4.	Beed	113840	121000	181
5.	Buldhana	196400	224140	194
6.	Jalgaon	395520	601600	259
7.	Jalna	185040	271060	249
8.	Nanded	221360	156500	120
9.	Parbhani	202040	237400	200
10.	Wardha	102260	121520	202
11.	Yavatmal	369920	351180	161

Source: Dept. of Agriculture, Government of Maharashtra.
* : 1 bale = 170 kg

positive growth. This is a good sign indicating that cotton output growth in this district is becoming sustainable. Adoption of innovative technologies like *Bt* cotton, new insecticides and improved practices may be the reason for this improvement.

Amravati : Amravati is another important cotton growing district of Maharashtra. Though the productivity is less total factor productivity index showed positive growth during the period of analysis. But output growth was not significant. This was due to the negative growth in input index during this period. This showed that there were serious problems which limit the input use in this district. Growth of all the 3 indices was negative during the first period. During this period total factor productivity decreased at the rate of -5.02 per cent whereas the growth of total input index and total output index was -2.70 and -7.72 per cent, respectively. But during the second period total factor productivity showed a positive growth of 2.93 per cent/year whereas total output index showed 2.40 per cent growth. This clearly indicates the improvement of cotton production scenario during the second period.

Aurangabad : In this district growth of total factor productivity was not significant during the period of analysis. But total output index showed a positive growth of 4.9 per cent which was due to the positive growth of total input index. If we examine two periods separately output showed positive growth in both the periods. In first period it was due to input growth only. During this period total factor productivity growth was negative. But the growth of output in second period was the results of positive growth in TFP as well as TII. But the contribution of TFP was more, which is a positive sign. Growth of total input index was higher during first period where as growth of total output index was higher during second period.

Beed : Beed registered a positive total factor productivity growth during the period of analysis. Total factor productivity increased at a

compound rate of 2.02 per cent/year. In this district growth of all the three indices were negative during first period. But they were positive during the second period. This district showed a spectacular increase in output as well as total factor productivity during the second period. This growth in output is sustainable as it was supported by the growth of total factor productivity.

Buldhana : Analysis revealed that growth of total factor productivity was positive and significant during both the periods as well as overall period in this district. Total factor productivity increased at the rate of 2.46 per cent/year. Cotton output registered a growth of 6.10 per cent/annum. The sustainability of this output growth is indicated by the positive growth of total factor productivity. In this district total factor productivity growth was comparatively less during second period when compared with that of first period. The factors which slow down the growth of total factor productivity needs to be corrected. However after 2005-2006 the total factor productivity index showed improvement.

Jalna : Jalna is one of the cotton producing districts of Maharashtra which have higher productivity. Availability of irrigation for cotton in this district and progressive nature of the farmers of this district as an important cotton producer. Total factor productivity growth was positive during overall period as well as both the individual periods indicating the sustainability of cotton production in this district. TII showed a positive growth of 2.08 per cent while TOI and TFP indices showed 5.69 and 3.62 per cent compound growth /year. Growth of total input index was not significant during both the periods. Growth of total factor productivity and total output index was comparatively higher during the second period.

Nanded : In this district output growth was positive in the overall period as well as individual periods. Similarly growth of total factor productivity was also positive during both the

Table 2. Indices of total input index, total output index and total factor productivity cotton in Maharashtra

Years	Akola			Amravati			Aurangabad			Beed			Buldhana		
	TII	TOI	TFP	TII	TOI	TFP	TOI	TII	TFP	TOI	TII	TFP	TOI	TII	TFP
1991-1992	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1992-1993	118	124	106	88	98	111	105	81	129	143	87	164	119	85	140
1993-1994	110	267	244	116	184	158	161	142	113	124	90	137	235	93	252
1994-1995	102	80	78	100	176	177	143	138	104	107	104	103	140	97	145
1995-1996	89	82	92	84	76	90	171	180	95	97	108	90	190	140	136
1996-1997	106	121	114	102	113	110	150	163	92	143	107	133	68	68	99
1997-1998	90	99	111	91	41	45	183	187	98	163	108	150	136	106	128
1998-1999	100	136	136	73	33	46	187	164	114	94	80	117	198	92	215
1999-2000	93	165	176	85	68	80	163	160	102	98	86	113	213	96	222
2000-2001	81	74	92	82	128	157	170	178	96	125	105	118	264	105	251
2001-2002	117	133	113	53	85	161	192	192	100	132	114	116	207	101	204
2002-2003	123	105	85	65	107	165	214	207	103	139	119	117	165	97	170
2003-2004	114	180	158	57	118	208	170	220	77	165	129	127	273	132	207
2004-2005	113	213	189	56	112	200	199	217	92	164	142	116	192	137	140
2005-2006	123	131	106	57	91	160	228	208	110	163	145	112	176	135	130
2006-2007	107	131	122	53	101	190	236	210	112	207	108	192	328	196	167
2007-2008	137	159	116	59	102	172	330	229	144	317	128	248	388	149	260
CGR	1.20	2.16	0.96	-4.47	0.20	4.67	4.90	4.77	0.13	4.30	2.28	2.02	6.10	3.63	2.46
1991-1992	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1992-1993	117	92	127	99	108	92	134	107	125	137	110	124	116	98	119
1993-1994	142	140	101	124	129	96	116	111	105	144	100	144	150	96	158
1994-1995	113	109	104	93	135	69	119	152	78	106	82	130	48	76	64
1995-1996	110	130	85	82	129	63	127	143	88	154	97	159	106	86	124
1996-1997	149	119	125	110	139	79	104	93	111	158	94	168	140	84	166
1997-1998	125	123	102	100	128	78	109	98	111	158	93	170	78	85	92
1998-1999	141	120	118	126	140	90	99	114	87	147	74	199	42	61	68
1999-2000	142	108	132	116	131	88	96	105	91	165	102	161	133	105	126
2000-2001	193	103	187	167	133	126	124	121	103	98	103	96	131	94	140
2001-2002	180	134	134	163	138	118	138	130	106	122	71	171	127	97	130
2002-2003	167	152	110	158	144	110	151	139	109	90	44	206	136	94	144
2003-2004	160	162	98	140	167	84	136	157	86	89	52	171	162	103	156
2004-2005	189	140	135	138	139	100	151	142	107	86	65	132	133	86	154
2005-2006	217	114	191	136	109	125	167	124	134	90	53	169	94	85	110
2006-2007	256	150	171	172	148	116	181	141	128	206	73	282	167	106	157
2007-2008	338	153	221	268	162	165	316	163	193	187	77	241	231	108	214
CGR	5.69	2.08	3.62	4.60	1.59	3.02	4.10	2.05	2.06	0.35	-3.66	4.01	3.38	0.60	2.78

TII: Total input index, TOI: Total output index, TFP: Total factor productivity

periods as well as overall period indicating the sustainability of output growth. During the period of analysis total factor productivity growth was 3.02 per cent/annum. Growth of TOI and TII was 4.60 and 1.59 per cent.

Parbhani : Growth of total factor productivity was negative during first period. But it registered a positive growth of 9.23 per cent during second period. Similarly both total output index and total input index showed a negative growth in the first period and positive growth during the second period. TII and TOI increased at the rate of 2.05 per cent and 4.01 per cent while total factor productivity increased at the rate of 2.06 per cent/annum. This indicates that cotton production recovered from serious problems in second period and moving towards sustainability.

Wardha : During the period of analysis total input index showed a negative growth of -3.66 per cent/annum while growth of total output index was not significant. But total factor productivity increased at the rate of 4.01 per cent showing that cotton production in this district is sustainable. Cotton output growth can be increased by increasing the quantity of inputs used in cotton production. Total input index growth was negative during first period and positive during second period.

Yavatmal : During the period of analysis total factor productivity of cotton increased at the rate of 2.78 per cent /annum, whereas total output index increased at the rate of 3.38 per cent /year. Growth of total input index was not significant. If we examine period wise growth rates it is clear that during the first period growth of total factor productivity was not significant. Total output index and total input index showed a negative growth. During second period compound growth rate of total factor productivity was 2.86 per cent/ annum while total output index was 3.14 per cent.

TFP in different time periods : Growth of total factor productivity in different periods is compared in Table 3. Out of 10 districts 8 districts showed positive significant TFP growth. Out of these 8 districts in Amravati and Wardha output growth is not significant and input growth was negative. But the output level was maintained due to the growth in TFP. Output growth can be further improved by improving the input growth. In 2 districts Akola and Aurangabad TFP growth was not significant. But these 2 districts showed positive output growth which was due to the growth in inputs. In these 2 districts output growth can be further improved by stimulating the productivity growth.

During the first period six districts showed positive total factor productivity growth

Table3. Growth rates of TII, TOI and TFP indices in different periods

District	1991-2001			2001-2008			1991-1992 to 2007-2008		
	TII	TOI	TFP	TII	TOI	TFP	TII	TOI	TFP
Akola	-2.56*	-1.87	0.70	0.62	3.46*	2.84*	1.20	2.16*	0.96
Amravati	-2.70**	-7.72*	-5.02*	-0.53	2.40	2.93*	-4.47*	0.20	4.67**
Aurangabad	6.94**	5.60**	-1.34	1.85**	7.55**	5.70	4.77**	4.90**	0.13
Beed	-0.05	-0.26	-0.21	1.03	12.24*	11.21*	2.28*	4.30*	2.02
Buldhana	0.47*	6.55**	6.08*	8.33*	11.03*	2.70	3.63	6.10	2.46*
Jalna	0.56	4.78**	4.22**	0.02	10.95**	10.92*	2.08	5.69*	3.62*
Nanded	2.56*	3.80**	1.24*	0.47	5.83*	5.37*	1.59*	4.60	3.02*
Parbhani	-0.04	-1.01**	-0.98	1.74	10.96*	9.23*	2.05	4.10*	2.06
Wardha	-0.88*	1.48	2.35**	2.40*	10.18*	7.79*	-3.66*	0.35	4.01**
Yavatmal	-1.18	-0.78	0.39	0.29	3.14*	2.86	0.60	3.38*	2.78*

* : significant at 10 percent level; ** : significant at 5 percent level; TII: Total input index, TOI: Total output index, TFP: Total factor productivity

while 4 districts showed negative growth. Highest total factor productivity growth was observed in Buldhana followed by Jalna and Wardha. Total factor productivity growth was negative in Amravati, Aurangabad, Beed and Parbhani during this period. During the second period total factor productivity growth was positive in all the 10 districts. During this period total factor productivity growth was highest in Beed followed by Jalna and Parbhani. During the overall period no district registered negative growth of total factor productivity. Highest total factor productivity growth was observed in Amravati followed by Wardha and Jalna.

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