Role of technological change in enhancing the income of rainfed farmers : A study of bajra crop in Western Maharashtra

Swati Choudhari

Based on Ph.D. thesis of **S.A.Choudhari** submitted to PGI, MPKV, Rahuri – MS.

Junior Research Assistants, Department of Agril. Economics. Mahatma Phule Krishi Vidapeeth, Rahuri.

Email: swatichoudhari.0503@gmail.com

Abstract: *In the present study an attempt has been made to distingwish the effects of technological change and inputs use efficiencies in bajra rainfed crop from Western Maharashtra during the two sub periods of 1996-2005 and 2006-2015. The total factor productivity (TFP) approach was followed in analyses of data. Analyses had indicated that there were contineous rise in the input, output and TFP indices during both the periods and in all divisions of Western Maharashtra. Therefore, the growth rates of these three indicators were worked out.*

Based on the finding, it is concluded that the modern inputs such as improved varieties (Shanti, Saburi, etc.), integrated nutrient management (organic manure +chemical fertilizer + biofetilizer), etc. were major contributors to TFP growth in Western Maharashtra.

But then, TFP in all Divisions declined during later period. It was mainly because of inefficiencies in resources use rather than use of technologies. One has to further examine the case of each major inputs in detail which had resulted in lower efficiencies, so that further corrections can be made in their use.

Key Words: *TFP, Input Index, Output Index, TFP Index.*

1. INTRODUCTION:

Bajra is the third major crop in Western Maharashtra.. It is mostly rainfed crop (16 %), the majority of small and marginal farmers who do not possess the bullock pairs, farm equipments etc. which are uneconomical to mentain go for cultivation of rainfed bajra. Before 1967 i.e. during pre-green revolution period, only local varieties of bajra were cultivated having very very low yield potentials. But after 1967- 68, there was rapid spread of high yielding varieties (HYVs)   in the late 80s and early 90s resulted in phenomenal output growth. During 1975-2015, bajra production increased at an extraordinarily high rate of 2.64 percent per annum with nearly half of this increase contributed by yield gains. The yield improvement has to be accompanied by potential increase in input use efficiencies. Greater the efficiency,   lower will be costs and hence larger will be the net gains from the use of scarce inputs in bajra production. Increased efficiencies of inputs will indirectly results into increased welfare level of bajra producers who are small and marginal farmers in Western Maharashtra

2. LITERATURE REVIEW:

Patil and Jha (1978) had ably analyzed changes in output, input and agricultural productivity growth in Maharashtra State and India, 1951-52 TO 1971-72. They concluded that agricultural output stagnated in spite of rapid growth in modern inputs mainly because the technological assets acquired in the 1950 s had depreciated greatly and this completely nullified the condition of modern inputs. Agricultural research and extension worker to disseminate new technology must have a most crucial role in rapid output growth. The importance of technology in the production of individual crops such as rice and wheat in India has been highlighted in the works of Kumar and Rosegrant (1994) and Kumar and Mruthyunjaya (1992) respectively. A recent study by Kumar (2004) examined the TFP growth in Indian fisheries sector. He concluded that the technological advancement will make fish available at cheaper rates to consumers while producers would get more income by developing export market.

As far as Maharashtra is concerned, Sidhu and Byerlee (1992) had ably analyzed   technical change and onion productivity in the Western Maharashtra as a whole rather than for each division of Western Maharashtra. Therefore, in the present paper an attempt has been made to assesses total factor productivity growth in respect of onion in different division of Western Maharashtra thereby to know the impact of technologies and the efficiencies of all inputs together during two different periods (i.e. Period I (1996-2005) and Period II (2006-2015)).

3. MATHOD:

Analysis of Total Factor Productivity (TFP)

Total factor productivity concept implies an index of total output per unit of total factor inputs. TFP growth measures the increase in output i.e. not accounted for by the increase in total inputs. Changes in total factor

productivity index can be used as one of the measures such as output per unit of individual inputs and have limitations as indicators of real productivity change i.e. partial productivity measures. Thus, total factor productivity index that measures the growth in net output i.e. not accounted for by the growth in basic factor input such as land, labour capital, superior to partial approach as it is composite measure of productivity, which related of output all inputs simultaneously. (Pillai 2000).

The accounting approach is popular because it is simple to calculate and requires no econometric estimation and therefore, the data requirement is minimal. The use of TFP indices gained prominence since 1976, 1978 proved that Theil-Tornquist discrete approximation to the Divisia index is consistent in aggregation and superlative to a linear homogenous trans logarithmic production function. Thus, the Divisia-Tornqvist index was used in the present study for computing Total Output Index (TOI), Total Input Index (TII) and Total Factor Productivity index (TFPI) in bajra crop of the three divisions viz; Nasik, Pune and Kolhapur in Western Maharashtra region.

Six inputs viz; seed, male labour, female labour, bullock labour, fertilizers, FYM and rental value of land were considered for analysis. Rental value of land was taken as one sixth of gross value of produce, bullock labour input as a number of bullock pair in days, FYM input taken as a quintal per hectare and human labour male or female in days.

The data on these inputs were collected from the records of the state Cost of Cultivation Scheme of Maharashtra operated in the Department of Agricultural Economics, MPKV, Rahuri. Share of each input cost was computed as proportion to the total production cost. Input cost share and input quantity data of the three divisions were used for computing the input index. The farm harvest price and production of bajra at division level were used to compute the output index. The value of a grain and byproduct were included into output index. The total factor productivity index was computed by dividing the output index by input index of the three divisions separately. By specifying TOI, TII equal to one in the initial year, the following equations provided the total output index, total input index and total factor productivity index. For the present analysis of total factor productivity, the period after 1996 till 2015 was considered. It is because the data on input use, production, cost of production, etc. were only available in continuous series after 1996 to 2015. Therefore, for further analysis Period I (1996-2005) and Period II (2006-2015) and overall Period (1996-2015) were considered.

TFP indices were computed as follows:

Total Output Index (TOI)

$$TOI_t/TOI_{t-1} = \Pi_j (Q_{jt}/ Q_{jt-1})^{(R_{jt} + R_{jt-1})\,½}$$

Total Input Index (TII)

$$TII_t/TII_{t-1} = \Pi_j (X_{it}/X_{it-1})^{(S_{it} + S_{it-1})\,½}$$

Total Factor Productivity Index (TFPI):

$$TFPI_t = (TOI_t/TII_t) \times 100$$

Where,

R_{it}	=	The share of output in the total revenue
Q_{jt}	=	Output
S_{it}	=	The share of input in total input cost
X_{it}	=	Input i and

Growth rate in TFP = Growth rate of TOI – Growth rate of TII

4. RESULT:

Total Factor Productivity Indices - Output, input and TFP indices of bajra for three divisions in Western Maharashtra during different time periods are presented in Table 1.

Nasik Division-

Indices of output and input have steadily increased throughout the period under study. During the Period I (1996-2005), the increase in magnitude of output index was 96.00 to 118.14 and in input index it was from 103.49 to 118.56, and the resulting total factor productivity index ranged from 92.76 to 99.65. It is because agriculture had realized almost all of it's production gains from increases in input supply and due to spread of HYVs. There was positive impact on total factor productivity indices. During the period 2006-2015, the range of index of output, input and TFP was 121.83 to 155.04, that of input index was from 121.07 to 143.68, 100.63 to 107.91.

Pune division – It is revealed from the table1 while that in TFP it was from during the period 1996-2005, the increase total input index, total output index and total factor productivity index was from 103.99 to 118.91, 96.50 to 118.49 and 92.80 to 99.65 respectively. It is due to positive impact of improved technology on total factor productivity. During the later period i.e. 2006-2015, the total input indices i.e. (121.42 to 144.49) were less than total output indices. It has resulted into total factor productivity indices of 100.62 to 107.86. It is because there was increased use of fertilizers, irrigation facilities and INM.

Kolhapur division – It is observed from the table1 that during the period 1996-2005, total input indices, total output indices and total factor productivity indices had increased from 103.76 to 118.45, 96.27 to 118.03, and 92.78 to 99.65, respectively. It is because introduction of HYVs during 90's had resulted in steady output growth. During the later period , total output indices i.e. (121.72 to 154.98) were more than total input indices i.e. (120.96 to 143.62) and therefore resulting total factor productivity indices were higher i.e. (100.63 to 107.91)

Western Maharashtra – It is noticed from the table 1 that during the period 1996-2005, total input indices, total output indices and total factor productivity indices was 103.74 to 118.64, 96.26 to 118.22 and 92.78 to 102.47. During later period 2006-2015, the total output indices i.e. (121.91 to 155.29) was more than total input indices i.e. (121.15 to 143.93). The indices of both input and output have resulted into total factor productivity indices i.e. 103.34 to 107.91

        Above analysis of indices have indicated that there were continous increase in their magnitudes in all divisions and in both the periods. The precise growth in each set of indices would only be indicated by the single value growth rates those can be compared safely.

Table 1 Annual output, input and TFP indices of Bajra of Western Maharashtra during different time periods (1996-2015)

Period	Year	Nasik			Pune			Kolhapur			Western Maharashtra		
		Input Index	Output Index	TFP Index	Input Index	Output Index	TFP Index	Input Index	Output Index	TFP Index	Input Index	Output Index	TFP Index
I	1996	103.49	96.00	92.76	103.99	96.50	92.80	103.76	96.27	92.78	103.74	96.26	92.78
	1997	106.00	99.69	94.05	106.50	100.19	94.08	106.27	99.96	94.06	106.26	99.95	94.06
	1998	108.51	103.38	95.27	109.01	103.88	95.29	108.78	103.65	95.28	108.77	103.64	95.28
	1999	111.02	107.07	96.44	111.52	107.57	96.45	111.29	107.34	96.45	111.28	107.33	96.45
	2000	113.54	110.76	97.56	113.89	111.11	97.56	113.66	110.88	97.56	113.69	110.92	97.56
	2001	116.05	114.45	98.62	116.40	114.80	98.63	115.94	114.34	98.62	116.13	114.53	98.62
	2002	118.56	118.14	99.65	118.91	118.49	99.65	118.45	118.03	99.65	118.64	118.22	99.65
	2003	121.07	121.83	100.63	121.42	122.18	100.62	120.96	121.72	100.63	121.15	121.91	100.63
	2004	123.58	125.52	101.57	123.93	125.87	101.56	123.47	125.41	101.57	123.66	125.60	101.57
	2005	118.56	118.14	99.65	118.91	118.49	99.65	118.45	118.03	99.65	118.64	118.22	102.47
II	2006	121.07	121.83	100.63	121.42	122.18	100.62	120.96	121.72	100.63	121.15	121.91	103.34
	2007	126.10	129.21	102.47	126.45	129.56	102.46	125.99	129.10	102.47	126.18	129.29	104.17
	2008	128.61	132.90	103.34	128.96	133.25	103.33	128.50	132.79	103.34	128.69	132.98	104.98
	2009	131.12	136.59	104.17	131.47	136.94	104.16	130.60	136.07	104.19	131.06	136.53	105.75
	2010	133.63	140.28	104.98	133.98	140.63	104.96	133.11	139.76	105.00	133.57	140.22	106.50
	2011	136.14	143.97	105.75	136.49	144.32	105.73	135.62	143.45	105.77	136.09	143.91	107.20
	2012	131.12	136.59	104.17	131.47	136.94	104.16	130.60	136.07	104.19	131.06	136.53	107.89
	2013	138.65	147.66	106.49	139.00	148.01	106.48	138.13	147.14	106.52	138.60	147.60	106.49
	2014	141.17	151.35	107.21	141.98	152.16	107.17	141.11	151.29	107.22	141.42	151.60	107.21
	2015	143.68	155.04	107.91	144.49	155.85	107.86	143.62	154.98	107.91	143.93	155.29	107.91

Growth in Total Factor Productivity Indices

        Growth rates in the total input index (TII), total output index (TOI), and total factor productivity (TFP) indices were estimated for bajra in different divisions in Western Maharashtra region, using Divisia- Tornqvist index for two sub – periods and entire period and those are presented in Table 2.

Table 2 Annual growth rates of output, input and TFP indices of bajra crops in different division during different time periods.

Divisions	Period I 1996-2005)			Period II 2006-2015)			Overall (1996-2015)		
	Output	Input	TFP	Output	Input	TFP	Output	Input	TFP
Nasik	3.84	2.42	1.16	3.83	1.95	2.78	3.84	2.43	1.00
Pune	3.81	2.39	1.15	2.84	2.01	0.73	3.83	2.43	0.99
Kolhapur	3.77	2.37	1.15	2.81	1.99	0.74	3.79	2.38	1.00
Western Maharashtra	3.80	2.39	1.15	2.81	1.99	0.74	3.82	2.41	1.00

Nasik division

It is revealed from the Table 2 that during Period I (1996-2005), the growth in total input index for bajra crop was 2.42 per cent per annum and output growth @ 3.84 per cent per annum and the resulting total factor productivity growth index was 1.16 per cent per annum. During 2006-2015, the growth in input index was lower (1.95 per cent) as compared to total output index (3.83) resulting into total factor productivity growth of 2.78 per cent. It implied that in case of bajra (pearl millet), the impact of technologies was much higher than the previous Period (1996-2005). It is because, the new bajra varieties along with other technological aspects got stabilized during this period. No doubt, the growth in total output index, total input index was lower in Period II than Period I. For the entire Period, the growth in total input index and total output index was 2.43 and 3.84 per cent per annum, respectively while growth in total factor productivity index has turned out to be low (1.00 per cent).

The magnitude of growth rates of output index and input index for bajra, though comparatively higher in Nasik division but had moderate increase in TFP as indicated by it's growth rate. This implies that the increase in total output were mainly brought by the increased use of inputs rather than new technologies.

Pune division

It is revealed from the Table 2 that, during 1996-2005, the growth in input index for bajra was less (2.39 per cent) than output index i.e. @ 3.81 per cent per annum resulting into total factor productivity growth of 1.15 per cent per annum. It is because, the impact of new technologies viz. use of HYV seed, fertilizer, pesticide, etc, was much higher during previous period than later period (2006-2015).

During 2006-2015, there was decrease in total input index (2.01 per cent) and total output index (2.84) over the Period. The growth in both input and output index had resulted into 0.73 per cent in total factor productivity growth. For the entire period, the growth in total input index, total output index, total factor productivity indices was 2.43, 3.83 and 0.99 per cent per annum, respectively.

It is concluded that the increase in total output were mainly brought by the increased use of fertilizers, improved varieties, integrated nutrient management (organic manure + chemical fertilizer + biofertilizer) and irrigation facilities.

Kolhapur division

It is revealed from the Table 2 that, during 1996-2005, the growth in total input index for bajra was less (2.37 per cent) than total output index (3.77 per cent). The growth in both the input and output index was resulted into 1.15 per cent total factor productivity growth. High yielding seed is an important component of the new production technology in agriculture. It is seen that, the introduction and rapid spread of high yielding varieties i.e. Shardha, Saburi, etc. in the late 80s and early 90s resulted in steady output growth for bajra.

During 2006-2015, there was decrease in total input index (1.99 per cent) and total output index (2.81 per cent). Therefore, total factor productivity had turned out to be 0.74 per cent. Therefore, for the entire period, the growth in total input index, total output index, total factor productivity index was 2.38, 3.79, 1.00 per cent per annum,

From this, it is concluded that there were use of new technologies of production or use of chemical fertilizers.

Western Maharashtra

It is noticed from the Table 2 that, during Period-I, the growth in input index for bajra was less (2.39 per cent) than output index (3.80 per cent). The growth in both input and output index has resulted into total factor productivity growth to the extent of 1.15 per cent. During 2006-2015, there was decrease in total input index (1.99 per cent) and total output index (2.81 per cent) over the Period. Therefore, total factor productivity had turned out to be 0.74 per cent. For the entire period, the growth in input index, total output index, total factor productivity index was 2.41, 3.82, 1.00 per cent per annum, respectively.

It is revealed from the Table 2 that, the magnitudes of growth rates of output index for bajra; though were higher than input index had registered a marginal growth in TFP. Modern inputs such as improved varieties (Shanti, Saburi, etc.), integrated nutrient management (organic manure +chemical fertilizer + biofertilizer), etc. were major contributors to TFP growth.

5. CONCLUSION:

Growth rates in TFP during first period i.e. 1996-2005 were similar in all the Divisions while during later period, eventhough they were similar except in Nasik Division but with less magnitude than earlier period. It is therefore, safely concluded that during first period (1996-2005) the effect of technology was greater than that in later period. This was mainly because of introduction of new bajra varieties (Shanti), fertilizers, improved varieties, integrated nutrient management (organic manure +chemical fertilizer + biofetilizer) and irrigation facilities for bajara. Moreover, the introduction and rapid spread of high yielding varieties i.e. Shardha, Saburi, etc. in the late 80s and early 90s resulted in steady output growth for bajra in all divisions. It is therefore inferred that, the modern inputs such

as improved varieties (Shanti, Saburi, etc.), integrated nutrient management (organic manure +chemical fertilizer + biofetilizer), etc. were major contributors to TFP growth in Western Maharashtra. But then, TFP in all Divisions declined during later period. It was mainly because of inefficiencies in resources use rather than use of technologies. One has to further examine the case of each major inputs in detail which had resulted in lower efficiencies, so that further corrections can be made in their use.

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