Original Research Article

Technical change in Hybrid Tomato Production- A Field Based Study

Abstract

This research article offers a technical change in hybrid tomato production by measuring the sources of output growth, comparing them to input growth, or improving total factor productivity. While measuring the sources of output growth, the contribution of total productivity is always estimated as residual after accounting for the growth of the inputs. The results revealed that the contribution of technology to the differential output was higher in the case of Arka Vishall (14.52%) compared to Arka Vikas (11.71%) and Arka Vardan (-4.58%). This output differential was decomposed into changes in technology and changes in input levels. First, the contribution of technology (Hybrid) in total change in output was estimated to be 3.82 percent. Second, the concerned input level effects, the positive contributions of labour (7.18 percent), farmyard manure (0.039%), irrigation (0.78%), and other costs (2.24%) to total change in output were observed. The negative contributions were found in the case of seedlings (-0.78%), fertilisers (-0.29%), and plant protection chemicals (-1.5%). The total input level effect on output change was estimated to be 8.10%. Third, the estimated change in output (11.92%) was almost equal to the actual change of 11.71%. Therefore, there is a need for appropriate policy interventions and efforts by the concerned to address these constraints in adopting new tomato hybrids and to make tomato cultivation a viable and profitable enterprise.

Key words: Technical Change Sources of output growth, Input growth, Total factor productivity and Cobb-Douglas form of production function

1.Introduction

The Indian agriculture sector is developing enthusiastically day by day. Horticulture has been an emerging sector in agriculture and accounts for 90% of the total horticulture production in the country, which consists of crops like vegetables, fruits, flowers, mushrooms, tuber crops, spices, plantations, aromatic, and medicinal plants. India is the second-largest producer of fruits and vegetables in the world after China. The increasing population and the mindset of adopting a healthy lifestyle have increased the demand for nutritional requirements in people, which provides vast chances for sustaining a large number of agro-based industries, which creates substantial employment chances. The horticulture sector contributes about 25% of agriculture GDP and about 8% of the cultivable area in the country. India has a variety of agro-climatic conditions that allow for the cultivation of a wide range of crops. In recent years, horticulture has made significant progress in terms of increased area and production under various crops,

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increased productivity, crop diversification, technological interventions for production, and post-harvest and forward association through value addition and marketing.

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Vegetables are important constituents of the Indian human diet as they are rich sources of carbohydrate, proteins, vitamins, minerals, glucosinolates, antioxidants, fibre, etc. Additionally, to alleviate protein malnutrition in India, efforts are under way to enrich carbohydrates in cereals. To supplement them, vegetables can be used in a very effective manner. Most of the vegetables being short-duration crops can be produced in succession on the same plot, and all the family labour of the vegetable grower can be employed throughout the year. The daily minimum requirement for vegetables, according to the universal dietary standards, is 284 gm per head, i.e., about 20% of the daily requirement of the total food of an adult. This requirement is more in the case of a vegetarian diet. The present production and consumption of vegetables in the country are far inadequate, being only about 1/4th to 1/3rd of the diet requirement. In order to improve the quality of the diet of the people, it is essential that the production of vegetables be increased considerably. This objective can be achieved by increasing the yield per unit area through adopting innovative agricultural production technology. Among the vegetables, potato, tomato, cabbage, bringal, cauliflower, beans, radish, carrot, lady finger, Knol Khol, beetroot, and guards are the major ones. Tomato (Lycopersicon esculentum mill) is one of the important and popular fruit vegetables, which had its origin in South America.

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Tomatoes have been used as food by the inhabitants of central and south America since prehistoric times. It originally came from Peru to tropical Mexico. It was introduced into Europe by the Spanish explorers in the early 16th century. It was introduced into India perhaps by the Portuguese merchants. In England, it was known as “Golden Apple” or “Love Apple” (Yawalker, 1969). Among vegetables, tomato occupies the world’s largest area under cultivation after potato and sweet potato, but it tops among the list of canned vegetables (Choudhury, 1967). In India, tomatoes have become a very popular vegetable, especially during the last 10 to 20 years. The fruit is available in the market round the year. The fruit contains 94 percent moisture. Tomato fruit is rich in vitamins A and C. It is extensively used in culinary preparations like soups, pickles, ketchups, sauces, juices, and chutneys. Tomato is also used as a vegetable; it is used regularly along with other vegetables, and it constitutes a good part of the human diet. It is

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said to have certain medicinal values and is recommended in the diet of the patients suffering from skin diseases, nightblindness, and stunted growth. In this context, technical change in hybrid tomato production plays an important role in meeting the demand for increasing population.

Output growth is usually attributed to growth in inputs and/or improvement in total factor productivity. While measuring the sources of output growth, the contribution of total factor productivity is always estimated as residual after accounting for the growth of the inputs. Quite often, the contribution of total factor productivity is interpreted as the contribution of technical progress. Such an interpretation implies that improvement in productivity arises from technical progress only. This assumption is valid only if farmers operate their production frontiers, producing the maximum possible output or realising the full potential of the technology operation on the frontier. This can be achieved if farmers follow best practice methods of application of the technology commonly referred to as technical efficiency. We know we have a wide choice among high-yielding tomato hybrids for yield, resistance to pests and diseases, plant height, and suitability to diverse agroclimatic regions in the state. Even though the spread of new hybrids has been impressive in the state. In this perspective, an attempt is made in this research to know the productivity differential between the hybrids, i.e., the output effects of an outward shift in tomato production surface and movement along the new production surface generated by hybrid (technical) change. The specific objective of the present research study is to measure the productivity differential in terms of shifts in technological parameters (an upward shift in production surface) and of change in the volume per acre input levels (i.e., movement along the new production surface).

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2. Data and Methodology

Vijayapu district was purposefully selected for the present study as it had a relatively larger area under the tomato crop and ranks second in area and production in Karnataka. The tomato crop is grown in all the taluks of the district. However, in the present study, three taluks, viz., Vijayapur, Indi, and Sindagi taluks, were selected purposefully by considering the distribution of tomato hybrids and higher productivity levels. ~~Besides, the researcher was quite familiar with the area.~~ The list of farmers growing tomatoes was prepared from the information obtained through the seed sale agencies and vegetable commission agents in all three taluks. From each selected taluk,

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30 tomato-growing farmers were randomly selected. Thus, making the total sample of 90 farmers for the study.

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2.1 Production function

Production function is obviously the convenient economic framework for testing the equality of parameters governing the input-output relationship and for decomposing the total change in output. For choosing the appropriate functional form, CES production functions for different varieties using the Kineta (1967) approximation methodology. The important forms of production functions used in a study of this nature are Cobb-DDouglas. Translog Production/CCost Function and Constant Elasticity of Substitution. In the present paper, the Cobb-Douglas form of production function was chosen.

The Cobb-Douglas form of production function has well-known properties that justify its wide application in economic literature. It is a homogenous function that provides a scale factor, enabling one to measure the returns to scale and to interpret the elasticity coefficients with relative ease. But at the same time, the Cobb-Douglas production function makes several restrictive assumptions. It is assumed that elasticity coefficients are constant, implying a constant share for the inputs. The elasticity of substitution among the factors is unity in the Cobb-Douglas form. Moreover, this function being linear in logarithm, output is zero if any of the input is zero, and an output expansion path is assumed to pass through the origin. The per-acre production function in Cobb Douglas form is specified as.

$Y = A\, S^{a} L^{b} F^{c} C^{d} P^{f} I^{g} K^{h} e^{u}$ ....(1)

Where,

Y= Physical output of tomato yield measured in quintals per acre.

A = Constant term, a scale parameter

S= Per acre value of seedlings measured in rupee

L= Per acre value of labour input (human labour and bullock labour) measured in rupees

F = FYM measured in rupees per acre

C = Per acre value of chemical fertilizers in rupees

P = Per acre value of plant protection chemicals measured in rupees

I = Per acre value of irrigation cost measured in rupees

K = other costs, include value of staking cost, repair and maintence cost and interest on working capital etc measured in rupees per acre

e= Random disturbance term independently distributed with zero mean and finite variance

The coefficients denoted by a, b, c, d, f, g, and h represent individually the output elasticity's. The parameters of the regression equation (1) were estimated by the least square method, using natural logarithmic form.

The Cobb - Douglas per acre production function (1) in logarithmic form is specified for Arka Vishall, Arka Vikas and Arka Vardan farms respectively as

$$\text{Log } Y_1 = \log A_1 + a_1 \log S_1 + b_1 \log L_1 + c_1 \log F_1 + d_1 \log C_1 + f_1 \log P_1 + g_1 \log I_1 + h_1 \log K_1 + U_1 \quad \ldots\ldots (2)$$

$$\text{Log } Y_2 = \log A_2 + a_2 \log S_2 + b_2 \log L_2 + c_2 \log F_2 + d_2 \log C_2 + f_2 \log P_2 + g_2 \log I_2 + h_2 \log K_2 + U_2 \quad \ldots\ldots (3)$$

$$\text{Log } Y_3 = \log A_3 + a_3 \log S_3 + b_3 \log L_3 + c_3 \log F_3 + d_3 \log C_3 + f_3 \log P_3 + g_3 \log I_3 + h_3 \log K_3 + U_3 \quad \ldots\ldots (4)$$

Variables in (2), (3) and (4) are defined in the same way as in (1)

For any production function, the total change in output is produced by changes in the factors of production and in the parameters that define the function. To decompose the total change in per acre tomato output into technological component and in level of input used per unit area cultivated. The output decomposition model relevant for the purpose of the present study specified here,

For decomposing the total change in output between Arka Vishall and Arka Vikas farms into technological effect and the level of input effect, by taking the difference between (2) and (3) and adding some term and subtracting the same term:

$$\text{Log } Y_1 - \text{Log } Y_2 = (\log A_1 - \log A_2) + (a_1 \log S_1 - a_2 \log S_2 + a_1 \log S_2 - a_1 \log S_2) + (b_1 \log L_1 - b_2 \log L_2 + b_1 \text{lóg } L_2 - b_1 \text{lóg } L_2) +$$
$$(c_1 \log F_1 - c_2 \log F_2 + c_1 \log F_2 - c_1 \log F_2) +$$
$$(d_1 \log C_1 - d_2 \log C_2 + d_1 \log C_2 - d_1 \log C_2) +$$
$$(f_1 \log P_1 - f_2 \log P_2 + f_1 \log P_2 - f1 \text{lóg } P_2) +$$
$$(g_1 \log I_1 - g_2 \log I_2 + g_1 \log I_2 - g_1 \text{lóg } I_2) +$$

$(h_1 \log K_1 - h_2 \log K_2 + h_1 \log K_2 - h_1 \log K_2 + (U_1 - U_2)$……………………(5)

Rearranging the Terms in (5), we get

$$\text{Log } Y_1 - \text{Log } Y_2 = [(\log A_1 - \log A_2)] + [(a_1-a_2) \log S_2 + (b_1-b_2) \log L_2 + (c_1-c_2) \log F_2 + (d_1-d_2) \log C_2 + (f_1-f_2) \log P_2 + (g_1-g_2) \log I_2] + (h_1-h_2) \log K_2] + [a_1 (\log S_1 - \log S_2) + b_1 (\log L_1 - \log L_2) + c_1 (\log F_1 - \log F_2) + d_1 (\log C_1 - \log C_2) + f_1 (\log P_1 - \log P_2) + g_1 (\log I_1 - \log I_2)] + h_1 (\log K_1 - \log K_2) + [(U_1 - U_2)] \quad \ldots\ldots(6)$$

Equation (6) can also be written as:

$$\text{Log } [Y_1/Y_2] = \log [A_1/A_2] + [(a_1-a_2) \log S_2 + (b_1-b_2) \log L_2 + (c_1-c_2) \log F_2 + (d_1-d_2) \log C_2 + (f_1-f_2) \log P_2 + (g_1-g_2) \log I_2] + (h_1-h_2) \log K_2] + [a_1 \log (S_1/S_2) + b_1 \log (L_1/L_2) + c_1 \log (F_1/F_2) + d_1 \log (C_1/C_2) + f_1 \log (P_1/P_2) + g_1 \log (I_1/I_2)] + h_1 \log (K_1/K_2)] + (U_1 - U_2) \quad \ldots\ldots(7)$$

By using (2) and (4) the output decomposition model for Arka Vishall and arka Vardan was developed and the final equation is as follows

$$\text{Log } [Y_1/Y_3] = \log [A_1/A_3] + [(a_1-a_3) \log S_3 + (b_1-b_3) \log L_3 + (c_1-c_3) \log F_3 + (d_1-d_3) \log C_3 + (f_1-f_3) \log P_3 + (g_1-g_3) \log I_3] + (h_1-h_3) \log K_3] + [a1 \log (S_1/S_3) + b_1 \log (L_1/L_3) + c_1 \log (F_1/F_3) + d_1 \log (C_1/C_3) + f_1 \log (P_1/P_3) + g_1 \log (I_1/I_3)] + h_1 \log (K_1/K_3) + (U_1 - U_3) \quad \ldots\ldots(8)$$

By using (3) and (4) the output decomosition model developed for Arka Vikas and Arka Vardan the final equation as follows:

$$\text{Log } [Y_2/Y_3] = \log [A_2/A_3] + [(a_2-a_3) \log S_3 + (b_2-b_3) \log L_3 + (c_2-c_3) \log F_3 + (d_2-d_3) \log C_3 + (f_2-f_3) \log P_3 + (g_2-g_3) \log I_3] + (h_2-h_3) \log K_3] + [a_2 \log (S_2/S_3) + b_2 \log (L_2/L_3) + c_2 \log (F_2/F_3) + d_2 \log (C_2/C_3) + f_2 \log (P_2/P_3) + g_2 \log (I_2/I_3)] + h_2 \log (K_2/K_3)] + (U_2 - U_3) \quad \ldots\ldots(9)$$

The decomposition equation (7), (8) and (9) involves decomposing natural logarithm of the ratio between Arka Vishall over Arka Vikas, Arka Vishall over Arka Vardan and Arka Vikas over Arka Vardan output respectively. It is approximately a measure of percentage change in output with the introduction of different Hybrids. The first bracketed expression on the right hand side is a measure of percentage change in output due to shift in scale parameters (A) of the production function, the second bracket of expression, the sum of the arithmetic change in output elasticities each weighted by the logarithm of the volume of that input used is a measure of change in output due to shifts in slope parameters (output elasticities) of the production function: the third bracket expression is the sum of the logarithm of the ratio for each input of Arka Vardan to Arka Vikas input (in equation (7))and of Arka Vardan to Arka Vishall input (in equation (8) and Arka Vikas to Arka Vardan input (in equation (9) each weighted by the output elasticity of that input, this expression is a measure of change in output due to changes in the per acre quantities of labour, fertilizer, plant protection chemicals, irrigation cost, and other costs includes staking cost, interest on working capital used given the output elasticities of these inputs under respective high yielding hybrids.(See Bisaliah 1977) for interpretation of these terms.).

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3. Results and Discussion

The results on production function estimates and decomposition analysis of output differentials across hybrids are presented in this section. Before partitioning the output into different components, the structural break in the estimated production functions across hybrids was tested using analysis of variance (Table-1). The analysis clearly indicated that the estimated production function parameters were significantly different from each other. This strongly supports the analysis of output differentials into different components across hybrids. Per acre linear regressions in natural logarithms (Cobb- Douglas type of production function) were estimated by least square method. Elasticity of output for land is obtained by the homogeneity of degree one constraint as follows. Y/L= A (S/L) a (L/L) b (F/L) c (C/L) d (P/L) f (I/L) g (K/L) h

Y = AL (1-a-b-c-d-f-g – h) S a L b F c C d P f I g K h. Output elasticities for land is (1- a-b-c-d-f-g-h).

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3.1 Cobb- Douglas Production Function Estimates or Per acre production function estimates

In the case of Arka Vishall, the calculated F value was 13.60 and the adjusted R^2 was higher at 0.7443 (Table-1). The calculated F value was 27.26 and adjusted R^2 was higher at 0.8638 in the case of Arka Vikas. Whereas, in the case of Arka Vardan, the calculated F value was 14.54 and adjusted R^2 was higher at 0.7658.The regression coefficients for labour, plant protection chemicals and irrigation were significant at five per cent level in all the three hybrids. Further, an examination of results (Table1) on production estimates and the difference between coefficients of different production function estimates. Support the inference that the technical changes that have taken place with the introduction of Arka Vishall in the place of Arka Vikas and Arka Vardan. Discussions on the implications of this kind of technical (hybrid) change to factor demand and functional income distribution are beyond the scope of this present study. (See for details see Brown (1968), Bisaliah (1982) Bisaliah (1984), and Umesh (1985).

The decomposition of the total change in tomato output of Arka Vishall over Arka Vikas group farm was carried out with the help of decomposition equation (7), using the values of production parameters from Table-1 and the input levels from Table-2. Results on the partitioning of productivity differentials between three hybrids are presented in Table-3. The per acre production of tomato in Arka Vishall group farms was found to be 11.71 per cent higher than that of Arka Vikas group farms. This output differentials was decomposed into change in technology and changes in input levels. First, the contribution of technology (Hybrid) in total change in output was estimated to be 3.82 per cent. This value was obtained by adding the values of the first and second bracketed expressions on the right-hand side of the equation. (7). Second, the concerned input level effects, the positive contributions of labour (7.18 percent), farm yard manure (0.039 percent), irrigation (0.78 percent) and other costs (2.24 percent) to total change in output were observed. The negative contributions were found in the case of seedlings (-0.78 percent), fertilizers (-0.29 percent) and plant protection chemicals (-1.5 percent). The total input level effect to output change was estimated to be 8.10 per cent. Third, the estimated change in output (11.92 percent) was almost equal to the actual change of 11.71 per cent.

Table: 1 Cobb- Douglas Production Function estimates (Per acre production function estimates)
(Output in quintals**)** **(N=30)**

Sl.No.	**Particulars**	**Arka Vishall**	**Arka Vikas**	**Arka Vardan**
1	Intercept	0.2653 NS	0.3809 NS	0.7134NS
2	Land	0.1742	0.1804	0.4401
3	Seedlings	0.0368	0.1500	0.0312
4	Labour	0.3394 **	0.2296 **	0.2928 **
5	Farm yard manure	-0.1061	-0.1084	-0.1009
6	Fertilizer	0.1785	-0.0212	-0.1027

7	Plant protection chemicals	0.2018 **	0.2837 **	0.2005 **
8	Irrigation	0.1062 **	0.2703 **	0.1038 **
9	Other costs	0.0692	0.0156	0.1352
10	R^2	0.8060	0.8966	0.8223
11	R^{2-} (adjusted)	0.7443	0.8638	0.7658
12	F ratio	13.60	27.26	14.54

Source: Field survey data*;* Note: ** Significant at five per cent

Table: 2 Sample Geometric mean levels of per acre output and input of tomato

(Rs/acre)

Sl. No.	Input/ output	Arka Vishall	Arka Vikas	Arka Vardan
1	Seedlings	2620	3246	2620
2	Labour	9935	8039	8947
3	Farmyard manure	2804	2815	2562
4	Fertilizer	2830	2878	2827
5	Plant protection chemicals	5717	6023	5585
6	Irrigation	4088	3797	3268
7	Other costs (include staking cost, repair and maintenance charges, capital etc)	13602	9833	13490
8	Output (qt/ ac)	378.05	336.26	328.87

Source: Field survey data

3.2 Decomposition analysis of output differentials between US-618and All round

It is evident from the Table-3, that the Arka Vishall group farms realized 14.24 per cent more output per acre than Arka Vardan group farms. The decomposition of the total change in tomato output of Arka Vishall and Arka Vardan group farms was carried out with the help of decomposition equation (8), Using the values of production function parameters from Table-1. The increase in output was decomposed into change in technology and change in input usage levels. The contribution of technology (Hybrid) in total change in output was estimated to be 8.83 per cent. This value was obtained by adding the values of the first and second bracketed expressions on the right hand side of the equation (8. In respect of input level effects, there was a positive contribution from labour (3.55 percent), fertilizers (0.024 percent), irrigation (2.37 percent) plant protection chemicals (0.47 percent) and other costs (0.056 percent) to total change in output. The negative contributions were found in the case of seedlings (-0.0010 percent), farm yard manure (-0.95 percent). The total input level effect to output change was estimated to be 5.52 per cent. The estimated change in output (14.35 percent) was almost equal to the actual change of 14.24 per cent.

3.3. Decomposition analysis of output differentials between Abinav and All round

The Arka Vikas group farms (Table-3) produced 2.54 per cent higher output per acre, than Arka Vardan group farms. The decomposition of total change in output of Arka Vikas over Arka Vardan was carried out with the help of decomposition equation (9) using the values of production parameters. (Table-1) and the input level of (Table-2). First, the contribution of technology (Hybrid) in total change in output was observed to be negative (-4.58 percent). This value was obtained by adding the values of the first and second bracketed expressions on the right hand side of the equation (9). Second, there was the positive contribution from seedlings (3.20 percent), irrigation (4.05percent), farm yard manure (1.02 percent) and plant protection chemicals (2.14 percent) to the total change in output. Labour (-2.40 percent), fertilizers (-0.037 percent) and other costs (-0.004 percent) have contributed negatively. Thus, the total input level effect to output change was estimated to be 7.44 per cent. Third, the estimated change in output (2.58 percent) was almost equal to the actual change of 2.54 per cent.

Table: 3 Decomposition analysis of total change in per acre tomato output (in%)

Items	**Arka Vishall over Arka Vikas**	**Arka Vishall over Arka Vardan**	**Arka Vikas over Arka Vardan**
Total change in measured output (%)	11.71	14.24	2.54
Sources of change			
Technology (Hybrid) effect	3.82	8.83	-4.58
Input level effect			
Seedlings	-0.78	-0.0010	3.2
Labour	7.18	3.55	-2.4
Farmyard manure	0.039	-0.95	1.02
Fertilizers	-0.29	0.024	-0.037
Plant Protection Chemicals	-1.5	0.47	2.14

Irrigation	0.78	2.37	4.05
Other costs (include staking ,repair and maintenance cost, capital etc)	2.24	0.056	-0.0041
Total due to input change	8.10	5.52	7.44
Total due to all sources	11.92	14.35	2.58

Source: Field survey data

4. Conclusion

The present study has been an attempt to account for productivity differential which have emerged with the introduction of different hybrids in tomato production in Vijayapur district. Econometric exercises performed in the study have identified that technical change in terms of hybrid effect that have taken place with the introduction of new hybrids. The result on decomposition analysis of output differential between Arka Vishall and Arka Vikas group farms had led to the inference that the per acre production of tomato in Arka Vishall farms was about 11.71 per cent higher than that of Arka Vikas farms. The net contribution of technological effect (hybrid) to the total change in per acre output was estimated to be 3.82%. With the same level of per acre inputs of seedlings, labour, farm yard manure, fertilizers, plant protection chemicals, irrigation and other costs as under Arka Vikas farms 8.10% more output can be obtained under Arka Vishall farms. This result establishes the net positive contribution of the technology (hybrid) to total productivity differential. The technological effect could perhaps be explained in terms of genetic properties of the hybrids. The total input level effect to per acre output differential was estimated to be 8.10 per cent. This was made up of positive contributions from labour (7.18%), farm yard manure (0.039%), irrigation (0.78%) and other cost (2.24%), which more than offset the negative contributions from seedlings (-0.78%) fertilizers (-0.29%) and plant protection chemicals (-1.50%). The results on decomposition analysis between Arka Vishall and Arka Vardan farms showed that the per acre production of tomato in Arka Vishall farms was about 14.52 per cent higher than that of Arka Vardan farms.

The net contribution of technological effect (hybrid) to the total change in per acre output was estimated to be 8.83 per cent. With the same level of per acre inputs of seedlings, labour, farm yard manure, fertilizers, plant protection chemicals, irrigation and other costs as under Arka

Vardan farms 5.52 per cent more output can be obtained under Arka Vishall farms. The total input level effect to per acre output differential was estimated to be 5.52 per cent. This was made up of positive contribution for labour (3.55%), fertilizers (0.024%) plant protection chemicals (0.47%), irrigation (2.37%) and other cost (0.056%) which were more than the negative contribution from seedlings (-0.0010%) and farmyard manure (-0.95%).

The results on decomposition analysis between Arka Vikas and Arka Vardan farms reflected that the per acre production of tomato in Arka Vikas farms was about 2.54 per cent higher than that of Arka Vardan farms. The net contribution of technological effect (hybrid) to the total change in per acre output was estimated to be -4.58 per cent. With the same level of per acre inputs of seedlings, labour, farm yard manure, fertilizers, plant protection chemicals, irrigation and other costs as under Arka vardan farms 7.44 per cent more output can be obtained under Arka Vikas farms. The result, clearly establishes the net negative contribution of the technology (hybrid) to total productivity differential. The total input level effect to per acre output differential was estimated to be 7.44 per cent. This was made up of positive contribution from seedlings (3.20%), farm yard manure (1.02%) plant protection chemicals (2.14%) , irrigation (4.05%) which were more than the negative contributions from labour (-2.40%), fertilizers (-0.037%) and other cost (-0.0041%).

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