The Key Factors to Augment Groundnut Farm Income in Gujarat: TFP Growth and Market Support

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ABSTRACT

This paper has provided insights on the returns to investment in groundnut research and sources of productivity in Gujarat state from 1990-91 to 2011-12. Two outputs and ten inputs have been used to construct total output, total input and total factor productivity index using Tomqvist Theil Index technique. Compound growth rates were worked out using semi-log trend equation. Although the area under groundnut decreased yet, the production and productivity increased significantly at the rate of 5.10 and 5.24 per cent per annum, respectively during the study period. The groundnut registered higher TFP growth of about 2.21 per cent per annum in last two and half decades resulting in annual decline of 0.27 per cent in real cost of production. The Investment on groundnut research generated 27.10 per cent IRR thus, found to be a highly paying proposition. The growth in TFP was remarkably increased in nineties largely contributed by the release of groundnut varieties viz., GG-2 in 1986, GG-20 and GG-12 in 1991, GG-13 in 1994. The government expenditure on research, extension education, irrigation infrastructure and rainfall generated significant returns. The steady growth in TFP needs to be maintained by enhancing the resources which have contributed to productivity. More public and private investments, in under developed regions of the state are needed to strengthen agricultural research and rural infrastructure. The sufficient procurement at MSP is essential to enhance farm income.

Key words: Groundnut, Growth, Investment, Research, Returns, TFP.

INTRODUCTION

Gujarat occupies an important place as supplier of groundnut, groundnut oil and groundnut cake to the rest of the country. Groundnut plays an important part in the agricultural and industrial economy of Gujarat state, particularly in Saurashtra region, this is known as “Peanut bowl of India”. Gujarat is one of the leading states in agricultural production in the country. The Government has allocated a significant proportion of its resources to agricultural research in the state. Gujarat agricultural has recorded the fastest growth (above 9.6%) among all Indian states, since 2000. This is more than three times the agricultural growth (2.9% per annum during 2000-01 to 2007-08) at all India level (Gulati, et al., 2009). Therefore, it is imperative to look at current research efforts and their accuracy in order to address emerging regional research needs.

This rate of growth in agriculture has been sustained by the technological progress embodied in the high yielding varieties with supporting public investment in irrigation, agricultural research and extension (R&E) and physical infrastructure. There is a compelling need for sustained efforts to increase production of essential items (cereals, pulses, edible oils, etc.). Faced with limits to further expand cultivated land and diminishing returns to further input intensification, productivity growth assumes a central role in meeting the challenges of the future. The most comprehensive measure of aggregate or sectoral productivity is Total Factor Productivity (TFP).

TFP is measured as the rate of index of total output to index of total factor inputs and encompasses the impact of technical change as well as change in the level of all inputs. Thus, TFP trend indicates whether production growth is taking place in a cost effective and sustainable manner or not. In view of the above, the present study was undertaken with the specific objectives viz., to measure the temporal changes in area, production and productivity of groundnut (Arachis hypogaea L.) crop of Gujarat; to estimate the growth of Total Factor Productivity and returns to investment for groundnut crop in Gujarat.

MATERIALS AND METHODS

In the present study, TFP is estimated taking into account two outputs and ten inputs. Output index includes main product and by-product. The ten inputs comprised of, seed (kg/ha), manure (tonne/ha), fertilizers (kg/ha), human labour (man days/ha), bullock labour (pair days/ha), irrigation (Rs/ha), insecticide/pesticide (Rs/ha), miscellaneous cost (Rs/...
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ha), depreciation (Rs/ha) and rental value of owned land (Rs/ha). The data on input, output and prices have been obtained from the Department of Agricultural Economics, Junagadh Agricultural University, Junagadh Campus, Junagadh collected under cost of cultivation scheme. The other required data were obtained from various published sources.

**Analytical framework**

Total factor productivity (TFP) refers to that part of growth in output, which cannot be explained by growth in factor inputs like land, labour and capital. Index of Total Factor Productivity (TFPI) measured the growth of net output per unit of total factor input. The TFP is defined as the ratio of an index of aggregate output to an index of aggregate input. Theil Tornqvist discrete approximation to the Divisia index is the most useful method for TFP computation. The use of TFP indices gained prominence since Dievert (1976, 1978) proved that Theil Tornqvist discrete approximation to the Divisia index was consistent in aggregation and superlative to linear homogeneous translogarithmic production function. The Tornqvist index is exact for the homogenous translog production function.

The Divisia indices have two important attractive properties: (i) they satisfy the time reversal and factor reversal test for index numbers and (ii) it is a discrete of the components, so that aggregate could be obtained by the aggregation of sub-aggregates (Kumar et al. 2008). An index of total factor productivity (TFP) compares changes in output with changes in aggregate inputs.

In the present study also, the Tornqvist Theil index was used for computing the total output index, total input index and total factor productivity index. These indices were calculated as follows:

**Total Output Index (TOI)**

Total output indices were constructed using the Tornqvist Theil index approach as follows:

\[
\text{TOI}_t = \prod_{i} (Q_{jt} / Q_{jt-1})^{R_{jt-1} / R_{jt}}
\]

**Total Input Index (TOI)**

\[
\text{TII}_t = \prod_{i} (X_{jt} / X_{jt-1})^{S_{jt-1} / S_{jt}}
\]

Where,

- \(Q_{jt}\) = Output of \(j^{th}\) crop in \(t^{th}\) year.
- \(Q_{jt-1}\) = Output of \(j^{th}\) crop in \((t-1)^{th}\) year.
- \(R_{jt}\) = Output share of \(j^{th}\) crop in total revenue in \(t^{th}\) year.
- \(R_{jt-1}\) = Output share of \(j^{th}\) crop in total revenue in \((t-1)^{th}\) year.
- \(X_{jt}\) = Quantity of \(i^{th}\) input used in \(j^{th}\) crop in \(t^{th}\) year.
- \(X_{jt-1}\) = Quantity of \(i^{th}\) input used in \(j^{th}\) crop in \((t-1)^{th}\) year.
- \(S_{jt}\) = Share of input \(i^{th}\) in total input cost in \(t^{th}\) year.
- \(S_{jt-1}\) = Share of input \(i^{th}\) in total input cost in \((t-1)^{th}\) year.

In the case of TFP for a single crop, revenue share refers to the share of main product and by-product in total revenue from the crop, while output includes main product and by-product. Thus, total output and input indices for groundnut crop were prepared taking 1990-91 as the base year.

The input data available only in value terms has been converted into quantity indices by dividing with its respective price indices. Input has been aggregated using their farm rental prices.

**Total factor productivity index (TFPI)**

Total factor productivity indices was computed as the ratio of total output index (TOI) to total input index (TII).

\[
\text{TFPI}_t = \frac{\text{TOI}_t}{\text{TII}_t} \times 100
\]

The estimation of input, output and TFP growth rates for any specified was done by fitting an exponential (or semi-log) trend equation to the three-yearly moving averages of input, output and TFP indices, respectively.

**Sources of TFP growth**

The changes in the variables, that cause growth in TFP, have vital importance to estimate how much each of these sources contributes to the growth of TFP. As an input to public investment decisions, it is useful to understand the relative importance of these productivity-enhancing factors in determining productivity growth. Following Chand et al. (2011) to examine the determinants of TFP, a multiple regression technique in double log functional form was carried out for groundnut in Gujarat during 1990-91 to 2011-12. In order to assess the determinants of TFP, the TFP index was regressed against the following variables:

- RES_STOK is Government expenditure on research and education (Rs/ha of crop area);
- EXT_STOK is Government expenditure on extension and farmers training (Rs/ha of crop area);
- LIT_R is rural literacy in per cent;
- RAIL (rail density, km per 100 sq km);
- IRR_INTEN is irrigation intensity in the state (GIA / NIA);
- IRR_GW is ratio of ground water irrigated area to total irrigated area (GWIA/GIA);
- ELECT_AG (electricity consumption per ha of crop area);
- CI (cropping intensity, %);
- NPRATIO is ratio of N to P2O5 nutrients;
- IRR_POTEN is ratio of irrigation potential created to utilization i.e., U/P);
- KH_RAIN is average total rainfall per year in state and GCA_CANAL (canal irrigated area to total cropped area, i.e., CANAL/GCA).

Regression analysis was attempted using the above variables and by clubbing together variables related to natural resources (NARI) and infrastructure (INF). Three variables representing natural agricultural resources were clubbed together by taking their average as:

\[
1/3 \times \text{CI} + 1/3 \times \text{NPRATIO} + 1/3 \times \text{IRR_GW}
\]

Similarly, infrastructural index (INF) was computed from infrastructural variables as:

\[
0.5 \times \text{RAIL} + 0.1 \times \text{ELECT_AG} + 0.3 \times \text{IRR_INTEN}
\]

(The weights 0.6, 0.3 and 0.1 were based on the experts judgement, as stated by Chand et al. (2011)).

Model 1 below uses NARI and INF indices to estimate the effect of various factors on TFP. All major individual
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variables representing natural resources and infrastructure were incorporated in model 2. Accordingly, the specification of regression equations was stated as:

**Model 1**

\[ \text{TFP} = f(\text{RES\_STOK}, \text{EXT\_STOK}, \text{LIT\_R}, \text{NARI}, \text{INF}, \text{RAIN}) \]

**Model 2**

\[ \text{TFP} = g(\text{RES\_STOK}, \text{EXT\_STOK}, \text{LIT\_R}, \text{NPRATIO}, \text{CI}, \text{IRR\_BW}, \text{ELECT\_AG}, \text{IRR\_INTEN}, \text{IRR\_POTEN}, \text{RAIN}, \text{GCA\_CANAL}) \]

Estimation was undertaken using a fixed effect approach for the pooled cross-section time series state-level dataset, with corrections for serial correlation and heteroskedasticity (Kmenta, 1981). Following Evenson et al. (1999), the research stock variable was constructed by summing up research investment of five years by assigning weights as 0.2 in the year t-2, 0.4 in the year t-3, 0.6 in the year t-4, 0.8 in the year t-5 and 1.0 in the year t-6. The extension stock variable was constructed by summing up three years’ extension investment by assigning weights as 0.2 in the year t-1, 0.4 in the year t-2 and 1.0 in the year t-3.

**Returns to research investments**

The value of marginal product for research is estimated as per below Equation:

\[ \text{EVMP} = \frac{V}{\text{RES\_STOK}} \]

Where,

- V is the value of crop production associated with TEP (value of output for crop multiplied by the same share of TFP in total output), RES\_STOK is the research stock and b is the TFP elasticity of research stock estimated from TFP models 1 and 2. The benefit stream was generated under the assumption that the investment made in research in the year t-i will start generating a benefit after a lag of five years, at an increasing rate during the next six years, will remain constant for the next six years and thereafter, it will start declining (one can also take the lag structure of 6,6,6 or 9,9,9). Following Evenson and Pray (1991), an investment of one rupee in the year t-i will generate a benefit equal to 0.1 EVMP in the year t-i+1, 0.2 EVMP in the year t-i+2, 0.3 EVMP in the year t-i+3, 0.4 EVMP in the year t-i+4, 0.5 EVMP in the year t-i+5, 0.6 EVMP in the year t-i+6 and so on. The benefit stream can be discounted at the rate, say ‘r’, at which the present value of benefit is equal to one. Thus, ‘r’ was considered as the marginal internal rate of return to public research investment.

**RESULTS AND DISCUSSION**

The major groundnut producing states in India are Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu and Rajasthan. Presently, groundnut has a share of approximately 25 per cent in the total oilseed production in the country (Table 1). Gujarat is the highest producer of groundnut contributing around 40 per cent in the national production, followed by Andhra Pradesh, Tamil Nadu, Rajasthan and Karnataka. Though the production has been fluctuating largely during last two decades, it was considerably increasing in Gujarat and Rajasthan whereas, it showed decreasing trends in Andhra Pradesh, Tamil Nadu and Karnataka. Gujarat had registered the record production of groundnut about 49.18 lakh tonnes in 2013-14 achieving productivity of 2668 kg/ha from an area of 18.43 lakh ha, surpassing its previous record of 44.78 lakh tonnes in 2003-04.

It can be seen from Table 2 that the area under groundnut cultivation in India significantly decreased at the rate of 2.10 per cent per annum, during last two decades (i.e. from 1990-91 to 2011-12) but its production remained by and large constant with slight increase or decrease however yield recorded significant increase at the rate of 1.44 per cent per annum. In Gujarat the area under groundnut was decreased at the rate of 0.13 per cent per annum, whereas production and productivity showed positive growth, in spite of negative growth in area. Rajasthan also noticed significantly positive growth in production and productivity of groundnut during 1990-91 to 2011-12 to the tune of 5.56 and 3.82 per cent per annum, respectively, but it was mainly due to increase in area. Tamil Nadu also achieved significantly positive growth in yield at the rate of 4.95 and 3.01 per cent per annum, during 2001-02 to 2011-12 and 1990-91 to 2011-12, respectively, but its production decreased due to decrease in area at larger rate. Thus, Gujarat has achieved considerable improvement in groundnut productivity during last two decades followed by Tamil Nadu.

**Growth in input, output and TFP index**

The first set of growth rates in Table 3 is based on three years moving average of indices of inputs, outputs and TFP of groundnut in Gujarat. The second set is based on annual values, deletes drought and bad weather year when yield

| States       | 1990-91 | 2000-01 | 2005-06 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|--------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Gujarat      | 9.83    | 7.40    | 33.58   | 35.75   | 27.17   | 7.63    | 49.18   | 30.18   |
| Andhra Pradesh| 22.67   | 21.42   | 13.66   | 14.58   | 8.44    | 11.15   | 12.36   | 7.89    |
| Karnataka    | 8.28    | 10.81   | 6.71    | 7.42    | 4.85    | 3.95    | 5.65    | 5.02    |
| Tamil Nadu   | 11.79   | 13.60   | 10.98   | 8.96    | 10.61   | 7.83    | 9.16    | 9.26    |
| Rajasthan    | 2.18    | 1.81    | 4.91    | 6.81    | 8.01    | 6.17    | 9.01    | 10.11   |
| All India    | 75.15   | 64.10   | 79.93   | 82.65   | 69.64   | 46.94   | 97.14   | 74.02   |

Source: Directorate of Economics and Statistics, GoI.
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Table 2: Annual compound growth rates of area, production and yield of groundnut. (in per cent).

| Particular   | Period          | Area     | Production | Yield     |
|-------------|-----------------|----------|------------|-----------|
| Gujarat     | 1990-91 to 2000-01 | -0.49 (0.0014) | 1.77 (0.0059) | 2.27 (0.0265) |
|             | 2001-02 to 2011-12 | -0.99* (0.0018) | 2.61 (0.0175) | 3.63 (0.0172) |
|             | 1990-91 to 2011-12 | -0.13 (0.0006) | 5.10** (0.0076) | 5.24** (0.0076) |
| Andhra Pradesh | 1990-91 to 2000-01 | -3.16** (0.0020) | -3.66 (0.0115) | -0.52 (0.0099) |
|             | 2001-02 to 2011-12 | -1.30 (0.0058) | 0.86 (0.0162) | 2.18 (0.0114) |
|             | 1990-91 to 2011-12 | -2.62** (0.0015) | -3.41** (0.0050) | -0.82 (0.0037) |
| Karnataka   | 1990-91 to 2000-01 | -1.57* (0.0036) | -0.77 (0.0053) | 0.81 (0.0065) |
|             | 2001-02 to 2011-12 | -1.39 (0.0045) | 0.12 (0.0100) | 1.54 (0.0072) |
|             | 1990-91 to 2011-12 | -2.66** (0.0014) | -4.00** (0.0037) | -1.36* (0.0027) |
| Tamil Nadu  | 1990-91 to 2000-01 | -3.95** (0.0039) | -1.91 (0.0188) | 2.13 (0.0178) |
|             | 2001-02 to 2011-12 | -4.83** (0.0044) | -0.12 (0.0062) | 4.95** (0.0042) |
|             | 1990-91 to 2011-12 | -5.22** (0.0015) | -2.38* (0.0048) | 3.01** (0.0044) |
| Rajasthan   | 1990-91 to 2000-01 | 0.68 (0.0070) | 2.33 (0.0112) | 1.64 (0.0069) |
|             | 2001-02 to 2011-12 | 5.17** (0.0040) | 10.65** (0.0115) | 5.21** (0.0109) |
|             | 1990-91 to 2011-12 | 1.67** (0.0023) | 5.56** (0.0043) | 3.82** (0.0032) |
| All India   | 1990-91 to 2000-01 | -2.48** (0.0012) | -1.84 (0.0057) | 0.66 (0.0054) |
|             | 2001-02 to 2011-12 | -1.25 (0.0028) | 1.63 0.0105) | 2.92 (0.0088) |
|             | 1990-91 to 2011-12 | -2.10** (0.0008) | -0.69 (0.0078) | 1.44* (0.0025) |

*Significant at 0.05 probability level.  ** Significant at 0.01 probability level.
Figures in the parentheses indicate standard error.

Table 3: Annual growth rate in input use, output, TFP and real cost of production (RCP) for groundnut crop in Gujarat: 1990-91 to 2011-12. (in per cent).

| Period                  | Input growth | Output growth | TFP growth | RCP growth | Share of TFP in output growth | Yield growth  |
|-------------------------|--------------|---------------|------------|------------|-------------------------------|--------------|
| Based on three- year moving averages | 0.21 | 3.68 | 3.46 | -0.38 | 94.04 | 3.98 |
| 1990-91 to 2000-01      | 0.99 | 1.78 | 0.78 | 0.86 | 43.92 | 3.18 |
| 2001-02 to 2011-12      | 0.07 | 2.31 | 2.23 | -0.28 | 96.68 | 4.31 |
| 1990-91 to 2011-12      | 0.18 | 2.39 | 2.21 | -0.27 | 92.36 | 4.55 |
| Based on “normal” years values | 0.99 | 6.62 | 5.57 | -2.38 | 84.19 | 2.27 |
| 1990-91 to 2000-01      | 0.89 | 1.48 | 0.58 | 0.98 | 39.36 | 3.63 |
| 2001-02 to 2011-12      | 0.11 | 2.91 | 2.80 | -0.74 | 96.26 | 5.24 |
| 1990-91 to 2014-15      | 0.17 | 2.74 | 2.57 | -0.44 | 93.80 | 4.86 |

*Note: Normal years excludes year of extreme drought and poor weather i.e. 2000-01.

The higher growth of TFP during 1990s resulted in annual decline in real cost of production by 0.38 per cent and by 0.27 per cent throughout last two and half decades. Similar results were reported by Chand et al. (2011) in their TFP analysis in India. They found that in Gujarat, the growth rates in input, output and TFP indices of groundnut were 1.1, 2.5 and 1.3 per cent per annum, respectively during 1975-05 implying thereby that Gujarat has shown an outstanding performance achieving moderate to high TFP growth in groundnut, since last three decades. Whereas, Shiyani and Pandya (2003) reported that in Gujarat total output indices of groundnut declined at the rate of 0.06 per...
cent per annum, while total input indices increased at the rate of 1.11 per cent, indicating negative growth (-1.16 per cent p.a.) in TFP of groundnut during 1981-82 to 1998-99. This negative growth in 1980s, which now turned into positive, is a healthy sign of improvement in recent decades.

This is credited to the release of groundnut varieties viz., GG-2 in 1986 (bunch type), GG-20 (semi-spreading) and GG-12 (spreading), in 1991, GG-13 (spreading) in 1994, GG-7 in 2000 by the then Gujarat Agricultural University in the state, remarkably increased the productivity of groundnut in last two decades. This has largely helped to reduce cost of production, although the input prices including labour charges increased remarkably during recent years. The variety GG-20 is performing well, covering about 80 per cent of the total groundnut area in the state. Recently released varieties viz., GJG-HPS-1 in 2008, GJG-9 and GJG-31 in 2010 by Junagadh Agricultural University are also attracting the farmers due to its high yield potential and export quality.

This is clear evidence explained by TFP analysis, which explained high growth indicating that the research expenditure incurred in 1980s and1990s for evolving better varieties of groundnut crop in the state had played a greater role for increasing productivity, as well as keeping lower cost of production, later on.

Sources of total factor productivity
As far as sources of productivity change are concerned, the technical change component assumes greater significance. The changes in the variables, that produce growth in TFP, have vital importance to estimate how much each of these sources contributes to the growth of TFP. An attempt has been made to further analyse in terms of contribution of various factors to TFP growth.

Estimates of regression coefficients which measure the effect of various sources of TFP were used to compute elasticity of TFP with respect to research stock and to assess the impact of research has been presented in Table 4. It indicates that government expenditure on agricultural research and education, extension education, expenditure for creating ground water irrigation facilities, irrigation intensity and rainfall assumes significantly greater role in accelerating productivity in agriculture, particularly for groundnut crop in Gujarat. Besides balanced use of nitrogen and phosphoric fertilizers (the ratio of nitrogen to phosphoric nutrients), efficient use of irrigation potential and increase in areas under canal irrigation have also considerable positive impact on groundnut TFP growth. Whereas, effect of rural literacy and cropping intensity was found to be negative as the migration of rural literates to urban areas due to availability of increased non-farm employment opportunities.

Table 4: Determinants of TFP for groundnut crop in Gujarat (1990-91 to 2011-12).

| Variable       | Regression Coefficient | Standard Error | t' ratio | Level of Significance |
|----------------|------------------------|----------------|----------|-----------------------|
| Model 1        |                        |                |          |                       |
| Constant       | 3.3356                 | 3.6555         | 0.9125   | —                     |
| RES_STOK       | 0.5436                 | 0.4315         | 1.2597   | 0.2270                |
| EXT_STOK       | 0.1733*                | 0.0781         | 2.2193   | 0.0423                |
| LIT_R          | -0.0610                | 0.0486         | -1.2569  | 0.2280                |
| NARI           | -0.8690                | 0.7429         | -1.1699  | 0.2603                |
| INF            | 0.5565*                | 0.2246         | 2.4780   | 0.0256                |
| RAINFALL       | 0.5410**               | 0.1777         | 3.0435   | 0.0082                |
| Adjusted R-Squared | 0.6749               |                |          |                       |
| Model 2        |                        |                |          |                       |
| Constant       | -2.9922                | 3.0065         | -0.9953  | —                     |
| RES_STOK       | 0.5180*                | 0.2857         | 1.8133   | 0.0999                |
| EXT_STOK       | 0.2380**               | 0.0588         | 4.0464   | 0.0023                |
| LIT_R          | -0.0655*               | 0.0371         | -1.7680  | 0.1078                |
| NPRATIO        | 0.2163                 | 0.2067         | 1.0464   | 0.3200                |
| CI             | -0.0624**              | 0.0181         | -3.4505  | 0.0052                |
| IRR_GW         | 1.1533**               | 0.3717         | 3.1025   | 0.0112                |
| ELECT_AG       | -0.1970                | 0.1886         | -1.0445  | 0.3208                |
| IRR_INTEN      | 0.0187*                | 0.0089         | 2.0891   | 0.0632                |
| IRR_POTEN      | 0.5842                 | 1.0291         | 0.5677   | 0.5828                |
| RAINFALL       | 0.5542                 | 0.2001         | 2.7689   | 0.0198                |
| CGA_CANAL      | 0.3685                 | 0.1995         | 1.8467   | 0.0946                |
| Adjusted R-Squared | 0.9074               |                |          |                       |

Note-1: ** and *Significant at 1 per cent and 5 per cent levels, respectively. All variables specified in logarithms, except those variables defined in percentage terms.

Note-2: Dependant variable is TFP index of groundnut at state level.
and distress like conditions in agriculture sector might be the reason for negative effect of rural literacy. In poor monsoon years the summer groundnut cultivation remains very low in Gujarat due to lack of irrigation water, which results in low cropping intensity, has less effect on TFP growth.

From Table 4 it can be further revealed that TFP elasticity with respect to research stock ranged from 0.5180 (model 2) to 0.5436 (model 1) for groundnut. The inverse of this elasticity gives research stock flexibility which represents the required increase in research stock to increase TFP by 1 per cent. This estimate shows that to achieve 1 per cent increase in TFP, the minimum investment in research needs to be increased by 1.93 per cent.

**Returns to investment on groundnut research**

The estimated value of marginal product (EVMP) of research investment presented in Table 5 revealed that additional investment of rupee one in groundnut crop research generated additional output worth Rs. 11.89 during 1990-91 to 2011-12 in Gujarat.

The internal rate of return (IRR) to research investment for groundnut crop of which research stock coefficient in TFP decomposition equation was statistically significant has been estimated following the assumption given in the methodology section. The result indicated that during the period 1990-91 to 2011-12, the overall rate of return to public agricultural research investment turned out to be 27.10 per cent for groundnut in Gujarat.

**Market support**

The improvement in TFP is an important source of output growth which directly contributes to cost saving and thus increase in income. Besides income also depends upon proper market price of the commodity. Market fluctuations due to uncertainty of monsoon thereby putting farming sector in crisis. Market volatility also largely affects the production of agricultural crops in case of low or bumper production. The distress is multidimensional involving social, economic, technological, gender and ecological aspects and therefore policy changes need to be incorporated and agricultural progress can take place by synergy between policy and technology.

Increasing productivity will serve the purpose of increasing farm income provided it is fully supported by the Government by procuring the agricultural commodities at MSP, whenever the price goes below MSP. It can be seen from Table 6 that with better technology and good monsoon in 2013-14 in Gujarat resulted in bumper production of groundnut about 492 lakh quintals. Hence, FHP decreased to Rs. 3518 per quintal, which was Rs. 482 per quintal less than MSP. Insufficient procurement of groundnut at MSP resulted to the loss of about Rs. 2370 crores to the groundnut cultivators in Gujarat and again Rs. 1289 crores in 2014-15. This indicates that Productivity is important, but if it is not backed by remunerative price, farmers will continue to suffer. Establishing the robust procurement machinery is the key for operationalising MSP to ensure income security to the farmers.

**CONCLUSION**

The Tornqvist Theil Index has been used to calculate the total output index, total input index and TFP index. Two outputs and ten inputs have been used to construct output and input indices for the period from 1990-91 to 2011-12.

The study reveals that, in Gujarat, though the area under groundnut decreased at the rate of 0.13 per cent per annum, in last two decades its production and productivity increased significantly at the rate of 5.10 and 5.24 per cent per annum, respectively. Also in both the decades of 1990s and 2000s the growth in production and productivity remained positive, in spite of negative growth in area. The growth in TFP was remarkably increased in the nineties but slowed down thence after due to replacement of area by cotton. The overall TFP growth of groundnut remained higher about 2.21 per cent per annum in last two and half decades resulting in annual decline in real cost of production by 0.27 per cent.

The remarkable growth in TFP nineties was largely contributed by the release of groundnut varieties viz, GG-2 in 1986, GG-20 and GG-12 in 1991, GG-13 in 1994. Returns to investment on groundnut crop research have been found

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**Table 5: Estimated value of MVP and IRR to research investment for groundnut crop in Gujarat.**

| Period      | Value of marginal product (Rupees) | Internal rate of return (Per cent) |
|-------------|-----------------------------------|-----------------------------------|
| 1990-91 to 2011-12 | 11.89                           | 27.10                             |

**Table 6: Estimation of Loss to groundnut cultivators when FHP rules below MSP in Gujarat.**

| Year      | Prod Lakh (qtl.) | FHP (Rs/qtl) | MSP (Rs/qtl) | Diff. (Rs/qtl) | Income by FHP (Rs. Crore) | Income by MSP (Rs. Crore) | Gain / Loss over MSP (Rs. Crore) |
|-----------|----------------|-------------|-------------|---------------|--------------------------|--------------------------|-------------------------------|
| 2010-11   | 358            | 2899        | 2300        | 599           | 10364                    | 8223                     | 2141                          |
| 2011-12   | 272            | 3727        | 2700        | 1027          | 10126                    | 7335                     | 2790                          |
| 2012-13   | 76             | 4286        | 3700        | 586           | 3268                     | 2822                     | 447                           |
| 2013-14   | 492            | 3518        | 4000        | - 482         | 17300                    | 19670                    | (-) 2370                      |
| 2014-15   | 302            | 3573        | 4000        | - 427         | 10783                    | 12072                    | (-) 1289                      |
to be a highly paying proposition generating 27.10 per cent IRR from 1990-91 through 2011-12. The government expenditure on crop research, extension education, ground water irrigation, irrigation intensity and rainfall contributed significantly in productivity enhancement. The balanced use of fertilizers and development of canal irrigation also contributed positively. In the years of bumper production insufficient procurement of groundnut by MSP adversely affected the farmers’ income.

It is essential that more public and private investments are made on technology improvement and providing incentives for micro irrigation system in the state through a favourable policy environment. Besides, timely and large scale market intervention operation is needed to ensure income security to the farmers at MSP. Increasing productivity by technological breakthrough and remunerative market price are equally importance to enhance farm income.

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