CHAPTER IV

RESULTS AND DISCUSSION

The results derived from the analysis of the data related to the various aspects of the present study entitled "Groundnut Production Dynamics During Pre and Post-Liberalization Eras: A case of Gujarat" are discussed in the following sections.

4.1 Growth Dimensions

4.2 Instability in Production

4.3 Cost of Cultivation, FHP and MSP

4.4 Profitability

4.5 Resource Use Efficiency

4.1 Growth Dimensions

The growth dynamics of groundnut crop in terms of area, production and productivity during the study period are presented in the Tables 4.1 to 4.3.

Table 4.1. Percentage analysis of growth dimensions of Groundnut crop in Gujarat state during the study period

(Per cent)

Period	Area	Production	Yield
Pre-Liberalization Period (1980-1991)	-10.59	-57.14	-51.41
Post-Liberalization - Period I (1992-2004)	7.44	-47.08	-50.91
Post-Liberalization - Period II (2004-2016)	-35.50	-61.36	-21.96
Post-Liberalization Period (1992-2016)	-31.36	-17.47	58.83
Overall Period (1980-2016)	-40.56	5.59	135.35

Source: Author's calculation from CACP data.

From the analysis it could be found that the percentage decrease in area, production and productivity during Pre-Liberalization Period (1980-1991) was -10.59, - 57.14 and - 51.41 per cent, respectively. The results also revealed that the per cent increase in area in groundnut crop during Post-Liberalization-I (1992-2004) was to the tune of 7.44 and there was a decrease in the groundnut area of about - 35.50 per cent during Post-Liberalization-II (2004-2016). The per cent decrease in production and yield during Post-Liberalization-I was found to be - 47.08 and - 50.91, respectively. The reason for such declining trend of groundnut area is mainly due to change of cropping pattern in Gujarat during the last few years.

It was found that during the entire Post-Liberalization Period (1992-2016) the percentage decrease in area and production was found to be - 31.36 per cent and - 17.47 per cent, respectively but the yield was found to be increased by 58.83 per cent. It was also found that during Overall Period (1980-2016) the yield and production of groundnut was increased by 135.35 per cent and 5.59 per cent, respectively. The larger rate of productivity was reflected by 5.59 per cent increase in production inspite of about - 41 per cent decrease under area of groundnut during the Overall Period.

This finding is in line with that of Pangayarselvi, R., Murali Gopal, S. and Swaminathan, B. (2014) who observed that the percentage change in terms of area, production and productivity of maize was to the tune of 60.63 per cent, 207.24 per cent and 91.41 per cent, respectively during Overall Period and the contribution of yield to production was more than that of contribution of area.

4.1.1 Trend in Growth Dimensions

The descriptive statistics of growth dimensions of groundnut crop in Gujarat state during the study period are presented in Table 4.2.

Table 4.2. Descriptive statistics of growth dimensions of Groundnut crop in Gujarat state during the study period

Period	Area		Production		Yield	
	Mean (mha)	CV (%)	Mean (mt)	CV (%)	Mean (kg/ha)	CV (%)
Pre-Liberalization (1980-1991)	1.91	16.33	1.39	53.97	703.67	53.36
Post-Liberalization - I (1992-2004)	1.87	6.87	1.60	53.31	860.00	53.11
Post-Liberalization-II (2004-2016)	1.73	15.71	2.83	44.29	1510.00	32.16
Post-Liberalization (1992-2016)	1.80	12.18	2.17	55.65	1185.00	47.94
Overall Period (1980-2016)	1.83	13.82	1.91	59.15	1024.55	54.28

Note: 1. A= Area, P=Production and Y=Yield; 2. mha=million hectares, mt = million tonnes, kg/ha= kilograms/hectare; 3. CV = Coefficient of Variation.

Source: Author's calculation from CACP data.

It was observed that the average area under groundnut crop during the Pre-Liberalization Period (1980-1991) was 1.91 million hectare while it was 1.87 million ha during Post-Liberalization Period-I (1992-2004) and 1.73 million hectare during Post-Liberalization Period-II (2004-2016). It was also observed that the average area was found to be 1.80 million hectare in the entire Post-Liberalization Period (1992-2016) and 1.83 million hectare during the Overall Period (1980-2016) of study.

It could also be observed that average production of groundnut crop was found to be 1.39 million tonnes during Pre-Liberalization Period (1980-1991). The average production during Post-Liberalization Period (1992-2016) was found to be 2.17 million tonnes which was respectively 1.60 and 2.83 million tonnes during Post-Liberalization Period-I (1991-2004) and Post-Liberalization Period-II (2004-2016). The average production of groundnut in the state was observed to be 1.91 million tonnes during Overall Period (1980-2016) of study.

At the same time, the average productivity was observed to be 703.67 kg/ha during Pre-Liberalization Period (1980-1991). The average productivity during Post-Liberalization-I and II was to the tune of 860.00 kg/ha and 1510.00 kg/ha, respectively. The average productivity of 1185 kg/ha was observed during Overall Period (1980-2016) of study.

The results revealed that the rise in productivity of groundnut during Post-Liberalization Period (1992-2016) was about 482 kg/ha. It may be due to release of high yielding varieties like GG-13, GJG-9, GJG-17 and GJG-22, respectively in the years of 1994, 2010 and 2011, respectively in the State.

The fluctuations in growth dimensions are measured by using the coefficient of variations (CV). It was found that in terms of area the fluctuations were higher during Pre-Liberalization (16.33 %) than the fluctuations observed during Post-Liberalization (12.18 %) and Overall Period (13.82 %). It is also observed that the fluctuation area seemed to be less unstable, when compared to that of production and productivity. The fluctuations in area was found to be 6.87 per cent and 15.71 per cent, respectively during Post-Liberalization-I and Post-Liberalization-II.

At the same time, the fluctuations in terms of production were lower during Pre-Liberalization Period (53.97 %) as compared to Post-Liberalization and Overall Periods. The fluctuations during the Post-Liberalization-I and II were 53.31 per cent and 44.29 per cent, respectively while fluctuations during Post-Liberalization (1992-2016) was found to be 55.65 per cent. The magnitude of coefficient of variation to the tune of 59.15 per cent during Overall Period (1980-2016) reflected the higher instability of production.

Similarly, the coefficient of variation for productivity was observed to be 53.36 per cent during Pre-Liberalization (1980-1991). The coefficient of variation was found to be 53.11 per cent during Post-Liberalization-I (1992-2004) and 32.16 per cent during Post-Liberalization-II (2004-2016) while during Post-Liberalization

(1992-2016) it was found to be of 47.94 per cent. The coefficient of variation was higher to the tune of 54.28 per cent during Overall Period (1980-2016).

The results revealed that high level of instability in production was noticed throughout the study period in Gujarat State. Since a major part of acreage under groundnut comes under rainfed regions, the fluctuations in rainfall would have in turn led to fluctuations in production levels.

This finding is in line with that of Pangayarselvi, R., Murali Gopal, S. and Swaminathan, B. (2014) who observed that the fluctuation in terms of area, production and productivity of maize was to the tune of 16.16 per cent, 47.60 per cent and 30.28 per cent, respectively during Overall Period.

4.1.2 Productivity in Groundnut Cultivation

The trends in growth dimensions of groundnut crop in Gujarat state during the study period are presented in Table 4.3.

Table 4.3. Trends in growth dimensions of Groundnut crop in Gujarat state during the study period

(Per cent per annum)

Period	A LGR	A CGR	P LGR	P CGR	Y LGR	Y CGR
Pre-Lib. (1980-1991)	-0.04**	-2.25**	-0.05**	-6.08**	-13.59***	-3.85**
Post-Lib. - I (1992-2004)	-0.01**	-0.56**	-0.04***	-3.52***	-20.03***	-2.69***
Post-Lib. - II (2004-2016)	-0.06*	-3.70**	-0.08**	-3.77**	0.76***	0.33***
Post-Lib. (1992-2016)	-0.02*	-1.07*	0.06**	2.79**	38.29*	3.85*
Overall Period (1980-2016)	-0.01*	-0.57*	0.04*	2.41*	28.67*	3.02*

Note: 1. Lib. Indicates Liberalization.

2. A=Area, P=Production and Y=Yield and LGR=Linear Growth Rate, CGR= Compound Growth Rate;
3. * Indicates significance at 1%; ** Indicates significance at 5%; and *** Indicates significance at 10%.

Source: Author's calculation from CACP data.

It is observed that the linear growth trend for area was negative (-0.04 %) and significant at 5 per cent during Pre-Liberalization Period. The linear trend for area during Post-Liberalization-I and II were found to be negative with - 0.01 per cent per annum and - 0.06 per cent per annum which were significant at 5 per cent and 1 per

cent significance level. The linear growth rate was negative and significant ($p<0.01$) at 1 per cent during both Post-Liberalization (-0.02 %) and Overall Period (-0.01 %).

The negative linear growth trend was observed in production during Pre-Liberalization with - 0.05 per cent per annum at 5 per cent level of significance. The negative linear growth rate was observed during Post-Liberalization Period-I and II with - 0.04 and - 0.08 per cent per annum which were respectively significant at 10 and 5 per cent significance level while the positive growth was noticed with 0.06 per cent per annum significant at 1 per cent level during Post-Liberalization Period. The linear growth during Overall Period was lower (0.04 % / annum) which was significant at 1 per cent.

The linear growth trend for productivity was observed to be negative with -13.59 per cent per annum during Pre-Liberalization which was significant at 10 per cent level. Similarly, the linear growth rate during Post-Liberalization-I was found to be -20.03 per cent per annum but during Post-Liberalization-II it was found to be positive with 0.76 per cent per annum significant at 10 per cent significance level while during Post-Liberalization it was 38.29 per cent and significant at 1 per cent level. The linear growth trend during Overall Period was positive (28.67 %) and significant at 1 per cent level.

The compound growth ratefor area was negative (-2.25 % / annum) and significant at 5 per cent during Pre-Liberalization Period while during Post-Liberalization-I and II, the compound growth rate was found to be negative with -0.56 per cent per annum and - 3.70 per cent per annum, respectively which were significant at 5 per cent significance level. It was also negative and significant ($p<0.01$) during Post-Liberalization as a whole with -1.07 per cent per annum. The compound growth rate during Overall Period was -0.57 per cent per annum significant at 1 per cent level of significance.

The compound growth rate for production was negative with -6.08 per cent per annum significant at 5 per cent during Pre-Liberalization Period. The negative compound growth rate was also observed during Post-Liberalization-I (-3.52 % / annum) which was found to be significant at 10 per cent level of significance whereas in Post-Liberalization-II it was found to be - 3.77 per cent per annum significant at 5 per cent level of significance. The positive compound growth rate was observed during Post-Liberalization (2.79 % / annum) and Overall Period (2.41 % / annum) which were found to be significant at 1 per cent level.

It was also observed that the compound growth rate for groundnut productivity was negative with - 3.85 per cent per annum significant at 5 per cent during Pre-Liberalization Period. The compound growth rate during Post-Liberalization-I was found to be negative with - 2.69 per cent per annum while during Post-Liberalization-II it was found to be 0.33 per cent per annum significant at 10 per cent level during both the periods. The positive and significant compound growth rate during Post-Liberalization with 3.85 per cent per annum and Overall Period of 3.02 per cent per annum were observed significant at 1 per cent level significance.

Studies confirm that with the advent of improved cropping technologies during Green Revolution, the contribution of growth in productivity became the major factor for growth in output (Bhalla, 2009 and Mythili, 2012). The same trend was also observed in case of groundnut crop during the study period as depicted in Table 4.3.

This finding is in line with that of Chandra Mohan Misra (2017) who observed that in the first phase during the period 1964-65 to 1969-70 the area increased at the rate of 1.92 per cent. But in the second phase lasting till the terminating year of the study (2013-14) it fell consistently at the rate of - 3.63 per cent annually. Both the overall actual and estimated series showed a growth rate of -3.34 per cent.

4.1.3 Cyclical trend: Fourier Analysis

This analysis was done only for Overall Period as the cycles were found to be significant over long period of time. So far as the Pre-Liberalization and Post-Liberalization Periods are concerned the time period was short and cycles were found to be non-significant. Here we test 8 year cycle model for area, production, productivity and farm harvest prices of groundnut during Overall Period.

Fourier analysis of groundnut area for Overall Period was carried out for cycle ranging in the length of time period from 3 years to 10 years and for each period of the cycle fourier coefficients were worked out. The significance of these cycles are judged based on the calculated K value ($\widehat{K}$). If $\widehat{K}$ value is greater than table K value (ps) *i.e.*, the cycle is said to be significant. The Fourier coefficients, amplitude square, mean square amplitude and the ratio K of groundnut area are presented in Table 4.4.

The results revealed that the absolute value of fourier coefficients using cosines were greater than using sines for groundnut. In the 8 year cycle length, fourier coefficients of cyclical peakness (A_p) was negative for 5, 6, 7, 8, 9 and 10 year

cyclical length and it was positive for 3 and 4 year cyclical length. It implies that they fall in lower part of the cycle.

Table 4.4. Fourier coefficients, amplitude square, mean square amplitude and the ratio K for Groundnut area (8 cycles)

Cycle Length (Years)	Fourier Coefficients		Amplitude square Rp^2	Mean square amplitude Rm^2	K value
	A_p	B_p			
3	0.23392	0.54249	0.34901	0.02372	2.66357
4	0.04602	0.00733	0.00217	0.02661	0.81627
5	-0.00882	-0.01257	0.00023	0.02572	0.00917
6	-0.10885	0.00927	0.01193	0.02382	0.50098
7	-0.03658	0.02370	0.00190	0.02382	0.07975
8	-0.01120	0.20415	0.04180	0.02463	1.69696
9	-0.07254	0.08942	0.01325	0.02359	0.56179
10	-0.12471	-0.04033	0.01717	0.02221	0.77340

Source: Author's calculation from CACP data.

The fourier coefficients of cyclical length (B_p) was negative for 5 and 10 year and it was found to be positive for 3, 4, 6, 7, 8 and 9 year cyclical length. It implies that they fall in upper part of the cycle. Squared amplitude was smaller than mean square amplitude for 4, 5, 6, 7, 9 and 10 year cyclical length. The calculated $\hat{K}$value was found smaller than the table value for all the 8 cycles. Thus, F-test seems to be non-significant. Therefore, all the 8 cycles of groundnut area was rejected.

The results showed that the cycles of groundnut area were found to be non-significant and hence the cycles for groundnut area were rejected.

This finding is in line with that of Pangayarselvi *et al*. (2015) who found that the K values were found to be non-significant for maize area in India. Therefore, the 8 cycles of maize area was rejected.

Similar to area, 8 cycle model for production of groundnut was tested and calculated. Fourier coefficients, amplitude square, mean square amplitude and the ratio K of groundnut production are presented in Table 4.5.

The results reveal that absolute value of Fourier coefficients using cosines were greater than using sines for Groundnut. In the 8 year cycle length, fourier coefficients of cyclical peakness (A_p) was negative for 4, 5, 9 and 10 year cyclical length and it was positive for 3, 6, 7 and 8 year cyclical length. It implies that they fall in lower part of the cycle.

Table 4.5. Fourier coefficients, amplitude square, mean square amplitude and the ratio K for Groundnut production (8 cycles)

Cycle Length (Years)	Fourier Coefficients		Amplitude square Rp^2	Mean square amplitude Rm^2	K value
	A_p	B_p			
3	0.2758	0.7010	0.5675	0.0900	6.3029*
4	-0.0686	0.0377	0.0061	0.0824	0.0744
5	-0.3548	-0.2092	0.1696	0.0981	1.7294
6	0.2596	0.4207	0.2444	0.0895	2.7299
7	0.3893	0.0176	0.1519	0.0891	1.7030
8	0.0187	-0.1064	0.0116	0.0979	0.1191
9	-0.3113	0.3705	0.2342	0.1151	2.0347
10	-0.0983	-0.1462	0.1828	0.0979	1.8668

Note: * Indicates significant at 1 per cent level.

Source: Author's calculation from CACP data.

The fourier coefficients of cyclical length (B_p) was negative for 5, 8 and 10 year and it was found to be positive for 3, 4, 6, 7 and 9 year cyclical length. It implies that they fall in upper part of the cycle. Squared amplitude was greater than mean square amplitude. The calculated $\widehat{K}$value was found greater than the table value for the 8 cycles. Production cycles of 3 year cycle was found to be 6.3029 significant at 1 per cent level for groundnut crop using F-test. Hence, the observed ratio for a period of 8 years could have occurred by chance. Thus, 3 years time period of the cycles should be considered in forming relevant farm plans.

This finding is in line with that of Savithri, T. M. (1999) who found that the K values were found to be significant for agricultural commodities production in Calicut and hence the observed ratio for a period of 6 year cycle could have occurred by chance.

The fourier coefficients, amplitude square, mean square amplitude and the ratio K of groundnut productivity are presented in Table 4.6.

Table 4.6. Fourier coefficients, amplitude square, mean square amplitude and the ratio K for Groundnut productivity (8 cycles)

Cycle Length	Fourier Coefficients		Amplitude square Rp^2	Mean square amplitude Rm^2	K value
	A_p	B_p			
3	-0.0367	-0.0308	0.0023	0.0017	1.3491
4	0.0460	-0.0334	0.0032	0.0016	2.0328
5	-0.0021	-0.0314	0.0010	0.0018	0.5409
6	0.0028	-0.0523	0.0027	0.0017	1.6139
7	0.0058	0.0389	0.0015	0.0017	0.9100
8	0.0404	-0.0130	0.0023	0.0018	1.2541
9	0.0294	-0.0130	0.0010	0.0017	0.6058
10	0.0090	-0.0620	0.0039	0.0018	2.1459*

Note: * Indicates significance at 1 % level.

Source: Author's calculation from CACP data.

The results revealed that absolute value of fourier coefficients using cosines were greater than using sines for groundnut. Among 8 cycle length, fourier coefficients of cyclical peakness (A_p) was negative for 3 and 10 year cyclical length while it was positive for 4, 5, 6, 7 and 10 year cyclical length. It implies that they fall in upper part of the cycle.

The fourier coefficients of cyclical length (B_p) was negative for 3, 4, 5, 6, 8, 9 and 10 year and it was found to be positive only for 7 year cyclical length. It implies that they fall in lower part of the cycle. Squared amplitude was greater than mean square amplitude for all the cycles except in case of 7 and 9 years cyclical length. The calculated $\widehat{K}$value was found greater than the table value for productivity cycles of 10 year. It was found to be 2.1459 which was significant at 1 per cent level for groundnut crop using F-test. Hence, the observed ratio for a period of remaining cycles could have occurred by chance.

Thus, the results indicated that 10 years time period of the cycles should be considered in forming relevant farm plans as they were found to be significant.

This finding is in line with that of Savithri, T. M. (2015) who found that the K values were found to be significant for 6 cycles for productivity of agricultural commodities like rice, ginger, arecanut and coconut, respectively significant at 5 per cent level.

The fourier coefficients, amplitude square, mean square amplitude and the ratio K of groundnut farm harvest prices are presented in Table 4.7.

Table 4.7. Fourier coefficients, amplitude square, mean square amplitude and the ratio K for Groundnut Farm Harvest Price (8 cycles)

Cycle Length	Fourier Coefficients		Amplitude square Rp^2	Mean square amplitude Rm^2	K value
	A_p	B_p			
3	-338.75	-506.68	371478.74	128176.02	2.8982
4	346.50	-395.14	276209.63	116732.91	2.3662
5	115.77	-325.73	119508.60	136108.91	0.8780
6	133.55	-282.66	97732.85	128176.02	0.7625
7	-29.26	139.49	20314.34	128176.02	0.1585
8	234.23	-193.20	152971.51	136108.91	1.1239
9	153.80	-193.20	60986.27	124422.53	0.4902
10	146.41	-507.65	279153.13	136108.91	2.0510

Source: Author's calculation from CACP data.

The fourier coefficients of cyclical length (B_p) was negative for 3, 4, 5, 6, 8, 9 and 10 year and it was found to be positive only for 7 year cyclical length. It implies that they fall in lower part of the cycle. Squared amplitude was greater than mean square amplitude for 3, 4, 6, 8 and 10 years cyclical length. The calculated $\widehat{K}$value was found smaller than the table value for all the 8 cycles. Thus, F-test seems to be non-significant. Therefore, the results indicated that all the 8 cycles of groundnut farm harvest prices was rejected.

The results showed that the 3 and 10 year cycles of groundnut production and productivity were found to be significant at 1 per cent level of significance which indicates that the 3 and 10 years time series data were to be used for obtaining reliable and accurate farm plans under different types of risk. As the results for groundnut area and farm harvest prices were found to be non-significant, the cycles were rejected.

4.2 Instability in Production

The pure effect of change in the mean yield, change in mean area, the effect of interaction between changes in mean area and mean yield and the change in covariance between area and yield were analysed by using Hazell's decomposition technique. The decomposition analysis was carried out and the percentage contribution of each component towards the change in average production of groundnut was estimated.

In order to examine the sources of instability more precisely, the change in variance in production for each crop group was decomposed into several components using Hazell's (1982) decomposition model. To apply Hazell's variance decomposition method, the total time span covered by the data has been divided into two periods. The first period covered 18 years starting from 1980 - 81 to 1997- 98 and the second period also covered 18 years beginning from 1998 - 99 to 2015 - 2016. Data on yield and area of groundnut were detrended separately for each period using linear trends. For each variable, the residual of the trend equation was added to the mean of the data series to generate detrended data centered on the mean. The detrended production was obtained by multiplying detrended yield and detrended area. The final analysis were conducted using these detrended data.

The sources of variance in groundnut production are represented in Table 4.8.

Table 4.8. Sources of variance in Groundnut production (in per cent)

Period	Area Variance V(A)	Yield Variance V(Y)	Area-yield-covariance Cov (A,Y)	Higher order interaction Cov (A,Y)	Residual R	Total
Period I (1980-1998)	5.27	91.28	16.00	2.27	-10.25	100.00
Period II (1999-2016)	5.00	74.50	22.17	0.01	-1.68	100.00

Note: 1. Lib. indicates Liberalization.

2. A= Area; Y= Yield; Cov = Covariance and R= Residual.

Source: Author's calculation from CACP data.

Fluctuations in groundnut production of Gujarat for the period 1980 - 1998 to 1999 - 2016 are analysed. Fluctuations in crop output may cause price instability, which in turn may adversely affect further growth in crop yield, employment and income distributions. It is, therefore, necessary to take appropriate measures to stabilize agricultural prices and agricultural production.

Fluctuations in crop yield particularly in the groundnut production happens to be a regular feature in Gujarat agriculture.The main reason for this is the dependence on nature i.e. rainfall for the cultivation of crops in the State of Gujarat. Natural hazards like flood and drought are also responsible for such fluctuations. Inadequate irrigation facilities and lack of permanent measures to control flood and erosion have further compounded the problem in the state. Therefore, an attempt has been made to

analyse the extent and source of instability in the production of groundnut in the Gujarat state.

Thus, we come to the conclusion that in the Pre-Liberalization Period fluctuation in production as well as productivity of crops is higher than the Post-Liberalization Period.

From the above discussion, it has been found that there exists a considerable variation in the production of groundnut in Gujarat. In this section an attempt has been made to find out the possible sources that causes variance in the production of groundnut. The variance of production has been decomposed into area variance, productivity variance and area productivity co-variance for groundnut and also for different time period separately. The results have been presented in Table 4.8.

In Gujarat yield variance was the main contributor to the production variance in both Period I (91.28 %) and Period II (74.50 %). Area-yield covariance was the next source of variance in production in Period II (22.17 %) and Period I (16.00 %) while area variance was the third source of variance in Period I (5.27 %) and Period II (5.00 %). The higher order interaction was the next source of variance in Period I (2.27 %) and Period II (0.01 %). The residual had a negative effect to the production variance with - 10.25 per cent in Period I and -1.68 per cent variance in Period II.

From the result, it is observed that yield variance was the main source contributing to the variance in groundnut production in Gujarat state.

The results of this study are in conformity with the studies conducted by Kalyan Bhattacharyya and Arabinda Mitra (2016) at West Bengal for groundnut crop. They concluded that the change in area and interaction effect (mean area and mean yield) had been the dominant source of total variation in production of groundnut in the state as well as in other selected states. Area effect has been dominated in all the eastern states.

The method to partition the changes in variance of production (V (Q)) between the first and the second periods into its constituent parts is being constructed and given in Table 4.9. The effect of different components in the changes in the variance of production of groundnut crop in Gujarat are presented in Table 4.9.

It is observed from the table that changes in the mean yields account for the largest shares of changes in variance of production for groundnut. They account for 22.2503 per cent of total groundnut production. Changes in mean area account for -

16.8264 per cent of the changes in total variance of production. Changes in the variance of area account for the largest share of the changes in variance of production for groundnut. They account for 7.2816 per cent of the increase in the variance of total groundnut production.

Table 4.9. Components of Change in the Variance of Production of Groundnut (in per cent) in Gujarat

Sources of change	Symbol	Components of change
Change in mean yield	$\Delta\bar{Y}$	22.2503
Change in mean area	$\Delta\bar{A}$	-16.8264
Change in yield variance	Δ V(Y)	0.3208
Change in area variance	Δ V(A)	7.2816
Interaction between changes in mean yield and mean area	$\Delta\bar{A}\Delta\bar{Y}$	-0.8501
Change in area-yield covariance	Δcov (AY)	12.7363
Interaction between changes in mean area and yield variance	$\Delta\bar{A}\Delta$ V(Y)	-0.0460
Interaction between changes in yields and area variance	$\Delta\bar{Y}\Delta$ V(A)	-25.6720
Interaction between changes in mean area and yield and changes in area–yieldcovariance	$\Delta\bar{A}\Delta\bar{Y}$cov (A)	6.0399
Change in residual	Δ R	94.7654
Total	-	100.0000

Source: Author's calculation from CACP data.

It is observed from the table that changes in the mean yields account for the largest shares of changes in variance of production for groundnut. They account for 22.2503 per cent of total groundnut production. Changes in mean area account for -16.8264 per cent of the changes in total variance of production. Changes in the variance of area account for the largest share of the changes in variance of production for groundnut. They account for 7.2816 per cent of the increase in the variance of total groundnut production.

For groundnut, changes in mean area account for the second largest component (-16. 8264 %) of the changes in variance of production. This component also had destabilizing effects on total groundnut production. Changes in the co-

variances between areas and yields account for 12.7363 per cent of groundnut production. But it had a stabilizing effect to the changes in variance of production.

It can be observed from the table that interaction terms are also an important contributing factor to the changes in variance of production. The interaction terms in groundnut accounted for - 0.8501 to - 25.6720 per cent of the increase in variance of groundnut. Interaction terms had little effect on the change in variance of total groundnut production in the state of Gujarat.

Finally, changes in the residual term also contribute to the changes in the production variance of groundnut (94.76 %). But, it accounts for 94.76 per cent of the changes in variance of groundnut production.

The results of the decomposition analysis revealed that the change in mean production of groundnut was mainly due to the change in mean yield. It is concluded that the future development programmes should envisage on stabilization of yield for bringing stabilization in production of the crop.

These results are in line with findings of Pradeep Kumar, S. (2015) in Tamil Nadu who found that the decomposition analysis revealed the change in mean production of paddy which was mainly due to the interaction between changes in yields and area variance in different districts of Tamil Nadu. The yield variance was found to be the most contributing factor to the tune of 163.73 per cent in Chengalpattu district of Tamil Nadu.

4.3 Cost of Cultivation, FHP and MSP

Groundnut is one of the major oilseed crop occupying a prominent place in the economy of cultivators and Gujarat is the leading state in India for groundnut production. Therefore, cost of groundnut production has paramount importance in determining the net income from it. The details of per hectare component wise costs of groundnut production for different periods were studied and the results have been furnished in Table 4.10.

The growth dynamics of groundnut crop in terms of cost of inputs used in groundnut production during study periods are discussed in the Tables 4.10 to 4.24. From Table 4.10, it could be observed that during Pre-Liberalization Period the percentage increase in family labour was 19.69 per cent over the base year. It was found that during Post-Liberalization Period (1992-2016) the percentage change in

family labour was found to be 394.88 per cent whereas during Overall Period the percentage increase in family labour was found to be 594.76 per cent.

Table 4.10. Percentage change in input cost of Groundnut crop in Gujarat state during the study period

Inputs	Pre-Liberalization (1980-1991)	Post-Liberalization (1992-2016)	Overall (1980-2016)
Family Labour (Rs./ha)	19.69	394.88	594.76
Hired HumanLabour (Rs./ha)	133.20	581.73	726.07
Bullock Labour (Rs./ha)	7.57	321.56	228.22
Chemical Fertilizers (Rs./ha)	50.62	240.12	100.82
Manures (Rs./ha)	27.58	239.97	214.48
Pesticides (Rs./ha)	117.07	182.76	188.30
Irrigation (Rs./ha)	170.00	149.61	431.90

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

In case of hired human labour, the percentage increase during Pre-Liberalization, Post-Liberalization and Overall Periods were found to be 133.20 per cent, 581.73 per cent and 726.07 per cent, respectively. The percentage increase in bullock labour during Pre-Liberalization, Post-Liberalization and Overall Periods were found to be 7.57 per cent, 321.56 per cent and 228.22 per cent, respectively.

During Pre-Liberalization Period the percentage increase in chemical fertilizers was found to be 50.62 per cent, whereas in Post-Liberalization the percentage increase in chemical fertilizers was found to be 240.12 per cent. During Overall Period, the percentage increase in case of chemical fertilizers was found to be 100.82 per cent. During Pre-Liberalization Period, the percentage increase in manures was found to be 27.58 per cent whereas in Post-Liberalization Period, the percentage increase was 239.97 per cent and during Overall Period it was found to be around 214.48 per cent.

The percentage increase in pesticides during Pre-Liberalization was 117.07 per cent and the same was the highest (182.76 %) during Post-Liberalization Period. The per cent increase in pesticides during Overall Period was found to be 188.30 per cent. The per cent increase in irrigation during Pre-Liberalization, Post-Liberalization and Overall Period were found to be 170.00 per cent, 149.61 per cent and 431.90 per cent, respectively.

The results showed that the highest per cent change was observed for hired human labour (726.07 %) followed by family labour, irrigation, bullock labour and manures etc. It indicated that more hired human labour were employed for cultivation of groundnut crop as compared to family labour and bullock labour during Overall Period.

The descriptive statistics of labour cost of groundnut crop in Gujarat state during the study period are presented in the Table 4.11.

Table 4.11. Descriptive statistics of labour cost of Groundnut crop in Gujarat state during the study period

Period	Family Labour		Hired Human Labour		Bullock Labour	
	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)
Pre-Liberalization (1980-1992)	367.17	17.50	454.08	41.35	536.50	15.69
Post-Liberalization (1992-2016)	3487.92	59.42	3658.52	70.62	3192.63	67.06
Overall Period (1980-2016)	2687.66	92.68	2590.38	100.26	2307.25	93.22

Note: 1. CV = Coefficient of Variation.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The average value of family labour for Pre-Liberalization Period, Post-Liberalization Period and Overall Period were found to be Rs. 367.17, Rs. 3487.92 and Rs. 2687.66 per hectare, respectively. It was observed that the fluctuations in terms of family labour were lower during Pre-Liberalization Period (17.50 %) as compared to Post-Liberalization Period (59.42 %) and Overall study period (92.68 %).

The average value of hired human labour for Pre-Liberalization Period, Post-Liberalization Period and Overall Period were found to be Rs. 454.08 per hectare, Rs. 3658.52 per hectare and Rs. 2590.38 per hectare, respectively. Similarly, the coefficient of variation for hired human labour during Pre-Liberalization Period, Post-Liberalization Period and during Overall Period were found to be 41.35, 70.62 and 100.26 per cent, respectively which indicated that the growth in family labour and hired human labour were not stable.

The average value of bullock labour during Pre-Liberalization Period, Post-Liberalization Period and Overall Period were found to be Rs. 536.50, Rs. 3192.63 and Rs. 2307.25 per hectare respectively. Whereas for bullock labour the coefficient of variation during Pre-Liberalization Period, Post-Liberalization Period and Overall Period were found to be 15.69, 67.06 and 93.22 per cent, respectively.

The results showed that the highest variation was observed for hired human labour (100.26 %). The variation in hired human labour was more as compared to family labour and bullock labour. Higher increase in manual labour expenses during Post-Liberalization period was due to increase in wage rates rather than physical units of labour uses. The difference in mean value of bullock labour expenses during Pre- and Post-Liberalization Period was less as compared to manual labour. It is due to reduction in use of bullock labour in groundnut cultivation. It was replaced by cheap machine labour.

The trends in labour cost particulars of groundnut crop in Gujarat state during the study period are presented in Table 4.12.

It was observed that the linear growth rate for family labour during Pre-Liberalization Period found to be 11.93 per cent which was significant at 5 per cent level, while during Post-Liberalization Period it was positive (265.09 % / annum) and significant at 1 per cent.

Table 4.12. Trends in labour cost particulars of Groundnut crop in Gujarat state during the study period

(Per cent per annum)

Period	Family Labour		Hired HumanLabour		Bullock Labour	
	LGR	CGR	LGR	CGR	LGR	CGR
Pre-Liberalization (1980-1992)	11.93**	3.18**	37.16*	8.16**	5.34	0.93
Post-Liberalization (1992-2016)	265.09*	7.49*	317.55*	9.33*	213.05*	8.33*
Overall Period (1980-2016)	207.92*	10.92*	214.15	10.55	161.88*	8.50*

Note: 1. LGR=Linear Growth Rate, CGR= Compound Growth Rate;

2. * Indicates significance at 1 % and ** indicates significance at 5 %.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The linear growth rate for hired human labour was found to be significant at 1 per cent (37.16 % / annum) during Pre-Liberalization Period while the linear growth of 317.55 per cent per annum was observed during Post-Liberalization significant at 1 per cent level of significance. The linear growth rate during Overall Period of study found to be 214.15 per cent per annum which was non-significant.

The lowest and non-significant linear growth rate for bullock labour was found during Pre-Liberalization Period (5.34 % / annum). The higher linear growth trend was observed in bullock labour during Post-Liberalization with 213.057 per cent per annum which was found to be significant at 1 per cent. The same was found to be lesser during Overall Period with 161.88 per cent per annum significant at 1 per cent level of significance.

It is also observed that the compound growth rate for family labour during Pre-Lib., Post-Lib. and Overall Periods were found to be 3.18 per cent per annum, 7.49 per cent per annum and 10.92 per cent per annum, respectively. The compound growth rate of hired human labour respectively during Pre-Lib. and Post-Lib. Periods was to the tune of 8.16 per cent per annum significant at 5 per cent and 9.33 per cent per annum significant at 1 per cent level. The compound growth rate during Overall Period was observed to be 10.55 per cent per annum which was non-significant. It was also observed that the compound growth rate for bullock labour was found to be non-significant during Pre-Liberalization Period (0.93 % / annum) while it was significant at 1 per cent during Post-Liberalization Period (8.33 % / annum). During Overall study period it was 8.50 per cent per annum which was significant at 1 per cent. Thus, results revealed that the growth in value of labours during Pre-Liberalization Period was less as compared to Post-Liberalization Period.

The results of fluctuations in use of different inputs in agriculture during the study period are presented in Table 4.13.

Table 4.13. Descriptive statistics of inputs in agriculture of Groundnut crop in Gujarat state during the study period

Period	Fertilizers		Manures		Irrigation		Pesticides	
	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)
Pre-Liberalization (1980-1992)	536.5	15.6	400.0	32.5	78.5	142.1	74.5	48.1
Post-Liberalization (1992-2016)	1347.0	57.4	1712.9	56.1	3559.7	86.0	685.8	85.5
Overall Period (1980-2016)	1005.7	79.1	1275.3	78.6	2399.3	124.5	482.0	115.8

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

It was observed that the fluctuation in use of fertilizer was 15.6 per cent during Pre-Liberalization Period, 57.4 per cent during Post-Liberalization Period and 79.1 per cent during Overall Period. Similarly, the fluctuations in use of manures during Pre-Liberalization, Post-Liberalization and Overall Period were found to be 32.5 per cent, 56.1 per cent and 78.6 per cent, respectively.

The variation in irrigation was to the tune of 142.1, 685.5 and 482.0 per cent, respectively during Pre-Liberalization Period, Post-Liberalization Period and Overall Period of study. Thus growth in terms of use of fertilizer and irrigation are seemed to be stable.It was found that the variation in pesticide was found to be lower (48.1 %) during Pre-Liberalization whereas it was higher during Post-Liberalization Period (85.5 %) and Overall Period (115.8 %).

The average value of fertilizers during Pre-Liberalization, Post-Liberalization and Overall Period were found to be Rs. 536.5, Rs. 1347.0 and Rs. 1005.7 per hectare, respectively. In the same way, the average value respectively during Pre-Liberalization, Post-Liberalization and Overall Period were found to be Rs. 400.0, Rs. 1712.9 and Rs. 1275.3 per hectare in manures, Rs. 78.6, Rs. 3559.7 and Rs. 2399.3 per hectare in irrigation and in Rs. 74.5, Rs. 685.8 and Rs. 482.0 per hectare, in pesticides.

The results showed that the highest variation was observed for irrigation (124.5 %) followed by pesticides, manures and fertilizers. This may be due to the reason that availability and use of irrigation is affected by monsoon while the use of

pesticides depends on incidence of pest and diseases. Therefore, the use of irrigation and pesticides varied more as compared to use of manures and fertilizers.

The trends in inputs in agriculture of groundnut crop in Gujarat state during the study period are presented in Table 4.14**.**

It is observed that the linear growth rate for fertilizers during Pre-Lib., Post-Lib. and Overall Period were to the tune of 8.0 per cent per annum, 63.1 per cent per annum and 56.9 per cent per annum.

Similarly, the linear growth trend for manures during Pre-Liberalization Period was 14.0 per cent per annum which was non-significant. The linear growth rate during Post-Liberalization Period (117.5 % / annum) and Overall Period (83.98 % / annum) was significant at 1 per cent level of significance.

Table 4.14. Trends in inputs in agriculture of Groundnut crop in Gujarat state during the study period (Per cent per annum)

Period	Fertilizers		Manures		Irrigation		Pesticides	
	LGR	CGR	LGR	CGR	LGR	CGR	LGR	CGR
Pre-Liberalization (1980-1992)	8.0**	2.7**	14.0	3.4	8.5	14.9	6.22**	10.8*
Post-Liberalization (1992-2016)	63.1*	4.0*	117.5*	7.5*	189.6**	7.0***	52.5*	12.5*
Overall Period (1980-2016)	56.9*	6.3*	83.9*	7.4*	185.4*	18.7*	38.4*	11.1*

Note: 1. * Indicates significant at 1%; ** indicates significant at 5% and *** indicates significant at 10%.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

So as per the irrigation is concerned, the linear growth rate respectively during Pre-Liberalization, Post-Liberalization and Overall Periods for irrigation were found to be non-significant with 8.5 per cent per annum, 189.6 per cent per annum (significant at 5 per cent significance level) and 185.4 per cent per annum (significant at 1 per cent level), respectively. It was observed that the compound growth rate during Post-Liberalization Period was found to be less with 7.0 per cent per annum which indicated that due to increase in the irrigation cost the growth got reduced as the farmers started using less quantity of irrigation for groundnut cultivation.

It is observed that the linear growth rate for insecticides during Pre-Lib., Post-Lib. and Overall Periods were found to be 6.22, 52.5 and 38.4 per cent per annum significant at 1 per cent significance level, respectively.

It was also observed that the compound growth rate for fertilizers, respectively during Pre-Lib., Post-Lib. and Overall Periods were found to be 2.7 per cent per annum significant at 5 per cent, 4.0 and 6.3 per cent per annum significant at1 per cent. Similarly, the compound growth rate for manures during Pre-Lib., Post-Lib. and Overall Period were found to be at 3.4, 7.5 and 7.4 per cent per annum.

The compound growth rate for irrigation was to the tune of 14.9 per cent per annum and non-significant during Pre-Liberalization Period. The compound growth rate for irrigation was found to be 189.6 per cent per annum at 5 per cent level of significance and it was 185.4 per cent per annum during Overall Period of study at 1 per cent significance level. It is also observed that the compound growth rate for insecticides during Pre-Lib., Post-Lib. and Overall Periods were to the tune of 10.8, 12.5 and 11.1 per cent per annum at 1 per cent significance level.

The results showed that highest linear growth rate was observed for irrigation (189.6 %) followed by manures, pesticides and fertilizers. During olden days the farmers were not aware of use of fertilizers and they used to apply in less quantity. Hence, growth was less while after Liberalization the people were aware and started using more quantity of fertilizers which resulted in higher growth of crop.

The percentage change in costs and returns of groundnut crop in Gujarat state during the study period are presented in Table 4.15.

It was observed that the percentage change in Cost A during Pre-Liberalization, Post-Liberalization, Post-Liberalization-I, Post-Liberalization-II and Overall Periods were found to the tune of 182.03, 184.50, 88.85, 496.55 and 1729.90 per cent respectively.

Similarly the percentage change in Cost B during Pre-Liberalization, Post-Liberalization, Post-Liberalization-I, Post-Liberalization-II and Overall Periods were found to the tune of 110.22, 154.88, 81.56, 479.26 and 1864.63 per cent, respectively. The percentage change in Cost C during Pre-Liberalization, Post-Liberalization, Post-Liberalization-I, Post-Liberalization-II and Overall Period were found to the tune of 169.16, 180.53, 83.68, 532.77 and 2064.72 per cent, respectively.

Table 4.15. Percentage change in costs and returns of Groundnut crop in Gujarat state during the study period (Per cent)

Period	Cost A	Cost B	Cost C	Gross returns
Pre-Liberalization Period (1980-1991)	182.03	110.22	169.16	231.59
Post-Liberalization – I (1992-2004)	184.50	154.88	180.53	31.08
Post-Liberalization – II (2004-2016)	88.85	81.56	83.68	124.74
Post-Liberalization (1992-2016)	496.55	479.26	532.77	561.30
Overall Period (1980-2016)	1729.90	1864.63	2064.72	3054.99

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

It was also observed from Table 4.15 that during Pre-Liberalization Period the percentage change in gross returns was found to be 231.59 per cent. The gross return was increased by 31.08 and 124.74 per cent during Post-Liberalization Period-I. The percentage increase in gross returns was 561.30 per cent during Post-Liberalization Period while during Overall Period it was found to be 3054.99 per cent. It was observed that the per cent change in gross returns during Post-Liberalization-I was found to be very less in comparision to all other costs during the study periods because of lack of knowledge among farmers about the use of resources and due to use of less quantity of inputs the returns were found to be less.

The results indicated that the increase in gross return was not benefitted the farmers because of similar increase in cost of cultivation of the crop. It is concluded that the per cent change in different costs and returns during Pre-Liberalization was less as compared to Post-Liberalization.

The descriptive statistics of cost and returns of groundnut crop in Gujarat state during the study period are presented inTable 4.16.

The average value of Cost A during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods was found to be Rs. 3457.9, Rs. 12953.7, Rs. 32717.5, Rs. 22835.6 and Rs. 16376.3 per hectare, respectively. It was found that in terms of variation the fluctuations in Cost A during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were to the tune of 34, 37.7, 31.7, 56.2 and 85.1 per cent, respectively.

Similarly, the average value of cost B during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods was found to be Rs. 2086.1, Rs.17136.8, Rs. 41492.4, Rs. 29314.6 and Rs. 20931.6 per hectare, respectively. The fluctuations in Cost B during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were to the tune of 58.1, 36.8, 32.4, 55.0 and 84.9 per cent, respectively.

The average value of cost C during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period it was found to be Rs. 4714.4, Rs. 20708.0, Rs. 52068.4, Rs. 36388.2 and Rs. 25830.2 per hectare, respectively. Similarly, the fluctuations in Cost C were to the tune of 34.5, 40.1, 31.6, 56.3 and 87.0 per cent, respectively.

Table 4.16. Descriptive Statistics of cost and returns of Groundnut crop in Gujarat state during the study period

Period	Cost A		Cost B		Cost C		Gross returns	
	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)
Pre-Liberalization Period (1980-1991)	3457.9	34.0	2086.1	58.1	4714.4	34.5	5532.7	50.6
Post-Liberalization – I (1992-2004)	12953.7	37.7	17136.8	36.8	20708.0	40.1	25262.0	34.7
Post-Liberalization – II (2004-2016)	32717.5	31.7	41492.4	32.4	52068.4	31.6	63598.5	44.5
Post-Liberalization (1992-2016)	22835.6	56.2	29314.6	55.0	36388.2	56.3	44430.2	63.8
Overall Period (1980-2016)	16376.3	85.1	20931.6	84.9	25830.2	87.0	31464.4	94.1

Note: 1. CV = Coefficient of Variation.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The average value of gross returns during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period it was found to be Rs. 5532.7, Rs. 25262.0, Rs. 63598.5, Rs. 44430.2, and Rs. 31464.4 per hectare, respectively. It is observed that the fluctuations in gross returns were observed and results were depicted. It was found that in terms of variation the fluctuations in gross returns during Pre-Lib., Post-Lib.-I, Post-Lib.-II, Post-Lib. and Overall Period were to the tune of 50.6, 34.7, 44.5, 63.8 and 94.1 per cent, respectively.

The results showed that the highest variation was observed in gross returns (94.1 %) as followed by Cost C (31.6 %), Cost A and Cost B during Overall Period.

The trends in costs and returns of groundnut crop in Gujarat state during the study period are presented in Table 4.17.

It is observed that the linear growth rate for Cost A during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 277.1, 738.4, 2264.0, 1611.9 and 1205.6 per cent per annum, respectively and all were statistically significant at 1 per cent.

Table 4.17. Trends in costs and returns of Groundnut crop in Gujarat state during the study period (Per cent per annum)

Period	Cost A		Cost B		Cost C		Gross returns	
	LGR	CGR	LGR	CGR	LGR	CGR	LGR	CGR
Pre-Lib. (1980-1991)	277.1*	7.7*	300.4*	7.3*	392.2*	8.0*	626.4*	12.7*
Post-Lib.-I (1992-2004)	738.4*	4.7**	822.3**	3.7**	1161.5*	4.6**	521.8**	1.9***
Post-Lib.-II (2004-2016)	2264.0*	7.2*	2870.0*	7.1*	3851.8*	7.2*	5880.4*	10.0*
Post-Lib. (1992-2016)	1611.9*	7.7*	1984.0*	7.2*	2561.9*	7.8*	3196.3*	7.2***
Overall Period (1980-2016)	1205.6*	9.4*	1530.5*	9.5*	1946.8*	10.0*	2410.9*	10.5*

Note: 1. Lib. Indicated Liberalization.

2. LGR=Linear Growth Rate, CGR= Compound Growth Rate; 2. * Indicates significant at 1%; ** Indicates significant at 5%.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

Similarly, the linear growth trends for Cost B during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 300.4, 822.3, 2870.0, 1984.0 and 1530.5 per cent per annum, respectively and were statistically significant at 1 per cent.

Similarly, the linear growth rate trend for Cost C was lower (392.2 % / annum) during Pre-Liberalization Period whereas higher (3851.8 % / annum) during Post-Liberalization period-II. The total cost (Cost-C) increased at the rate of 2561.9 per cent per annum during Post-Liberalization Period. Similarly, the linear growth rate for gross returns during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 626.4 per cent per annum, 521.8 per cent per annum, 5880.4, 3196.3 and 2410.9 per cent per annum, respectively.

The compound growth rate of Cost A during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 7.7, 4.7, 7.2, 7.7 and 9.4 per cent per annum, respectively and the results were statistically significant. Similarly the compound growth rate of Cost B during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 7.3, 3.7, 7.1, 7.2 and 9.5 per cent per annum, respectively and the results were statistically significant at 1 per cent.

In the same way the compound growth rate of Cost C during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 8.0, 4.6, 7.2, 7.8 and 10.0 per cent per annum, respectively and the results were statistically significant at 1 per cent. The compound growth rate for gross returns during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 12.7, 1.9, 10.0, 7.2 and 10.5 per cent per annum, respectively and the results were statistically significant at 1 per cent and 10 per cent, respectively.

The results showed that the compound growth rate was highest for gross returns (10.5 %) which indicated that value of all labour and input cost used were less and as days passed on the farmers were aware about the new practices and inputs were used in higher quantity to get higher returns.

The percentage change in FHP and MSP of groundnut crop in Gujarat state during the study period are given in Table 4.18.

It is observed that percentage change in FHP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 192.81, 45.44, 171.48, 321.22 and 1062.43 per cent, respectively.

Table 4.18. Percentage change in FHP and MSP of Groundnut crop in Gujarat State during the study period (Per cent)

Period	FHP	MSP
Pre-Liberalization Period (1980-1991)	192.81	213.10
Post-Liberalization – I (1992-2004)	45.44	86.66
Post-Liberalization – II (2004-2016)	171.48	168.66
Post-Liberalization (1992-2016)	321.22	437.33
Overall Period (1980-2016)	1062.43	1856.31

Note: 1. FHP = Farm Harvest Price, MSP = Minimum Support Price.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

Similarly the percentage change in MSP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 231.10, 86.66, 168.66, 437.33 and 1856.31 per cent, respectively.

The results showed that highest per cent change was observed in MSP (1856.31 %) as compared to FHP (45.44 %) which indicated that the per cent change in MSP was more as compared to FHP.

The descriptive statistics of FHP and MSP of groundnut crop in Gujarat state during the study period are presented in Table 4.19.

Table 4.19. Descriptive Statistics of FHP and MSP of Groundnut crop in Gujarat state during the study period

Period	FHP		MSP	
	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)
Pre-Liberalization Period (1980-1991)	620.10	37.04	390.90	32.92
Post-Liberalization – I (1992-2004)	1333.42	13.72	1060.00	21.50
Post-Liberalization – II (2004-2016)	2910.25	34.81	2585.00	41.10
Post-Liberalization (1992-2016)	2121.83	50.67	1822.50	54.69
Overall Period (1980-2016)	1621.25	70.10	1345.31	82.88

Note: 1. FHP = Farm Harvest Price, MSP = Minimum Support Price; 2. CV = Coefficient of Variation.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

There were fluctuations in the farm harvest and minimum support prices so in order to determine the changes analysis was carried out and the results were presented in Table 4.19. It was found that in terms of variation the fluctuations in FHP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 37.04, 13.72, 34.81, 50.67 and 70.10 per cent, respectively. The average value of FHP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be Rs. 620.10, Rs. 1333.42, Rs. 2910.25, Rs. 2121.83 and Rs. 1621.25 per hectare, respectively.

Similarly, the average value in MSP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be Rs. 390.90, Rs. 1060.00, Rs. 2585.00, Rs. 1822.50 and Rs. 1345.31 per hectare, respectively. The variation in MSP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 32.92, 21.50, 41.10, 54.69 and 82.88 per cent, respectively.

The results showed that the highest variation was observed for MSP as compared to FHP during study periods except during Pre-Liberalization Period.

The trends in FHP and MSP of groundnut crop in Gujarat state during the study period are analysed and results are presented in Table 4.20.

Table 4.20. Trends in FHP and MSP of Groundnut crop in Gujarat state during the study period (Per cent per annum)

Period	FHP		MSP	
	LGR	CGR	LGR	CGR
Pre-Liberalization Period (1980-1991)	59.36*	9.92*	34.26*	9.19*
Post-Liberalization – I (1992-2004)	44.72*	3.94*	62.48*	6.11*
Post-Liberalization – II (2004-2016)	245.35*	9.40*	280.62*	11.62*
Post-Liberalization (1992-2016)	134.85*	6.32*	138.14*	7.61*
Overall Period (1980-2016)	97.77*	6.76*	95.21*	8.16*

Note: 1.* Indicates significant at 1%.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

It was observed that the linear growth rate of FHP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 59.36, 44.72, 245.35, 134.85 and 97.77 per cent per annum,

respectively and the results were statistically significant at 1 per cent. The compound growth rate of FHP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be lower with 9.92, 3.94, 9.40, 6.30 and 6.76 per cent per annum, respectively and the results were statistically significant at 1 per cent.

The results of trends in MSP of groundnut crop (Table 4.20) showed that the linear growth rate during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 34.26, 62.48, 280.62, 138.14 and 95.21 per cent per annum, respectively which were statistically significant at 1 per cent. The compound growth rate of MSP during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be with 9.19, 6.11, 11.62, 7.61 and 8.16 per cent per annum, respectively and the results were statistically significant at 1 per cent.

The results showed that the highest compound growth rate was observed in both MSP (11.62 % / annum) and FHP (9.40 % / annum) during Post-Liberalization-II. It indicated more rapidly increase in FHP and MSP during the recent years.

4.4 Profitability

It was important to know the percentage change in profitability of groundnut obtained during different periods and results showing percentage change in income measures of groundnut in Gujarat state during the study period were presented in Table 4.21.

The results showed that percentage change in farm business income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 182.03, 122.41, 88.85, 496.55 and 1729.91 per cent, respectively.

The percentage change in family labour income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 113.33 per cent, 154.88 per cent, 81.56 per cent, 479.26 per cent and 1864.63 per cent, respectively. Similarly the per cent change in net income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Period were found to be 30.56, 99.99, 267.16, 77.24 and 501.02 per cent, respectively.

Table 4.21. Percentage change in profitability measures of Groundnut crop in Gujarat state during the study period (Per cent)

Period	Farm Business Income	Family Labour Income	Net income	Intensive Income	Farm Investment Income
Pre-Liberalization Period (1980-1991)	182.03	113.33	30.56	50.42	208.39
Post-Liberalization - Period I (1992-2004)	122.41	154.88	99.99	77.01	119.92
Post-Liberalization - Period II (2004-2016)	88.85	81.56	267.16	155.95	86.35
Post-Liberalization Period (1992-2016)	496.55	479.26	77.24	118.81	519.40
Overall Period (1980-2016)	1729.91	1864.83	501.02	692.34	1701.14

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The per cent change in intensive income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 50.42, 77.01, 155.95, 118.81 and 692.34 per cent, respectively. Similarly, the per cent change in farm investment income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 208.39, 119.92, 86.35, 519.40 and 1701.14 per cent, respectively.

The results showed that the highest per cent change was observed in family labour income (1864.83 %) while that of to net income (501.02 %) was the lowest during Overall Period which indicated that higher profits were obtained to farmers who employed more number of family labours in cultivation of groundnut crop.

The descriptive statistics and trends in profitability of groundnut crop in Gujarat state during thestudy period are presented in Table 4.22.

The average value of net income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be Rs. 5553.33, Rs. 16713.00, Rs. 15390.16, Rs. 16051.58, and Rs. 12552.16 per hectare, respectively. The higher profit during Post-Liberalization Period may be due to the reason of improvement in technology and farm cultivation practices. The variation in net income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 31.88, 51.41, 80.38, 65.03 and 78.78 per cent, respectively.

Table 4.22. Descriptive statistics and trends in profitability of Groundnut crop in Gujarat state during the study period

Period	Net Income		Net Income	
	Mean (Rs./ha)	**CV (%)**	**LGR (% / annum)**	**CGR (% / annum)**
Pre-Liberalization Period (1980-1991)	5553.33	31.88	234.26	4.52
Post-Liberalization – I (1992-2004)	16713.00	51.41	639.73	31.89
Post-Liberalization – II (2004-2016)	15390.16	80.38	2228.61	52.58
Post-Liberalization (1992-2016)	16051.58	65.03	114.75	1.60
Overall Period (1980-2016)	12552.16	78.78	431.71	0.27

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

Similarly, the linear growth rate trend for net income during Pre-Liberalization Period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were to the tune of 234.26, 639.73, 2228.61, 114.75 and 431.71 per cent per annum, respectively.The results showed that decrease in growth of net income was observed during Post-Liberalization period. The results showed that the trends in net income was non-significant during all the periods of study. The compound growth rate for net income during Pre-Liberalization Period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 4.52, 31.89, 52.58, 1.6 and 0.27 per cent per annum, respectively.

The results showed that highest variation (80.38 %) and compound growth rate (52.58 % / annum) were observed for net income during Post-Liberalization Period-II.

The descriptive statistics of profitability measures of groundnut crop in Gujarat state during thestudy period are presented in Table 4.23.

The variations in farm business income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 34.0, 35.2, 31.7, 57.0 and 85.9 per cent, respectively. The average value of farm business income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be Rs. 3457.9, Rs.12584.3, Rs. 32715.5, Rs. 22650.9 and Rs.16232.6 per hectare, respectively.

Table 4.23. Descriptive statistics of profitability measures of Groundnut crop in Gujarat state during the study period

Period	Farm Business Income		Family Labour Income		Intensive Income		Farm Investment Income	
	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)	Mean (Rs./ha)	CV (%)
Pre-Lib. (1980-1991)	3457.9	34.0	2257.0	40.9	6250.1	29.3	3029.0	39.8
Post-Lib. – I (1992-2004)	12584.3	35.2	17136.8	36.8	21389.6	45.2	10292.5	34.9
Post-Lib.– II (2004-2016)	32717.5	31.7	41492.4	32.4	24672.2	58.7	27313.5	30.6
Post-Lib. (1992-2016)	22650.9	57.0	29314.6	55.0	23030.9	52.8	18803.0	57.0
Overall Period (1980-2016)	16232.6	85.9	20931.6	84.9	17437.4	73.1	13545.0	85.1

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The variations in family labour income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 40.9, 36.8 per cent, 32.4, 55.0 and 84.9 per cent, respectively. The average value of family labour income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be Rs. 2257.0, Rs. 17136.8, Rs. 41492.4, Rs. 29314.6 and Rs. 20931.6 per hectare, respectively.

The variations in intensive income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 29.3, 45.2, 58.7, 52.8 and 73.1 per cent, respectively. The average value of intensive income during Pre-Liberalization Period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be Rs. 6250.16, Rs. 21389.6, Rs. 24672.25, Rs. 23030.96 and Rs.17437.4 per hectare, respectively.

The variations in farm investment income during Pre-Liberalization Period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be 39.8, 34.9, 30.6, 57.0 and 85.1 per cent, respectively. The average value of farm investment income during Pre-Liberalization Period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall Periods were found to be Rs. 3029.08, Rs. 10292.5, Rs. 27313.5, Rs. 18803 and Rs. 13545.03 per hectare, respectively.

The results showed that highest variation was observed in farm business income (85.9 %) during Overall period. It may be due to more fluctuation of groundnut price and variation in its productivity. The major area under groundnut is cultivated as rainfed crop. So variation in rainfall directly affects its productivity.

The trends in profitability measures of groundnut crop in Gujarat state during the study period are presented in Table 4.24.

The linear growth rate for farm business income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 277.15, 567.97, 2274.0, 1613.91 and 1202.38 per cent per annum, respectively which were significant during Pre-Liberalization and Post-Liberalization periods at 1 per cent level of significance. The compound growth rate of farm business income during Pre-Liberalization Period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 7.7, 3.91, 7.2, 7.77 and 9.54 per cent per annum, respectively. The results obtained during Pre-Liberalization Post-Liberalization Period-II were found to be significant at 1 per cent significance level.

Table 4.24. Trends in profitability measures of Groundnut crop in Gujarat state during the study period (Per cent per annum)

Period	Farm Business Income		Family Labour Income		Intensive Income		Farm Investment Income	
	LGR	CGR	LGR	CGR	LGR	CGR	LGR	CGR
Pre-Lib. (1980-1991)	277.1*	7.7*	415.9**	9.0*	315.0*	5.3**	283.3	9.33
Post-Lib.– I (1992-2004)	567.9	3.9	822.3	3.7	-439.4	-5.9	456.8	3.5
Post-Lib. – II (2004-2016)	2274.0*	7.2*	2870.0*	7.1*	2746.8**	13.0**	1820.2*	6.9*
Post-Lib. (1992-2016)	1613.9	7.7	1984.0	7.2	492.4	1.3	1348.8	7.8
Overall Period (1980-2016)	1202.3	9.5	1530.5	9.5	779.3	5.09	994.3	9.3

Note: 1. Lib. Indicates Liberalization; 2. * Indicates significant at 1%; ** Indicates significance at 5%; and *** Indicates significance at 10%.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

In the same way the linear growth rate of family labour income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 415.9, 822.31, 2870.06, 1984.01 and 1530.50 per cent per annum, respectively. The compound growth rate of family labour during Pre-Liberalization Period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 9.00, 3.77, 7.10, 7.28 and 9.55 per cent per annum, respectively. The results showed that the growth rates obtained during Pre-Liberalization and Post-Liberalization Period-II were found to be significant at 1 per cent level of significance.

The linear growth rate of intensive income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 315.02, -439.49, 2746.88, 492.43 and 779.35 per cent per annum, respectively. The compound growth rate of intensive income during Pre-Liberalization period, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 5.36, -5.98, 13.05, 1.36 and 5.09 per cent per annum, respectively. The results were significant during Pre-Liberalization and Post-Liberalization Period-II.

In farm investment income the linear growth rate during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 283.33, 456.86, 1820.2, 1348.8 and 994.3 per cent per annum, respectively. The compound growth rate of farm investment income during Pre-Liberalization, Post-Liberalization-I, Post-Liberalization-II, Post-Liberalization and Overall periods were found to be 9.33, 3.55, 6.95, 7.84 and 9.32 per cent per annum, respectively. The results were significant at 1 per cent during Post-Liberalization Period-II.

The results showed that highest compound growth rate was observed in case of intensive income (13.0 % / annum) which indicated that the compounded growth in intensive income was more as compared to other income measures of profitability.

4.4.1 Cost and Return and its Sensitivity

A farm earns profit when its net return is above its total costs that means when the benefit cost ratio (BCR) is greater than one. Profitability is the main aim of any farm (Majumder *et al.*, 2009).

The per hectare cost and returns of groundnut production during Post-Liberalization Period are presented in Table 4.25.

Table 4.25. Per hectare cost and returns of Groundnut production during Post-Liberalization Period

Particulars	Mean Value	Percentage (%)
Family Labour	3231.37	16.29
Hired HumanLabour	2853.30	14.38
Bullock Labour	2503.30	12.62
Seeds	4905.94	24.74
Chemical Fertilizers	1185.22	5.97
Manures	1462.22	7.37
Plant protection chemicals	408.11	2.05
Irrigation	1975.99	9.96
Others	1303.02	6.57
Total cost	19828.51	100.00
Gross Returns	37129.95	-
Net Returns	17301.44	-
Benefit Cost Ratio (BCR)	1.87	-

Note: 1. Mean Value=Geometric mean value.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

It is observed that the Gross return was found to be Rs. 37129.95 per hectare while the total cost was Rs. 19828.51 per hectare. Hence the average net return of groundnut production was Rs. 17301.44 per hectare, indicating groundnut production is profitable. Labour cost accounted for 43.29 per cent of the total cost followed by seeds cost (24.94 %).

The cost of irrigation, chemical fertilizers and manures accounted for 9.96, 5.97 and 7.37 per cent of the total cost, respectively. Other expenses and plant protection chemical cost accounted for only a minimal of 6.57 per cent and 2.05 per cent, respectively. This is because, there are only few farmers who used other expenses and plant protection chemicals to produce groundnut. The BCR, on full cost basis, was found 1.87 which indicates that groundnut production is more profitable in the study

area and generates more return to the total investment during the Post-Liberalization Period of study.

The mean value of family labour, hired human labour, bullock labour, seeds, chemical fertilizers, manures, plant protection chemicals, irrigation and other expenses were found to be Rs. 3231.37, Rs. 2853.30, Rs. 2503.30, Rs. 4905.94, Rs.1185.22, Rs.1462.22, Rs.408.11, Rs. 1975..92 and Rs.1301.02 per hectare, respectively.

It was also observed that the percentage change in family labour, hired human labour, bullock labour, manures, plant protection chemicals and others were found to be 16.29, 14.38, 12.62, 7.37, 7.28, 2.05 and 6.57 per cent, respectively. The results showed that the highest gross returns of Rs. 37129.95 per hectare were obtained in groundnut production with less cost and the benefit cost ratio was also found to be greater than one. Cost, yield and output price can affect the profitability of groundnut production. This study found that profitability is more sensitive to the change in yield and output price of groundnut (Table 4.26). The sensitivity of profitability to change in total cost and input cost on during Post-Liberalization Period are presented in Table 4.26.

If labour cost, inputs (other than labour) and both labour and inputs increased by 10 per cent, the net returns was found to be respectively Rs. 16442, Rs. 16777 and Rs. 15318 per hectare at the same level of gross income. Similarly if there was 10 per cent increase in FHP then gross returns would be increased to Rs. 40842.95 per hectare.

Table 4.26. Sensitivity Analysis of change of total cost and input cost on profitability during Post-Liberalization Period

Changes	Gross return (Rs./ha)	Total Cost (Rs./ha)	Net return (Rs./ha)
10% increase in labour cost	37129.95	20687.30	16442.64
10% increase in inputs (other than labour)	37129.95	20952.56	16177.39
10% increase in labour and inputs	37129.95	21811.36	15318.59
10% increase in FHP	40842.95	19828.51	21014.43
10% decrease in FHP	33416.95	19828.51	13588.44
10% increase in output price and input price (all the inputs)	41529.51	21861.41	19668.10

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

If FHP got decreased by 10 per cent then the gross returns would be decreased to Rs. 33416.95 per hectare. While there was 10 per cent increase in output and input price the gross return was increased to Rs. 41529.51 per hectare whereas the net return was found to be Rs. 19668.10 per hectare.

Similarly, the 10 per cent increase in labour cost increased the total cost to Rs. 20867.30 per hectare while 10 per cent increase in inputs gives a total cost of Rs. 20952.56 per hectare. If 10 per cent increase in labour and inputs is observed then the total cost will be Rs. 21811.36 per hectare. The 10 per cent increase in output and input price gave a total cost of Rs. 21816.41 per hectare.

It is also observed that 10 per cent increase in labour cost, in both inputs and labour and in inputs only gives a decrease in net returns of Rs. 16442.64, Rs. 16177.39 and Rs. 15318.59 per hectare. While the 10 per cent increase in FHP and in both output and input prices gives a net returns of Rs. 21044.33 and Rs. 19688.10 per hectare. Similarly, the 10 per cent decrease in FHP gave a net return of Rs. 13588.44 per hectare.

The results showed that profitability is more sensitive to the change in yield and output price of groundnut and farmers would likely be more affected by output price and cost of labour which can be compensated by increasing yield.

The per hectare cost and returns of groundnut production during Overall Period are presented in Table 4.27.

It is observed that the Gross return was found to be Rs. 18859.86 per hectare while the total cost was Rs. 10516.10 per hectare. Hence the average net return of groundnut production was Rs. 8343.75 per hectare, indicating groundnut production is profitable. Labour cost accounted for 43.32 per cent of the total cost followed by seeds cost (27.20 %). Irrigation and plant protection chemical cost accounted for only a minimal of 5.01 per cent and 2.12 per cent, respectively. This is because, there are only few farmers who used irrigation and plant protection chemicals, respectively to produce groundnut. The BCR, on full cost basis, was found 1.79 which indicates that groundnut production is more profitable in the study area and generates more return to the total investment during the Overall Period of study.

Table 4.27. Per hectare cost and returns of groundnut production during Overall Period

Particulars	Mean Value	% share in total cost
Family Labour	1558.42	14.81
Hired Human Labour	1506.23	14.32
Bullock Labour	1491.92	14.18
Seeds	2861.19	27.20
Chemical Fertilizers	766.31	7.28
Manures	937.86	8.91
Plant protection chemicals	223.28	2.12
Irrigation	526.92	5.01
Others	643.92	6.12
Total cost	10516.10	100.00
Gross Returns	18859.86	-
Net Returns	8343.75	-
Benefit Cost Ratio (BCR)	1.79	-

Note: Mean Value= Geometric mean values.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The mean value of family labour, hired human labour, bullock labour, seeds, chemical fertilizers, manures, plant protection chemicals, irrigation and others were found to be Rs. 1558.42, Rs. 1506.23, Rs. 1491.92, Rs. 2861.19, Rs.766.31, Rs.937.86, Rs.223.28, Rs. 526.92and Rs.643.92 per hectare, respectively. It was also observed that the percentage change in family labour, hired human labour, bullock labour, manures, plant protection chemicals and others were found to be 14.81, 14.32, 14.18, 27.20, 7.28, 8.91, 7.28, 8.91, 2.12, 5.01 and 6.12 per cent, respectively.

This finding is in line with that of Ngulube *et al*., (2001) who found out that the BCR for high input was found 1.87 which indicates that groundnut production is economically profitable in the study area of malawi and generates almost double return of the total investment.

The sensitivity of profitability to change in total cost and input cost during Overall Period are presented in Table 4.28. If labour cost, inputs (other than labour) and both labour and inputs increased by10 per cent, the ne returns was found to be respectively Rs. 6948.76, Rs. 6355.44 and Rs. 6903.52 per hectare at different levels of gross income.

Similarly, if there was 10 per cent increase in FHP then gross returns would be increased to Rs. 20745.84 per hectare. If FHP got decreased by 10 per cent then the

gross returns would be decreased to Rs. 16973.87 per hectare. While there was 10 per cent increase in output and input price the gross return was increased to Rs. 23356.69 per hectare whereas the net return was found to be Rs. 10792.59 per hectare.

Table 4.28. Sensitivity Analysis of change of total cost and input cost on profitability during Overall Period

Changes	Gross return (Rs./ha)	Total Cost (Rs./ha)	Net return (Rs./ha)
10% increase in labour cost	19315.51	12366.75	6948.76
10% increase in inputs (other than labour)	19455.80	13100.36	6355.44
10% increase in labour and inputs	20356.78	13453.26	6903.52
10% increase in FHP	20745.84	11642.50	9103.34
10% decrease in FHP	16973.87	11437.70	5536.17
10% increase in output price and input price (all the inputs)	23356.69	12564.10	10792.59

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

Similarly, the 10 per cent increase in labour cost increased the total cost to Rs. 12366.75 per hectare while 10 per cent increase in inputs gives a total cost of Rs. 13100.36 per hectare. If 10 per cent increase in labour and inputs the total cost was found to be Rs. 13453.26 per hectare. The 10 per cent increase in output and input price gave a total cost of Rs. 12564.10 per hectare.

It is also observed that 10 per cent increase in labour cost, in both inputs and labour and in inputs only gives a decrease in net returns of Rs.6948.76, Rs. 6355.44 and Rs. 6903.52 per hectare. While the 10 per cent increase in FHP and in both output and input prices gives a net returns of Rs. 9103.34 and Rs. 10792.59 per hectare. Similarly, the 10 per cent decrease in FHP gave a net return of Rs. 5536.17 per hectare.

The results showed that groundnut farmers would likely be more affected by output price and cost of labour which can be compensated by increasing yield.

4.5 Resource Use Efficiency

Resource use efficiency means how efficiently farmer can use his resources in production process. It is important to ensure efficient use of resources, because resources are always limited (Majumder e*t al*., 2009).Resource use efficiency analysis was done only for Post-Liberalization and Overall periods as it has sufficient observations to take care of degrees of freedom.

The Augmented Dickey Fuller Test (ADF) is unit root test for stationarity and it is utilized for a larger and more complicated set of time series models. This test was carried out for Post-Liberalization and Overall Period by detrending the data and the results are presented in Appendices (I and II). The results showed that only few variables were significant and hence again further analysis was carried out to find more significant variables.

4.5.1 Cobb-Douglas Production function

Resource use efficiency was analyzed by using Cobb-Douglas production function and the results showed only few variables significant and the results are presented in tables. OLS estimates of groundnut production using the Cobb-Douglas function during Post-Liberalization Period are presented in Table 4.29.

The estimated Cobb-Douglas production function shows an F value of 7.8940 which is significant at 1 per cent level of significance (Table 4.29). The value of the Adjusted R^2 is 0.7295 which indicates that 72.95 per cent of variability in production can be explained by the explanatory variables used in the model. The summation of all the production co-efficient indicates returns to scale. The returns to scale were found to be 0.53 (<1) which means that production function exhibit decreasing return to scale.

The coefficients of family labour, hired human labour, seeds and plant protection chemicals were found to be positive with 0.5430, 0.600, 0.9165 and 0.1480, respectively while the coefficients of bullock labour, chemical fertilizers, manures, irrigation and other expenses were found to be negative with - 0.4869, - 0.5207, - 0.3190, - 0.1468 and - 0.0084, respectively.

Table 4.29. OLS estimates of Groundnut production using the Cobb-Douglas function during Post-Liberalization Period

Variables	Coefficient	t-ratio	p-value
Family Labour	0.5430**	0.9786	0.0344
Hired HumanLabour	0.600**	0.8244	0.0423
Bullock Labour	-0.4869	-1.3508	0.1982
Seeds	0.9165	1.6038	0.1310
Chemical Fertilizers	-0.5207	-1.3861	0.1874
Manures	-0.3190**	-0.4157	0.0383
Plant protection chemicals	0.1480**	0.4326	0.0507
Irrigation	-0.1468	-1.6062	0.1305
Others	-0.0084	-0.032	0.9749
R^2	0.8353	-	-
Adjusted R^2	0.7295	-	-
F-value	7.8940*	-	-
Returns to scale	0.53	-	-

Note: 1.* Indicates significance at 1 %, ** Indicates significance at 5 %.
Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The t-ratio of family labour, hired human labour, seeds and plant protection chemicals were found to be positive with 0.9786, 0.8244, 1.6038 and 0.4326, respectively. It is observed that the t-ratio for bullock labour, chemical fertilizers, manures, irrigation and others were found to be negative with - 1.3508, - 1.3861, - 0.4157, - 1.6062 and - 0.032, respectively. The p-value of family labour, hired human labour, bullock labour, seeds, chemical fertilizers, manures, plant protection chemicals, irrigation and other expenses were found to be 0.0344, 0.0423, 0.1982, 0.1310, 0.1874, 0.0383, 0.0507, 0.1305 and 0.9749, respectively. The p-value indicates that the resources of family labour, hired human labour, manures and plant protection chemicals were found to be significant while the resources of bullock labour, seeds, chemical fertilizers, irrigation and other expenses were found to be non-significant.

The OLS estimates of groundnut production using the Cobb-Douglas function during Overall Period are presented in Table 4.30.

Table 4.30. OLS estimates of Groundnut production using the Cobb-Douglas function during Overall Period

Variables	Coefficient	t-ratio	p-value
Family Labour	0.5160*	1.80063	0.0833
Hired HumanLabour	0.4890*	0.34957	0.0072
Bullock Labour	- 0.5562	-2.1363	0.0402
Seeds	- 0.3010*	- 3.2364	0.0032
Chemical Fertilizers	- 0.4562	-1.4896	0.1483
Manures	0.1796	0.5394	0.5942
Plant protection chemicals	- 0.0040	-0.0368	0.9710
Irrigation	0.1260*	0.9105	0.0037
Others	-0.1031	-0.4626	0.6474
R^2	0.934	-	-
Adjusted R^2	0.91115	-	-
F-value	40.879*	-	-
Returns to scale	1.30	-	-

Note: 1.* Indicates significance at 1 % and ** Indicates significance at 5 %.
Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The estimated Cobb-Douglas production function shows an F value of 40.879 which is significant at one per cent level of significance. The value of the Adjusted R^2 was 0.91115 which indicates that 91.15 per cent of variability of gross return can be explained by the explanatory variables used in the model.The summation of all the production co-efficient indicates returns to scale and the returns to scale were found to be 1.30 which was greater than 1 which means that production function exhibit increasing return to scale. The increasing return to scale indicates that the current scale of groundnut production is non-significant and there is necessary to increase the productivity through an increase in scale (Kassali, 2011).

The coefficients of family labour, hired human labour, manures and irrigation were found to be positive with 0.5160, 0.4890, 0.1796 and 0.1260, respectively while the coefficients of bullock labour, chemical fertilizers, plant protection chemicals and others were found to be negative with - 0.5562, - 0.4562, - 0.0040 and - 0.1031, respectively. The p-value of family labour, hired human labour, seeds and irrigation were found to be 0.0833 and 0.0072, 0.0032 and 0.0037, respectively which indicates that they are significant while other resources hired human labour, chemical fertilizers, plant protection chemicals and others were found to be non-significant.

The results showed that the resources family labour, hired human labour, seeds and irrigation were found to be significant during Overall Period of study.

4.5.1 Stepwise regression and Backward elimination

By production function only few variables were found to be significant and hence again further analysis was carried out to find out more significant variables. Cobb-Douglas production function was again fitted to find out the resource use efficiency of groundnut cultivation in Gujarat State during Post-Liberalization and Overall Period and the best model was identified using backward elimination method. The results of stepwise regression and backward elimination are presented in the Tables 4.31 and 4.32.

It could be seen that the value of adjusted coefficient of determination of first production function was 0.913 using all the 9 regressors. But, only few of the regression coefficients were significant. Using stepwise backward regression method, the least contributing variable was removed and again a Cobb-Douglas production function was fitted. The adjusted R^2 could be improved to a value of 0.934. This procedure was repeated and ultimately, the best model for prediction was identified based on maximum value of adjusted R^2.

Table 4.31. Cobb-Douglas production function for Groundnut cultivation in Gujarat state during Post-Liberalization Period

Sl. No.	Cobb-Douglas Production Function	R^2	Adj. R^2
(1)	$Y=5253.223+0.540x_1+0.492X_2-0.065X_3+0.184X_4-0.073X_5 -0.290X_6+0.140X_7+0.006X_8+0.17X_9$	0.947	0.913
(2)	$Y=5181.004+0.537X_1+0.488X_2-0.006X_3+0.177X_4-0.069X_5 -0.283X_6+0.140X_8+0.020X_9$	0.947	0.919
(3)	$Y=4986.776+0.512X_1^{**}+0.519X_2^{**}-0.055X_3+0.168X_4-0.055X_5-0.283X_6^{**}+0.141X_7$	0.947	0.924
(4)	$Y=5370.819+0.521X_1^{**}+0.568X_2^{**}+0.135X_4-0.051X_5 0.356X_6+0.144X_8^{*}$	0.947	0.928
(5)	$Y=4698.625+0.496X_1^{**}+0.556X_2^{**}+0.098X_4-0.319X_6^{*}+0.140X_7$	0.947	0.932
(6)	$\mathbf{Y=5627.776+0.543X_1^{**}+0.600X_2^{**}-0.319X_6^{**}+0.148X_7^{**}}$	**0.946**	**0.934**

Note: * Indicates significance at 1 % level and ** indicates significance at 5 % level.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The sixth model in the Table 4.31 was selected as the best model for prediction. Using this model, 93.4 per cent of variation in net returns per unit area could be explained. From this model it was evident that the variables X_1 (value of family labour/ha), X_2 (value of hired human labour/ha) and X_7 (value of plant protection chemicals used/ha) have significant positive results in increasing the net returns per hectare whereas the variable X_6 (value of manures used/ha) have negative result in decreasing the net returns per hectare. This indicated that the production of groundnut could be increased by increasing the amount of manures and plant protection chemicals applied.

Selected model $Y=5627.776+0.543X_1^{**}+0.600X_2^{**}-0.319X_6^{**}+0.148X_7^{**}$

Cobb-Douglas production function for Groundnut cultivation in Gujarat state during Overall Period are presented in Table 4.32.

It could be seen that the value of adjusted coefficient of determination of first production function was 0.954 using all the 9 regressors. But, only few of the regression coefficients were found significant. Using stepwise backward regression method, the least contributing variable was removed and again a Cobb-Douglas production function was fitted. The adjusted R^2 could be improved to a value of 0.960. This procedure was repeated and ultimately, the best model for prediction was identified based on maximum value of adjusted R^2.

The fifth model in the Table 4.32 was selected as the best model for prediction. Using this model, 96 per cent of variation in net returns per unit area could be explained. From this model it was evident that the variables X_1 (value of family labour/ha), X_2 (value of hired human labour/ha) and X_8 (value of irrigation/ha) have significant positive results in increasing the net returns per hectare whereas the variable X_4 (quantity of seeds/ha) had significant negative result in decreasing the net returns per hectare. This indicated that the production of groundnut could be increased by increasing the amount of seeds applied and increasing the application of plant protection chemicals.

Selected model $Y= 2897.6581+0.516X_1^{*}+0.489X_2^{*}+0.157X_3-0.301X_4^{*}+0.126X_8^{**}$

Table 4.32. Cobb-Douglas production function for Groundnut cultivation in Gujarat state during Overall Period

Sl. No.	Cobb-Douglas Production Function	R^2	Adj. R^2
(1)	$Y=2624.862+0.536x_1$**$+0.381X_2-0.102X_3+0.228X_4-0.043X_5-0.187X_6+0.124X_7+0.012X_8$*$+0.023X_9$	0.966	0.954
(2)	$Y=2664.853+0.544X_1$**$+0.388X_2-0.102X_3+0.245X_4-0.049X_5-0.198X_6+0.124X_8$*$+0.0159X_9$	0.966	0.954
(3)	$Y=2526.816+0.521X_1$*$+0.413X_2$**$-0.093X_3+0.237X_4-0.037X_5-0.197X_6+0.124X_8$*	0.966	0.958
(4)	$Y=2183.543+0.501X_1$*$+0.413X_2$**$-0.087X_3+0.204X_4-0.189X_5-0.180X_6+0.122X_8$*	0.966	0.959
(5)	**$Y=2897.6581+0.516X_1$*$+0.489X_2$*$-0.301X_4$*$+0.126X_8$****	**0.965**	**0.960**
(6)	$Y=3832.574+0.602X_1$*$+0.545X_2-0.299X_5+0.139X_7$*	0.964	0.960

Note**:** * indicates significance at 1 % level and ** indicates significance at 5 % level.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

The contribution of regressors towards change in returns per unit area during Post-Liberalization Period of the selected Cobb-Douglas model is discussed in Table 4.33.

Table 4.33. Contribution of regressors towards change in returns per unit area during Post-Liberalization Period

For 1% change in ln X_i	% Change in ln Y (Net returns/ha)
Value of family labour/ha (X_1) (Rs./ha)	0.543
Value of hired human labour/ha (X_2) (Rs./ha)	0.600
Value of manures used/ha (X_6) (Rs./ha)	-0.319
Value of plant protection chemicals applied/ha (X_7) (Rs./ha)	0.148

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

It is observed that the value of hired human labour and quantity of manures applied were found to be significant at one per cent level. It implies that every one per cent addition in the value of hired human labour gave 0.600 per cent increment in the net returns per unit area of groundnut. Effect of application of plant protection chemicals captured through addition made in to the tune of 0.148 per cent.

It was also observed that the contribution of family labour was 0.543 per cent per one per cent increase in the same. The contribution of family labour was lower than the contribution of hired human labour. It may be of groundnut in Gujarat due to the reason that family labours spent a couple of hours in serving tea and drinking water to hired human labour. All the variables except manures showed a positive relationship with net return per unit area. Manures has an inverse relationship as indicated by -0.319 per cent reduction in net returns for every one per cent increment in manures.

The contribution of regressors towards change in returns per unit area during Overall Period are presented in Table 4.34.

It is observed that the value of family labour, value of hired human labour and value of irrigation applied were found to be significant at one per cent level. For every one per cent addition in the value of family labour gave 0.516 per cent increment in the net returns per unit area of groundnut in Gujarat. This may be due to the efficiency of over family labour over hired human labour which adds to the total production and thus increasing the net returns per unit area.

4.34. Contribution of regressors towards change in returns per unit area during Overall Period

For 1% change in ln X_i	% Change in ln Y (Net returns/ha)
Value of family labour/ha (X_1) (Rs./ha)	0.516
Value of hired labour/ha (X_2) (Rs./ha)	0.489
Value of seeds used/ha (X_4) (Rs./ha)	-0.301
Value of irrigation applied/ha (X_8) (Rs./ha)	0.126

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

It is observed that the value of family labour, value of hired human labour and value of irrigation applied were found to be significant at one per cent level. For every one per cent addition in the value of family labour gave 0.516 per cent increment in the net returns per unit area of groundnut in Gujarat. This may be due to the efficiency of over family labour over hired human labour which adds to the total production and thus increasing the net returns per unit area.

The quantity of seeds applied improves the germination and thus helps in better profit resulting in increased production and returns per unit area. All the variables

except seeds showed a positive relationship with net return per unit area. Seeds has an inverse relationship as indicated by - 0.301 per cent reduction in net returns for every one per cent increment in seeds.

4.5.3 Marginal Value Productivity

A neo classical theory indicates that marginal value product (MVP) must be equal or above the unit price of respective input for profit maximization. This principle is used to examine the resource use efficiency for the groundnut crop. MFC is the price per unit of resources. If the efficiency ratio is greater than one, the resource under consideration is underutilized and viceversa. It is observed that maximum resources are overutilized whereas the other resources were underutilized.

The details regarding marginal value product of inputs/resources for groundnut crop during Post-Liberalization Period have been discussed in this section. The estimated MVP of different resources for groundnut is presented in Table 4.35.

Table 4.35. MVPs of inputs/resources in production function during Post-Liberalization Period

Resources	Geometric Mean	Co-efficient	MVP	MFC	Efficiency Ratio
Gross Returns	37129.95				
Family Labour**	3231.40	0.54	6.23	1	6.23
Hired Human Labour**	2853.30	0.60	7.80	1	7.80
Bullock Labour	2503.30	- 0.48	-7.22	1	-7.22
Seeds	4905.94	0.91	6.93	1	6.93
Chemical Fertilizers	1185.22	-0.52	-16.31	1	-16.31
Manures**	1462.22	- 0.31	- 8.10	1	- 8.10
Plant protection chemicals**	408.11	0.14	13.46	1	13.46
Irrigation	1975.99	-0.14	-2.75	1	-2.75
Others	1303.02	-0.00	-0.23	1	-0.23

Note: 1. MVP= Marginal Value of Product, MFC=Marginal Fixed Cost.
2. *Significance at 1% level; **Significance at 5 % level and ***Significance at 10 % level.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

It was observed that MVP and efficiency ratio of family labour, hired human labour, seeds and plant protection chemicals were found to be greater than one with

6.23, 7.80, 6.93 and 13.46, respectively which indicated that the resources were found to be underutilized in groundnut production.

The MVP and efficiency ratio of bullock labour, chemical fertilizers, manures, irrigation and other expenses were found to be negative and lesser than one with - 7.22, -16.31, - 8.10, - 2.75 and - 0.23, respectively which indicated that these resources were overutilized in groundnut production. That means the sample farmers used more inputs than the optimal. Hence, there is scope for the farmer to decrease the use of all selected resources to maximize gross return. The MVP of plant protection chemicals was found to be 13.46 which utilized most efficiently in the production process as it gave return of Rs. 13.46 per investment of one rupee. The MVP of plant protection chemicals followed by MVP of hired human labour (7.80), seeds (6.93) and family labour (6.23) were found to be positive and significant at 10 per cent level.

The results showed that the resources of family labour, hired human labour, seeds and plant protection chemicals were underutilized in groundnut production. The resources bullock labour, chemical fertilizers, manures and irrigation were found to be overutilized which indicated that the farmers should decrease the use of all these resources to maximize gross return.

For calculating resource use efficiency this study considers nine factors which are family labour, hired human labour, bullock labour, seeds, chemical fertilizers, manures, plant protection chemicals, irrigation and other expenses. The estimated MVP of different resources for groundnut during Overall Period are presented in Table 4.36.

The details regarding marginal value product of inputs/ resources for groundnut crop during Overall Period have been discussed in this section. The estimated MVP of different resources for groundnut are presented in Table 4.36.

Table 4.36. MVPs of inputs/resources in production function of Overall Period

Resources	Geometric Mean	Co-efficient	MVP	MFC	Efficiency Ratio
Gross Returns	18859.86				
Family Labour*	1558.42	0.51	6.24	1	6.24
Hired Human Labour*	1506.23	0.48	6.12	1	6.12
Bullock Labour	1491.92	0.70	1.98	1	1.98
Seeds*	2861.19	- 0.30	-1.98	1	-1.98
Chemical Fertilizers	766.31	- 0.45	-11.22	1	-11.22
Manures	937.86	0.17	3.61	1	3.61
Plant protection chemicals	223.28	-0.00	-0.34	1	-0.34
Irrigation**	526.92	0.12	4.50	1	4.50
Others	643.92	-0.10	-3.01	1	-3.01

Note: 1. MVP=Marginal Value of Product; MFC=Marginal Fixed Cost.
2. *Significance at 1% level and **Significance at 5% level.

Source: Author's calculation from CCPC data project of the Department of Agricultural Economics, JAU, Junagadh.

MFC is the price per unit of resources. If the efficiency ratio is lesser than one, the resource under consideration is overutilized and viceversa. It is observed that maximum resources are overutilized whereas the other resources were underutilized.

It was observed that MVP and efficiency ratio of family labour, hired human labour, bullock labour, manures and irrigation were found to be greater than one with 6.24, 6.12, 1.98, 3.61 and 4.50, respectively which indicated that the resources were found to be underutilized in groundnut production. The MVP and efficiency ratio of seeds, chemical fertilizers, plant protection chemicals and other expenses were found to be negative and was lesser than one with - 1.98, -11.22, - 0.34 and - 3.01, respectively which indicated that these resources were overutilized in groundnut production. That means the sample farmers used more inputs than the optimal. There is scope for the farmer to decrease the use of all selected resources to obtain optimum gross return.

The MVP of family labour was found to be 6.24 which utilized most efficiently in the production process as it gave return of Rs. 6.24 per investment of one rupee. The MVP of family labour followed by MVP of hired human labour (6.12), irrigation (4.50), manures (3.61) and bullock labour (1.98) were found to be positive and significant while the other resources bullock labour, seeds, chemical

fertilizers, plant protection chemicals and other expenses were found to be negative and non-significant.

The results showed that maximum of the resources were underutilized in groundnut production which indicated that the farmers should increase the use of these resources to maximize gross return.

This finding is in line with that of Ahmed *et al*., (2015) who observed that the efficiency ratio for given resources is greater than one hence, all the resources were underutilized. That means the sample farmers used less inputs than the optimal and hence there is scope for the farmer to increase the use.