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Determinants of Growth and Instability of Groundnut Production in Karnataka: Evidence from Hazel's Decomposition Model

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ABSTRACT

The study conducted in Karnataka state with an objective to find out the sources of growth and instability of groundnut production. The CAGR, CDI and Hazel's decomposition model was used. The growth pattern showed a downward trend along with higher instability in area, production and yield of groundnut in all the districts during period II. The variation in groundnut production was predominantly due to interaction effect of yield and area during period I, whereas change in mean area largely contributed during period II in the state. The change in mean yield, change in mean area, interaction effect and change in residuals had a stabilizing effect on groundnut production. The change in mean yield and change in mean area was primary sources of growth in all the districts and divisions. The study suggests that the research efforts may be concentrated on developing a suitable yield increasing technology in the state like HYV, expansion of irrigation area under groundnut. It helps to enhance the per unit production of groundnut as well as stabilize the area and yield of the groundnut in the state in particular and country as a whole.

Highlights

- The interaction effect of mean area and yield are major sources of growth in the state. The marginally highest variability was noticed in production than compared to area and yield of groundnut.

Keywords: CAGR, CDI, Hazell's Decomposition Model, Sources of Growth and Instabiity, Karnataka, India

The groundnut (*Arachis hypogaea*) is a legume crop grown mainly for its edible seeds. The growth in domestic production of edible oils has not been able to keep pace with the growth in consumption and the gap between production and consumption is being met through imports. The domestic consumption of edible oils has increased substantially over the years and has touched the level of 19.82 million tonnes during 2012-13 (GOI, 2014). Oilseeds imports yet to reach 100,000 MT mark but are growing at a steady pace (GAIN Report, 2018). The cost of import of oilseeds reached to approximately more than $ 40 million during 2018-19 (GAIN Report, 2018).

Indian government's was spending millions of rupees on programmes and policies of oilseeds viz., NODP (1985), TMV (1986), OPDP (1991) under TMO, ISOPOM (2004), NMOOP (2014) to meet demand and supply of oilseeds gap and foster oilseed sector growth in the country. Oilseed cultivated in world in an area of 26.13 million hectares with production was around 25.30 million tonnes and yield was 968 kg per hectare (GOI, 2016). Asia accounts for about 50 per cent of area and 60 per cent of world groundnut production. India is the second largest producer of the groundnut in the world after China (GOI, 2017). India accounts 4.56 million hectare of area with 6.77 million tonnes of production and 1486 kg per hectare of yield (GOI, 2016).

Karnataka is the sixth largest state in area (13.71 lakhs hectare) and production (11.21 lakhs tonnes) of oilseeds crops in the country with yield 833 kg per hectare (GOK, 2016). Among the oilseeds, the groundnut (42.07%) accounts highest in area under oilseeds (GOK, 2013). The area, production and productivity of groundnut in Karnataka was 6.50 lakh ha, 5.59 lakh tonnes and 896 kg per hectare respectively during the year 2015-16 (GOK, 2016).

Hence, based on above background, the present study was undertaken in Karnataka state with the overall objective of assessing the sources of growth and instability of groundnut production in Karnataka state. The study helps to identify the potential districts for groundnut production in the state. The results of this study would help in suggesting suitable policy options and regional level planning to increase oilseed productivity in the state.

Objectives of the study

1. To examine the growth and instability of groundnut production in Karnataka.
2. To identify the potential districts for groundnut cultivation in Karnataka.
3. To study the sources of growth and instability of groundnut production in Karnataka.
4. To suggest appropriate policy measures for sustainability of groundnut production.

REVIEW OF LITERATURE

Many research studies have said that growth and instability are directly linked. Accordingly, Chattapadhyay (2001) and Paltasingh and Goyari (2013) said that relationship between growth and instability have a direct or positive relationship where higher instability co exists with low growth or vice versa. Groundnut showed that high degree of instability in production (Rao and Raju, 2005). Pandey *et al.* (2005) reported that the groundnut yield instability showed a mixed response. Chand and Raju (2009) said that oilseed production is found more risky as compared to cereals and pulses. The high degree of instability in oilseeds production leads to large gap between consumption and production of edible oils in our country. The gap between production and consumption is being met through imports. Chand and Raju (2009) opined that instability in production affects price stability and can cause consumers and low income earners become vulnerable to market situations. Instability is one of the important decision tools that capture the degree of uncertainty and risks involved in farm production and adversely affect farmer's decisions to adopt modern technologies and investment in farming.

MATERIALS AND METHODS

The study was conducted in Karnataka during the period from 1975-76 to 2015-16. Karnataka state was divided into four administrative division's viz., Bangalore, Mysore, Belgaum and Gulbarga. These divisions of the state were chosen for the study, since the policy implication, if any from the study would help in regional planning. The growth, instability and sources of groundnut production in the state were estimated at district level. This would help in district level planning in agricultural sector in general and oilseed sector in particular in the state. Among the oilseed crops grown in the state, it contributes around 71 percent of production to total oilseed production in Karnataka during 2012-13 (GOK, 2013). Hence, groundnut was chosen for the present study.

The data related to area, production and productivity of groundnut was collected from DES, Bangalore, DAC, DSO, Indiastat.com, etc. The study period (1975-76 to 2015-16) was divided into two sub period's; period-I (1975-76 to 1995-96) and period-II (1995-96 to 2015-16) to assess the impact of new technological innovations evolved after 1995s on groundnut production in the state.

Tools Used for Analysis

Compound Growth Rate Analysis

The CAGR analysis was used to estimate the growth in area, production and productivity of groundnut in Karnataka. The districts were classified as low (less than 2 percent), medium (2 to 3 percent) and high growth (more than 3 percent) based on CAGR values (Mahendradev, 1987).

Cuddy-Della Valle Index (CDI)

The instability in area production and yield of groundnut were measured by using Cuddy-Della Valle Index. This method is being used by number

of researchers as a measure of variability in time series data. CDI corrects the deficiencies of CV method. The districts were classified as low (< 15%), medium (15 to 20%) and high instability (> 20 %) based on CDI values (Mahendradev, 1987). CDI is expressed as follows;

$$CDI = CV\sqrt{1-R^2}$$

Where, CV = Coefficient of variation (in percent)

R^2 = Coefficient of determination from a time trend regression adjusted by the number of degrees of freedom

Hazell's Decomposition Analysis

The sources of growth and instability of groundnut production was assessed by Hazell's decomposition model (Hazell, 1982). The area and yield data of groundnut were detrended and these detrended series was used as the basic data for decomposition of changes in average production and changes in variance of groundnut production.

The Hazell's decomposition procedure produces the four components of change in average production that indicates the sources of growth of groundnut production (Table 1). The first two terms, change in the mean yield and change in mean area are called as 'pure effects' which arise even if there were no other source of change. The third term is an interaction effect, which arise from the simultaneous occurrence of changes in mean yield and mean area. The fourth term in the equation represents interaction between area and yield covariance.

Table 1: Components of Change in Average Production

Sl. No.	Sources of Change in average production	Symbol	Components of Change
1	Change in mean yield	ΔY^-	$A_1^- \Delta Y^-$
2	Change in mean area	ΔA^-	$Y_1^- \Delta A^-$
3	Interaction between changes in mean yield and mean area	$\Delta A^- \Delta Y^-$	$\Delta A^- \Delta Y^-$
4	Change in area–yield covariance	$\Delta\, cov\,(AY)$	$\Delta\, cov\,(A,Y)$

The Hazell's decomposition procedure also produces the ten components of change in variances of the production that indicates the sources of instability of groundnut production (Table 2).

Table 2: Components of Change in the Variance of Production

Sl. No.	Sources of Change	Symbol	Components of Change
1	Change in mean yield	$\Delta\overline{Y}$	$2A_1^-\Delta Y^- \operatorname{cov}(A_1,Y_1)+\left\{2Y_1^-\Delta Y^- +(\Delta Y^-)^2\right\}V(A_1)$
2	Change in mean area	ΔA^-	$2Y_1^-\Delta A^- \operatorname{cov}(A_1,Y_1)+\left\{2A_1^-\Delta A^- +(\Delta A^-)^2\right\}V(Y_1)$
3	Change in yield variance	$\Delta V(Y)$	$\overline{A}_1^2\Delta V(Y)$
4	Change in area variance	$\Delta V(A)$	$\overline{Y}_1^2\Delta V(A)$
5	Interaction between changes in mean yield and mean area	$\Delta A^-\Delta Y^-$	$2\Delta A^-\Delta Y^- \operatorname{cov}(A_1,Y_1)$
6	Change in area–yield Covariance	$\Delta\, cov\,(A,Y)$	$\left\{2A_1^-Y_1^- - 2\operatorname{cov}(A_1,Y_1)\right\}\Delta\operatorname{cov}(A,Y)-\left\{\Delta\operatorname{cov}(A,Y)\right\}^2$
7	Interaction between changes in mean area and yield variance	$\Delta A^-\,\Delta V\,(Y)$	$\left\{2A_1^-\Delta A^- +(\Delta A^-)^2\right\}\Delta V(Y)$
8	Interaction between changes in yields and area variance	$\Delta Y^-\,\Delta V\,(A)$	$\left\{2Y_1^-\Delta Y^- +(\Delta Y^-)^2\right\}\Delta V(A)$
9	Interaction between changes in mean area and yield and changes in area–yield covariance	$\Delta A^-\Delta Y^-\,\Delta\, cov\,(AY)$	$\left(2A_1^-\Delta Y^- + 2Y_1^-\Delta A^- + 2\Delta A^-\Delta Y^-\right)\Delta\operatorname{cov}(A,Y)$
10	Change in residual	ΔR	$\Delta V(A,Y)$ – Sum of the other components

RESULTS AND DISCUSSION

Growth Performance of Groundnut in Karnataka

The growth rate of area, production and yield of groundnut in Karnataka was computed and presented in Table 3. The study showed that all the districts and divisions have exhibited a significantly negative growth in area during the period II and whole period except Tumkur, Chitradurga, Bangalore division and Dakshin Kannada during whole period. The negative growth in area might be due to decrease in groundnut area under cultivation during same period. The results are in line with Deshpande (2004) reported that the production started declining post WTO due to decrease in area under cultivation due to imports of edible oils. The reverse trend in groundnut area might be due to edible oil imports in 1996-97 to lowered oilseed cultivation (Girish *et al.*, 2012). The area under groundnut exhibited positive growth rate during pre WTO period, whereas negative growth rate during post WTO period (Sonnad, 2008). The highest growth in groundnut was noticed in Chitradurga district followed by Dakshin Kannada, Tumkur, Uttar Kannada and Mandya during the period I. It might be due to high base value as compared to current year value.

The growth rate of groundnut production witnessed a significantly negative during period II. The study showed that all the districts and divisions exhibited a significantly negative growth in production during the period II than compared to the period I. The decline in the production may be due reduced area under cultivation of crops as compared with period I. The results are in line with Deshpande (2004) who reported decline in production after the establishment of WTO due to decrease in area under cultivation. The result showed that all the districts witnessed a significantly positive growth in groundnut yield except Tumkur, Chitradurga, Mysore, Mandya and Bidar districts during the period I, whereas reverse trend was observed in all the districts except Dakshin Kannada, Belgaum, Bijapur, Bellary, Bidar, Raichur and Gulbarga during the period II. The results are in line with Kumar (2015) who positive growth in yield of paddy during the post reform period than compared to pre reform period. The study concludes that positive trend in growth rates of area, production and yield of groundnut during period I across the districts and divisions. It may be due to government initiatives in the form of TMO (1986) as well as price and marketing support for oilseed growers (Girish *et al.*, 2012). The declining trend in area, production and yield of the groundnut during period II might be due to imports of edible oils and relatively stagnant real prices of groundnut in the market (Girish *et al.*, 2012). Deshpande (2004) reported that the production started declining post WTO due to decrease in area under cultivation.

Table 4 represents the classification of the districts based on growth rates of area, production and yield of groundnut. The study concluded that among the districts and divisions, Bangalore division, Bangalore, Chickmangalur, Uttar Kannada, Dakshin Kannada, Tumkur and Chitradurga districts were successful in terms of performance in groundnut production during period I followed by Kolar, Ballary and Shivamogga districts, whereas these districts performance was reverse during period II.

Instability of groundnut production in Karnataka

The instability of area, production and yield of groundnut was presented in Table 5. The level of instability was marginally higher in area (10.75 %) and production of groundnut (28.45 %) during the period II when compared to period I. The variation in production and yield of groundnut was higher during the period II. During same period, Kolar, Tumkur, Shivamogga, Mysore, Mandya, Hassan, Dharwad, Belgaum, Uttar Kannada, and Bellary districts witnessed highest variation in groundnut production whereas remaining districts showed a reverse trend. The study showed that the yield variation was higher during period II. It indicates that the level of productivity instability was increased during after 1995s. The results are in line with Mondal and Swarup De (2016) who reported that after adoption of NEP (1991) in India, the total food grain productivity became unstable. Kumar (2015) who observed that increased instability in area during post reform period.

Among the divisions, the variation in area and yield of groundnut was lower in Belgaum division followed by Gulbarga, Mysore and Bangalore; whereas lower variation in groundnut production

Table 3: Growth Rate of Area, Production and Yield of Groundnut in Karnataka (Percent)

Districts / Divisions	Period I			Period II			Whole Period		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Bangalore	1.82	3.61	1.72	-8.82	-5.92	-0.37	-3.84	-1.69	0.47
Kolar	1.22	2.42	1.18	-5.12	-7.92	-1.86	-2.15	-2.15	0.56
Tumkur	5.59	4.98	-0.57	-3.28	-9.09	-5.05	0.84	-1.11	-1.44
Chitradurga	9.13	7.46	-1.53	-0.67	-2.43	-1.48	3.68	2.59	-0.91
Shivamogga	0.31	2.96	2.64	-16.53	-17.18	-2.40	-9.05	-8.23	0.07
Bangalore Division	4.64	4.61	0.88	-2.75	-5.98	-2.12	0.62	-0.20	-0.13
Mysore	0.78	0.62	-0.04	-4.57	-5.70	-2.57	-2.39	-2.64	-0.90
Mandya	2.80	0.41	-2.33	-11.54	-11.26	-0.19	-3.84	-3.85	-0.26
Hassan	0.91	1.66	0.74	-6.36	-6.99	-1.82	-4.13	-3.95	-0.39
Chickmagalur	1.48	3.72	2.22	-0.51	-1.07	-1.82	-1.86	-1.76	-0.53
Dakshin Kannada	5.98	6.32	0.31	-2.86	-2.22	0.55	1.21	2.54	1.26
Mysore Division	1.25	1.53	0.35	-4.81	-5.36	-1.61	-2.34	-2.29	-0.52
Dharwad	-0.70	1.66	2.37	-6.39	-1.96	-0.32	-3.77	0.25	1.63
Belgaum	-1.90	-0.54	1.38	-0.66	-2.60	0.49	-1.67	-1.90	1.01
Bijapur	-1.58	-0.70	0.88	-17.24	-0.54	0.32	-9.53	-0.18	0.81
Uttara Kannada	3.18	5.10	1.86	-2.59	-2.95	-0.17	-0.06	0.90	1.06
Belgaum Division	-1.24	0.43	2.65	-5.21	-1.79	0.03	-3.37	-0.49	1.58
Bellary	0.79	2.74	1.93	-1.96	-0.03	2.06	-0.82	1.17	2.06
Bidar	-10.28	-11.95	-1.87	-12.40	-5.10	3.05	-10.41	-6.80	1.47
Raichur	-0.58	-0.27	0.32	-2.88	-0.36	1.52	-1.49	0.22	1.21
Gulbarga	-0.38	0.98	1.36	-5.51	-5.01	1.82	-1.98	-1.20	1.44
Gulbarga Division	-0.54	0.61	0.59	-3.61	-1.65	2.08	-1.66	-0.06	1.55
Karnataka	0.84	1.93	1.08	-2.99	-3.49	-0.58	-1.13	-0.40	0.71

Table 4: Classification of Districts Based on Growth rates of Groundnut in Karnataka

Periods	Particulars	Low (< 2%)	Medium (2 to 3%)	High (> 3%)
Period I	Area	Belgaum Division, Bidar, Belgaum, Bijapur, Dharwad, Raichur, Gulbarga Shivamogga, Mysore, Ballary, Karnataka State, Hassan, Kolar, Chickmangalur and Bangalore	Mandya	Uttar Kannada, Tumkur, Dakshin Kannada, Chitradurga
	Production	Bidar, Belgaum, Bijapur, Dharwad, Raichur, Gulbarga, Mysore, Karnataka State, Hassan, Kolar, Chickmangalore and Mandya	Kolar, Ballary and Shivamogga	Bangalore, Chickmangalore, Uttar Kannada, Dakshin Kannada, Tumkur, Chitradurga
	Yield	Mandya Bidar Chitradurga Tumkur, Mysore, Dakshin Kannada Raichur, Hassan, Bijapur, Kolar, Gulbarga, Belgaum, Bangalore, Uttar Kannada and Ballary	Chickmangalur, Dharwad, Shivamogga	—
Period II	Area	All Districts	—	—
	Production	All Districts	—	—
	Yield	All Districts except Bellary and Bidar	Ballary	Bidar
Whole Period	Area	All Districts except Chitradurga	—	Chitradurga
	Production	All Districts except Dakshin Kannada and Chitradurga	Dakshin Kannada and Chitradurga	—
	Yield	All Districts except Bellary	Bellary	—

Table 5: Cuddy Della Instability Index of Area, Production and Yield of Groundnut

Districts	Period I			Period II			Whole Period		
	A	P	Y	A	P	Y	A	P	Y
Bangalore	19.89	45.36	22.70	23.24	44.61	22.62	36.72	42.89	23.47
Kolar	19.34	27.39	17.87	24.93	57.37	40.23	37.11	39.25	32.56
Tumkur	13.09	30.07	21.07	20.73	62.06	47.64	35.88	37.01	40.05
Chitradurga	19.69	28.67	18.44	15.14	37.97	36.82	34.66	46.90	25.70
Shivamogga	21.75	24.99	14.40	65.98	81.49	15.55	55.66	66.22	21.61
Bangalore Division	14.22	23.29	15.03	14.44	41.10	22.42	34.00	35.07	21.16
Mysore	18.21	29.97	22.86	27.63	34.70	20.19	25.28	26.05	23.16
Mandya	26.79	36.60	18.44	40.93	51.20	26.51	65.62	63.89	21.84
Hassan	41.18	38.80	21.38	42.20	51.40	20.52	54.56	54.07	21.40
Chickmagalur	26.48	40.92	19.09	23.40	39.96	23.75	29.82	30.93	25.18
DK	17.43	25.41	18.60	9.47	16.16	13.60	32.37	28.67	15.87
Mysore Division	16.53	34.41	18.20	40.62	28.13	15.86	32.23	31.11	18.28
Dharwad	11.99	22.72	20.27	19.02	52.03	35.89	19.36	23.75	30.92
Belgaum	5.94	18.86	16.31	17.22	22.62	21.19	10.33	22.57	20.60
Bijapur	16.23	24.75	21.09	35.67	17.57	25.62	26.22	32.27	25.99
UK	24.02	25.84	12.21	5.63	60.44	8.47	35.68	34.43	10.61
Belgaum Division	7.82	15.00	15.65	20.96	30.69	14.26	16.36	25.82	16.00
Bellary	20.81	21.81	18.12	24.41	38.48	48.02	33.52	32.91	34.16
Bidar	40.93	46.59	30.32	215.59	42.47	21.65	157.74	94.90	25.18
Raichur	9.63	25.76	17.07	12.60	24.18	12.54	14.12	23.53	15.44
Gulbarga	16.29	25.51	22.49	23.62	20.42	19.84	28.00	32.85	20.49
Gulbarga Division	11.37	15.78	15.48	12.22	23.99	19.13	17.83	20.92	17.56
Karnataka	9.60	24.79	12.51	10.75	28.45	23.74	20.43	21.46	20.80

was noticed in Gulbarga division followed by Belgaum, Mysore and Bangalore. The highest variation in area, production and yield of groundnut was noticed in Bangalore division. The level of instability in area was marginally higher during the period II when compared to period I, whereas same trend was observed in production and yield of groundnut. The inter-period comparison of the study indicates that higher level of instability in area, production and yield was observed during the period II as compared to period I. The results are in line with Ramrao (2003) who reported inter period groundnut instability was higher during period II when compared to period I. The results are in line with Larson *et al*. (2004) who reported that production instability for food grains had increased between the two sub periods.

The Uttar Kannada, Dakshin Kannada and Raichur districts were classified (Table 6) under lower instability in groundnut area and yield during period II. The all other districts and divisions were classified under higher instability category during the period II except Chitradurga, Belgaum and Dharwad in groundnut area, Dakshin Kannada and Bijapur in groundnut production whereas Gulbarga, Shivamogga, Mysore division and Gulbarga in groundnut yield.

Sources of growth and instability in Groundnut

Sources of Growth in groundnut

The percentage contribution of each component towards the change in average production of groundnut was estimated by using Hazell's Decomposition Model and presented in the Table 7.

Whole period: During the whole period, change in mean yield was mainly contributing for the production of groundnut in all districts and divisions in Karnataka except Tumakur, Chitradurga, Bellary

Table 6: Classification of Districts Based on instability in Groundnut production

Periods	Particulars	Low (< 15%)	Medium (15 to 20%)	High (> 20%)
Period I	Area	Karnataka State, Belgaum, Raichur, Dharwad and Tumkur,	Bijapur, Gulbarga, Dakshin Kannada, Mysore, Kolar, Chitradurga and Bangalore	Ballary, Shivamogga, Uttar Kannada, Chickmangalore, Mandya, Bidar and Hassan
	Production	—	Belgaum	All Districts except Belgaum
	Yield	Karnataka State, Uttar Kannada and Shivamogga	Belgaum, Raichur, Kolar, Ballary, Chitradurga, Mandya, Dakshin Kannada and Chickmangalore	Dharwad, Tumkur, Bijapur, Hassan, Gulbarga, Bangalore, Mysore and Bidar
Period II	Area	Karnataka State, Uttara Kannada, Dakshin Kannada and Raichur	Chitradurga, Belgaum and Dharwad	Tumkur, Bangalore, Chickmangalore, Gulbarga, Ballary, Kolar, Mysore, Bijapur, Mandya, Hassan, Shivamogga and Bidar
	Production	—	Dakshin Kannada and Bijapur	All Districts except Dakshin Kannada and Bijapur
	Yield	Uttar Kannada, Raichur and Dakshin Kannada	Shivamogga and Gulbarga	All districts except Uttar Kannada, Raichur, Dakshin Kannada, Shivamogga and Gulbarga
Whole Period	**Area**	Belgaum and Raichur	Dharwad	All districts except Dharwad, Belgaum and Raichur
	Production	—	—	All Districts
	Yield	Uttar Kannada	Raichur, Dakshin Kannada	All Districts except Uttar Kannada, Raichur, Dakshin Kannada

districts and Bangalore division followed by the change in mean area. The results are similar with Devi *et al.* (2017) who reported that the yield effect had very high (93.96 %) influence on pulses production in India. The results are in line with Reddy (2013); Rao and Raju (2005). The change in mean yield, change in mean area and covariance effect was positive, while the interaction between change in mean yield and area was negative during same time period. The results are in tune with the studies conducted by Kumar (2015) for paddy crop in Tamil Nadu.

Period-I: During period I, the interaction between change in mean yield and mean area were acted as a major source of growth in all districts and divisions of the state. The change in mean area and change in mean yield of groundnut was negative in all the districts and divisions. The results are in line with Sharma and Jain (2006) said that the area, yield and their interaction effect were major source of growth in soybean in almost all districts of Madhya Pradesh. The results are similar with Kumar and Kumar (2005) who reported that the yield effect had high influence on the production of chickpea in India.

Period-II: During period II, the change in mean yield and mean area were acted as major sources of growth of production in all districts and divisions of the state. The results are in line with Sharma and Jain (2006) and Kumar and Kumar (2005) who reported that the area effect and yield effect were major source of growth for soybean and chickpea production respectively. The study showed that all the districts and divisions witnessed a positive change in mean yield and mean area, whereas interaction between change in mean yield and mean area has witnessed negative. The change in area-yield covariance was positive in all districts in the state except Mandya, Bidar, Raichur and Gulbarga districts. The results are similar with the studies conducted by Kumar (2015); Sharma and Jain (2006).

Sources of Instability in groundnut

The percentage change in the variance is understood instability in crop production. The percent contributions of change in the variance of

Table 7: Percent Contribution of Change in Average Production of Groundnut in Karnataka

Districts	Percent contribution of											
	Period I				Period II				Whole Period			
	Change in Mean Yield	Change in Mean Area	Interaction between change in Mean Yield and Mean Area	Change in Area-Yield Covariance	Change in Mean Yield	Change in Mean Area	Interaction between change in Mean Yield and Mean Area	Change in Area-Yield Covariance	Change in Mean Yield	Change in Mean Area	Interaction between change in Mean Yield and Mean Area	Change in Area-Yield Covariance
Bangalore	-22.64	-24.94	52.35	-0.07	32.11	22.97	-44.64	0.279	29.34	23.36	-46.81	0.48
Kolar	-20.96	-25.24	53.75	0.05	29.48	23.49	-45.93	1.093	28.13	24.35	-47.47	-0.04
Tumkur	-17.54	-26.70	55.50	0.26	25.78	29.12	-44.54	0.569	23.07	26.95	-49.26	-0.73
Chitradurga	-11.91	-30.46	57.02	-0.61	25.72	27.21	-46.96	0.108	18.08	30.29	-50.45	-1.18
Shivamogga	-20.32	-25.30	54.28	-0.10	35.06	22.72	-41.23	0.988	34.60	22.12	-43.20	0.09
Bangalore Division	-17.45	-26.88	55.58	0.09	27.19	25.88	-46.69	0.237	23.63	25.89	-50.39	0.08
Mysore	-24.00	-25.68	49.98	0.35	27.09	26.81	-45.75	0.349	27.76	25.61	-46.21	-0.42
Mandya	-16.50	-28.09	55.37	-0.04	33.73	23.68	-43.03	-0.432	30.09	25.18	-44.67	-0.06
Hassan	-21.90	-26.03	51.40	0.67	32.73	23.64	-43.09	0.545	28.08	24.68	-46.91	-0.34
Chickmangalur	-22.61	-24.97	52.01	0.42	25.22	26.86	-47.23	0.693	27.36	25.32	-46.97	0.35
Mysore Division	-22.32	-25.94	51.48	0.26	26.82	26.32	-46.80	0.048	27.44	25.49	-46.80	-0.26
Dharwad	-24.59	-24.39	50.99	0.04	27.82	22.80	-48.41	0.970	27.74	22.04	-50.16	-0.05
Belgaum	-27.03	-23.52	49.32	-0.14	27.92	24.54	-46.97	0.569	29.82	22.79	-47.20	-0.19
Bijapur	-24.97	-23.91	50.94	-0.18	27.26	22.54	-49.19	1.016	27.84	23.18	-48.21	0.77
Uttar Kannada	-18.49	-26.47	54.75	-0.29	27.79	23.93	-48.28	0.000	28.58	21.54	-49.50	0.38
Belgaum Division	-25.47	-23.83	50.67	-0.04	27.80	23.57	-48.04	0.583	29.22	20.74	-49.96	0.07
Bellary	-20.79	-26.54	52.59	-0.08	26.92	24.35	-46.33	2.401	23.47	26.91	-48.75	0.87
Bidar	-28.56	-23.30	46.65	-1.49	10.60	28.62	-56.43	-4.348	26.88	23.05	-48.59	1.47
Raichur	-24.42	-24.92	50.47	-0.19	27.98	22.62	-49.34	-0.061	28.53	23.17	-48.12	0.18
Gulbarga	-22.95	-25.20	51.80	-0.05	30.60	22.75	-46.24	-0.414	29.12	21.51	-49.15	0.22
Gulbarga Division	-23.36	-25.37	51.26	-0.01	28.13	23.77	-47.96	0.133	27.49	23.76	-48.66	0.09
Karnataka	-22.39	-25.24	52.37	0.00	27.17	25.38	-46.90	0.548	26.37	24.56	-49.06	0.01

groundnut production in Karnataka during whole period, period I and period II were presented in the Tables 8, 9 and 10 respectively. The table shows the negative as well as positive signs. The negative sign of this statistics indicates stability, while a positive sign implies the instability for the crop production

Whole Period

During whole period, the variance in production of groundnut for the state as a whole was predominantly due to interaction between change in mean yield and mean area (39.84 %) followed by change in yield variance (9.36 %) change in area variance (3.97 %), whereas the change in mean yield, change in mean area, interaction effect and change in residuals had a stabilizing effect on groundnut production. The results are similar with Singh *et al.* (2014) who reported that area-yield co-variance had a stabilizing effect on reduction of instability in rice production in Gujarat. The results are in line with Sharma *et al.* (2006) who reported that the changes in yield variance and interaction between changes in mean area and yield variance accounted for nearly whole of the per cent change in the variance of total food grains production in India.

Table 8: Percent Contribution of Change in the Variance of Groundnut Production in Karnataka during Whole Period (1975 to 2015)

Districts	Change in Mean Yield	Change in Mean Area	Change in Yield Variance	Change in Area Variance	Interaction Between Change in Mean Yield and Mean Area	Change in Area-Yield Covariance	Interaction between change in mean area and yield variance	Interaction between change in yield and area variance	Interaction between change in mean area and yield and change in area-yield covariance	Change in Residual
Bangalore	-19.83	-22.41	-2.16	7.76	31.90	0.00	1.29	0.00	4.31	10.34
Kolar	21.83	21.72	-11.50	-2.62	-34.95	0.04	6.05	0.25	0.28	-0.78
Tumkur	-17.79	-13.19	16.47	-7.61	26.35	-0.68	4.75	2.40	-0.61	10.15
Chitraduga	0.10	-24.69	-0.81	17.30	33.68	-0.26	-1.80	-9.63	-1.89	-9.84
Shimoga	28.57	26.53	2.72	2.72	-33.33	0.00	-2.72	0.00	-1.36	2.04
Bangalore Divison	**21.05**	**19.45**	**-2.63**	**13.16**	**-39.81**	**-0.06**	**-0.74**	**-1.38**	**0.11**	**1.61**
Mysore	-14.44	-19.63	0.37	13.70	17.04	-0.37	-0.37	-4.81	-9.26	20.00
Mandya	36.00	12.00	-4.00	28.00	-8.00	0.00	0.00	-12.00	0.00	0.00
Hassan	-20.00	-20.00	0.00	20.00	40.00	0.00	0.00	0.00	0.00	0.00
Chickmagalur	23.68	21.05	-2.63	7.89	-34.21	0.00	0.00	-2.63	-2.63	5.26
Mysore Division	**-16.79**	**-17.04**	**-1.13**	**19.55**	**20.68**	**-0.25**	**0.63**	**-5.89**	**-5.26**	**12.78**
Dharwad	-4.13	-11.65	37.79	11.57	12.15	0.00	-13.11	7.27	0.08	2.25
Belgaum	27.24	6.15	1.50	5.23	-41.45	0.08	-1.00	0.75	-4.57	12.04
Bijapur	-12.05	0.94	3.98	19.42	18.83	1.17	1.87	-3.16	-6.67	31.93
UK	5.88	17.65	0.00	17.65	35.29	0.00	0.00	11.76	0.00	11.76
Belgaum Division	**15.44**	**-4.31**	**-9.98**	**19.37**	**-21.91**	**-0.05**	**4.95**	**19.07**	**0.00**	**-4.93**
Bellary	-4.46	4.54	26.66	12.80	-6.08	-1.22	4.29	-4.38	3.97	-31.60
Bidar	4.12	1.76	-0.59	67.65	-4.71	-0.59	0.00	15.29	0.59	-4.71
Raichur	13.87	23.54	-3.19	-9.04	-24.97	0.00	-1.64	-1.44	-4.62	17.68
Gulbarga	3.91	-15.26	7.31	27.74	7.69	-0.13	-3.78	18.03	1.64	-14.50
Gulbarga Division	**-5.75**	**-17.78**	**16.42**	**21.89**	**13.30**	**-0.03**	**-6.68**	**2.16**	**2.60**	**-13.41**
Karnataka	**-21.45**	**-22.39**	**9.36**	**3.97**	**39.84**	**0.01**	**-2.43**	**-0.02**	**0.07**	**-0.47**

Table 9: Percent Contribution of Change in the Variance of Groundnut Production in Karnataka during Period I (1975 to 2015)

Districts	Change in Mean Yield	Change in Mean Area	Change in Yield Variance	Change in Area Variance	Interaction Between Change in Mean Yield and Mean Area	Change in Area-Yield Covariance	Interaction between change in mean area and yield variance	Interaction between change in yield and area variance	Interaction between change in mean area and yield and change in area-yield covariance	Change in Residual
Bangalore	-18.52	-12.70	-2.12	13.76	44.97	0.00	-1.59	2.65	-1.06	-2.65
Kolar	-13.34	3.51	-7.82	12.84	42.53	0.00	-11.33	3.51	2.21	2.91
Tumkur	3.23	35.09	1.41	21.68	-1.75	-0.17	5.15	3.51	16.02	12.00

Chitraduga	-5.63	8.15	-0.48	33.03	18.87	-0.09	-6.42	-7.92	-13.54	-5.89
Shivamogga	-5.08	22.03	-5.08	15.25	22.03	0.00	-10.17	5.08	-6.78	-8.47
Banglore Division	**-12.75**	**-2.40**	**0.05**	**29.00**	**43.56**	**-0.09**	0.18	4.06	4.53	3.40
Mysore	8.15	16.30	2.72	11.96	-20.65	-0.54	0.54	-1.09	1.09	36.96
Mandya	-13.33	-3.33	0.00	40.00	40.00	0.00	0.00	-3.33	0.00	0.00
Hassan	0.00	0.00	0.00	50.00	25.00	0.00	0.00	0.00	0.00	25.00
Chickmagalur	-13.64	-9.09	0.00	13.64	31.82	0.00	0.00	4.55	9.09	18.18
Mysore Division	**-5.29**	**12.26**	**-3.34**	**18.11**	**11.14**	**-0.56**	**-2.23**	**-0.56**	**10.31**	**36.21**
Dharwad	-2.91	-14.29	20.58	28.09	-11.38	0.00	3.15	-5.33	-2.18	-12.11
Belgaum	-21.67	-10.74	11.71	-0.72	38.68	-0.06	-3.74	-0.18	1.09	-11.41
Bijapur	16.53	15.48	16.53	2.09	-24.27	-0.21	1.46	0.63	-3.35	-19.46
UK	11.11	11.11	0.00	11.11	-44.44	0.00	0.00	0.00	11.11	11.11
Belgaum Division	**-24.42**	**-19.04**	**-1.62**	**-0.85**	**44.21**	**0.04**	**0.04**	**-0.23**	**0.98**	**8.57**
Bellary	12.21	-12.72	14.50	-1.02	-26.46	0.00	19.59	0.00	4.58	8.91
Bidar	-19.09	-12.73	-1.82	16.36	31.82	0.00	0.91	0.00	4.55	-12.73
Raichur	19.12	17.92	7.52	-1.49	-39.82	-0.05	1.05	--0.10	1.10	11.84
Gulbarga	9.48	35.66	6.23	15.71	-18.20	0.00	3.74	1.75	-2.24	-6.98
Gulbarga Division	3.92	**-24.40**	**34.32**	**-4.36**	**-11.06**	**0.00**	**14.66**	**-0.19**	**1.26**	**5.82**
Karnataka	**-19.70**	**-5.15**	**-9.49**	**8.12**	**48.08**	**-0.00**	**-7.51**	**1.26**	**0.21**	**0.48**

Table 10: Percent Contribution of Change in the Variance of Groundnut Production in Karnataka during Period II (1975 to 2015)

Districts	Change in Mean Yield	Change in Mean Area	Change in Yield Variance	Change in Area Variance	Interaction Between Change in Mean Yield and Mean Area	Change in Area-Yield Covariance	Interaction between change in mean area and yield variance	Interaction between change in yield and area variance	Interaction between change in mean area and yield and change in area-yield covariance	Change in Residual
Bangalore	0.00	8.33	-25.00	25.00	0.00	0.00	16.67	0.00	-8.33	16.67
Kolar	19.55	23.79	6.36	3.30	-29.56	-0.35	-4.36	-0.24	-4.00	8.48
Tumkur	15.49	24.85	17.08	-1.35	-22.88	-0.21	-8.02	0.97	-3.49	5.67
Chitraduga	17.12	28.70	5.41	-7.46	-27.67	0.00	-1.80	3.47	-2.45	5.92
Shimoga	22.22	11.11	0.00	27.78	-16.67	0.00	0.00	-11.11	-5.56	5.56
Banglore Division	18.58	23.21	8.84	-3.58	-29.10	0.08	-4.30	1.26	-3.29	7.76
Mysore	28.33	23.33	3.33	0.00	-33.33	0.00	-1.67	0.00	-3.33	6.67
Mandya	0.00	0.00	0.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00
Hassan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chickmagalur	33.33	33.33	0.00	0.00	-33.33	0.00	0.00	0.00	0.00	0.00
Mysore Division	-21.57	-16.99	0.65	22.22	27.45	0.00	-0.65	-8.50	0.65	-1.31
Dharwad	19.42	22.68	2.68	-3.15	-34.93	-0.23	-1.22	-0.82	-2.16	12.71

Belgaum	15.74	18.27	-4.06	-3.05	-24.37	0.00	2.03	0.51	-8.63	23.35
Bijapur	19.50	9.96	3.73	12.03	-28.22	-1.24	-1.24	4.98	0.83	-18.26
UK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgaum Division	14.53	15.19	-1.74	-12.45	-26.37	0.15	0.81	-0.98	-5.45	22.33
Bellary	5.53	6.88	-22.40	-5.94	-8.64	1.89	10.66	1.08	-9.58	27.40
Bidar	0.00	0.00	0.00	88.14	0.00	0.00	0.00	5.08	-5.08	-1.69
Raichur	-27.45	3.92	11.76	7.84	23.53	0.00	-5.88	3.92	1.96	-13.73
Gulbarga	-17.38	-9.66	-9.44	17.17	24.46	0.00	6.87	1.07	4.51	-9.44
Gulbarga Division	2.19	6.48	-30.70	24.69	-5.43	0.00	15.44	0.86	-3.15	11.06
Karnataka	20.55	22.23	-0.40	0.98	-32.70	-0.08	0.19	-0.28	-6.27	16.32

The change in mean yield was mainly contributed for variance in groundnut production in Bangalore division. In Mysore division, the interaction between change in mean yield and mean area (20.68%) was major sources of instability in groundnut production. The change in area variance was contributed more to the variance in production of groundnut in Belgaum (19.37 %) division and Gulbarga (21.89 %) division. The results are in line with Sharma *et al.* (2006).

Period I: During period I, the variance in production of groundnut was predominantly due to interaction between change in mean yield and mean area (48.08 %) followed change in area variance (8.12 %) and interaction between change in yield and area variance (1.26 %) in state, whereas change in mean area, change in mean yield and change in yield variance had a stabilizing effect on groundnut production in Karnataka. The results are in line with Sharma *et al.* (2006). The variance in production of groundnut was predominantly due to interaction between change in mean yield and mean area in Bangalore (43.56 %) division, Belgaum (44.21 %) division and Karnataka state as whole. The change in area variance and change in yield variance was predominantly contributed for variance in groundnut production in Mysore and Gulbarga divisions respectively.

Period II: During period II, the variance in production of groundnut was predominantly due to change in mean area (22.23 %) followed by change in mean yield (20.55 %) and change in residual (16.32 %) in state, whereas remaining factors had a stabilizing effect on the groundnut production in Karnataka. The results are in corroboration with Singh *et al.* (2014). The decomposition analysis revealed that the variance in production of groundnut was predominantly due to the change in mean area in Bangalore (23.21 %) and Belgaum (15.19 %) division followed by change in mean yield, whereas the change in area variance and interaction effect was largely contributed in Gulbarga and Mysore division respectively.

CONCLUSION

The growth pattern of groundnut indicated a downward trend especially during period II with respect to area, production and yield in all the four regions of the Karnataka. The decline in the production of groundnut may be due reduced area under cultivation of crops during after 1995's. The study concludes that positive trend in growth rates of area, production and yield of groundnut during period I across the districts and divisions. It may be due to government initiatives in the form of Technological Mission on Oilseeds as well as price and marketing support for oilseed growers. The study concluded that the fluctuation in area, production and yield was noticed in groundnut during the period II. All the districts and divisions were classified under higher instability category during the period II except Chitradurga, Belgaum and Dharwad in groundnut area, Dakshin Kannada and Bijapur in groundnut production whereas Gulbarga, Shivamogga, Mysore division and Gulbarga in groundnut yield. The level of instability was found to be higher in groundnut production when compared to area and yield across the periods in Karnataka

The study concluded that the interaction between

change in mean yield and mean area were acted as major sources of growth in all districts and divisions including state as whole except some districts during the period I, whereas change in mean yield and mean area were acted as major sources of growth during the period II and whole period. The study concluded that the variances in production of groundnut for the state as a whole was largely due to interaction between changes in mean yield and mean area followed by change in yield variance and change in area variance during whole period and period I. During period II, variance in production of groundnut was largely due to change in mean area followed change in mean yield and change in residual. The remaining factors had a stabilizing effect on the groundnut production in Karnataka.

Policy Suggestions

The policy suggestions are given based on the conclusions drawn from the study. The study suggests that research efforts may be concentrated on evolving suitable yield increasing technology like HYV, expansion of area under irrigation and large scale promotion of stabilization measures like crop insurance which can enhance the per unit production as well as stabilize the area and yield of groundnut. The government agenises like SAU, KOF Extension units, etc., have to arrange for the buyback of oilseeds with processors that could benefit the oilseeds farmers and in turn farmers will expand the area under oilseeds crops.

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