

Analysis of trends and instability in area, production and productivity of Indian coffee

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Received : 08.02.2013; Revised : 05.03.2013; Accepted : 30.03.2013

ABSTRACT

This paper attempts to estimate trends in area, production and productivity of Arabica and Robusta coffee for the period of 1995-96 to 2011-12. The analysis is based on data for past 17 years. The entire analysis was done separately for all coffee growing states for the study. The trend in growth analysis reveals that the trend in area, production and productivity over the years were positive in first and third period and while in the second period, was shown negative as indicated by the cubic equation. The study also noticed that the trend of Robusta with respect to area and production surpassed Arabica at national level. Further, as the crop was introduced in the last decades in to non-traditional areas in a bigger way, the instability with respect to both Arabica and Robusta was very high and hence, affecting on stability at national figures. The main sources of instability in coffee production (Arabica and Robusta) were found to be changed in area variance and changed in yield variance.

KEY WORDS : Area, Coffee, Production, Productivity, Trend, Stability

How to cite this paper : N. Ashoka, Naik, Balachandra K. and Kulkarni, Vilas S. (2013). Analysis of trends and instability in area, production and productivity of Indian coffee. *Internat. J. Com. & Bus. Manage.*, 6(1) : 103-107.

Coffee is the second largest commodity in the world trade next only to petroleum, and hence aptly described as 'Brown gold'. Coffee occupies a pride place among plantation crops grown in India, which is most important cash crop grown in tropics. India ranks sixth in coffee production after Brazil, Vietnam, Colombia, Indonesia and Ethiopia. India produces both Arabica and Robusta varieties of coffee in proportion of 31:69 per cent with an area of 49:51 per cent respectively. Coffee is cultivated in about 4.04 lakh hectare (comprises about 1.97 lakh hectare of Arabica and 2.06 lakh hectare of Robusta) with production of 3.22

lakh metric tons where in Arabica accounts 1.05 lakh metric tons and 2.17 lakh metric tons of Robusta (Coffee Board, 2011). Cultivation of this stimulating beverage crop is mainly confined to the southern states of Karnataka, Kerala and Tamil Nadu which are traditional coffee growing regions in India. To a lesser extent, coffee is also grown in Non-Traditional Areas (NTAs) which includes Andhra Pradesh, Orissa and north-eastern states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tripura and West Bengal). In Karnataka, Coorg, Chikmagalur and Hassan are major districts, which produce both Arabica and Robusta in almost an equal proportion while Kerala specialized in Robusta and Tamil Nadu in Arabica. The focus of coffee cultivation in NTAs is an integral part of tribal development and afforestation programme (Babu Reddy, 2001). Summer showers are important for flowering in coffee and are received during the month of March-April.

Coffee is predominantly export oriented commodity in India with 70 per cent of its production is being exported thereby earning sizeable foreign exchange. The objective of

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this paper is to study the prospects and growth of Indian coffee industry and emerging challenges that it is facing with changing market scenario.

METHODOLOGY

For the purpose of the present investigation, time series data for last 17 years i.e. from 1995-96 to 2011-12 have been collected from various issues of 'Coffee Statistics' published by Coffee Board of India, Bangalore. The statistical figures related to area, production and productivity of coffee were compiled and analyzed by fitting polynomial trend equations.

Trend analysis:

The trend analysis was carried out to measure the growth in area, production and productivity of both Arabica and Robusta coffee in India, employing polynomial function as below.

$$Y_t = a + b_1X + b_2X^2 + b_3X^3 + e$$

where,

Y_t = Area/Production/Productivity in time period t

a = Intercept

X = Time period

b_1, b_2 and b_3 are Regression coefficient to be estimated

e = Error term.

Instability analysis:

In order to study stability in coffee industry with respect to area, production and productivity, co-efficient of variation was estimated using the expression given below.

$$CV = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

ANALYSIS AND DISCUSSION

Different trend equations are fitted depending upon their goodness of fit and their suitability to assess the trend in

area, production and productivity of coffee in major growing states in the study. The data over the period 1995-96 to 2011-12 were considered for the study. The cubic function was fitted for all area, production and productivity due to its superiority over other functions in terms of better coefficient of determination (R^2). In this study, an attempt has been made to compute magnitude of change that had taken place in area, production and productivity of coffee in major growing states by computing coefficient of variation.

Trends and instability in area, production and productivity of coffee in India:

The trend in area, production and productivity of coffee are presented in Table 1. It is observed from the table that, growth trends in Arabica coffee area increased for overall study period *i.e.*, in first stage at the rate of 7878.01 ha per year and in later part at the rate of 580.01 ha and in terminal stage it increased to the tune of 20.95 ha per annum. The overall trend equation was statistically significant, as revealed by F value (96.73) and fluctuation in area due to time factor to the extent of 95 per cent as indicated by R^2 . Arabica coffee production was increased at the rate of 11536.43 tons per annum in the first stage across India, it noticed decline rate in second stage *i.e.*, at the rate of 1479.23 tons per annum and again in last stage which increased at to 50.38 tons per annum which were statistically significant at 5 per cent level. The variability in Arabica coffee production was explained by time factor to the tune of 42 per cent as revealed by coefficient of determination. At the national level, annual productivity of Arabica coffee was noticed to grow by 33.14 kg/ha in the first stage, declined by 6.00 kg/ha in afterward stage and in terminal stage it had increased by just 0.22 kg/ha. Basically on two major counts, coffee cultivation had not expanded much *viz.*, short of suitable elevated land with the industry and change in rainfall pattern. Besides, higher cost of production for Arabica coffee and yield gap at different parts of the country

Table 1 : Trend in area, production and productivity in coffee in India (1995-96 to 2011-12)

	Arabica			Robusta		
	Area	Production	Productivity	Area	Production	Productivity
Intercept	133894.9	81979.93	631	156827.2	75823.38	513.28
b1	7878.01** (2345.26)	11536.43* (4736.44)	33.14 (27.01)	1383.98 (1520.57)	33226.96** (6695.17)	183.86** (34.37)
b2	580.77*** (298.30)	-1479.23* (602.44)	-6.00 (3.43)	403.05 (193.40)	-3493.41** (851.57)	-21.77** (4.36)
b3	20.95*** (10.91)	50.38* (22.04)	0.20 (0.125)	-18.15* (7.076)	119.33** (31.15)	0.754** (0.159)
R^2	0.95	0.42	0.78	0.98	0.85	0.71
F	96.73	3.20	15.65	236.06	26.39	11.12
CV	10.27	9.79	15.24	9.51	16.20	11.03

Note: *, ** and *** indicate significance of values at $P=0.05, 0.01$ and 0.10 , respectively
Figures in parenthesis indicate standard error of respective coefficient

were the other reasons associated with ups and down in coffee industry.

In this study, an attempt has also been made to compute the magnitude of change that had taken place in area, production and productivity by computing the coefficient of variation. The results are presented in Table 1. The extent of variation in Arabica coffee area at national level was 10 per cent. The variability in the area occurred due to moderately increasing area under cultivation particularly in NTAs. The production variability was 3.20 per cent due to pest and diseases and productivity level of the crop. The coefficient of variation in productivity was 15.24 per cent, it was on par with production. The variation has accounted for output growth fluctuation over the years. The productivity of Arabica coffee could be improved further by breeding efforts.

Indian Robusta coffee registered a remarkable progress in area, production and productivity during last decade. During the period between 1995-96 to 2011-12, the area under Robusta coffee increased steadily. It was also observed from the table 1 that, the growth in Robusta coffee area was noticed at the rate of 1383.98 ha per annum in initial stage, it continued to increase in later part to the tune of 403.05 ha per annum and started declining in terminal period to the extent of 18.15 ha per annum. However, the result of overall period of study was statistically significant as shown by F statistic (15.06). The production growth observed was 33226.96 tons per year in first stage and shown declining trend to the tune of 3493.41 ha per annum and started improving slowly at 119.33 tons per annum in later stage. The productivity has also improved from 752 to 1019 kg/ha during the same period. In the initial period, Robusta coffee productivity increased at 183.86 kg/ha per annum and started declining at 21.77 kg/ha per annum in next stage and in terminal stage it witnessed 0.75 kg/ha per annum improvement.

The magnitude of change in area, production and productivity of Robusta coffee at national level suggested

that more or less stable coefficient of variation of 9.51 per cent in case of area, quite stable in case of production (16.20 %) and productivity (11.03 %). The variation in area took place due to sensible increasing area under Robusta coffee cultivation in the country. The production variable was explained by the improvement in productivity from 752 kg/ha in 1995-96 to 1019 kg/ha in 2011-12, signifying tremendous improvement in Robusta coffee production technology.

Trends and instability in area, production and productivity of coffee in Karnataka state:

The trends in area, production and productivity of coffee in Karnataka state (Table 2) indicated that, Arabica coffee area showed increasing trend during first stage and was statistically significant at 1 per cent level. In the second stage, the declining trend (616.63 ha per annum) was noticed and in the third stage, it improved with an increasing rate of 17.76 ha per annum. The variation in Arabica coffee area was influenced substantially because growers stopped growing Arabica coffee due to fluctuation in world coffee prices during post 2000 period and increase in incidence of pest and diseases, which might have affected profitability of the crop. Whereas the trend in Arabica production in Karnataka state for the study period indicated that the cubic coefficient increased in initial stage (10389.54 ha per annum), declined in later stage (1315.89 per annum) which were statistically significant at 5 per cent level and in third stage again it shown increasing trend (43.51 ha per annum). The trend in Arabica productivity in Karnataka state for study period has shown that the cubic coefficient was statistically non-significant.

The area under Arabica coffee in Karnataka state was found to be stable as indicated by low coefficient of variation at 4.86 per cent. As a plantation crop, it is confined to certain agro-climatic zones, hence the scope for variability in area is low. Production variability was due to unseasonal rains and pest and diseases. The coefficient of variation in productivity

Table 2 : Trend in area, production and productivity in coffee in Karnataka state (1995-96 to 2011-12)

	Arabica			Robusta		
	Area	Production	Productivity	Area	Production	Productivity
Intercept	87976.7	66751.54	778.44	71558.99	47815.74	729.55
b1	6650.68** (1478.86)	10389.34* (4689.81)	41.92 (43.82)	144.57 (1474.52)	15666.65* (1503.36)	174.62* (51.54)
b2	-616.63** (188.10)	-1315.89* (596.50)	-7.04 (5.57)	520.46** (187.55)	-1337.12*** (642.78)	-20.68* (6.65)
b3	17.76* (6.88)	43.51*** (21.82)	0.25 (0.20)	-21.34* (6.68)	44.20*** (23.51)	0.71* (0.23)
R ²	0.80	0.45	0.49	0.98	0.88	0.49
F	17.76	3.59	4.25	244.87	33.54	4.21
CV	4.86	12.10	12.64	17.85	21.42	10.22

Note: *, ** and *** indicate significance of values at P=0.05, 0.01 and 0.10, respectively
Figures in parenthesis indicate standard error of respective coefficient

was 12.64 per cent, it was at par with production. The variation in productivity has accounted for output growth fluctuation over the period of years.

At, first and second stage, area under Robusta coffee in Karnataka state increased to the extent of 144.57 and 520.46 ha per annum, and in terminal stage, Robusta coffee area has shown decreasing trend at a rate of 21.34 ha per annum. The increase area dedicated to Robusta coffee cultivation was mainly due to conversion of Arabica coffee area into Robusta coffee because of resistance of the crop against pests and diseases and lesser cost of cultivation. The overall Robusta coffee production and productivity trend in Karnataka state was increasing for the study period. The area and production of Robusta coffee in Karnataka were found to be moderately stable as revealed by coefficient of variation of 17.85 and 21.42, respectively whereas productivity was found to be stable with low co-efficient of variation of 10.22. This calls for research efforts to improve the production technology to increase the productivity of Robusta coffee in Karnataka state.

Trends and instability in area, production and productivity of coffee in Kerala state:

Kerala state is the second largest producer of coffee in India next only to Karnataka. It occupies about 3,865 ha area under Arabica coffee and 81,033 ha under Robusta coffee. Kerala state witnessed decline in Arabica production both in first and second stage *i.e.*, 58.64 and 9.01 tons per year, respectively whereas it improved just by 0.70 tons per year in the terminal stage (Table 3). The decline in production associated with decline in productivity by 22.40 and 1.57 kg/ha per annum in the same period. The variation in Arabica coffee area, production and productivity were 4.23, 18.32 and 19.52 per cent, respectively.

In the overall period, the cubic co-efficient with respect to area was statistically significant as shown by F value (133.85) and variation due to time factor was to the tune of 96 per cent as indicated by R^2 . Whereas the trend in Robusta coffee area in Kerala state was at increasing rate (874.76 ha per year) in first stage. In the later stage, the rate of decline (76.48 ha per

Table 3 : Trend in area, production and productivity in coffee in Kerala state (1995-96 to 2011-12)

	Arabica			Robusta		
	Area	Production	Productivity	Area	Production	Productivity
Intercept	3783.89	20.34.45	530.70	77350	257.65	342.52
b1	92.51 (81.60)	-58.64 (80.94)	-22.40 (22.38)	874.76** (96.93)	13017.33** (2763.51)	155.55 (34.01)
b2	-9.46 (10.76)	-9.01 (10.29)	-1.57 (2.84)	-76.48** (12.3)	-1418.75** (351.49)	-17.86** (4.33)
b3	0.22 (0.39)	0.70*** (0.37)	0.16 (0.10)	2.27** (0.45)	50.40** (12.86)	0.60** (0.15)
R ²	0.36	0.79	0.78	0.96	0.70	0.67
F	2.50	16.83	16.10	133.85	10.17	9.10
CV	4.23	18.32	19.52	1.06	13.96	13.29

Note: *, ** and *** indicate significance of values at P=0.05, 0.01 and 0.10, respectively
Figures in parenthesis indicate standard error of respective coefficient

Table 4 : Trend in area, production and productivity in coffee in Tamil Nadu state (1995-96 to 2011-12)

	Arabica			Robusta		
	Area	Production	Productivity	Area	Production	Productivity
Intercept	27356.79	12307	446.20	530.88	3790.72	680.10
b1	-960.26** (212.70)	218.91 (845.11)	24.08 (33.32)	57.24*** (27.05)	141.63 (258.50)	16.87 (46.72)
b2	109.09** (27.05)	26.51 (107.49)	-1.11 (4.23)	-7.86* (3.44)	-19.08 (32.88)	-2.28 (5.94)
b3	-3.45** (0.98)	-1.95 (3.93)	-0.0092 (0.15)	0.28* (0.125)	0.85 (1.20)	0.11 (0.21)
R ²	0.67	0.19	0.25	0.29	0.26	0.24
F	8.92	1.04	1.50	1.81	1.52	1.43
CV	2.29	10.88	11.35	0.89	11.12	11.22

Note: *, ** and *** indicate significance of values at P=0.05, 0.01 and 0.10, respectively
Figures in parenthesis indicate standard error of respective coefficient

year) was noticed which was statistically significant at 1 per cent and in third stage, it improved with an increasing rate of 2.27 ha per year. Similar trends were witnessed in case of production and productivity too.

Kerala state has witnessed high stability (1.06 per cent) state in case of Robusta coffee area and quite stable with respect to Robusta production and productivity to the extent of 13.96 and 13.29 per cent as noticed by coefficient of variation. Increase in production is more contributed by increase in productivity level of the crop.

Trends and instability in area, production and productivity of coffee in Tamil Nadu state:

During 2011-12, Tamil Nadu occupied 25,708 and 5636 ha area under Arabica and Robusta coffee cultivation, respectively. It is quite interesting to know the trend in Arabica coffee area in Tamil Nadu state. It noticed decline in area both in initial and terminal stage *i.e.*, 960.26 and 3.45 ha per annum (Table 4). Production trend were positive (218.91) for initial stage because of productivity stand 24.08 kg/ha per annum during the same period. The productivity registered negative trend both in second and terminal stage and hence affected on production level.

The area under Arabica coffee was found to be more stable in Tamil Nadu state as it witnessed lower coefficient of variation (2.29 %) and moderate stability was observed in case of production and productivity as indicated by coefficient of variation of 10.88 and 11.35, respectively. Thus, increase in production was more because of increase in productivity of Arabica coffee in Tamil Nadu state during the study period.

At the first stage, the trend in area for Robusta coffee in the state increased at a rate of 57.24 ha per year, witnessed decline of 7.86 ha per year in the later stage and in terminal stage again it noticed marginal increase *i.e.*, 0.28 ha per year. Similar trend were observed in case of production and productivity.

The area under Robusta coffee in Tamil Nadu was also found to be highly stable as noticed by lower coefficient of variation value (0.89) as scope of expanding area is limited because of agro-climatic factors. Production and productivity were also found to be moderately stable as revealed by coefficient of variation values, 11.12 and 11.22, respectively. Thus, it is significant that increase in production of Robusta coffee in the state during the study period was solely due to increase in productivity. The varietal improvement and improvement in production technology might have triggered the productivity growth in the study area. Prakash (1986) made study on supply response, market margins and growth rates of Indian coffee. Babu Reddy (2001) made some observations on trends in Indian coffee industry while Gairhe and Reddy

(2012) presented the scenario of coffee in India in the form of review.

Conclusion and policy implications:

The foregoing analysis indicated that, area, production and productivity of coffee in the country is increasing with moderate fluctuations from year to year except in NTAs. In order to sustain production, it is necessary to formulate and implement a time bound action plan to increase the productivity and exploit the possibilities at expansion of especially in NTAs. The average productivity of Arabica and Robusta coffee grown at NTAs are 108 kg and 109 kg/ha, respectively whereas the productivity for rest of India is 592 and 968 kg/ha. As expansion of land is limited factor, the production needs to be enhanced through yield improvement which are important considerations to reach with to improve coffee production in the country. Top priority to the productivity stabilization measures like, increase productivity through research and development, management of estates, spending on re-plantation programmes and a subsidy components by the government. Filling up the vacancies and uprooting old bushes and replanting with best available stress resistance planting material would be the main area of concern to increase the productivity of coffee estates. The productivity could be improved further by breeding stress resistant varieties.

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