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Focus

Productivity and Resource Use Efficiency in Milk Production in Tribal Area of Dhar District (Madhya Pradesh)

ATUL SHARMA, A. K. CHAUHAN AND RISHIKANTA SINGH

The present study was conducted in tribal area of Dhar district of Madhya Pradesh with the objective to assess the resource use efficiency in milk production. From Dhar district two tehsils viz. Kukshi tehsil and Dharmpuri tehsil having the highest number of tribal population in the district were purposively selected. Two villages were randomly selected from each tehsils. A total of 160 milk producing households comprising of 70 small (1–2 milch animals), 65 medium (3–4 milch animals), and 25 large (5 and above) were selected randomly from the four villages. It was found that the average milk productivity of milch buffalo, crossbred cow and local cows were 3.80 liters, 6.60 liters, and 2.87 liters, respectively. Cobb-Douglas forms of milk production function were found to be the best fit to assess the resource use efficiency. The regression coefficients of expenditure on green fodder and concentrate were found positive and significant for all the three species. Green fodder was found to be underutilized for buffalo and optimally utilized in case of crossbred cow. Concentrate was found to be underutilized for both local cows as well as for buffaloes.

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Dairy subsector contributes major share, i.e., two third in the livestock sector of the country. Milk production in India is increasing at the rate of about 4 percent whereas in the world it is increasing at the rate of 1 percent. India ranks first in milk production in the world, increasing its milk production from 21.2 million tons in 1968–69 to 121.8 million tons in 2010–11. Consequently, the per capita availability of milk has increased from 112 gram (g) per day to 281 g per day during the corresponding period (Ministry of Agriculture, GOI).

Milk production is a complex process involving a number of genetic and non-genetic factors. Type of breed and ability for milk secretion by individual animals are the important genetic factors. The important non-genetic factors influencing milk production include the quality of feed and fodder, labor, order of lactation and stage of lactation, etc. There is evidence (Kumar and Padian, 2001; Sharma and Singh, 1993; Singh et al., 2012) that there is a great variation in relative economic efficiency of different breeds/species of milch animals reared by different categories of herd size farms due to the variation in genetic potential, feeding, and management practices. To realize the maximum returns from milk production, all the scarce resources must be utilized optimally. There are enough studies on resource use efficiency in milk production in different parts of the county, but the studies on how the scarce resources are utilized by the tribal dairy farmers in milk production are rare. Therefore, this study was planned to be conducted in Madhya Pradesh state as it has the largest tribal population in the country. Dhar district possesses the highest tribal population and is situated in south-western corner of the state. Dhar district has 54.5 percent tribal population and main tribes residing in the

district are Bhils, Bhilalas, Patlyas, Bareliyas, etc. The district has around 2.5 percent of the state's breed-able bovine population and contributes around 2.8 percent of the total milk production of the state (*Annual Report 2008-09*, Government of Madhya Pradesh). Tribal households are characterized by the presence of livestock, which they keep both as an asset to be maintained in case of emergency as well as meeting the immediate food insecurity. In view of this, the paper attempts to analyze productivity of different dairy animals and the resource use efficiency in respect of the use of principal inputs that go in the production of milk in tribal area of Madhya Pradesh state.

Data and Methodology

The study is based on primary data. Dhar district of the Madhya Pradesh state was purposively selected for undertaking the present investigation as it has the largest tribal population. From Dhar district, two tehsils were selected purposively, having the highest number of tribal population in the district. Two villages from each selected tehsils were selected randomly. Thus Semaldha and Mehgoan villages from Kukshi tehsil and Pandhania and Dhol villages from Dharmpuri tehsil were selected. The total milk-producing households were classified into three category, namely small (up to 2 milch animals), medium (with 3–4 milch animals), and large (with 5 and more animals) herd size category by using cumulative square root frequency method. A predetermined sample of 160 tribal milk producers was drawn according to the proportion of population in each category. This has yielded a sample of 70 small herd-size farm households, 65 medium herd-size farm households, and 25 large herd-size farm households. The required primary data were collected in 2012 on the well-structured pretested schedule by personal interview/enquiry method. The information from the sample households was collected on number of milch animals, milk yield of individual lactating animals, quantity of green fodder, dry fodder and concentrate fed to individual animal, prices paid for feed and fodder, labor used in different activities of dairy, prevailing wage rate, prices of milk in the area, veterinary expenses, and miscellaneous expenses. Tabular method and production function were employed for the analysis of data.

Production Function Analysis

Production function shows the relationship between output (milk yield) and inputs (explanatory variables) used in the production process. In the present study, production function analysis was employed to estimate the resource productivity and resource use efficiency in milk production. The regression equations were fitted for different species of lactating animals maintained by the tribal households.

Choice and Specification of Milk Production Function

The specification of milk production function used in the present study is as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5)$$

where,

Y = Income from milk per animal per day (₹)

X_1 = Expenditure on green fodder per animal per day (₹)

X_2 = Expenditure on dry fodder per animal per day (₹)

X_3 = Expenditure on concentrates per animal per day (₹)

X_4 = Value of labor used per animal per day (₹)

X_5 = Miscellaneous expenses per animal per day (₹)

The choice of a specific functional form was based on statistical criteria, that is, sign and statistical significance of estimated parameters and coefficient of multiple determination (R^2). Two types of functions were tried, which are as follows:

Linear : $$Y = a + \sum_{i=n}^{n} b_{ii} x + u$$

Cobb-Douglas : $$Y = a + \prod_{i=1}^{n} x_i^{b_i} e^u$$

where,

Y = Output

X_i = i^{th} input used

a = Constant term

b_i = Partial regression co-efficient of the i^{th} input to be estimated

u = Random error distributed normally with zero mean and constant variance

e = Base of natural log

Ideally, the output (Y) and inputs (X_i) in the above production functions were measured in monetary values rather than their physical quantities; this was done

because the quality of feeds and fodders differs from one respondent to the other and can be more appreciably reflected in value terms.

Marginal Value Productivity

Marginal value productivity of inputs were estimated from the fitted production function. The steps involved in the estimation of marginal value product of inputs for two forms of production function are given as follows.

Linear Function

In linear function, the regression coefficients (b_i) of the explanatory variables indicate the marginal value product (MVP).

$$MVP_i = b_i$$

Cobb-Douglas function

The MVP can be worked out by taking the first order partial derivative of output with respect to the concerned input.

$$MVP_{xi} = b_i \frac{Y}{xi}$$

where,

$\bar{Y}$ = Geometric mean of output Y

$\bar{X}_i$ = Geometric mean of i^{th} input

b_i = Partial regression coefficient of X_i

Resource Use Efficiency

Resource use efficiency of inputs measures whether or not the inputs are used efficiently. They are used efficiently if the MVP of the input is equal to its unit price, that is:

$$MVP_i = P_i$$

where,

P_i is the unit price of the input.

In order to examine the resource use efficiency, the marginal value productivity of various inputs were worked out for significant regression coefficient in the estimated milk production function. Any deviation of MVP of input from its unit price may be termed as resource use inefficiency. The higher the difference between MVP of an input and its price, the higher is the resource use inefficiency and vice versa. If the difference between MVP and unit price is statistically not significant, it indicates optimal use of that particular resource.

Further, t-statistic was used to test the statistical significance of the difference between the MVP of an input and its unit price.

Results and Discussion

Composition of Milch Animals

Of the different species of milch animals maintained by the sample household, buffaloes constitute the largest, that is, 238 animals followed by local cow 201 numbers and the least is crossbred consisting of only 86 numbers. Of the total animals the maximum lactating animals are found in local cow consisting of 88 percent, followed by buffaloes 78 percent and the least by crossbred, that is, only 69 percent.

Milk Productivity

Milk yield, which ultimately brings out returns to the milk producers, depends upon a number of factors, such as breed, order and stage of lactation, season of calving, quality of feeds and fodders, etc. The average daily milk yield per milch cow was worked out for different herd size

Table 1: Composition of Bovine and Average Herd Size of Sample Households

(Numbers)

Category	Buffalo		Crossbred Cow		Local Cow	
	Lactating	Milch	Lactating	Milch	Lactating	Milch
Small	56 (90)	62	7 (70)	10	50 (91)	55
Medium	71 (66)	108	22 (61)	36	83 (86)	97
Large	58 (91)	64	30 (75)	40	43 (88)	49
Total	185 (78)	238	59 (69)	86	176 (88)	201

Note: Figures in parentheses indicate the percentage of lactating animals to the total milch animals.

Table 2: Milk Productivity across different Herd Size Categories (Liters /Animal/ Day)

Species		Herd Size Category			
		Small	Medium	Large	Over all
Buffalo	Lactating	3.09	4.21	5.56	4.29
	Milch	3.12	3.89	4.54	3.80
Crossbred Cow	Lactating	5.43	7.32	8.34	7.61
	Milch	4.89	6.12	7.45	6.60
Local Cow	Lactating	2.44	3.32	4.35	3.32
	Milch	2.45	2.87	3.33	2.87

category and the same is given in Table 2. It was observed that the overall average daily milk yield per milch local cow was 2.87 liters which ranges from 2.45 liters per animal per day for small category to 3.33 liters for large herd size categories. The overall average daily milk yield per milch crossbred cow was 6.60 liters which ranges from 4.89 liters per animal per day for small category to 7.45 liters for large herd size category, respectively.

In case of buffalo, the overall average daily milk yield per milch buffalo was 3.60 liters which ranges from 3.12 liters per animal per day for small category to 4.54 liters for large herd size category, respectively. In case of lactating animals, the overall average milk productivity was 3.32 liters for local cows, 4.29 liters for crossbred cow, and 6.60 liters for buffaloes, respectively.

Average Daily Milk Production, Consumption, and Marketed Surplus

Milk production is an important indicator of income earning capacity as milk is the major source of income for dairy farming. The average daily milk production per household is presented in Table 3. The overall average daily milk production per households was 11.42 liters and it increased with the increase in herd size category, ranging from 4.75 liters for small category to 30.38 liters in case of large category. The average milk consumption per day per household was 1.23 liters which also increased with the increase in herd size category. The average marketed surplus was 10.19 liters constituting 89 percent of the total milk production of the sample households.

Table 3: Average Production, Consumption and Marketed Surplus of Milk across different Herd-size Categories (Liter /Day/ Households)

Category	Total Milk Production	Total Consumption	Total Marketed Surplus
Small	4.75	1.00	3.75 (78.94)
Medium	11.31	1.27	10.04 (88.77)
Large	30.38	1.76	28.62 (94.20)
Overall	11.42	1.23	10.19 (89.22)

Note: Figures in parentheses indicate the percentage of marketed surplus to the total milk production.

Milk Production Function for Lactating Animals of Different Species

Different research workers have reported different forms of mathematical models for milk production function for different species/breeds and for different agro-climatic zones. In the present study, two forms of milk production function, viz, Linear and Cobb-Douglas were tried to estimate the milk production, that is, input–output relationship. The Cobb-Douglas form of production function was found to be the best fit for all types of lactating animals keeping in view the significance and sign of explanatory variables and the value of R^2.

In order to identify the presence of multicollinearity among the explanatory variables, zero-order correlation matrix was examined and it was found that multicollinearity was not a serious problem in estimating the parameters of the mathematical model.

The results of the estimated Cobb-Douglas production function for different species of lactating animals have been presented in Table 4. In case of local cow, concentrates and green fodder were found positive and statistically significant at 1 percent level of significance. This indicates that these two inputs have positive influence on milk production. In case of crossbred cow, green fodder and

Table 4: Estimated Coefficient of Cobb-Douglas Production Function

Parameters	Species		
	Local Cow	Crossbred Cow	Buffalo
No. of Observations	176	59	185
Intercept	2.29	2.47	2.06
Green Fodder	0.14**	0.29**	0.20**
Dry Fodder	–0.4	0.02	0.07
Concentrates	0.70**	0.42**	0.56**
Labor	–0.08	0.01	–0.04
Misc.	0.01	0.04	–0.13
R^2	70.6	58.0	74.4

Note: ** Significant at 1 percent level

concentrates were found positive and statistically significant at 1 percent level while for buffalo green fodder and concentrate were found positive and statistically significant at 1 percent level.

A close perusal of the table revealed that the values of coefficient of multiple determination (R^2) for local cow, crossbred cow, and buffalo were 70.6, 58.0, and 74.4, respectively, which indicated that 70.6, 58.0, and 74.4 percent of total variation in returns from milk was explained by the independent variables included in the regression functions.

A further perusal of the table revealed that green fodder and concentrate are important variables influencing milk production in all the three species. Its regression coefficients were positive and statistically significant ($P < 0.01$). It reveals that for local cow, on an average, 1 percent increase in the expenditure on green fodder and concentrate will lead to 0.14 percent and 0.70 percent increase in returns from milk. For crossbred cow, 1 percent increase in the expenditure on green fodder and concentrate will lead to 0.29 percent and 0.42 percent increase in returns from milk. In case of buffalo, 1 percent increase in the expenditure on green fodder and concentrate will lead to 0.20 percent and 0.56 percent increase in returns from milk.

It was observed that the increase in milk production for a unit percent increase in green fodder was the maximum for crossbred cow while the response for a unit percent increase in concentrate was the maximum for local cow.

The positive and significant impact of green fodder and concentrate on returns from milk were in conformity with the findings of studies conducted by Sharma and Singh (1993), Shiyani (1993), Dixit (1999), Mangesh (2003), Meena (2008), Mahajan (2010), and Singh (2012).

Resource Use Efficiency in Milk Production

In order to examine the resource use efficiency, the MVP of inputs whose regression coefficient was found statistically significant in estimated production function were compared with their respective prices. If the difference between MVP of an input and its unit price is statistically not significant then it indicates that the input is being used efficiently. A significant higher MVP of an input than its price shows that more of the input can be used to increase productivity, while a significant lower MVP of an input than its unit price indicates that the input is used in excess and needs reduction.

The perusal of the Table 5 indicates that the resource use efficiency of green fodder for buffalo was found positive and significant indicating under utilization of this input and further increase in milk production can be achieved by increased use of green fodder while for crossbred cow, it was found positive and non significant indicating its optimal utilization. In case of local cow, the marginal value productivity of green fodder was lower than its acquisition cost but not significant.

The difference between MVP and unit price of concentrate for local cow and buffalo was found positive and significant indicating underutilization. This suggests that there is a scope to achieve higher returns from milk production by feeding more concentrate feed. The MVP of concentrate for crossbred cow was not significant indicating that milk production will not be affected by increasing or decreasing its utilization. Similar findings were also observed in the studies conducted by Sharma and Rajpali (1989), Sharma and Singh (1993), Singh (2007), and Kumar et al., (2001).

The study suggested that there is a scope of increasing the milk yield by judicious use of inputs mixed for getting higher returns from milk production. The

Table 5: Resource Use Efficiency in Milk Production

Inputs	Species	MVP	Unit Price	Difference	SE
Green Fodder	Local Cow	0.683	1.00	–0.317	0.199
	Crossbred Cow	1.370	1.00	0.370	0.257
	Buffalo	1.616	1.00	0.616**	0.223
Concentrates	Local Cow	3.280	1.00	2.280**	0.246
	Crossbred Cow	1.566	1.00	0.566	0.430
	Buffalo	2.644	1.00	1.644**	0.244

Notes: ** Significant at 1 percent level
SE= Standard Error

extension agencies are advised to extend the scientific management practices for proper input use to the tribal dairy farmers.

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Productivity is never an accident. It is always the result of a commitment to excellence, intelligent planning and focused effort.

—Paul J. Meyer

Focus

Dynamics of Changing Milk Production in India: A State- and Region-wise Analysis

DEEPAK SHAH

The application of scientific production techniques coupled with greater importance being given to the development of the diary cooperative infrastructure has led the milk production of our country to increase substantially over the past three decades. However, the slowing down in the milk production increases in more recent time in most of the states and region of the country certainly is a cause of concern. In order to have sustainable growth of milk production, a medium-term strategy is needed, which can realize the utilized production potential of milch animal in different states of India. This could be considered as an integral part of long-term strategy for increasing the resource base of the farmer. The prospects for milk production in various states in the near future will also depend on the extent to which farmers take up fodder cultivation as an integral part of milk production.

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Dairy industry of India has undergone considerable transformation over time due to the application of scientific production techniques by medium and large farmers and greater importance being given to the development of dairy cooperative infrastructure that has contributed in no small measure towards substantial growth in milk production since the early seventies. The investment, effort, innovation, and energy of our farmers and industry have seen India moving from insignificant to becoming a major player in the world dairy scene. India today ranks as the world's largest milk producer and the value of output through dairying is the largest as compared to any other agricultural commodity.[1] The gross value of output from livestock sector at current prices has grown more than 25 folds from Rs.10,597 crores in 1980–81 to Rs.2,61,000 crores in 2008–09 (GOI, 2010). Nonetheless, encompassing a wide geographical area and reflecting different political systems, differing levels of economic development, social systems, and changes in taste, preferences and traditions, the approach to dairy development has varied widely from region to region in India. Viewing our dairy spectrum in the light of these variabilities, it becomes pertinent to ask whether the future of our dairy industry will remain as bright as in the past if we were only to follow the principles and practices of the past and when cooperatives have to face increasing challenges and competition in the post-WTO trade order.

It is heartening to note that India at present produces 112.54 million tonnes of milk annually. However, the consumer prices of milk in India are still comparable to one of lowest in the world due mainly to unremunerative and unattractive price offered to our dairy farmers for their milk produce This is also owing to the fact that our purchasing power, and the demand for the milk are not able to expand in line with the increasing milk production. The increasing population coupled with growing incomes

has led to rapid increase in demand for milk in our country. The rise in annual milk production from 31.6 million tonnes in 1980–81 to 112.54 million tonnes in 2009–10 has contributed a great deal to rise in per capita availability of milk in India. This has not only placed India on top of milk-producing countries in the world but also ensured sustained growth in the availability of milk and milk products for the burgeoning population. If our milk production continues to grow at it does now, we would have never opportunities for launching a more meaningful marketing campaign.

Although many factors contributed towards rise in milk production in India, the key role in bringing about this transformation has been the initiation of Operation Flood programme.[2] The most significant contribution of Operation Flood programme is considered to be the replication of Anand pattern[3] cooperative throughout the country. It is due to this replication that many states in the country have shown their milk production to increase by leaps and bound. However, the approach to diary development has varied widely from state to state and region to region in India. Therefore, the crucial questions of the hour that could strike one are how the structure of milk production changed over time in various states and union territories in India and what are the reasons for changes. Notwithstanding the regional imbalance in milk production prevailing in the country, what step need to be initiated to augment country's milk production and thereby bridge the gap between nutritional requirements and supply of milk. What future prospects does India hold in the diary sector in view of the rapidly increasing population and in the light of rise in domestic demand for milk. In order to address these queries and as a prelude to have better understanding of the structural changes, an attempt has been made in this study to analyze and evaluate the pattern of production of milk in various states and union territories of India.

Data Base and Methodology

Data used for this study were collected from secondary sources. Time series data for 30 years (1976/77–2005/06) on annual milk production of different states and union territories were collected from various issues of the annual publication *Bulletin of Food Statistics*, Directorate of Economics and Statistic, Ministry of Agriculture, New Delhi, and *Basic Animal Husbandry Statistics*, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, New Delhi. To this time series data, exponential trend equation has been fitted in order to compute compound rate of growth which was also tested for its significance.

Further, coefficient of variation (CV) was used as an index of instability. However, since the time series data often content the trend component, an index of instability as suggested by Coppock (1962) and subsequently used by Mitra and Shah (1998) was also incorporated in the analysis, which appeared to have taken care of the trend component in the time series data.[4] The rank correlation coefficient between the two different periods was also estimated to find out the changes in the ranking of the states in terms of milk production.[5]

The findings of this study mainly revolves around: (a) evaluating the structural changes in the milk production in different states and union territories of India, (b) analyzing the changing share of different states and union territories in total national milk production over the given period of time, (c) evaluating the past and present position of the states in terms of there rank in total country's milk production, (d) an insight into the trends in rate of growth and instabilities in milk production of different states and region of the country, and (e) future scenario of demand and supply situation of milk in the country with view to analyze the prospectus of dairy sector in years to come. However, before going into the evaluation of these vary many details, the study in the beginning provides a brief overview on importance of dairy sector with focus on key achievements in dairy development of India.

Key Achievements in Dairy Development

The history of India shows a number of other programmes that drew primary attention of the government and gave significant importance to cattle development projects. For instance, key village scheme was introduced as long back as in 1951. Intensive Cattle Development Project (ICDP) was launched in 1964. In addition, Integrated Rural Development Programme (IRDP), launched in 1978–79, also included dairying as one of the important components for supplementing income of the farmers.

In fact, India's dairying scene has witnessed certain major changes in the last 35–40 years, especially after the inception of Operation Flood[2] programme launched in 1970 by National Dairy Development Board. Government outlay on development of livestock sector rose dramatically from a mere Rs 905 million in the third plan (1961–66) to the sixth plan (1980-85) total outlay of 3,966 million rupees on animal husbandry and dairying, of which 2,983 million rupees was meant for expenditure on dairying alone. During

Table 1: Outlay and Expenditure of Central and Centrally Sponsored Schemes under Animal Husbandry and Dairying in India

(Rs. crores)

Plan	Period	Total Plan Outlay	Animal Husbandry		Dairying		Total		Expenditure on Animal Husbandry to Total Outlay (%)	Expenditure on Dairying to Total Outlay (%)
			Outlay	Expd.	Outlay	Expd.	Outlay	Expd.		
First	1951–56	1960.0	14.19	8.22	7.81	7.78	22.0	16.00	37.36	35.36
Second	1956–61	4600.0	38.50	21.42	17.44	12.05	55.94	33.47	38.29	21.54
Third	1961–66	8576.5	54.44	43.40	36.08	33.60	90.52	77.00	47.95	37.12
Annual	1966–69	6625.4	41.33	34.00	26.14	25.70	67.47	59.70	50.39	38.09
Fourth	1969–74	15778.8	94.10	75.51	139.00	78.75	233.10	154.26	32.39	33.78
Fifth	1974–78	39426.2	–	178.43	–	–	437.54	232.46	40.78	–
Sixth	1980–85	97500.0	60.46	39.08	336.10	298.34	396.56	337.42	9.85	75.23
Seventh	1985–90	180000.0	165.19	102.35	302.75	374.43	467.94	476.78	21.87	80.02
Annual	1990–91	–	43.71	36.18	79.67	41.43	123.38	77.61	29.32	33.58
Annual	1991–92	–	57.97	43.28	97.49	77.99	155.46	121.27	27.84	50.17
Eighth	1992–97	434100.1	400.00	305.43	900.00	818.05	1300.0	1123.5	23.49	62.93
	1992–93	80771.0	56.54	43.85	99.76	136.69	156.30	180.54	28.06	87.45
	1993–94	100120.1	78.26	54.59	257.74	216.44	336.00	271.03	16.25	64.42
	1994–95	112197.1	98.28	60.64	224.43	185.09	322.71	245.73	18.79	57.35
	1995–96	128590.0	94.00	66.66	250.00	179.67	344.00	246.33	19.38	52.23
	1996–97	–	103.94	81.04	155.98	100.29	259.92	181.33	31.18	38.58
Ninth	1997–2002	2345.64	1076.12	–	469.52	–	1545.6	–	–	–
	1997–98	–	160.15	94.84	39.00	29.24	199.15	124.08	47.62	14.68
	1998–99	–	170.40	53.03	50.60	23.97	221.00	77.00	24.00	10.85
	1999–2000	–	160.08	97.26	73.90	16.45	233.98	113.71	41.57	7.03
	2000–01	–	124.90	85.10	51.00	39.59	175.90	124.69	48.38	22.51
	2001–02	–	156.49	115.61	37.45	37.60	193.94	153.21	59.61	19.39
Tenth	2002–07	–	1384.00	–	361.00	–	1745.00	–	–	–
	2002–03		156.48	125.36	37.02	34.99	193.5	160.35	64.79	18.08
	2003–04		172.10	181.20	29.90	19.61	202.00	200.81	89.70	9.71
	2004–05		284.38	348.73	51.62	63.66	336.00	412.39	103.79	18.95
	2005–06		397.91	326.94	92.00	91.58	489.91	418.52	66.73	18.69
	2006–07		415.00	437.17	79.00	75.91	494.00	513.08	88.50	15.37
Eleventh			4323.00		580.00					
	2007–08		350.92	338.13	88.50	111.50	439.42	449.63	76.95	25.37
	2008–09		481.00	444.54	98.00	98.10	579.00	542.64	76.78	16.94
	2009–10	–	558.29	318.64	101.10	52.77	659.39	371.41	48.32	8.00

Source: Basic Animal Husbandry Statistics (2010), Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India, New Delhi.

the seventh plan (1985–90), Rs 3,028 million was earmarked for dairying out of a total outlay of 4,679 million rupees for animal husbandry and dairy. Expenditure on dairying increased sharply during the eighth plan (1992–97). Of the total outlay of Rs 13,000 million for animal husbandry and dairying, the expenditure on dairying was nearly 63 percent (Table 1). Nonetheless, though outlay on development of livestock sector increased to Rs 15,456 million in the ninth plan (1997–2002), only 30 percent of the total outlay was earmarked for dairying and the remaining for the development of various other animal husbandry activities. The outlay for dairying in the ninth plan was substantially lower than the outlay for dairying in eighth plan but higher than the outlay for dairying in the seventh plan. Such increased allocation in plan outlay, leaving ninth and other plans aside, is a reflection of the importance of dairying in government's overall policy encompassing country's agricultural economy. Since dairying has already turned into a viable and well-developed sector, efforts of the government are now fully geared to strengthen other activities relating to livestock sector.

It is to be further noted that the government of late is promoting dairy related activities in non-operation flood areas with emphasis on building up efficient cooperative infrastructure, rejuvenation of sick dairy cooperative federations, and creation of infrastructure in the states for production of good quality milk and milk products[6] (GOI, 2005). In this context, an Integrated Dairy Development Programme in non-Operation Flood, hilly, and backward areas was launched during the eighth plan, which continued in the ninth as well as in tenth plan with a total outlay of Rs.175 crores as a Centrally Sponsored Plan Scheme with 100 percent grants in aid basis to the states.[7] Since the inception of the scheme, 53 projects with the total outlay of Rs.292.19 crores has been sanctioned covering 149 districts in 23 States and one union territory (GOI, 2005).

The Indian dairy industry acquired substantial growth from eighth plan onwards with rise in milk production from 58 million tones in 1992–93 to 112.54 million tones in 2009–10. Interestingly, when share of

Table 2: Trend in Share of Agriculture and Livestock Sector in GDP of India: At Current Prices

(in billion rupees)

		GDP (Agriculture Sector)		GDP (Livestock Sector)		
Year	GDP	Rupees	% Share of Total GDP	Rupees	% Share of total GDP	% Share of Agriculture GDP
1980–81	1224	425	34.72	59	4.82	13.88
1985–86	2338	700	29.94	139	5.95	19.86
1990–91	4778	1352	28.30	308	6.45	22.78
1995–96	10733	2778	25.88	650	6.06	23.40
1996–97	12435	3340	26.86	747	6.01	22.37
1997–98	13901	3535	25.43	819	5.89	23.17
1998–99	15981	4065	25.44	911	5.70	22.41
1999–2000	17685	4097	23.17	947	5.35	23.11
2000–01	19250	4089	21.24	1047	5.44	25.61
2001–02	20977	4425	21.09	1093	5.21	24.70
2002–03	22614	4255	18.82	1149	5.08	27.00
2003–04	25382	4830	19.03	1183	4.66	24.49
2004–05	29676	3460	11.66	1106	3.73	31.97
2005–06	34023	4024	11.83	1190	3.50	29.57
2006–07	39419	4488	11.39	1306	3.31	29.10
2007–08	45410	5254	11.57	1475	3.25	28.07
2008–09	52286	5744	10.99	1702	3.26	29.63

Sources: CSO (1990, 2003, and 2010), Planning Commission, New Delhi and 'Basic Animal Husbandry Statistics' (2006) Ministry of Agriculture, Government of India, New Delhi.

agriculture in total GDP of India declined steadily from 34.72 percent in 1980–81 to 25.43 per cent in 1997–98 and further to as low as 10.99 percent in 2008–09, livestock sector has shown a rising trend in terms of share in agricultural GDP, which increased from 13.88 percent to 29.63 percent during this period (Table 2). *Dairying of late is considered as the secondary source of income for millions of rural households. It is the most preferred activity among small and marginal farmers and even landless due to low capital intensity, higher dependence on common grazing and forest land, short operating cycle with steady returns emanating throughout the year.* With 70 million households holding a total 98 million cows and buffaloes, around 22.5 percent of the total rural household income in India comes from dairying activity (Raju, 2004).

In fact, the National Commission on Agriculture (1972) in their Interim Report on milk production also recognized the importance of dairy sector and recommended that benefits of increasing demand for milk in large cities, towns and industrial area should go to small and marginal farmers and landless labourers. In India, landless labourers account for 21 percent of total rural households. Nonetheless, they own 12 percent of the milch animals and provide 16 percent of all rural-produced milk. It stands to reason that dairying is a paying proposition for these poor rural people (Bedi, 1987). Hence efforts should be made to promote as much milk production as possible involving this segment of rural population. The commission suggested an integrated rural development approach based on a system of Kaira District Co-operative Milk Producers' Union Limited commonly known as AMUL in Anand of Gujarat (Jain, 1979).

The success of the Kaira Union gave birth to other milk producer unions in Gujarat. These milk producer unions subsequently inspired the formation of NDDB in 1965 and provided all the impetus and resources required for its creation. Further, in view of several positive features in favour of milk cooperatives in Gujarat, it was finally decided by the government of India to extend institutional support in order to industrialize and organize all the dairy efforts in entire rural India, through cooperatives. In 1970–71 the NDDB drew up an all-encompassing programme known as "Operation Flood," to replicate the Anand Pattern[5] Dairy Co-operatives in 18 areas of the country. The major objective of the operation flood programme was to build a viable and self-sustaining national dairy industry on cooperative lines. Total system approach was adopted for dairy development, which encompassed production, procurement, processing, and marketing of milk. The efforts made by the government towards the development of this important sector of agriculture has paid rich dividends so far in terms of generating adequate employment and income to milk producers, and also in terms of value addition to the national economy.

The programme initiatives undertaken by NDDB and various development projects have led to rise in productivity levels of animals over time. Nevertheless, still there are wide variations in terms of number of bovines (in-milk) and productivity of milch animals across states. As a result of this the milk production is seen to vary considerably across different states of the country. It is, therefore, essential to evaluate dynamics of changing structure of milk production across various states and regions of India with a view to ascertain future prospects of the country in meeting the domestic demand for milk in view of rapidly rising human population.

Milk Production: Structural Changes

The pattern of milk production across various states and union territories (UTs) of India presents us with several interesting observations. The scenario over the past three decades though reveals dramatic increase in milk production of the country; the period gone by is also seen to be marked with considerable slowing down in milk production increases for majority of the states, particularly after the early nineties period (Table 3). This held especially true for states such as Assam, Haryana, Himachal, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Nagaland, Punjab, Sikkim, Tamil Nadu, Uttar Pradesh, and West Bengal. On the other end of the spectrum, states such as Andhra Pradesh, Arunachal Pradesh, Bihar, Goa, Daman and Diu, Gujarat, Meghalaya, Orissa, Rajasthan, and Tripura showed major increase in their milk production figures only during the period between the early-nineties and mid-two thousand. Some of the major milk producing states showed nearly four-fold increase in their milk production between late seventies and mid-two thousand periods. As a result, total milk production in the country increased by three folds between late seventies and mid-two thousand periods. Like majority of the states, all the UTs of India showed a slowing down in their milk production increase between early-nineties and mid-two thousand periods as against the period between late-seventies and early-nineties periods. In general, UTs of India showed two-fold rise in their milk production between late seventies and mid-two thousand periods. However, the contribution of UTs in total milk production was less than 1 percent

Table 3: Structural Changes in Milk Production across States and UTs in India: 1976–77 to 2005–06

(in '000 tonnes)

States/ UTs	Triennium Average			Percent Change		
	P – I	P – II	P – III	II over I	III over II	III over I
Andhra Pradesh	2171	3019	7280	39.07	141.17	235.38
Arunachal Pradesh	30	35	47	17.98	35.24	59.55
Assam	440	637	738	44.90	15.80	67.80
Bihar	1903	3173	5534	66.77	74.41	190.85
Goa, Daman & Diu	31	28	55	–9.09	92.94	75.40
Gujarat	2138	3637	6709	70.14	84.46	213.83
Haryana	1757	3566	5247	103.02	47.14	198.71
Himachal Pradesh	289	593	842	105.07	41.85	190.90
Jammu & Kashmir	224	692	1412	209.24	104.14	531.30
Karnataka	1123	2485	3932	121.22	58.23	250.03
Kerala	731	1788	2066	144.60	15.57	182.67
Madhya Pradesh	2103	4795	6553	127.99	36.65	211.55
Maharashtra	1440	3931	6572	172.99	67.18	356.37
Manipur	56	83	74	48.95	–10.08	33.93
Meghalaya	52	50	71	–3.85	42.00	36.54
Mizoram	3	8	15	233.33	84.00	513.33
Nagaland	3	43	69	1336.46	58.46	2176.24
Orissa	229	506	1207	120.64	138.60	426.45
Punjab	2900	5403	8618	86.31	59.50	197.17
Rajasthan	3142	4466	8359	42.16	87.16	166.07
Sikkim	15	29	47	89.13	63.22	208.70
Tamil Nadu	1579	3400	5003	115.33	47.16	216.87
Tripura	15	32	86	115.91	170.53	484.09
Uttar Pradesh	5398	10182	17800	88.63	74.81	229.75
West Bengal	1180	2985	3789	153.01	26.95	221.19
Total States	28918	55567	92125	92.15	65.79	218.57
Andaman & Nicobar	3	23	24	812.65	4.29	851.76
Chandigarh	18	34	44	95.82	29.13	152.85
Dadar & Nagar Haveli	1	5	6	433.33	6.25	466.67
Delhi	148	229	304	54.50	32.94	105.41
Pondicheri	12	27	41	125.00	53.09	244.44
Total UTs	212	319	420	50.13	31.69	97.72
India	29131	55886	92545	91.85	65.60	217.69

Note: Period I: 1976/77–1978/79; Period II: 1990/91–1992/93; Period III: 2003/04–2005/06

throughout the period between late seventies and mid-two thousand.

It is to be noted that though majority of the states of India have shown perceptible rise in their milk production between late seventies and mid-two thousand periods, the major milk-producing states in the country are Uttar Pradesh, Rajasthan, Punjab, Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, and to some extent Bihar, Haryana, Karnataka, Tamil Nadu, and West Bengal. The states, which contribute to the bulk of the nation's milk production, are seen to fall in the northern and the western regions of the country. These are by far the most progressive regions as far as diary development is concerned. The contribution of these two regions put together to total milk production of India has been about 70 percent over the past three decades (Table 4).

Although several states in India have taken varied measures to augment their milk production, the rise in the same chiefly depends on the success of dairy cooperatives that still play a crucial role in safeguarding the interests of rural households and towards overall development of dairy sector in the country. *While in some states dairy cooperatives are quite successful in improving the socioeconomic conditions of rural households, they are also seen to be beset with number of deficiencies in other states. The success of dairy cooperatives is noticed to be confined to a few states such as Gujarat, Punjab, Andhra Pradesh, and Rajasthan where brands like Amul, Verka, Vijaya, and Saras have acquired significant dimension and by and large penetrated consumer market to a greater extent.* Contrary to this, a large number of dairy cooperatives, including unions and state federations,

Table 4: Share of Different States and UTs in All India Milk Output: 1976–77 to 2005–06

Period	Regions	States and Union Territories
P - I	Northern (48%)	Punjab (10%); Rajasthan (11%); U.P. (19%); Haryana (6%); H.P. (1%); J & K, Chandigarh and Delhi (1%)
	Southern (19%)	A.P. (7%); Karnataka (4%); Kerala (2%); T.N. and Pondicheri (5%)
	Eastern(13%)	Assam (1%); Bihar (6%); Orissa (1%); West Bengal (4%); Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Arunachal Pradesh and Andaman and Nicobar (1%)
	Western (20%)	Gujarat (7%); M.P. (7%); Maharashtra, Goa, Dadar & Nagar Haveli and Daman & Diu (5%)
P - II	Northern (48%)	Punjab (10%); Rajasthan (11%); U.P. (19%); Haryana (6%); H.P. (1%); J & K, Chandigarh and Delhi (1%)
	Southern (19%)	A.P. (7%); Karnataka (4%); Kerala (2%); T.N. and Pondicheri (5%)
	Eastern(13%)	Assam (1%); Bihar (6%); Orissa (1%); West Bengal (4%); Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Arunachal Pradesh and Andaman and Nicobar (1%)
	Western (20%)	Gujarat (7%); M.P. (7%); Maharashtra, Goa, Dadar & Nagar Haveli and Daman & Diu (5%)
P - III	Northern (46%)	Punjab (9%); Rajasthan (9%); U.P. (19%); Haryana (6%); H.P. (1%); J & K, Chandigarh and Delhi (2%)
	Southern (20%)	A.P. (8%); Karnataka (4%); Kerala (2%); T.N. and Pondicheri (6%)
	Eastern(13%)	Assam (1%); Bihar (6%); Orissa (1%); West Bengal (4%) ; Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Arunachal Pradesh and Andaman and Nicobar (0%)
	Western (21%)	Gujarat (7%); M.P. (7%); Maharashtra, Goa, Dadar & Nagar Haveli and Daman & Diu (7%)

Note: 1) Period I: 1976/77–1978/79; Period II: 1990/91–1992/93; Period III: 2003/04–2005/06

2) Figures in parenthesis are proportionate contribution of respective state/UT's milk output to total national milk output.

Table 5: Bovine Population in India

(in '000 numbers)

Regions	1987			2003		
	Cattle	Buffalo	Bovine	Cattle	Buffalo	Bovine
Northern	47,012 (24.02)	35,339 (47.69)	82,351 (30.52)	40,590 (21.92)	48,653 (49.68)	89,243 (31.52)
Southern	35,323 (18.05)	16,198 (21.86)	51,521 (19.10)	30,180 (16.30)	16,348 (16.69)	46,528 (16.43)
Eastern	64,595 (33.01)	8,357 (11.28)	72,952 (27.04)	62,756 (33.89)	10,422 (10.64)	73,178 (25.85)
Western	48,772 (24.92)	14,202 (19.17)	62,974 (23.34)	51,656 (27.89)	22,500 (22.98)	74,156 (26.19)
India	1,95,702	74,096	2,69,798	1,85,182	97,923	2,83,105

Source: Livestock Census of India (1987, 2003)

Note: Figures in parentheses are percentages to total cattle, buffalo and bovine population of India.

are not able to function well and have become defunct in some states. The cases in point are the functioning of cooperatives in Uttar Pradesh, Kerala, and Madhya Pradesh where *Parag*, *Mima*, and *Uttam* have turned into loss-making enterprises. These cooperatives require significant restructuring to become performing.

The major problems that hinder the smooth functioning of these dairy cooperatives is the excessive government interference in decision-making process due to vested political interests, lack of financial support, low-capacity utilization, lack of monitoring and evaluation, poor market orientation, excessive staff to handle day-to-day activities, poor financial control, and lack of leadership and motivation to manage cooperatives. These problems coupled with unremunerative pricing and inefficient procurement policies have led to poor financial health of dairy cooperatives. In states like Madhya Pradesh, Orissa, and Uttar Pradesh, bureaucratic interference in the management of cooperatives has resulted in their deteriorating performance since under the bureaucratic leadership cooperatives are neither able to respond to the requirements of producers nor the industry. This is mainly owing to the fact that bureaucrats lack professional skills needed to manage producer cooperatives. Another reason for the deteriorating health of dairy cooperatives is the pricing policy adopted by the state governments. Although the procurement prices fixed by the state governments of Maharashtra and Punjab are reasonably in line with the producers' expectations, such prices fixed by the state governments of Andhra Pradesh and Karnataka often create distortions with respect to processed dairy products, chiefly owing to the fact that in these states selling price is determined by the government through on-the-spot interventions, which ultimately adversely affected the financial health of the cooperatives.

It deserves mention that though northern and western regions account for the bulk of the nations' total milk production, these two regions also account for more than 55 percent of the total bovine population of the country (Table 5). Almost 50 percent of the total buffalo population of India belongs to the northern region and 23 percent to the western region. The southern and eastern regions of India account for 17 percent and 11 percent of the total buffalo population of India. As for cattle population, eastern region of India accounts for the highest proportion, followed by western, northern, and southern region.

Another interesting observation emerging out from Table 5 is the decline in cattle population in India between 1987 and 2003 in the face of rise in buffalo population during the same period. Since the increase in buffalo population is much faster than the decline in cattle population, the overall bovine population in India has increased by 4.93 percent between 1987 and 2003. Northern and western regions have shown sharp increases in their buffalo population between 1987 and 2003. The western region has not only shown increase in buffalo population but also cattle population during this period. As a result, the bovine population of western region has grown by 17.76 percent between 1987 and 2003.

Dairy cooperative development appears to be more successful in northern and western regions as compared to the other region of the country. Nevertheless, it is disquieting to note that the contribution of northern region

Table 6: Changing Structure of Milk Production in Different Regions of India: 1976–77 to 2005–06

(in '000 tonnes)

Regions	Triennium Average			Percent Change		
	P – I	P – II	P – III	II over I	III over II	III over I
Northern	13875	25166	42626	81.38	69.38	207.22
Southern	5616	10719	18323	90.86	70.94	226.26
Eastern	3927	7604	11702	93.66	53.89	198.03
Western	5713	12397	19894	116.99	60.47	248.21
Share in India (%)						
Northern	47.63	45.03	46.06	-5.46	2.28	-3.30
Southern	19.28	19.18	19.80	-0.51	3.23	2.70
Eastern	13.48	13.61	12.64	0.94	-7.07	-6.19
Western	19.61	22.18	21.50	13.11	-3.10	9.61

Note: Period I: 1976/77–1978/79; Period II: 1990/91–1992/93; Period II: 2003/04–2005/06

to country's total milk production has been declining continuously since the late seveties; the decline being 48 percent during the late seventies to 46 percent by the mid-two thousand. Contrary to this, the share of western region in the country's total milk production has increased from 20 percent during the last seventies to 22 percent by the mid-two thousand (Table 6). The contributions of southern and eastern regions have remained by and large constant over the given 30 years' time period. It could be readily further discerned from Table 6 that the western region, in particular, has shown perceptible overall increase (248 percent) in its milk production figures, followed by southern region (226 percent), northern region (207 percent), and eastern region (198 percent).

Interestingly, all the regions of India have shown slowing down in their milk production increase between early-nineties and mid-two thousand periods as against the period between late-seventies and early-nineties; the slowing down being more sharp in western region, followed by eastern, southern and northern region. The production of milk in different states and region depends upon the productivity of milch animal and total breedable milch population (Patel, 1993). There have been significant inter- and intra-regional variations in the productivity of cows and buffaloes. The productivity of cows and buffaloes are seen to be relatively high in states falling in northern and western region (Shah, 2002). So far as growth in breedable bovine population in concerned, it is notice to be higher in states falling in northern region followed by western, southern, and eastern regions (Patel, 1993). These observations are symptomatic of higher production potentiality of northern and western regions in contrast to southern and eastern regions. As a matter of fact, *differences in the distribution of breedable bovine population in different regions of the country are mainly due to differences in the resources base with regard to feeds and fodder, animal health cover and number of insemination in the field areas for breed improvement. As a result, improvement in genetic architecture of milch animals is also seen to be vastly different.* The cumulative effect of these factors has largely affected the milk production in different regions of India.

Ranking of States

It is evident from Table 7 that Uttar Pradesh ranked first in total milk production of the country over the past 30 years. However, the position of Rajasthan has come down from 2nd during the late seventies to 4th by the early nineties with a rise in its ranking to 3rd by the mid-two thousand. The ranking of Andhra Pradesh in total milk production of India though declined from 4th in the late-seventies to 10th by the early-nineties, its ranking again rose to 4th in the mid-two thousand. Similarly, Gujarat showed a decline in its ranking in total milk production of India from 5th in the late-seventies to 6th by the early-nineties only to regain its 5th position in the same in the mid-two thousand. States

Table 7: Ranking of States According to Milk Output during Different Periods: 1976–77 to 2005–06

States	P - I	P - II	P - III	Change	
Andhra Pradesh	4	10	4	Constant	
Arunachal Pradesh	21	21	23	Decrease	
Assam	14	15	17	Decrease	
Bihar	7	9	8	Decrease	
Goa, Daman & Diu	20	24	22	Decrease	
Gujarat	5	6	5	Constant	
Haryana	8	7	9	Decrease	
Himachal Pradesh	15	16	16	Decrease	
Jammu & Kashmir	17	14	14	Increase	Rank Correlation Coefficients
Karnataka	12	12	11	Increase	
Kerala	13	13	13	Constant	R12 = 0.9508
Madhya Pradesh	6	3	7	Decrease	
Maharashtra	10	5	6	Increase	R23 = 0.9608
Manipur	18	18	19	Decrease	
Meghalaya	19	19	20	Decrease	R13 = 0.9646
Mizoram	25	25	25	Constant	
Nagaland	24	20	21	Increase	
Orissa	16	17	15	Increase	
Punjab	3	2	2	Increase	
Rajasthan	2	4	3	Decrease	
Sikkim	22	23	24	Decrease	
Tamil Nadu	9	8	10	Decrease	
Tripura	23	22	18	Increase	
Uttar Pradesh	1	1	1	Constant	
West Bengal	11	11	12	Decrease	

Note: Period I: 1976/77–1978/79; Period II: 1990/91–1992/93; Period III: 2003/04–2005/06

like Arunachal Pradesh, Haryana, Bihar, Himachal Pradesh, Madhya Pradesh, Tamil Nadu, and West Bengal have shown an overall decline in their ranking in terms of their contribution to country's total milk production; the decline in ranking being from 21st to 23rd by the mid-two thousand for Arunachal Pradesh, from 8th to 9th for Haryana, from 7th to 8th for Bihar, from 15th to 16th for Himachal Pradesh, from 6th to 7th for Madhya Pradesh, from 9th to 10th for Tamil Nadu, and from 11th to 12th for West Bengal .

The state of Kerala did not show any change in its ranking in terms of its contribution to country's total milk production, and occupied 13th rank in this respect during the entire period between late-seventies and the mid-two thousand. Similarly, Mizoram also occupied 25th rank in country's total milk production throughout the period between late-seventies and the mid-two thousand. Some of the states showed an increase in their ranking in terms of their share in country's total milk production. During the period between late-seventies and the mid-two

thousand, the ranking in this respect was found to increase from 10th to 6th for Maharashtra, from 12th to 11th for Karnataka, from 24th to 21st for Nagaland, from 16th to 15th for Orissa, from 3rd to 2nd for Punjab, and from 23rd to 18th for Tripura.

The estimated rank correlation coefficient in respect of cross-section of states was found to be not only positive but also very high between the period 1 and 2 (0.9508), 2 and 3 (0.9608), and 1 and 3 (0.9646). This indicates that, in general, there has not been much of a change in the ranking of different states in respect of their contribution to country's total milk production during the difference between late seventies and the mid-two thousand since decrease in ranking in this respect for some states was compensated by increase in ranking for some other states.

Growth and Instability

The pattern of milk output growth along with instability in rates of growth for different states and UTs over the past three decades is presented in Table 8. Wide variations in

Table 8: Growth and Instability in Milk Production across States and UTs in India

States/ UTs	CGR %			C.V.V. %			CII %		
	P – I	P – II	P – III	P – I	P – II	P – III	P – I	P – II	P – III
Andhra Pradesh	3.31	6.68	4.91	13.82	27.61	43.29	5.55	4.85	5.66
Arunachal Pradesh	2.74	5.33NS	1.39	11.08	26.79	22.24	2.10	29.32	20.03
Assam	3.13	0.46NS	2.10	12.80	7.00	18.22	3.24	7.53	5.82
Bihar	4.39	3.95	3.45	17.93	25.60	33.40	5.33	10.17	8.03
Goa , Daman & Diu	–0.25NS	4.57	3.29	23.02	19.49	32.33	24.87	5.17	17.41
Gujarat	4.45	4.66	4.41	18.61	19.60	35.95	7.12	3.00	5.30
Haryana	4.93	2.97	4.31	19.79	12.54	33.38	4.97	1.36	3.79
Himachal Pradesh	5.81	2.47	4.22	22.77	10.79	32.10	1.50	2.70	2.59
Jammu & Kashmir	7.68	6.31	8.01	30.83	26.69	59.65	4.93	18.74	13.43
Karnataka	6.59	4.07	5.29	24.46	19.98	41.39	4.73	7.12	6.12
Kerala	7.51	1.14NS	4.61	27.33	11.66	35.25	8.67	6.35	8.43
Madhya Pradesh	7.25	2.48	4.54	30.90	11.36	34.30	8.01	3.27	6.22
Maharashtra	7.38	3.86	6.14	29.12	16.03	44.94	4.89	2.83	4.31
Manipur	3.52	–0.39NS	0.58	14.09	11.11	12.76	1.57	8.33	6.26
Meghalaya	–1.49NS	2.73	1.32	11.84	11.64	15.83	13.90	1.04	9.46
Mizoram	11.91	5.40	7.96	49.99	29.01	58.23	16.06	20.89	18.57
Nagaland	24.88	3.80	14.40	114.41	18.70	70.43	60.16	4.02	39.61
Orissa	6.11	6.90	5.96	22.89	30.78	50.10	7.04	6.56	6.69
Punjab	4.89	3.59	4.37	19.16	14.95	34.11	1.98	1.52	1.89
Rajasthan	2.87	5.18	4.01	11.90	21.28	34.60	3.60	3.23	3.52
Sikkim	4.92	3.71	4.20	19.73	17.39	33.90	3.94	5.42	4.71
Tamil Nadu	7.88	3.31	4.36	29.80	14.53	32.74	13.14	4.50	9.71
Tripura	6.07	8.95	7.46	23.44	35.86	62.03	3.80	12.54	9.18
Uttar Pradesh	5.12	4.46	4.59	19.86	18.92	36.61	3.05	0.73	2.15
West Bengal	8.36	1.67	4.07	30.25	7.30	29.72	8.19	1.26	6.26
Total States	5.40	3.97	4.55	20.87	16.65	35.46	1.76	0.93	1.51
Andaman & Nicobar	23.69	–0.18NS	8.81	68.66	6.34	47.95	51.78	7.32	35.09
Chandigarh	5.32	1.55	4.05	22.48	7.26	31.29	5.78	3.02	4.70
Dadar & Nagar Haveli	10.80	0.80NS	8.51	43.27	31.55	67.16	22.88	57.11	41.89
Delhi	4.31	2.08	2.80	18.65	8.99	22.51	8.21	2.39	5.84
Pondicheri	8.69	2.84	5.37	36.77	12.48	38.78	23.92	5.34	16.31
Total UTs	4.44	1.91	2.75	19.44	8.31	22.13	8.00	2.31	5.65
India	5.39	3.96	4.54	20.84	16.60	35.38	1.77	0.93	1.51

Note: 1) Period I: 1976/77–1990/91; Period II: 1991/92–2005/06; Period III: 1977/78–2005/06
2) CGR – Compound Growth Rate; CV – Coefficient of Variation; CII – Coppock's Instability of Index
3) All values of CGR significant at 1% level of probability
4) NS – Not Significant at 1% level of probability

rates of growth of milk production were noticed for different states and UTs. During the period between 1976–77 and 2005–06, states falling in northern region showed 4–8 percent annual growth in their milk production figure with Jammu and Kashmir showing the maximum growth (8.01 percent), followed by Uttar Pradesh (4.59 percent), Punjab (4.37 percent), Haryana (4.31percent), and Rajasthan (4.01 percent). The milk production figures of the states of southern region are estimated to have growth in the range of 4 to 5 percent per annum during the same period with Karnataka showing the highest growth (5.29 percent), followed by Andhra Pradesh (4.91 percent), Kerala (4.61 percent), and Tamil Nadu (4.36 percent). The annual growth in milk production for the states of eastern region was found to be in the range of 1 to 14 percent with Nagaland showing the highest rate of growth (14 percent) followed by Mizoram (8 percent), Orissa, West Bengal and Sikkim (4-6 percent), and Arunachal Pradesh, Assam, Bihar, and Manipur (1–3 percent). As for western region, Maharashtra and Madhya Pradesh recorded about 5–6 percent annual growth in their milk production, followed by Gujarat and Goa, which showed 3–4 percent annual growth in their milk production during the same period.

In general, the milk production of the country is estimated to have grown at the rate of 4.54 percent per annum over the given three decades period with states put together showing an average growth of 4.55 percent and UTs, 2.75 percent. Interestingly, a number of states showed deceleration in their rates of growth of milk production during the second half 1991/92–2005/06) of the overall period as against the first half (1976/77–1990/91). A case in point in this respect were the states such as Assam, Bihar, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Nagaland, Punjab, Sikkim, Tamil Nadu, Uttar Pradesh, and West Bengal, which showed slowing down in their rates of growth of milk production between 1991–92 and 2005–06 as against 1976–77 and 1990–91. Contrary to this, some other states like Andhra Pradesh, Arunachal Pradesh, Goa, Gujarat, Meghalaya, Orissa, Rajasthan, and Tripura showed an acceleration in their rates of growth of milk production during the second half (1991/92–2005/06) of the overall period as against the first half (1976/77–1990/91). All the UTs showed deceleration in their rates of growth of milk production during the second half as against the first half of the overall period.

Although India has witnessed about 4.5 percent annual growth in milk production during the period between 1976–77 and 2005–06, this growth in milk production is achieved at the face of wide overall fluctuations/instabilities in the same. Very high degree of instability was noticed in case of states like Bihar, Gujarat, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Orissa, Tamil Nadu, Tripura, and West Bengal seemed to be associated with high growth rate. To a certain extent this has been true of certain UTs also like Dadra and Nagar Haveli, Pondicheri, and Andaman and Nicobar.

Moderately high degree of instability is seen to be associated with moderate as well as high growth rates in the case of states like Andhra Pradesh, Goa, Daman and Diu, Haryana, Maharashtra, Mizoram, Nagaland, Rajasthan, and Sikkim. However, states like Arunachal Pradesh, Assam, Manipur, and Meghalaya are seen to show very slow growth in their milk production figures, which are also seen to be associated with very low to moderately high instability in rates of growth. Nevertheless, the overall instability of the country's milk production is seen to be less than the annual rate of growth in milk production during the period between 1976–77 and 2005–06. This is an indication of the fact that annual milk production in India has been growing at a reasonable rate with very low instability. The period between 1991–92 and 2005–06 not only witnessed slowing down in rate of growth of milk production but also reduced fluctuations in rates of growth of country's milk production. However, since the country achieved a reasonable overall annual growth in milk production, which was associated with very low year-to-year fluctuations, this kind of growth is needed for the overall sustainability of future growth in milk production of the country.

Regional Imbalances

The milk production data of various states were further analyzed to get an overall idea about the imbalance prevailing in different regions of India in terms of rates of growth in production. The results are brought in Table 9. An overall analysis in relation to comparative position of different regions discloses that the eastern reason lags far behind other regions of the country in terms of growth performance of milk production. The rate of growth in milk production of this region over the past three decades is seen to be only 3.75 percent a year, which turns out to be much below the national average rate of growth. As a matter of fact, all the states of the eastern region have shown their milk production to have growth rate less than

Table 9: Growth and Instability in Milk Production in Different Region of India

Regions	CGR %			C.V.V. %			CII %		
	P – I	P – II	P – III	P – I	P – II	P – III	P – I	P – II	P – III
Northern	4.63	4.20	4.45	18.11	17.52	35.43	2.05	0.96	1.57
Southern	5.97	4.31	4.80	22.79	17.91	37.16	4.73	3.05	4.02
Eastern	5.73	3.10	3.75	22.01	16.26	30.33	3.69	5.25	4.54
Western	6.32	3.62	4.97	24.90	15.38	37.68	3.32	2.07	2.94

Note: 1) Period I: 1977/78–1990/91; Period II: 1991/92–2005/06; Period III: 1977/78–2005/06
2) CGR – Compound Growth Rate; CV – Coefficient of Variation; CII – Coppock's Instability of Index
3) All values of CGR significant at 1 percent level of probability

the national average with Mizoram, Nagaland, and Orissa being the only aberration in this scenario (Table 9). On the other hand, western and southern regions showed much faster rate of growth in milk production compared to national average. The northern region showed its milk production to grow slightly lower than the national average. However, the growth in milk production of northern region is seen to be higher than eastern but lower than western and southern regions.

Another important aspect is the deceleration in rates of growth of milk production in all the regions of India during the period between 1991–92 and 2005–06 as against the period between 1976–77 and 1990–91. This deceleration was more pronounced in western region, followed by eastern, southern, and northern region. As for instability in rates of growth, the eastern region showed maximum overall fluctuations in milk production during the given period of time, followed by southern, western, and northern region. The fluctuations in rates of growth of milk production were higher for northern, southern, and western regions during the first half of the overall period as against the second half. However, eastern region of India showed higher fluctuations in rates of growth of milk production only during the second half as against the first half of the overall period.

It is to be noted that the share of northern region in overall milk output of India has come down in due course of time (Table 6). The reasons of declining share of northern region over the past three decades are not far to seek from. Slow output growth in milk production of major states could be considered as one of the principal clauses for the falling share of this region in total milk production of the country. Despite the fact that states like Uttar Pradesh and Rajasthan together account for about 60 percent of the total milk production of the northern region, the growth in milk output of these two states is seen to be rather very slow, particularly in the case of Rajasthan. *Although, in general, the productivity of bovines as well as growth in breedable population of the same is higher in northern region as compared to other region of the country, it is to be noted that within the northern region while the breedable buffalo population is the lowest in Uttar Pradesh, the growth in breedable cattle population is negative in Rajasthan when compared with the other states of this region.* Added to this, the milk productivity of buffalo is also the least in Uttar Pradesh as compared with the other states of this region. As for milk productivity of cattle, the states like Haryana and Punjab have shown much higher productivity as compared to Rajasthan and Uttar Pradesh. Thus, poor growths in breedable bovine population coupled with lower productivity of bovines have greatly affected the milk output growth of these two states over time. The cumulative effect of these factors have led to downward slide in the share of this region in country's total milk production over the given time period.

Thus, the overall analysis presents us with two different scenarios. While on one hand there has been substantial growth in milk production of majority of the states, a time-scale declaration, on the other hand, in rates of growth also seen to be caught up with most of the states during some phase of the overall period considered. The slowing down in milk production growth of majority of the states in more recent times has raised question about our ability to meet the domestic requirements in the near future. It becomes, therefore, essential to assess future demand supply position of the country in milk production.

Demand–Supply Perspective

Several research workers have provided various estimates of India's demand for milk (Dastagiri, 2003; Kumar and Mathur, 1996; Patel, 1993). Among various studies, the

study conducted by Dastagiri (2003) relates to estimation of production, consumption, and surplus of milk in India for the years 2000 and 2020. While estimating demand, this study assumed 1.63 percent, 1.54 percent, 1.40 percent, and 1.51 percent per annum growth in population during 1993–2000, 2000–10, 2010–20, and 1993–2020, respectively, 1.46 percent, 3.62 percent, and 3.49 percent per annum growth in per capita income for rural, urban, and pooled, respectively, and pace of urbanization consistent with the recent historical trend. The estimates provided by Dastagiri (2003) with respect to production (supply) and consumption (demand) of milk and various other livestock products are brought out in Table10.

Table 10: Projections of Livestock Products Production and Domestic Consumption

Year/ Livestock Product		2000	2020	Growth rate
Milk	Production	78.56	232.09	5.56
	Consumption	60.77	147.21	4.77
	Surplus	17.79	84.88	
Mutton and goat meat	Production	0.67	9.85	14.40
	Consumption	1.36	12.72	13.62
	Surplus	–1.31	–3.13	
Beef and buffalo meat	Production	3.29	9.11	5.22
	Consumption	0.61	1.15	3.39
	Surplus	2.68	7.96	
Chicken	Production	0.65	2.70	7.38
	Consumption	0.33	0.81	4.72
	Surplus	0.32	1.89	
Egg	Production	32.75	102.91	5.89
	Consumption	13.88	44.06	6.12
	Surplus	8.87	68.85	
Fish	Production	5.66	13	4.40
	Consumption	4.45	8.52	3.30
	Surplus	1.21	4.48	
Pork	Production	0.55	8.22	14.44
	Consumption	N.E.	N.E.	N.E.
	Surplus			
Mutton	Production	0.55	8.21	14.44
	Consumption	N.E.	N.E.	N.E.
	Surplus			
Beef	Production	1.48	5.61	6.87
	Consumption	N.E.	N.E.	N.E.
	Surplus			

Source: Dastagiri (2003)

Since India is likely to generate significant surpluses of milk, the residual after domestic requirement will, therefore, be available for conversion into value added products for exports provided international prices remain favourable. Under such a veritable situation, cooperatives will have to play a crucial role in diverting farmers' produce in the world market. And, among various states, Maharashtra, that ranks first in terms of number and capacity of milk plants operating under central authority as well as state registered authority, will face newer kind of challenges under changed market conditions. The other major states viz., Uttar Pradesh, Gujarat, Rajasthan, Karnataka, Tamil Nadu, and Punjab will also face competition in this respect.

In fact, *cooperatives have an edge over other competing sectors due to their organizational structure. The federal structure despite many weaknesses provides a very wide network to link many producers to the tertiary level of the economy. Their relevance will now be felt not only in expanding production but also in export trade of milk and milk products.* However, how best India can meet the challenges arising in the WTO regime would depend on India's export capabilities and available surplus for exports, aside from favorable international market conditions. In the present milieu, the subsidies extended by the European Union countries have created havoc and cheated farmers belonging to developing countries due to depressed international market prices. As long as subsidized production in modern bloc countries continue, the farmers in the developing bloc nations will remain the deprived sections to reap the fruits emanating in the free trade regime due to trade distortions.

Conclusions

The application of scientific production techniques coupled with greater importance being given to the development of the diary cooperative infrastructure has led the milk production of our country to increase substantially over the past three decades. Since India still holds enormous potential in its diary sector, this potential needs to be tapped in the desire manner and direction. India has already become leading producer of milk in the world. The future supply and demand scenario already indicates that India would be a country surplus in milk and, therefore, is likely to generate value-added milk products for exports

after meeting the domestic requirements. However, the slowing down in the milk production increases in more recent time in most of the states and region of the country certainly raises cause of concern. Corrective measures, therefore, need to be exercised to overcome slow growth of milk production in various regions of the country. Strategies should be framed for the sustainable growth of milk production in various states and region of India. In this context, it is worthwhile to mention that a medium-term strategy that can realize the utilized production potential of milch animal in different states of India, which could be considered as integral part of long-term strategy for increasing the resource base of the farmer, will be more conducive than a strategy based on capital-intensive and high-production technology. Since there still exists vast scope for increasing milch animal productivity, this potential needs to be exploited by following improved animal husbandry practices. However, this warrants effective machinery for imparting extension services to the farmers through cooperatives. The prospects for milk production in various states in the near future will also depend on the extent to which farmer take up fodder cultivation as an integral part of milk production. These measures may provide rich dividends for increased milk production in the country.

Notes

1. In course of time, India has gradually changed her position from stagnant producer during the decades of fifties and sixties to the world's largest producer of milk of late. Though the contribution of agriculture and allied sectors to the gross domestic product (GDP) of India declined from 55 percent in the early fifties to 39.5 percent in 1981–82 and further to 23.9 percent in 2001–02, the livestock remained among the few high-growth sectors in rural India (Sharma, 2004). This could be evident from the fact that this sector accounted for 25.5 percent of agricultural GDP and 5.6 percent of total GDP of India in 2001–02. Not only this, the share of livestock in gross value of agricultural output at 1993–94 prices increased from 18.6 percent in 1971–72 to 35.5 percent in 2001–02 (CSO, 2003). The dairy sector contributed the largest share in agricultural GDP.
2. The first phase of the "OF" program began on July 1, 1970 and ended on March 31, 1981 with an investment of Rs.116.50 crores, covering 39 milk sheds, 13,270 dairy cooperative societies (DCSs), 17.5 lakh members, 2.56 million kg average daily milk procurement with 27.8 lakh liters per day liquid milk marketing. Operation Flood – II, which began in 1981, aimed at building a National Milk Grid linking 136 rural milksheds in 22 states and UTs with the urban demand centers in the country and creating infrastructure required to support a viable dairy industry. The "OF-III" programme began in April 1, 1987 and concluded on April 30, 1996 with an investment of Rs.137.95 crores, covering 170 milk sheds, 72,744 DCSs, 93.0 lakh members, 11.0 million kgs average daily milk procurement with 110.0 lakh liters per day liquid milk marketing.
3. A typical Anand Pattern dairy cooperative structure has three tiers of a well-structure organization with a milk producer consulting the smallest unit of the entire business enterprises. The three tiers are: the village level dairy cooperative society federating producer member; the district level cooperative milk producers' union federating the village societies and the state level federation constituting of all the district level unions. Of these three tiers, the district cooperative union is the mist active unit as it owns the physical infrastructure required for the milk procurement, processing and manufacturing of milk products and for generating inputs required for increasing milk production.
4. According to Coppock (1962), the annual instability index equals the anti-log of the square root of the logarithmic variance. The series is given in algebraic form as follows:

N = Number of years

$$V\log = \frac{1}{N-1}\left[\sum \log X_{t+1} - \log = \frac{1}{X_t - N\text{-}1}\sum (\log X_{t+1} - \log X_t\right]^2$$

or

$$V\log = \frac{\left[\log \frac{X_{t+1}}{X_t} - m\right]^2}{N-1}$$

X = Value of the parameter

m = Mean value of the logarithmic first difference

Coefficient of Variation is computed using the following formula:

C.V. = (Standard Deviation / Mean) x 100

C.V. = (σ / μ) x 100

5. The rank correlation coefficient was estimated as follows:

$$R_{ij} = 1 - \frac{6 \sum D^2}{N(N^2 - 1)}$$

where

R_{ij} denotes rank correlation coefficient between period "i" and "j,"

D refers to the difference of rank between paired items in two series

N stands of number of observation in the series.

6. For pursuing objectives relating to promotion of dairy activities in non-operation flood areas, Department of Animal Husbandry and Dairying of the Ministry of Agriculture implemented four schemes in the dairy sector during 2004–05, including a new central sector scheme "Dairy/Poultry Venture Capital Fund." Aside from this, the NDDB continues its activities for the overall development of dairy sector in OF areas.

7. The main objectives of the scheme encompass: (a) development of milch cattle, (b) increase the milk production by providing technical inputs services, (c) procurement, processing and marketing of milk in a cost effective manner, (d) ensure remunerative prices to the milk producers, (e) generate additional employment opportunities, and (f) improve social, nutritional and economic status of residents of comparatively more disadvantaged areas.

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The simple act of paying positive attention to people has a great deal to do with Productivity.

—Thomas J. Peter

Focus

Environmental Externalities by the Small-scale Dairy Farmers: A Case Study from India

K. A. C. H. A. KOTHALAWALA, SANJAY KUMAR, Y. P. SINGH, MAHESH CHANDER AND H.R. MEENA

Environmental problems occur when cow dung and dead animal are improperly utilized or disposed off during production process of livestock, especially in cattle and buffalo. This research was carried out to find out whether the small-scale dairy is competitive enough to mitigate the environmental problem during the course of dairy farming or not as compared to a large-scale dairy. Simple stratified random sampling was used, where 120 dairy farmers from Bareilly district of Uttar Pradesh were interviewed. Using nutrient mass balance approach, the environmental externality among different classes of dairy farmers was measured. There was negative mass balance in landless farmers in both the N and P_2O_5 in both the blocks. The N mass balance of marginal farmers was positive. Other groups—small, medium, and large—had positive mass balance in both the N and P_2O_5. Negative mass balance in landless and marginal farmers implies a lack of land to absorb all nutrients they produced in the dairy. Positive mass balance of N and P_2O_5 in the three groups implies that there was land to assimilate more nutrients than they produced. Large farmers showed huge excess capacity to absorb the nutrients produced within the farm household. On an average, the area produced 54.37 kg dung per ha. Irrespective of the landholding size, dead animals thrown to the outskirts was the common practice among all groups of dairy farmers. Nutrient mass balance, dung disposal, dung loading explained the higher efficiency of meeting the environmental issues. Dead animal disposal pattern needs some improvement.

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A major environmental problem associated with livestock production is disposal of dung along and dead animals during the growth period. Environmental problems may occur if these products are improperly utilized or disposed off. The problem outlined is not scale specific. It can occur to thousands of smallholders as well as in one large-scale operator. Nutrient mass balance (N, P, P_2O_5 mainly) that is the deficit between nutrient production from animal units and crop uptake of these nutrients is a measurement to detect surplus nutrient, which will lead to many environmental externalities. According to the LEAD paper (FAO, 2002) nutrient mass balance for swine production showed an excess nitrogen and phosphorous in swine production in Thailand, the Philippines, and Brazil. For each of the three countries in which the swine population was sampled, larger producers for the most part showed larger deficits, indicating a greater need to find adequate disposal methods for manure while smallholders showed lesser deficit in that study. Camargo and Poapongsakorn (2002) reported that nutrient balances for the large number of small-scale broiler-producing households with positive mass balances in Thailand and around 5 percent of small and medium producers in Brazil could absorb manure in their own land. They studied about the nutrient mass balance in Thailand dairy farms and found out that small-scale producers are capable of disposing their waste when adequate land is there. Sharma et al. (2002) did mass balance calculations for dairy, poultry, and pig-keeping households in India. In this study, the amount of nutrients in the manure is estimated in terms of organic nitrogen (N) and phosphate (P_2O_5). Nutrient value from livestock was calculated on the basis of animal units. On the basis of given amount of N and P_2O_5 in lbs in different animal units, the nutrient availability has been calculated. The nutrient balance of the farm is taken from the difference of manure nutrient production and nutrient uptake by crops. It was concluded that Indian dairies have a capacity to assimilate the nutrients they produce. Delgado et al. (2004)

reported that the mass balance and cost for environmental mitigation for dairy production was comparatively in balance according to the study carried out in India and some other countries. Berge et al. (2004) carried out a study to asses the suitability of three different indicators (N application rate, N surplus and residual mineral soil N in autumn) for NO_3 leaching on sandy soils. The study was carried out on dairy systems and other arable farms. It was revealed that in the dairy system, all three indicators performed approximately equally well, and NO_3 concentration was clearly related to N balance components. Marini and Amburgh (2005) studied about whole animal N metabolism, N excretion , and its partition between dung and urine in growing heifers. It was reported that the increasing N content of the diet increased urinary N excretion and N balance, but did not affect fecal N excretion in particular nitrogenous compounds that were readily converted to ammonia. Gerber et al. (2005) did a nutrient balance (nitrogen, phosphate, and Potash) in soil level in South, East, and Southeast Asia for a given area of agricultural land. In that study available manure and mineral fertilizer were taken as two inputs and crop uptake and manure as a fuel were taken as out puts. FAOSTAT was considered for the number of animals, crop production and fertilizer application at country level. It was revealed that manure could represent a substantial source of phosphate especially in countries where mineral fertilizer consumption is low. Moreover it was considered that the areas with more than 30 kg of manure per ha had high overloads (>30kg/ha) and areas with <30 kg per of manure per ha were low overload areas.

Material and Method

Stratified random sampling was the sampling method selected for the study. Bareilly district consists of 6 *tahsil*s and there are 15 development blocks under them. Out of these blocks, two were selected as first strata. The *gram panchayat* was selected as the second strata. Though it

Table 1: Bovine Population Dynamics (Percentage)

S. No.	Tahsil	Category	Different *Tahsils* in Bareilly Districts: 2003			
			Cattle Pou. % to bovines *	Buffalo Pou. % to bovines **	Bovine pop % total pop. ***	Total animal Population
1	Faridpur	Rural Urban Total	0.37 0.01	0.60 0.02	77.33 2.11	172457 5923 178283
2	Aonla	Rural Urban Total	0.31 0.01	0.66 0.02	73.59 2.47	197298 9344 206544
3	Meerganj	Rural Urban Total	0.32 0.02	0.62 0.04	70.73 4.33	94194 8580 102677
4	Nawabganj	Rural Urban Total	0.28 0.01	0.69 0.02	77.90 2.23	112300 3748 115951
5	Baheri	Rural Urban Total	0.27 0.03	0.66 0.04	71.29 5.46	125739 12838 138479
6	Bareilly	Rural Urban Total	0.34 0.01	0.63 0.02	76.35 2.43	151492 7826 159220
	Total Rural		0.31	0.63	74.41	853485
	Total Urban		0.02	0.03	4.40	51151
	Total District					904539

Note: * Total cattle population to the total bovines in the *tahsil*
** Total buffalo population to the total bovines in the *tahsil*
*** Total bovine population to the total animal population in the *tahsil*

was mentioned as the village as the second strata in the research outline, *gram panchayat* was finally selected due to inadequate number of households (< 30) in some of the villages in selected two blocks.

Two blocks, namely, Bhojipura and Bitharichainpur were selected randomly out of fifteen blocks in the district. Table 1 indicates that bovine population distribution in *tahsils* in the district. Since it showed less variability (70.73–77.90%) in bovine population across the *tahsils*, it was assumed that the selected blocks represented the population of the district. Trikunia and Sarkara were randomly selected out of a total of 64 *gram panchayats* from Bitharichainpur block. Similarly Dalpatpur and Ishapur were selected randomly from Bhojipura block out of a total of 68 *gram panchyats* (Table 2). The list of all farmers having at least one milch animal in the farm was prepared from the selected four *gram panchyats*. Trikunia had a total of 202 dairy farm households and 30 were selected randomly. Sarkara had 134 dairy farm households and 30 were selected randomly. Similarly Dalpatpur had 102 dairy farm households and Ishapur had 136 households. Thirty households from each *gram panchayat* were selected randomly. Thus a total of 120 households made up the sample for the study.

Table 2: Sampling Design

S. No.	Block	Number of gram pancha-yats	Selected gram pancha-yats	Number of villages	Number of dairy farm HH
1	Bhojipura	68	Trikunia	3	30
			Sakara	2	30
2	Bitharichainpur	64	Dalputpur	2	30
			Ishapur	1	30
Total number of sample					120

Table 3: Distribution of Different Groups in Blocks

	Group	Land size	Number of households		Area
			Bhojipura	Bithari-chainpur	
1	Landless	No own land	4	8	12
2	Marginal	<1 ha	25	31	56
3	Small	1–2 ha	15	15	30
4	Medium	2–4 ha	14	6	20
5	Large	>4 ha	2		2
Total			60	60	120

The collected data were compiled systematically in two sets as Bhojipura and Bitharichainpur. According to the available literature since there is positive correlation between land holding and number of animals kept (Saran et al. 2002) and operating land holding has impact on animal waste handing (Sharma et al.2002). Further categorization was done according to the land area they own (Table 3). There were five groups, as indicated in Table 3.

Estimation of Nutrient Mass Balance

To achieve the last objective, that is to study about the environmental externalities in sample households, the potential of the farm household to utilize all nutrients produced on farm were estimated.

Environmental externality is estimated based on:

- Nutrient production from the cattle units in the farm.
- Nutrient uptake by the crops cultivated in the land.
- Manure disposed from the farm.
- Mass balance of nutrients.

Estimation of cattle units

According to Kellog et al. (2000) and glossary of livestock standard units (2005), animal units were calculated as follows.

Adult crossbred cow = 1.4

Adult buffalo = 1.3

Adult local cow = 1.0

Crossbred heifer above 1 year = 0.75

Calf above 1 year = 0.50

Calf below 1 year = 0.33

Nutrient (N and $P_2 O_5$) production from the cattle units in the farm

Total N and $P_2 O_5$ production from each block was calculated. These two nutrients were chosen because they are the nutrients for which regulations are primarily written, assuming that there is any regulation at all. The following formula (Sharma et al. 2002) was used to calculation of the mass balance.

$$T_h^n = \Sigma a_l^n AU_{lh} + CF_h^n$$

where,

l = livestock category (dairy)

n = nutrient type (N / $P_2 O_5$)

h = household

T_h^n = Total nutrient n deposited by household

AU_{lh} = Animal units of livestock type 1 (cattle) in household h

CF_h^n = Form of nutrient n applied as commercial fertilizer by household h

a In = Amount of nutrient n produced per animal unit of livestock type I

The amount of nitrogen and phosphate production was estimated as 16.9 lbs and 29.3 lbs in each 0.7 unit, respectively.

It was taken as 2.2 lbs = 1 kg

Since there was not much chemical fertilizer usage according to the farmers it was assumed as nil.

Estimation of crop uptake

The capacity of these nutrients that were used at the household level was estimated assuming that all the available land was planted with a crop that would uptake the nutrients. Since this area cultivates rice as one crop per year it was assumed that land is cultivated with rice. This was to determine whether the household had the capacity to utilize all the nutrients produced by the existing animal units. It was considered that N uptake for rice production is 100 kg/hectare and P_2 C_5 uptake is 32 kg/ hectare (Sharma et al., 2002).

Nutrient in manure removed from the farm

According to the information furnished by the farmer on dung cake production (Kanda), compost production, and outside selling, the total production of dung per year in quintals were estimated. Further, the percentage of removal of dung cake out of the total was calculated. Accordingly the balance percentage in the land was calculated in each household.

Mass Balance of Nutrients

$$MB = " [C_u \_ (T_n \times B_d)]$$

where

MB = Mass balance of the group

T_n = Total nutrient deposited by the household dairy

C_u = Nutrient removed by crop uptake

B_d = Nutrient balance after removal by dung disposal (% of total)

Mass balance was calculated for both the blocks for all the five groups.

Result and Discussion

The mass balance of nutrients (N and P_2O_5) in five defined groups in both the blocks has been presented in the Table 4. There was negative mass balance in landless farmers in both the nutrients in both the blocks. It shows N mass balance was –7.89 kg per ha and P_2O_5 mass balance was –13.68 kg per ha in block A, while that was –11.63 kg per ha and –21.57kg per ha in block B, respectively. Marginal farmers too had negative mass balance of P_2O_5 (–6.12 kg per ha in block A and of –15.66 kg per ha in block B).The N mass balance of marginal farmers was positive. All the other groups viz. small, medium, and large had positive mass balance in both the N and P_2O_5.

Table 4: Dung Cake Production and mass balance of Nitrogen and Phosphate (kg/ha)

Item	Bhojipura						Bithrichainpur						
	Land less	*Margi-nal*	*Small*	*Medium*	*Large*	**Over all Block**	*Land-less*	*Margi-nal*	*Small*	*Medium*	*Large*	**Over all Block**	**Over all Area**
Dung cake production(%)	66.48	36.5	35.6	47.8	38.8	45.05	56.6	44.59	42.35	45.31	–	47.21	46.21
Selling (%)	**10**												
N mass balance (kg)	–7.89	50.75	117.97	247.99	467.65	175.29	–11.63	32.56	135.1	244.67	–	100.8	137.73
Potash mass balance(kg)	–13.68	–6.12	7.35	52.96	119.67	32.04	–21.57	–15.66	12.6	50.18	–	6.93	19.21

Negative mass balance in landless and marginal farmers says that there was not enough land to absorb the all nutrients they produced in the dairy. Positive mass balance of N and P_2O_5 in the entire three groups viz. small, medium, and large implies that there was land to assimilate more nutrients than they produce at present. Large farmers showed huge excess capacity to absorb the nutrients produced within the farm household. On an average both the blocks had excess capacity (positive mass balance) in N as well as P_2O_5. This indicates that the landless farmers showed negative mass balance in their farm premises where the area had excess capacity to uptake those nutrients. The normal practice was the dumping of dung in the neighbors' land specially those who did not own livestock.

Further, cropping pattern of the area showed farmers cultivate rice as a summer crop. Apart from that, wheat in winter season and some other fodder crop in between was also cultivated. Therefore, the cropping intensity was at least two in this area. In the calculation it was assumed that the cropping intensity was one in the area. Since the small, medium, and large farmers had positive mass balances (land has capacity to assimilate more nutrients) with one crop of rice there should be much more capacity to assimilate the nutrients produced when cropping intensity was two or three.

Additionally, it was observed that farmers used dung for other purposes (eg., house plastering). Accordingly, though the landless farmers had negative balance within the household system, the area has enough capacity to utilize excess nutrients. On an average, block A had a capacity to absorb 175.3 kg of N and 32.04 kg of P_2O_5 per ha and block B had a capacity to absorb 100.18 kg of N and 6.38 kg of P_2O_5 per ha. Therefore it is evident that the area has excess capacity to assimilate N and P_2O_5 than they produce. The findings were in accordance with the findings of Sharma et al. (2002) and Delgado et al. (2004) that the nutrient mass balance of Indian dairy systems are in balance. Nutrient uptake by crops depends on nutrient up take by soil. Tropical soils require far more nutrients than other types. According to the high cropping intensity it was clear that soil could absorb more nutrients. Therefore, it can be concluded that the farming systems are efficient enough to internalize the probable environmental externalities due to livestock production.

Dung Disposal Pattern

Dung disposal is a very important aspect in environmental externality. Dung can be disposed as a compost fertilizer, fuel or any other place, which can cause negative effect on environment. Dung cake is a common source of energy in rural households in India. Therefore dung disposal pattern

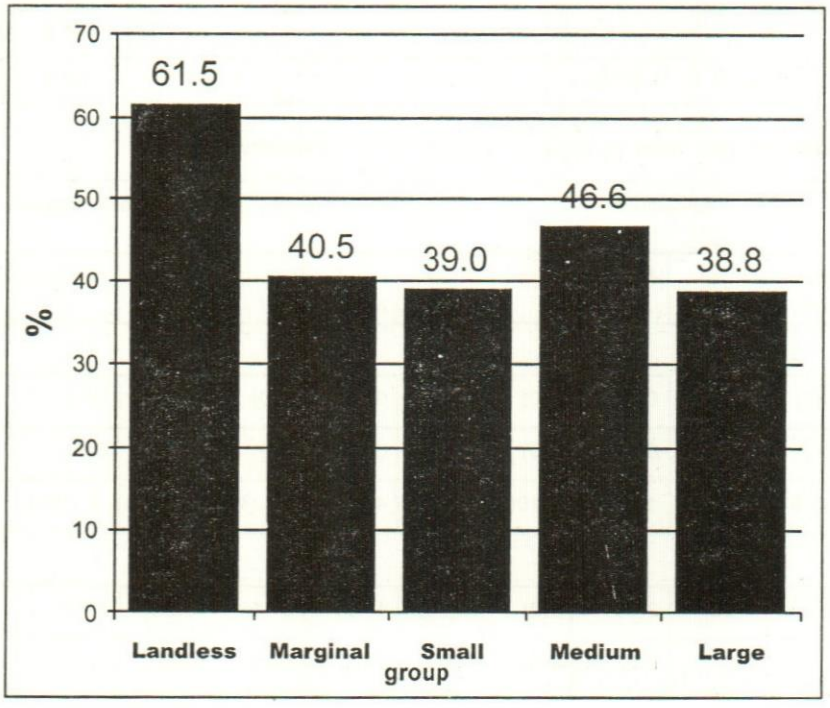

Fig. 1. Dung Disposal as Dung Cake

was analyzed and presented in Table 4. According to the table, landless farmers produce more dung cakes (66.5% and 56.6% in block A and B, respectively) compared to the other groups. The observations are rather low with the findings of India Dairy Field Survey, 2002–2003 that dung disposal as dung cake was around 80% in north zone of India. Since manure is a potentially valuable fertilizer and soil conditioner in areas with mixed farming systems, the remaining dung was utilized in their own lands. Farmers without lands used more of dung cake and disposed the balance on neighbor's lands. Therefore, dung utilization pattern as a fuel and a fertilizer shows higher capacity to recycle nutrients, which would result both environmentally and economically viable system in the area.

Dung Production

On an average, block A produces 30.3 kg per ha and block B produces 62.25 kg per ha. On an average the area produces 54.37 kg per ha. According to the dung utilization pattern (Table 5) block A uses 45.4% dung and block B uses 47.41% dung for dung cake. The balance is nearly half of the production in both the blocks. Therefore dung overload is around 30 kg per ha. According to the study on livestock density and nutrient balances across Asia, it is categorized that the areas with less than 30 kg per ha per day had low overload area and areas with more than 30 kg per ha per day had high overload area (Gerber et al., 2002). Therefore, it is seen that the area comes under low overload area.

Disposal of Dead Animals

The pattern of disposal of dead animals has an impact on environmental pollution. Therefore, the pattern of carcass disposal of each group was studied to evaluate the impact of scale of operation of dairy farming on environment. The dead animal disposal pattern in the area has been depicted

Table 4: Dung Production in Different Scale level

Group	Bhojipura			Bithrichainpur			Study Area		
	kg	ha	kg/ha	kg	ha	kg/ha	kg	ha	kg/ha
Landless	45.0	0.00		50.0	0.00		47.5	0.00	
Marginal	50.0	0.67	74.63	60.0	0.41	146.34	55.0	0.54	101.85
Small	60.0	1.48	40.54	69.0	1.56	44.23	64.5	1.52	42.434
Medium	70.0	2.59	27.03	70.0	2.61	26.82	70.0	2.60	26.923
Large	67.5	5.00	13.50				67.5	5.00	13.5
Overall	58.50	1.42	41.20	62.25	0.86	72.38	60.9	1.14	53.42

Table 5: Dung Cake Production and mass balance of Nitrogen and Phosphate (kg/ha)

Animal	Bhojipura						Bithrichainpur						
	Land less	*Margi-nal*	*Small*	*Medium*	*Large*	**Block**	*Land-less*	*Margi-nal*	*Small*	*Medium*	*Large*	**Block**	**Oveall**
1. Adult animals													
Burry	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)		0(0)	0(0)
Burn	0(0)	1(3)	0(0)	0(0)	0(0)	1(1.5)	0(0)	0(0)	0(0)	0(0)		0(0)	0(0)
Outskirt	4 (100)	31(97)	15(100)	14(100)	2(100)	66(98.5)	4 (100)	31 (100)	15(100)	6 (100)		56(93)	122(96)
2. Calves													
Burry	1 (25)	9 (28)	3(20)	2(10)	0(0)	15(23)	1(12)	5 (16)	3(20)	1(17)		10(17)	25(20)
Burn	0(0)	1(3)	0(0)	0(0)	0(0)	1 (1.5)	0 (0)	0(0)	0(0)	0(0)		0(0)	1(0)
Outskirt	3 (75)	22(69)	12(80)	12(90)	2(100)	1(75.5)	7 (88)	26(84)	12(80)	5 (83)		50 83)	101(80)

in the Table 6. Irrespective of the landholding size, dead animals being thrown to the outskirt was the common practiced among all groups of dairy farmers. All the farmers except one in the study area disposed the adult dead animals in the outskirt of the village. Only one marginal scale farmer in block A practiced burning for adult animals. Majority of the farmers (more than 60% in each group) practiced disposal at outskirt for calves too. Around 23% and 20% of farmers in block A and block B, respectively, practiced incineration. Only one farmer in block A practiced incineration for calves. There was no relationship observed with the pattern of dead animal disposal and land size. It was observed that the outskirt was 2.3 km away from the residential area. But it can be said that the dead animal disposal pattern needs change to adopt incineration or burials in the area.

Conclusion

Nutrient mass balance, dung disposal, dung loading explained the higher efficiency of meeting environmental issues within the system. Dead animal disposal pattern needs some improvement in this village area. Further, since livestock keeping is a common practice among most of the people in the area, there was no negative impression about smell and flies from dairy farming. Despite the fact that dung is a valuable fertilizer, around 50% of the produce is burnt as a fuel. Organic manure restores the soil fertility over years unlike chemicals that progressively deplete nutrients. Therefore, it should be strongly discouraged. Biogas production, which can serve the duel purpose, can be encouraged and financial assistance can be provided through concern departments and alternative source of fuel like LPG may be popularized in the villages. The method of disposal of dead animals in open place like outskirts of the villages may cause public health hazards. Therefore, farmers may be encouraged to adopt burry or incineration method of the animals through extension programs.

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Growing up on a dairy farm, you certainly learn discipline and a commitment to purpose.

—Mike Johanns

Focus

Cost–Volume–Profit Analysis Dairy Industry

P. SARVESWARA RAO AND B. RAMACHANDRA REDDY

Milk is a part and parcel of human life. Dairy industry offers opportunities galore to entrepreneurs' worldwide who wish to capitalize on one of the world's largest and fastest growing markets for milk and milk products. National Dairy Development Board designed National Dairy Plan to increase milk production in tune with the increasing demand. Andhra Pradesh is the 3rd largest producer of milk in the country.

Cost–volume–profit analysis of the sample units is studied. The proportion of cost of raw material consumed to total cost was more with Tirumala Milk Products Pvt. Ltd. when compared to Heritage Foods (India) Ltd. and Sangam Dairy during the study period. Therefore it is advised that Sangam Dairy should control all the controllable costs to improve its profits above the present level.

Out of the three sample units under study Tirumala Milk Products Pvt. Ltd. is having the best performance from the point of view of cost–volume–profit analysis followed by Sangam Dairy. Heritage Foods (India) Ltd. is also good from the point of view of its cost structure.

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India is the "oyster" of the Global Dairy Industry. It offers opportunities galore to entrepreneurs' world wide who wish to capitalize on one of the World's largest and fastest growing markets for milk and milk products. A bagful of 'pearls' awaits the international dairy processor in India. The Indian Dairy Industry is growing rapidly and trying to keep pace with the galloping progress around the World.

Indian Dairy Sector is expected to triple its production in the next 10 years in view of the expanding potential for export to Europe and the West. Moreover with WTO regulations expected to come into force in coming years all the developed Countries which are among the big exporters today would have to withdraw the support and subsidy to their domestic milk products sector. India is the lowest cost producer of per litre of milk in the World, at 27 cents, compared with U.S.63 cents and Japan $ 2.8.

Mission Milk to Increase Milk Production

National Dairy Development Board (NDDB) designed National Dairy Plan (NDP) to increase milk production intune with the increasing demand for the milk. According to the NDDB during 2010-11 the milk production was 12.28 crore tonnes and the demand for the same will be 20 crore tones by 2021-22. NDP is to be implemented in 14 States namely - Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odissa, Punjab, Rajastan, Tamilnadu, Uttar Pradesh and West Bengal.

By Recognising the importance of this Plan(NDP) World Bank expressed its willingness to sanction loan upto 80% of the Project cost (17,000 crores). It expressed its willingness to release Rs.2,242 crores for the Missions Milk's I phase.

Andhra Pradesh is the 3rd largest producer of milk in India. The first place occupied by Uttar Pradesh, followed by Rajasthan producing 21,031,000 tonnes and 13,234,000 tonnes respectively. Andhra Pradesh has determined to increase its production from 11,203,000 tonnes in 2010-11 to 15 crore tones by 2020. APDDCF under the brand name Vijaya has introduced "Vijaya Vitaminised Milk" recently and released into the market.

The Present Study

Three sample units one is Sangam Dairy (The Guntur District Milk Producers Mutually Aided Co- operative union Ltd.) the second one is Heritage Foods (India) Limited and the third Tirumala Milk Products Pvt. Ltd. have been selected for the present study. A brief profile of each sample unit is given below.

Sangam Dairy

Under the operation flood I programme, Guntur District was selected to develop dairy activities in Amul pattern. Keeping in view the 3 tier system, constituting of village dairy co-operative society at Village level, managed by the elective representatives of milk producers, a co-operative union at district level, managed by the representatives of village dairy co-operative societies and co-operative Federation at state level which is apex body, the Guntur District Milk producers co-operative Union Ltd., was registered under Andhra Pradesh Co-operative Societies Act, 1964 with registration No.836 DD with 81 affiliated milk producer cooperative societies. Presently around 643 milk producers cooperative societies and 325 milk collection centres are functioning in the area of Guntur District Milk producers cooperative Union Ltd., They are supplying a maximum quantity of 2.2 lakh litres milk per day during flush season.

The main products for the three dairy units are:

Products

1. SMP
2. Whole milk powder
3. Ghee
4. Butter: Table butter, white butter
5. Tetra pack milk: ½ liter
6. Tetra brick: 1 litre.

By Products

1. Luccy
2. Flavoured milk: Sakti
3. Dood peda: Kova

Milk producers' welfare is only the aim of Sangam Dairy.

Heritage Foods (India) Limited

Heritage Foods India Ltd., (HFIL) was incorporated under the Companies Act, 1956 in June, 1992 as a public limited company with its corporate office at Hyderabad.

The success story of Heritage Foods started with when its main promoters, Shri N. Chandrababu Naidu and his associates were overcome by a passion to contribute to the welfare of the milk farmers in Chittoor district of Andhra Pradesh through a fruitful partnership with the larger community of investors in the country. The delicensing of the dairy Industry under economic liberalization and globalization process started in 1991 came as a shot in the hand (arm) for the promoters of HFIL who saw the excellent opportunity to exploit the potential markets of the dairy Industry at home and abroad. Heritage Foods (India) Limited entered the capital market on 17th November, 1994 with a public issue of 6,50,000 equity shares of Rs.10 each for cash at par aggregating to Rs.65 millions to part finance the 147.5 millions project. The main Dairy plant 'Gokul' at Kasipentla on Tirupati – Banglore high way in Chittoor District is having initially a capacity of processing 1,00,000 litres per day of milk produces and value added products like ghee, butter, skimmed milk powder and butter. The production plant of the company in Chittoor District is ideally located with respect to availability of raw material (Milk) and proximity to the major markets like Chennai and Bangalore. The company has started marketing liquid pasteurized milk in sachets in Bangalore since June, 1993 and in Chennai since July, 1993. The product is sold, under the brand name "HERITAGE". Heritage milk was also introduced in Hyderabad city by the end of June, 1995. In Visakhapatnam the company launched milk sale in November, 1995. Milk is sold through dealer (agents) network in these metros. Heritage is an ISO9002 certified company.

Tirumala Milk Products Pvt. Ltd.

Tirumala Milk Products Pvt. Ltd. established a dairy unit named Tirumala Milk Products (P) Limited, at Kadivedu village, Chillakur Mandal, Nellore District, Andhra Pradesh and commissioned for commercial production for marketing

during September 1999 to handle 2,25,000 liters of milk per day. The plant is located on Calcutta – Chennai National highway (NH 5), 9 kms from Gudur town towards Chennai, in an area of 13.00 acres. The unit is registered as S.S.I. Unit. The milk in bulk is being purchased from other dairies processed, homogenised, packed and marketed mainly in Chennai, Bangalore and Mysore cities. The milk is being also sold in Gudur, Tirupati and Nellore towns to view of on consumers' demand. By marketing the milk in various towns, assured market outlet is provided to large number of village milk producers for their surplus milk. The required machinery is installed in the dairy. Strict quality standards are applied before marketing the milk for which well-equipped laboratory is established. In order to deliver quality milk to the consumers insulated trucks are used to transport milk from the dairy to various destinations.

Tirumala Milk Products (P) Limited is a dream come true to the dynamic young entrepreneurs who have jointly efforted to convert their skills, knowledge and experience in the field of processing and producing Milk and Milk Products.

Realizing the milk production potentialities of the inversion track of the Government of Andhra Pradesh and Government of India, with self managed financial resources and established the Tirumala Dairy in the year 1995, at Narsaraopet (Dist. Guntur) and erected new plant at Kadivedu in the year 1999. Today, the Dairy has posed to equate major Dairies in the southern region which has not only captured the market but also has made "THIRUMALA" an accepted Brand and preference of the consumers.

Cost–Volume–Profit Analysis of Sample Units

The cost structure of the sample dairies was analyzed in order to understand the effect of costs on profit. To know the proportion of different components in total cost the percentage of each component in total cost is calculated and shown in Table 1, Table 2, and Table 3.

Table 1: Cost Structure of Sangam *(Rs. in Lakhs)*

Year	Variable Cost				Total variable Cost	Fixed Cost	Total Cost
	Raw Material Consumed	Power Fuel	Frieght Admn & Selling expenses	Repairs & Maintenance			
2005-06	9041.05 (76.32)	423.94 (3.58)	835.85 (7.05)	112.41 (0.95)	10413.25 (87.90)	1433.16 (12.10)	11846.41 (100)
2006-07	10308.69 (77.30)	463.97 (3.48)	741.58 (5.56)	137.76 (1.03)	11652.00 (87.37)	1684.96 (12.63)	13336.96 (100)
2007-08	11949.72 (76.19)	534.44 (3.41)	956.61 (6.10)	174.64 (1.11)	13615.41 (86.81)	2068.46 (13.19)	15683.87 (100)
2008-09	14938.95 (79.42)	683.80 (3.63)	870.10 (4.63)	215.53 (1.15)	16708.38 (88.83)	2101.14 (11.17)	18809.52 (100)
2009-10	16912.32 (79.18)	571.31 (2.67)	1175.98 (5.51)	250.77 (1.17)	18910.38 (88.53)	2450.27 (11.47)	21360.65 (100)
2010-11	19892.70 (79.38)	709.90 (2.83)	1357.62 (5.42)	265.75 (1.06)	22225.97 (88.69)	2833.79 (11.31)	25059.76 (100)

Source: Compiled from annual reports.
Note: Figure in brackets indicates individual cost percentages to total cost.

Table 2: Cost Structure of Heritage

(Rs. in Lakhs)

Year	Variable Cost				Total variable Cost	Fixed Cost	Total Cost
	Raw Material Consumed	Power Fuel Water	Frieght Admn & Selling expenses	Repairs & Maintenance			
2005-06	22935 (83.80)	1003 (3.67)	1810 (6.61)	23 (0.08)	25771 (94.16)	1597 (5.84)	27368 (100)
2006-07	28168 (80.67)	1150 (3.29)	2984 (8.55)	23 (0.07)	323225 (92.58)	2592 (7.42)	34917 (100)
2007-08	48693 (78.73)	355 (0.58)	5539 (8.96)	45 (0.07)	54632 (88.34)	7213 (11.66)	61845 (100)
2008-09	63425 (78.98)	2056 (2.56)	6393 (7.76)	59 (0.07)	71933 (89.57)	8375 (10.43)	80308 (100)
2009-10	70519 (80.34)	1998 (2.28)	7075 (8.06)	117 (0.13)	79709 (90.81)	8062 (9.19)	87771 (100)
2010-11	87800 (81.88)	2349 (2.19)	7731 (7.21)	130 (0.12)	98010 (91.40)	9224 (8.60)	1072134 (100)

Source: Compiled from annual reports.
Note: Figure in brackets indicates individual cost percentages to total cost.

Table 3: Cost Structure of Tirumala Milk products (Pvt) Ltd.

(Rs. in Lakhs)

Year	Variable Cost				Total variable Cost	Fixed Cost	Total Cost
	Raw Material Consumed	Power Fuel Water	Frieght Admn & Selling expenses	Repairs & Maintenance			
2005-06	11747.17 (82.49)	249.79 (1.75)	1576.23 (11.07)	202.46 (1.42)	13775.65 (96.73)	465.73 (3.27)	14241.38 (100)
2006-07	23382.62 (83.83)	444.24 (1.60)	3013.15 (10.80)	354.29 (1.27)	27194.30 (97.50)	698.40 (2.50)	27892.70 (100)
2007-08	30035.22 (83.14)	639.65 (1.77)	3864.25 (10.70)	625.87 (1.73)	35164.99 (97.34)	962.17 (2.66)	36127.16 (100)
2008-09	37040.18 (82.74)	794.04 (1.77)	4652.39 (10.39)	863.36 (1.93)	43349.97 (96.83)	1418.84 (3.17)	44768.81 (100)
2009-10	47527.23 (82.39)	961.40 (1.67)	5915.52 (10.25)	1140.81 (1.98)	55544.96 (96.29)	2141.13 (3.71)	57686.09 (100)
2010-11	63883.18 (81.13)	1367.02 (1.74)	7861.75 (9.99)	1191.16 (1.51)	74303.11 (94.37)	4435.85 (5.63)	78738.96 (100)

Source: Compiled from annual reports.
Note: Figure in brackets indicates individual cost percentages to total cost.

It can be seen from the table – 4 that the Sangam Dairy had crossed the break even point in 3 years out of the six years under study. During 2005-06, 2007-08 and 2009-10 the actual sales were less than the break even sales and the resultant margin of safety during three years was negative. This reveals that sales performance was not adequate during these years. It is observed that the variable cost was either increasing or decreasing consistent, with output produced. During three years although the firm operated below the B.E.P. level it is able to earn profit because of income from conversion charges & Rental Changes and miscellaneous income. During 2006-07, 2008-09 and 2010-11 the dairy was able to cross Break Even point and could maintain a margin of safety ranging from Rs. 457.548 lakhs to Rs. 2333.889 lakhs. The profit volume ratio had varies between 10.66% and 14.85%. It was more or less constant during the study period. The average worked out to 12.09%.

It is evident from the Table – 5 that Heritage Foods (India) Ltd., Crossed the Break – Even sales point in 3 years out of the six years study period i.e., for 3

Table 5: Break Even Analysis of Heritage Foods (India) Ltd.

(Rs. in Lakhs)

Particulars	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11

It can be seen from the table – 4 that the Sangam Dairy had crossed the break even point in 3 years out of the six years under study. During 2005-06, 2007-08 and 2009-10 the actual sales were less than the break even sales and the resultant margin of safety during three years was negative. This reveals that sales performance was not adequate during these years. It is observed that the variable cost was either increasing or decreasing consistent, with output produced. During three years although the firm operated below the B.E.P. level it is able to earn profit because of income from conversion charges & Rental Changes and miscellaneous income. During 2006-07, 2008-09 and 2010-11 the dairy was able to cross Break Even point and could maintain a margin of safety ranging from Rs. 457.548 lakhs to Rs. 2333.889 lakhs. The profit volume ratio had varies between 10.66% and 14.85%. It was more or less constant during the study period. The average worked out to 12.09%.

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Table 5: Break Even Analysis of Heritage Foods (India) Ltd.

(Rs. in Lakhs)

Particulars	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Sales	29207	34633	58803	79256	90038	109618
Variable Cost	25771	32325	54632	71933	79709	98010
Contribution (Sales – V.C)	3436	2308	4171	7323	10329	11608
Fixed Cost	1597	2592	7213	8375	8062	9224
Break Even Sales	13574.97	38894.60	101689.29	90641.677	70276.538	87105.14
Margin of Safety	15632.03	-4261	-42886.29	-11385.677	19761.462	22512.86
P/v Ration	11.76	6.66	7.09	9.24	11.47	10.59
h) Average 9.47						

Source: Compiled from annual reports.
Note : Figure in brackets indicates individual cost percentages to total cost.

Table 6: Break Even Analysis of Tirumala Milk products (Pvt.) Ltd.

(Rs. in Lakhs)

Particulars	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
a) Sales	22202.19	28527.34	37380.24	47079.48	58590.97	83449.01
b) Variable Cost	13775.65	27194.30	35164.99	43349.97	55544.96	74303.11
c) Contribution (a-b)	8426.54	1333.04	2215.25	3729.51	3046.01	9145.90
d) Fixed Cost	465.73	698.40	962.17	1418.84	2141.13	4435.85
e) Break-Even Sales $\left(\frac{d \times a}{c}\right)$	1227.10	14945.909	16235.705	17910.731	41185.32	40473.56
f) Margin of Safety (a-c)	20975.09	13581.43	21144.54	29168.75	17405.65	42975.45
g) P/v Ration $\left(\frac{c}{a} \times 100\right)$	37.95	4.67	5.93	7.92	5.20	10.96
h) Average 12.10						

Source: Compiled from annual reports.
Note: Figure in brackets indicates individual cost percentages to total cost.

consecutive years 2006-07, 2007-08 and 2008-09 the firm is not able to cross its break-even level. During 2006-07, 2007-08 and 2008-09 the actual sales were less than the break-even sales and the resultant margin of safety during three years was negative. This reveals that sales performance was not adequate during three years. As a result of this the reported net result for the company during 2008-09 was negative. The Heritage Foods (India) Ltd., was able to cross the break even point and could maintain a margin of safety ranging from Rs.15632.03 lakhs to Rs.22512.86 lakhs. The profit volume ration had ranged between 7.09% and 11.76% averaging at 9.47%.

Break even analysis of Tirumala Milk Products Pvt. Ltd. given in Table – 6 reveals that the firm has crossed the break even point in all the years of study. The total contribution was sufficient to meet the fixed expenditure and contributing more towards profit all the years. It resulted in a positive margin of safety every year. The P/V ratio of the firm ranged from 4.67% to 37.95% averaging 12.10%. This reveals it had a sound cost control policy.

A comparative analysis of the margin of safety and P/V ratio of the three diaries reveals that Tirumala Milk Products Pvt., Ltd.,was found better than Sangam and Heritage Foods (India) Ltd.

The break even sales and margin of safety of the sample dairy units have been shown in the charts as follows;

Findings

1. The proportion of variable cost is very high for Tirumala Milk Products Private Ltd., when compared to the Sangam and Heritage Foods (India) Ltd.,
2. The proportion of fixed cost is very low for Tirumala Milk Products Private Ltd., when compared to the others two dairies. While Sangam dairy reported to have high fixed cost.
3. Fixed cost proportion is comparatively high for sangam dairy.
4. Sangam Dairy and Heritage Foods (India) Ltd., has operated below the level of BEP for 3 years out of our study period of 6 years.
5. Although Sangam operated below the Break even point level of sales it never incurred loss because it had income from conversion charges and miscellaneous income. But Heritage Foods (India) Ltd. reported loss during 2008-09.
6. Tirumala Milk Products Private Ltd. had operated above the level of BEP Sales level throughout the study period 2005-06 to 2010-11.

Conclusion

Out of the three sample units under study Tirumala Milk Products Private Ltd., is having the best performance from the point of view of cost volume profit analysis followed by Sangam Dairy. Heritage is also good from the point of view of its cost structure.

The ability to learn faster than your competitors may be only sustainable competitive advantage.

—Ariede Geus

Captive Breeding of Marine Ornamental Fish *Amphiprion spp* (Clown fishes) and Technology Transfer to Coastal Communities for Livelihood Enhancement

SUJATHKUMAR, N.V, N. MALAICHAMY, K. RENUKA AND T. SHUNMUGARAJ

The global ornamental fish trade is estimated about US$4.50 billion and is said to be a fast-growing sector. China is the largest exporter of marine and aquaculture products, accounting for about a 65 percent share. Ornamental fish are the most fascinating creatures of the aquatic environment. Bright colour, interesting behaviour, and their ability to adapt in captive condition are the main reasons for this popularity. At present the vast majority of marine ornamental fish for aquariums are still collected from the oceans. Unlike the freshwater ornamental fish, very few of them have been bred under captivity. Few species from the families of Apogonidae, Gobiidae, Grammatidae, Pomacentridae, and Pseudochromidae are being cultured and bred successfully under captivity in India. The successful breeding marine ornamental fish under captive condition in hatcheries depends on the development of healthy broodstock, knowledge of modes of their reproduction, adequate lighting, water quality, acceptable first live food organisms, healthy environment for metamorphosis, and overall husbandry techniques which predict the possibility of captive breeding and survivability of larvae. The marine ornamental fish are widely distributed in the Gulf of Mannar, Gulf of Kutch, Andaman and Nicobar and Lakshadweep areas due to the presence of coral reef. Among these species, the clown fish like Amphiprion sebae, Amphiprion percula, Amphiprion occillaries, etc., could easily be cultured and bred under captivity by the coastal communities. The features such as long life span, spawning frequently, relatively advanced, and shortest larval stage make captive breeding possible and successful. Cement and FRP tanks with minimum of 500–700 liters of seawater with salinity of 30–34 ppt and with proper lighting are sufficient for clown fish broodstock development and breeding. This paper deals with the simple techniques for the development of broodstock and captive breeding of clown fish from wild collection to broodstock development in hatchery and the methods involved for successful breeding under captive condition. At present the breeding techniques for clown fish are almost standardized and these techniques could easily be made available to those who are involved in ornamental fish farming in the island areas for commercial venture and livelihood enhancement.

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The present global ornamental fish trade is about US$4.5 billion. Countries such as Indonesia, Srilanka, Taiwan, Malaysia, Singapore, and Australia are the leading exporters of marine ornamental fish around the world. Many fish collectors in these countries employ prohibited methods of fishing which causes several problems to coral reefs and its associated organisms. International organizations have been trying for more than a decade to persuade marine ornamental fish collectors that they should use nets instead of illegal fishing methods. Therefore, in the last few years, scientists and researchers have attempted the breeding of most commonly available marine ornamental fish in captivity for aquarium trade. The most common marine fish for captive breeding is the clown fish, *Amphiprion sebae* which belongs to the large Perciform family Pomacentridae. This species is available in the coral reef regions of Indo-Pacific reefs regions (Nelson, 1984). It is small, often brilliantly coloured with mostly below 12 cm in length and feeds on small invertebrates and fish.

Materials and Methods

Atleast 10 to 13 sexually mature fish, measuring approximately 8.0 cm to 10.50 cm, were bought from the local marine ornamental fish collector in March 2010. During the first two and half months, all the fish were kept together in 800 liter FRP tank along with three sea anemones. Four pairs were formed after a period of two months and each pair were transferred to 600–700 liter cement tanks. The temperature in these breeding tanks was maintained at 26–28°C, salinity at 30–33 ppt, and pH at 8.0 to 8.2. A photoperiod consisting of 12 hours of light and 12 hours of darkness was provided exclusively by incandescent light from a 36 watt tube light suspended 50 cm above the surface of the water in each tanks. The fish were fed three times in a day using live clam meet and artemina.

Behavioral Observations

Observations on breeding behavior were taken two times in a day (10.30 a.m., and 03.30 p.m.) during the first 2 months and concentration was given on the courtship behavior of fish.

Breeding

After a period of 3 months, two pairs of *Amphiprion sebae* layed eggs in cleaned area of the cement tanks which is about 1400 to 2500 in numbers and measuring approximately 1.4 to 1.8 mm in size. Hatching took place after 7 days of incubation at 28°C.

Live Feed Culture

Live feeds were cultured in order to feed the larvae of *Amphiprion sebae*. The first feeding involved algae (*Nanochloropsis oculata*, *Chlorella spp*, and *Isochrysis spp*) with enriched rotifers (*Brachionus plicatilis*) feed at a temperature of 28°C.

Larvae Rearing

The larvae were kept in the parent tank itself for 2 days which contains about 600–700 liter of filtered seawater. Approximately 25–30 percent of the water exchanged each morning. Any uneaten feed were removed immediately on notice in order to maintain the water quality. After 2 days, the larvae were shifted to larval rearing FRP tanks which contains about 500–700 liter of UV treated filtered seawater with the salinity of 30–33 ppt, temperature 27–28°C, and the pH of 8.0 to 8.1.

Results

Reproductive Behavior

The two fish pairs began spawning five months after they had been moved into the cement tanks. In all the two couples, courtship began just a month before spawning, with the initiative in courtship being taken by the males. The females began to spawn, laying the eggs and this usually occurred in the morning (10–12 noon). The eggs, about 1500–2500 in number, were immediately fertilized by the males. The embryo development and first larvae appears in the surface of the tank within approximately 164 hrs at 28°C.

Embryo Development

All the eggs in the nest are encased in a flexible, transparent yellow colored conical capsule. At about 43 hours, embryonic precursors of the head and the body development are evident. At this stage, the embryo inverts itself, so that the head now points towards the distal end of the egg. This new position, with the head of the embryo at the distal end of the chorion, is essential to embryo hatching. At 73 hours, numerous myomers form along the mid-body region and the head, eyes, tail, and notochord are evident. The yolk mass is still large (3rd and 4th day). Hindgut, eye, brain, and nerve cord are in a more advanced stage of development (5th day). The heart, located in a small sac in front of the yolk sac, in a postero-ventral position to the head, is beating. At 152 hours, just before hatching, pectoral fins are well developed and the vertical fin-fold has partially separated into dorsal, caudal, and anal fins, although no fin rays are visible (6th day). The

lobes of the brain have developed. The retina of the eye is pigmented and the embryo is now active, wriggling within the capsule.

Hatching

Hatching takes place after 6 days of incubation. The tail has wrapped completely around the egg, reaching its distal end. Shortly before hatching, the distal end of the chorion becomes soft and pliable and the movements of the embryo become more frequent and violent until the weakened chorion gives way. The larvae that emerge from the capsule still possess a small yolk sac.

Larval Development

After 24 hours of hatching, the larvae were very active and swim near the surface of the water; the yolk sac is completely absorbed. The first food (algal enriched rotifer) was provided immediately with density of approximately 20 rotifers/ml. Pigmentation is very light. On the 7th day, the body becomes very deep, with no pigmentation and the first caudal rays are evident from day 13.

Discussion

Reproductive development can be divided into several distinct processes, gonadal growth, development, final maturation, and spawning. If suitable husbandry and appropriate environmental variables are provided, many species undergo gonadal maturation in captivity condition. In the course of this study, therefore, particular attentions was focused on the selection of healthy individuals (Melville and Griffiths, 1997) on the rearing and maintain tank size (Ostrowsky, 2000), and on providing the fish couples with a suitable environment conditions to spawn naturally. The data show that *Amphiprion sebae* needs atleast a minimum of 3–5 month period to start spawning in captivity. The female lay eggs and the embryo development is very rapid, the larvae are very small and the yolk sac is sufficient to sustain them only during the first 24 hours.

Considering that the major portion of the yolk sac is normally used up during the initial stages of development, it is essential that the larvae immediately be provided with a suitable first food. It was estimated that each larva needs to consume roughly 900–1400 rotifers each day (Wilkerson, 1998). Unfortunately, it is not enough to deposit 1000 rotifers per larva into a rearing tank and simply assume that each larva will find its quota. With this in mind, the rotifer density was kept very high on the first day after the larvae hatched, ensuring that the larvae would see them frequently. A 15–20 rotifers/ml density provides the larvae with enough rotifer sightings to realize that rotifers may be edible and it also provides the larvae with abundant practice targets on which to sharpen their predatory skills. In this study, a great deal of attention was focused on the effects of diet on larvae survival. In particular, the study found that no larvae will survive more than 36 hours after hatching unless an enriched first food is used. The most fascinating outcome of this work is that *Amphiprion sebae* can be successfully reared in captivity. This technology could be effectively disseminated to the coastal and Island communities by using appropriated extension methods in order to popularize the breeding technology and to enhance the livelihood of the people.

Conclusions

The results obtained in the present study strongly suggest that a scientific method is needed in order to utilize breeding protocols and successfully rear marine ornamental fish in captivity. The information contained herein may represent a starting point for the breeding of the different species involved in the marine aquarium trade. The optimization of breeding and rearing protocols is fundamental to further development of marine ornamental fish maintenance and breeding in hatchery conditions. The breeding technology could be effectively transferred to the coastal communities for livelihood enhancement.

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Every man is a creature of the age in which he lives and few are able to raise themselves above the ideas of the time.

—Voltaire

Feature

Comparative Analysis of Female and Male Research Scholars in Publishing their Research Findings in Science Citation Index Journals

S.A. HASAN, MAHENDRA KUMAR SHARMA, SUSHILA KHILNANI AND RAJESH LUTHRA

Qualitative analysis of female and male research scholars in publishing their research findings in Science Citation Index (SCI) journals using impact factor, a chief quantitative measure of the quality of a journal, revealed that female research scholars have been publishing in quality SCI journals in proportion to their numerical strength and at par with their male counterparts. Majority of SCI research papers published by both female (76%) and male (75%) research scholars were in SCI journals having Impact Factor (IF) range >1.000 to ≤ 50.000. Female research scholars however outperformed male research scholars in the area of Physical Sciences, whereas, male research scholars outperformed female research scholars in the area of Chemical Sciences in publishing research papers in journals with IF range >1.000 to ≤ 50.000, whereas in the area of Mathematical and Engineering & Technology, Earth & Environmental Sciences and Life Sciences, the performance of female research scholars was at par with male research scholars. Thus the dogma that female researchers are less productive compared to male counterparts is unfounded.

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A scientific journal is a periodical publication which usually report new research findings for promoting the progress of science (http //en.wikipedia.org). Majority of these scientific journals are highly specialized, however, some journals publish research articles across a wide range of scientific fields. Articles submitted to these journals are peer reviewed before publication to maintain the journals' standard of quality and scientific validity (http:// en.wikipedia.org).

The quality of a journal is determined by its impact factor (IF) which is calculated by dividing the total citations received by articles published in a journal in two previous years by the number of articles published during the same period (www.elsevier.com/ framework_editors/ pdfs/ Perspectives1.pdf). Impact factor is an indication of relative importance of a journal within its field (http:// en.wikipedia.org). Various types of research papers such as letters (short communication), articles, supplementary articles, and review articles are published in a journal. Apart from ascertaining quality of a journal within the field, IF is used as one of the parameters to determine research funding, promotion, etc. (Adam and Simonson, 2004 & Lund, 2006).

A number of schemes have been instituted by CSIR to provide financial support to attract and encourage the young bright science students for pursuing doctoral and postdoctoral research. The main objective of doctoral and postdoctoral programmes is to mentor the young researchers in specialized niche areas of research. Apart from learning tools and techniques of doing research, these researchers also contribute to the productivity of host institutions through publications in peer reviewed journals. An attempt has been made to analyze the contribution of female research scholars in comparison to their male

counterparts in publishing their research findings in Science Citation Indexed (SCI) journals which are included in Thomson Reuters Journal Citation Reports (JCR).

Methodology

Data has been collected from the records of research scholars who have been awarded CSIR fellowships/ associateships to pursue doctoral and postdoctoral research. Information with respect to research scholars such as number of research papers published during the tenure of the fellowship/associateship, subject specialization, and SCI journal(s) in which they published their research findings were extracted from 901 records (320 female and 581 male) belonging to the period 2004–2009. The tenure of a CSIR Junior Research Fellow (JRF)-NET is 5 years, whereas that of Senior Research Fellow (SRF) and Research Associate (RA) is 3 years. For this study, the impact factor (IF) of a journal, indicating the relative importance of an SCI journal within the field, is based on Journal Citation Report (JCR)–2010.

Results

A total of 2693 research papers were published in SCI journals by 901 research scholars. The contribution of female research scholars (320, 35.5%) in publishing research papers in SCI journals was 33.4% compared to 66.6% by their male counterparts (581, 64.5%). Thus the contribution of female and male research scholars in publishing their research findings in SCI journals was proportionate to their numerical strength and also the research papers published per female and per male research scholar during the tenure of the fellowship were 2.8 and 3.1, respectively.

Majority (76%) of 900 SCI research papers published by female research scholars have been published in journals having an IF range >1.000 to ≤ 15.000 and only 24% SCI research papers were published in journals having IF ranges >0.001 to ≤ 1.000 (Table 1). Similarly, 75% of 1793 SCI research papers published by male research scholars have been published in journals having an IF range >1.000 to ≤ 50.000 and only 25% SCI research papers were published in journals having an IF range >0.001 to ≤ 1.000 (Table 1).

Overall average IF per paper in case of female research scholars was 2.243 and in case of male research scholars it was 2.356. Thus the results showed that female research scholars were at par with their male counterparts in publishing their research findings in SCI journals.

Table 1: Profile of research papers published in Science Citation Index (SCI) journals by female and male research scholars, based on Impact Factor

Impact Factor (IF) Range	Female Research Scholars			Male Research Scholars		
	Research papers published	Cumulative Impact Factor (CIF)	IF per Research paper	Research papers published	Cumulative Impact Factor (IF)	IF per Research paper
>0.001–≤0.500	73	23	0.316	198	68	0.341
>0.500–≤1.000	141	101	0.720	246	188	0.762
>1.000–≤2.000	227	335	1.478	421	623	1.479
>2.000–≤3.000	211	509	2.412	443	1083	2.444
>3.000–≤4.000	144	491	3.407	238	810	3.405
>4.000–≤5.000	59	262	4.433	149	656	4.404
>5.000–≤10.000	44	284	6.460	91	600	6.592
>10.000–≤15.000	1	13	12.899	4	47	11.829
>15.000–≤50.000	0	0	0	3	150	49.926
Total	**900**	**2018**	**2.243**	**1793**	**4225**	**2.356**

Subject-wise analysis showed that in the area of Chemical Sciences, 21.0% research papers published by female research scholars were in the journals with IF range >2.000 to ≤3.000, compared to 30.3% by male research scholars. Furthermore, 54.6% of the research papers published by female research scholars were however in journals having the IF ≤2.000 compared to 39.6% by male research scholars, whereas in journals having IF>3.000, female research scholars published 24.3% research papers compared to 29.9% by their male counterparts (Table 2).

In the area of Earth and Environmental Sciences, female research scholars published 15.4% research papers in journals with IF range >1.000 to ≤2.000, compared to 31.1% by male research scholars. Analysis further revealed that 42.3% of the research papers published by female research scholars were in journals having IF ≤1.000, compared to 40.0% papers published by male research scholars, whereas in journals having IF >2.000, female research scholars published 42.3% research papers compared to only 28.9% by their male counterparts (Table 2).

Table 2: Subject-wise profile of research papers published in Science Citation index (SCI) journals by female and male research scholars, based on Impact Factor

Impact Factor (IF) Range	Chemical Sciences	Earth & Environment Sciences	Life Science	Mathematical Sciences, Engineering & Technology	Physical Sciences Factor (IF)	TotaL
Female Research Scholars						
>0.001–≤0.500	34(10.2)	2 (7.7)	10(3.3)	5 (20.8)	22(10.1)	**73**
>0.500–≤1.000	79 (23.7)	9(34.6)	37(12.3)	3(12.5)	13(6.0)	**141**
>1.000–≤2.000	69(20.7)	4(15.4)	73(24.3)	8(33.3)	73(33.6)	**227**
>2.000–≤3.000	70(21.0)	4(15.4)	88(29.3)	5(20.8)	44(20.3)	**211**
>3.000–≤4.000	40(12.0)	5(19.2)	51(17.0)	3(12.5)	45(20.7)	**144**
>4.000–≤5.000	29(8.7)	2(7.7)	18(6.0)	0(0.0)	10(4.6)	**59**
>5.000–≤10.000	12(3.6)	0(0.0)	22(7.3)	0(0.0)	10(4.6)	**44**
>10.000–≤15.000	0(0.0)	0(0.0)	1(0.3)	0(0.0)	0 (0.0)	**1**
>15.000–≤50.000	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0 (0.0)	**0**
Total	**333 (37.0)**	**26 (2.9)**	**300 (33.0)**	**24 (2.7)**	**217(24.0)**	**900**
Male Research Scholars						
>0.001–≤0.500	96(13.6)	17(18.9)	13(2.5)	5(11.1)	67(15.3)	**198**
>0.500–≤1.000	85(12.0)	19(21.1)	88(17.1)	7(15.6)	47(10.8)	**246**
>1.000–≤2.000	99(14.0)	28(31.1)	112(21.7)	26(57.8)	156(35.7)	**421**
>2.000–≤3.000	214(30.3)	13(14.4)	141(27.4)	7(15.6)	68(15.6)	**443**
>3.000–≤4.000	73(10.3)	8(8.9)	98(19.0)	0(0.0)	59(13.5)	**238**
>4.000–≤5.000	85(12.0)	5(5.6)	34(6.6)	0(0.0)	25(5.7)	**149**
>5.000–≤10.000	48(6.8)	0(0.0)	29(5.6)	0(0.0)	14(3.2)	**91**
>10.000–≤15.000	4(0.5)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	**4**
>15.000–≤50.000	2(0.3)	0(0.0)	0(0.0)	0(0.0)	1(0.2)	**3**
Total	**706(39.0)**	**90(5.0)**	**515(29.0)**	**45(2.5)**	**437(24.0)**	**1793**

In the area of Life Sciences, female research scholars published 29.3% research papers in the journals with IF range >2.000 to ≤3.000, compared to 27.4% by male research scholars. 39.9% of the research papers published by female research scholars were however in journals with IF range ≤2.000, compared to 41.3% by male research scholars, whereas in journals having IF >3.000, female research scholars published 30.6% research papers compared to 31.2% research papers by male research scholars (Table 2).

In the area of Mathematical Sciences and Engineering & Technology, female research scholars published 33.3% research papers in journals with IF range >1.000 to ≤2.000, compared to 57.8% by male research scholars. Analysis further showed that 33.3% of the research papers published by female research scholars were in journals having IF range ≤1.000 compared to 26.7% by male research scholars, whereas in journals having IF >2.000, female research scholars published 33.3% research papers compared to only 15.6% by male research scholars (Table 2).

In the area of Physical Sciences, female research scholars published 33.6% research papers in the journals with IF range >1.000 to ≤2.000 compared to 35.7% by male research scholars. 16.1% of research papers published by female research scholars were however in journals with IF range ≤1.000, compared to 26.1% by male research scholars, whereas in journals having IF >2.000, female research scholars published 50.2% research papers, compared to only 38.2% by male research scholars (Table 2).

Thus, in the area of Life and Chemical Sciences, maximum research papers were published in journals having IF range >2.000 to ≤3.000 whereas in other areas maximal research papers were published in journals with IF range >1.000 to ≤2.000 (Table 2). Furthermore, maximum research papers were published in the area of Chemical Sciences, followed by Life Sciences, Physical Sciences, Earth & Environment Sciences and Mathematical Sciences, Engineering & Technology (Hasan et al., 2012).

Subject-wise comparative analysis further revealed that female research scholars published 84% of their research papers in the area of Physical and Life science in broad range of journals having IF >1.000 to ≤50.000, followed by Mathematical Sciences and Engineering & technology (67%), Chemical Sciences (64%), and 58% in Earth & Environment Sciences, in comparison to 80% in Life Sciences, 74% each in Physical and Chemical Sciences, 73% in Mathematical Sciences and Engineering & Technology, 60% in Earth & Environment Sciences by their male counterparts (Table 2). Data showed that irrespective of gender, maximal research papers published in journal having IF >1.000 to ≤50.000 were in the area of Life Sciences (82%) followed by Physical Sciences (79%), Mathematical and Engineering & Technology (70%),

Table 3: Subject-wise list of top 10 Science Citation Index (SCI) journals in which research scholars published their research findings

Chemical Sciences	Earth & Environment Sciences	Life Sciences	Mathematical Sciences and Engineering & Technology	Physical Sciences
Indian J Chem A (40)*	Curr Sci (12)*	Curr Sci (36)*	J Appl Polym Sci (6)	Acta Crystall E (31)
Tetrahedron Lett (40)	Indian J Phys (5)*	Indian J Exp Biol (22)*	Phys Review A (4)	Phys Review B (23)
Polyhedron (33)	J Geol Soc India* (5)	Plant Sci (15)	Appl Math Comput (3)	Indian J Phys (17)*
Inorg Chem (31)	J Struct Geol (5)	Bioch Biophy Res Comm (14)	Chem Eng Tech (3)	J Appl Phys (17)
Indian J Chem B (30)*	Biores Tech (4)	Process Biochem (11)	Int J Engg Sci (3)	Phys Review d (16)
Acta Crystall E (29)	Climate Dynamics (3)	J Biol Chem (10)	Acat Math Hungar (2)	Ind J Pure Appl Phys (13)*
J Org Chem (22)	Earth Moon Planet (3)	J Mol Biol (9)	IEEE (2)	Pramana J Phys (13)*
Chem Commun (21)	Env Monit Assess (3)	Acta Crystall D (8)	Indian J Phys (2)*	Appl Phys Lett (12)
Acta Crystall C (19)	Chemosphere (2)	Mutation Res (8)	J Appl Cryst (2)	Phys Review C (12)
J Chem Phys (18)	Dis Aquat Organism (2)	Ind ian J Bioch Biophys (7)*	Metal Mater Transact A (2)	Physica B (12)

Note: *National Journals; Figures in parenthesis represent the number of research papers published in that journal.

Chemical Sciences (69%), and Earth & Environmental Sciences (59%). Female research scholars however outperformed male research scholars in the area of Physical Sciences, whereas, male research scholars outperformed female research scholars in the area of Chemical Sciences in publishing research papers in journals with an IF range >1.000 to ≤50.000, whereas in the area of Mathematical and Engineering & Technology, Earth & Environmental Sciences and Life Sciences, the performance of female research scholars was more or less at par with male research scholars.

Results of our study showed that female research scholars published in 400 foreign SCI journals and 22 Indian SCI journals compared to 531 foreign SCI journals and 28 Indian SCI journals by their male counterparts. Subject-wise lists of top 10 SCI journals in which research scholars published their research findings are depicted in Table 3. In the area of Chemical, Earth & Environment, and Life Sciences, maximum research papers were published in "Tetrahedron Lett," "J Struct. Geol," and "Plant Science" among the foreign journals and "Indian J Chem A," "Current Science," and "Current Science" among Indian journals, respectively. Whereas, in the area of Engineering & Technology and Physical Sciences, maximum research papers were published in "J Appl Polym Sci," "Acta Crystall E" among foreign journals, and "Indian J Phys" and "Indian J Physics" among the Indian journals, respectively. "Appl Math Comput" was the most preferred journal among the foreign journals in the area of Mathematical Sciences.

Conclusion

Female research scholars contributed to 34% of total research papers (2693) commensurate with their numerical strength (36%). The number of SCI papers/female research scholar was 2.8 similar to their male counterparts (3.1). The average IF per female research scholar was 6.3 compared to 7.3 to their male counterparts, and impact factor per research paper published by female research scholars was 2.243 compared to 2.356 by their male counterparts. Further, the female research scholars published 76% of their research findings in journal having IF >1.000 compared to 75% by male research scholars. Thus results of the study showed that the female research scholars were at par with their male counterparts in publishing research papers in quality research journals.

As per the data of National Science Foundation (NSF), USA, India was among the top 15 leading countries in terms of publishing science and engineering (S&E) research articles in the year 2009 and was placed at the 11th position, whereas USA was the leading country followed by China. The absolute number of researchers in India is approximately nine times less than China and USA, whereas the number of articles per 100 researchers in India is more than double that of China (Hasan, Khilnani, and Luthra, 2012a) and at par with USA. Women, however constitute 15% of the total manpower engaged in R&D (Hasan et al., 2012). In the year 2004–05, a total of 6569 science PhDs were awarded (www.ugc.ac.in) and it is hoped that by the year 2020, India will be producing 12000 PhDs each year by the end of twelfth five year plan (Hasan, Khilnani and Luthra, 2010a) with substantial share of females as 50% of those awarded doctoral degree in chemical and biological sciences in India were women (www.dst.gov.in). Similarly, women's representation among earned doctorates in USA was particularly high in biological sciences and lowest for engineering, and it is believed that the goal of achieving 50% women in Science, Technology, Engineering and Mathematics (STEM) may take 100 years (Kaminski and Geisler, 2012). In India, the dropout rate in case of female students from class-I to class-VI is 34% which increases to 42% at senior secondary level (http:/mhrd.gov.in). Further, only about 15% of graduate students enrol in science postgraduate courses throughout the country (Hasan, Khilnani, and Luthra, 2010b). Thus directed efforts are required to plug in the leaky pipeline from primary level to tertiary level education to increase the women representation in science and technology.

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Be the change that you wish to see in the world.

—Mahatma Gandhi

Feature

Impact Assessment of "North Gujarat Initiative" Water Policy Programme

JOGINDER SINGH AND GURINDERJIT SINGH

Basically water augmentation through well exploration, water saving and related activities performed by NGOs has generated significant impact on rural economy of North Gujarat state of India. Direct economic gain to the farmers was estimated as Rs 10560/acre and landless labour classes as about Rs 1000/household. It was made possible as a consequence of shift in crop pattern, introduction of new farm enterprises, like vegetables and fruits, expansion of dairy farming, increase in crop productivity and cropping intensity. The economic use of crop and livestock residues reduced the cost of production, improved product quality and resulted in various other environmental benefits.

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The agricultural profile of Gujarat state of India indicates that arid and semi-arid climate accounts for 25% and 34% area respectively and the rest is semi-humid. The average temperature ranges from 39.9°C and 12.5°C. About 52% area is sown with a cropping intensity of 113%. Cotton, groundnut, millets, pulses, and oilseeds in kharif (summer) and wheat and mustard in rabi (winter) season are the major crops of the state. The cropping intensity is low due to lack of irrigation facilities and only 34% area is irrigated. The main sources of irrigation are well, tube well, and canal. Even the irrigated area does not get abundant water and thus by default crops requiring less water, water conservation technologies, and suitable water pricing are followed.

The International Water Management Institute & Tata (IWMI–Tata) programme launched the "North Gujarat Sustainable Groundwater Initiative" (NGI) in 2002 to explore approaches to protect and strengthen the livelihoods of resource poor households suffering from serious ecological crisis in North Gujarat. The objectives of the project were to establish a groundwater management regime involving demand and supply side approaches by an education campaign on water; and to lay the groundwork for a larger regional sustainable groundwater initiative with a view to have impact of the interventions on the livelihood, agricultural and dairy economy of the pilot villages.

During the Phase I project period, lessons learnt were incorporated into the Phase II project launched in July 2005 in Banaskantha and Patan districts of the state. The major activities undertaken in the project were: (i) large-scale promotion of low water-intensive crops with low cost drip irrigation; (ii) large-scale promotion of several types of micro-irrigation systems for water-intensive fodder crops like alfalfa, high-value field crops such as potato, groundnut and row crops such as cotton, castor, vegetable,

and fennel; and (iii) large-scale promotion of organic farming, with vermi-composting and scientific composting and use of bio-pesticides.

Based on the physical progress report of Phase I and Phase II, IWMI along with its major organizations, identified the main interventions. The interventions in the field of agriculture included water-saving technology (well blasting, drip irrigation, sprinkler irrigation, mulching and supply of drum kit); organic farming (vermi-composting, wermi-wash, panchamrut and compost pit), horticulture (plantation of orchards, vegetable farming and seed kit for kitchen gardening), micro-financing and generating awareness of new technology through various measures such as training, exposure visits, meetings, demonstrations, etc. Amongst these interventions, 11 activities as mentioned in the Table 1 were considered important, as having significant impact on farm economy through increase in employment, income, information, and ecological improvements, particularly water saving, soil health, and human health.

Hence this study of impact assessment was carried out with the following specific objectives:

1. To study the introduction and expansion of farm enterprises and farmers' apprehensions of their scope and overall structure of agricultural sector.
2. To assess the impact of different interventions of the project on socio-economic and ecological parameters in the rural area of North Gujarat.

Methodology

The activities performed by four partner NGOs were somewhat overlapping and the number of activities was used to select appropriate sample size out of the farmers covered/ situations developed in each category. Efforts were made to make reasonable spread of sample over all the development blocks (*talukas*) of the district. For example, 29 farmers of covered under Cohesion Foundation Trust, 95 respondents in case of IWMI-TATA Partnership, 42 farmers in case of M G Patel Sarvodaya Kendra, and 19 respondents in case of Lok Vikas Area, Siddhpur formed the ultimate study sample.

Therefore, all 19 cases of well blasting were studied in detail. Similarly, 61, 19, and 7 farmers adopting drip

Table 1: Number of Farmers covered under each activity (Population) & the sample size

Activity	IWMI-TATA Partnership		MG Patel Sarvodaya Kendra		Cohesion Foundation		Lok Vikas Area, Siddhpur		Total	
	Pop.	Sample	Pop.	Sample	Pop.	Sample	Pop.	Sample	Pop.	Sample
Well blasting	0	0	592	19	0	0	0	0	592	19
Drip irrigation	304	35	89	4	101	15	47	7	541	61
Sprinkler irrigation	256	11	179	5	19	0	4	3	458	19
Plastic mulching	11	6	0	0	0	0	1	1	12	7
Horticulture	386	43	133	4	82	23	55	10	656	80
Vermi-composting	1123	26	192	9	149	9	144	3	1507	47
Compost pit	120	8	26	10	76	5	41	2	263	25
Panchamrut	144	3	18	1	126	1	0	0	288	5
Vermiwash	4	4	3	0	25	0	0	0	32	4
Drum kit	250	9	100	1	3	2	8	3	361	15
Vegetable kit	1064	9	100	16	65	9	131	2	1360	36
Total number of		154		70		64		31		318
interventions										
Total respondents		95		42		29		19		186

Note: Population (Pop.) indicates the total number of farmers selected by the respective NGO.

irrigation, sprinkler irrigation, and plastic mulching respectively were taken at random based on the number covered by each partner. To assess the impact of horticultural development by plantation of different types of orchards, 80 such farmers were interviewed for this study. In a similar fashion, organic farming and vermi-composting, compost pit, panchamrut, vermiwash, drum kit, and vegetable kit were studied by taking 47, 25, 5, 4, 15, and 36 cases. Thus an overall sample comprised 186 farm situations. Fortunately, most of the farm situations thus selected had more than one intervention. Therefore, 186 respondent farmers provided 318 observations of different interventions, which are presented in Table 1. Data of each observation for the year 2007–08 were thus collected, compiled, and analyzed for this report.

The questionnaire covering each activity was prepared, pre-tested, and finalized. The study was carried out by collection of data through personal interviews and its compilation was done. Data were also formatted and tabulated to derive some meaningful inferences.

Socio-economic Profile of Respondents

The farm size is the fundamental indicator to know the socio-economic status of the farmers. The sample of respondents taken from the four NGOs showed highly variable farm size which varied from 6.30 acres in MGP to 13.77 acres in case of LVA Siddhpur with an overall average of 9.46 acres. In comparison to average size of operational holding of 5.88 acres for the Gujarat state as a whole, the NGOs seemed to have bias towards larger farm holdings due to the fact that the adoption of technology is faster as large farmers have capacity to invest, undertake higher degree of risk in adoption of new technology, and demonstration effects on other farmers is better.

Another important productive asset of farmers was the size of dairy herd. In the context of well-developed dairy system such as milk purchase, input supply system, micro-finance, and veterinary services in the area as a component of Amul Dairy, it has occupied a place of pride in the agriculture sector. With a few commercial dairy farms coming up in the area, an average farm household maintained about 7 milch animals (3 cows, 3 buffaloes, and 1 other animal). Most of them were selling surplus milk over and above family requirements which averaged to 31 liters per day per farm. Still there is a lot of scope of dairy enterprise if water availability for fodder cultivation and dairy animals is enhanced. Livestock manure is also gainfully utilized for crop farming apart from having regular income to meet the household expenses. Therefore, 20% respondents indicated that they were increasing dairy enterprise due to increase in water availability. Only 7% opined that dairy was decreasing due to scarcity of labour, shifting attention of farmers towards crops, high cost of animals and risk. The rest of the respondents indicated no change in the size of this enterprise.

It was also pertinent to have an idea of the source of farm power of the respondents under study. About 43% farmers had own tractors and another 43% were carrying out farm operations through custom hiring of tractor. Only 14% farmers were operating their farms with the help of bullock as a source of draught power.

Employment of farm labor is another important indicator of direction of agriculture in the area. Total number of farm workers and their composition vary with farm size and the crop pattern. On the whole, family labor is a significant component of farm labor used and account for 3.20 persons per farm. Within this family labor, average number of female workers was 1.37 and children as 0.22. Apart from this, 1.30 permanent laborers and a highly variable seasonal casual labor were also employed.

Water Resource

Even though Banas and Saraswati rivers pass though the region, yet the surface irrigation is inadequate. The chief source of irrigation is electric operated tubewells. It was reported that heavy expenditure is incurred by the farmers in digging out water. Such tubewells go deeper even to more than 500 feet. Because of drawing of water more than recharging, the water table is reported to be falling at the rate of about 10 feet per year. In certain areas high rainfall and less use of water have resulted in rise in water table. In such areas, an alternative source of irrigation is diesel operated tubewells because the water table in such areas is not very deep. The farmers are bearing cost of electricity for pumping out water for irrigation at par with that for domestic use. Therefore, the unsubsidized cost of irrigation in the area is the major determining force for rationalizing the use of water. For this reason, the choice of farm enterprises and method of water use have to be judicious to increase its use efficiency. The water quality in general, was stated to be good and no drainage problem was reported.

Water-saving Interventions

On the selected 186 respondent farms as many as 121 interventions having direct bearing on water saving were

Table 2: Number of water saving and water conservation interventions by the NGOs

NGO	Sample size	Total water conservation Interventions	Drum kit	Drip irrigation	Sprinkler irrigation	Plastic mulching	Well blasting
MMIITP	95	61	9 (0.025)	35 (7.75)	11 (15.0)	6 (2.1)	0
MGP	43	30	2 (0.025)	4 (4.10)	5 (5.2)	0	19
Cohesion Foundation	29	16	1 (0.025)	15 (6.28)	0	0	0
Lok Vikas Area, Siddhpur	19	14	3 (0.025)	7 (8.30)	3 (4.5)	1 (1.0)	0
Overall	**186**	**121**	**15 (0.025)**	**61 (7.2)**	**19 (10.7)**	**7 (1.9)**	**19**
Investment (Rs/farm)			**200**	**36758**	**21465**	**13286**	**NA**

Note: NA means not available
Figures in parentheses indicate the average area covered per selected respondent.

made (Table 2). The drum kit was supplied to some landless labor scheduled tribe households for kitchen gardening so that they can enjoy the taste of fresh fruits and vegetables apart from getting regular supply of fresh piped water for drinking purposes and even for the milch animals. The average cost of drum kit charged was Rs 200/household on an area of 0.025 acre. Most of the respondents availed facility of drip irrigation. Amongst the sample, nearly one-third respondents reported to have obtained it on an average area of 7.2 acres per farm with an investment of Rs 36756. All the four NGOs took it an important activity.

Some farmers preferred sprinkler irrigation on certain crops, particularly vegetables as it has an effect like rain frequently washing the foliage. Although its water requirements are more than drip system, yet it was got done by 19 out of 186 farmers. Covering an area of 10.7 acres per farm, the investment came out to Rs21465. The investment was generally shared by NGO to the extent of 50%. Small farmers are adopting water saving technology in quite a fair number as NGI is also providing interest free loan to them through revolving fund system. Another significant achievement of the NGOs was to help adoption of plastic mulching for still more water conservation. Mostly it was followed by the farmers along with drip irrigation in case of vegetable cultivation. For this, 7 farmers incurring an initial expenditure of Rs13286 on an average field area of 1.9 acres were studied.

Yet another specialized activity was performed by MGP which did well blasting on 19 farms to explore the possibility of water under the ground. Its cost was highly variable depending upon the rate of success at the number of places and depth-wise. The cost of well blasting was subsidized to the tune of 75%. Many of the farmers in the project area with low water availability in their bore well turned towards adoption of high valued low water requiring orchard crops like pomegranate by building the water storage tanks and adopting micro irrigation systems.

Impact of Water Saving

Crop pattern of sample farms

The selection of crops and shift in crop pattern on the sample farms showed an obvious impact of the project. As may be seen from Table 3, groundnut, castor, cotton, bajra, and moong are the major kharif crops and wheat, mustard and potato were the main rabi crops in the area. Obviously, the choice of crop enterprises is based on the soil conditions, water availability and relative profitability. During the past five years, the per cent area under cotton, groundnut, fennel, fodder crops, potato and other vegetables has increased while the area as per cent of cropped area under millets, moong, guar, maize, wheat, and mustard has shown declining trend. By and large, the crop pattern has remained diversified and even inter-cropping continued to a common practice to mitigate the effect of climatic adversities.

Table 3: Crop pattern-percent area under important crops

Crop	Percentage of cropped area		Water requirement (mm)**
	Year 2003	Year 2008	
Cotton	7.24	9.6	760
Bajra	12.06	6.9	600
Groundnut	13.09	15.73	515
Castor	13.63	12.24	600
Sorghum	1.53	2.15	600
Moong	2.58	1.35	500
Guar	5.06	2.89	600
Wheat	11.23	10.6	400
Fennel	1.44	2.84	400
Potato	11.01	15.9	450
Alfalfa	3.81	5.32	500
Mustard	13.06	9.13	345
Vegetables	0.41	2.21	450
Tobacco	0.65	0.56	400
Maize	3.18	2.56	700
Average Water requirement (mm)*	**520.2**	**519.4**	
Cropped area (acres)	**9.87**	**10.86**	

Note: * Weighted average based on per cent area under different crops

Source: ** Data book ICAR 2007 and various other published sources. Figures of water requirement indicate evapo-transpiration and not the water actually applied.

One of the objectives of the efforts of almost all the NGOs was to reduce the water requirement for agriculture. Based on the water requirements of different crops worked out by Indian Council of Agricultural Research (ICAR) and some other published sources, the weighted average use per acre per annum (weights being the percentage area under the crops) was estimated which worked out to 519.4 mm in 2008 and 520.2 mm in 2003. Therefore, it is evident that the water requirement in agriculture with the change in crop pattern could not make a dent on lessening the load on water resource.

Cropping intensity

On the other hand, the area sown more than once or cropping intensity has increased by about 10.03% during this period making additional use of water by the same rate. The water loss due to evaporation would have certainly gone down by water saving measures such as drip irrigation, sprinkler irrigation, mulching, etc., but such data were not available.

Crop productivity

In the absence significant technological transformation, it is very difficult to achieve substantial increase in crop yields. However, by way of timely guidance and enhanced availability of most critical water resource, the average yields of most of the crops have gone up (Table 4). The increase in productivity per acre was 23% in castor, 17% in fennel, and 13% in cotton crop. Moong and wheat crops showed marginal improvement in productivity. The average yield of millets and potato, however showed declining trend.

Table 4: Average Yield of major crops (q/acre)

Year	2003	2008	Percentage increase
Cotton	7.4	8.37	13.11
Millets	4.45	3.87	–13.03
Groundnut	5.64	7.59	34.57
Castor	7.25	8.93	23.17
Moong	2.64	2.75	4.17
Sesamum / Guar	4.33	4.33	0
Wheat	9.23	9.58	3.79
Fennel	5.52	6.48	17.39
Potato	95.71	89.55	–6.44

Therefore, the direct economic benefit accrued to the farmers of all these activities together in terms yield improvement, increase in cropping intensity and cost reduction was enquired which averaged to Rs 2769, Rs 660 and Rs104 per acre respectively. Thus the net gain came out to Rs 3533 per acre. Apart from this benefits due to shift in crop pattern were also assessed. It was also reported by the respondents that by shifting from flooding to sprinkler and drip systems, drum kit and mulching they realized that the water requirements of the crops, mainly for transpiration has not gone down but had definite impact on minimizing evaporation. Thus overall decline in the water use has made possible more area to be irrigated. Pest problem is minimized due to less humid atmosphere. Product quality has improved. Better seed

germination because of almost controlled atmospheric conditions. It is possible to take early crop to benefit from market requirements. The weeds are less and thus the cost of herbicides has gone down. Application of fertilizers is made through drip system resulting in its higher use efficiency.

Organic Farming

It was another significant intervention of NGOs to promote organic agriculture with a view to improve the water holding capacity of soil, soil nutrition, make economic use of byproducts and minimize the use of costly chemical pesticides and fertilizers. During the past three years, as many as 13.44%, 2.69%, 25.27%, and 2.15% farmers were guided and helped in keeping dung and compost in the pits, preparing and using of panch-amrut as a bio-pesticide for making organic agriculture effective, preparing and using of vermi-compost and vermi-wash as an disinfectant respectively (Table 5). Such activities covered a small part of the total farm area due to lack of local inputs. Cost too varied with the size of operation and only technical guidance was provided by the NGOs. Some farmers also reported to have derived benefit of higher price of farm products, improvement in soil health, less plant protection cost, more employment of human labor and less air pollution.

Table 5: Number of respondents with organic farming as an intervention

NGO	Sample size	Com-post pit	Pancha-mrut	Vermi-com post	Vermi-wash	Total
IWMIITP	95	8	3	26	4	**41**
MGP	43	10	1	9	0	**20**
Cohesion Foundation	29	5	1	9	0	**44**
Lok Vikas Area, Siddhpur	19	2	0	3	0	**5**
Overall	**186 (100.00)**	**25 (13.44)**	**5 (2.69)**	**47 (25.27)**	**4 (2.15)**	**81 (43.55)**

Note: Figures in parentheses are percentages

Orchard Plantation

Orchard plantation, particularly pomegranate was considered as another feasible intervention to reduce the water use and improve the soil fertility. It was reported that some NGOs, as an income improving and water saving drive, are helping farmers in planting Sindhuri variety of pomegranate, popularly grown in Nasik district of Maharashtra state. Amongst the potential fruits, pomegranate ranked at the top, followed by papaya and mango. The other fruit orchards taken up were amla, grapes, lemon and sapota. Department of Horticulture was providing a subsidy of Rs9000 per acre on papaya and pomegranate plantations under National Horticulture Mission Scheme, which almost cover the cost of sapling and plantation at least in the first year. Many farmers were taking additional advantage by intercropping with water melon, bottle gourd, onion, garlic and bitter gourd etc in first and second year with pomegranate.

In spite of this the pay off period being long (3 years in case of pomegranate), the small farmers cannot jeopardize the livelihood of their families for this waiting period. Therefore, efforts were concentrated on larger farm situations. Thus out of 186 sample respondents, 76 plantations were done on an average of 4.1 acres (Table 6). Although most of the orchards were still in their infancy and thus the cost-return could not be standardized, yet based on the experience so far and some reasonable assumptions, an effort is made to prepare a partial budget of orchards. Table 6 presents the profitability of different types of orchards in North Gujarat. Some types of orchards like pomegranate and papaya were introduced on large scale as their profitability was quite high amounting to Rs 47000 and Rs 193000 per acre respectively. Although return from papaya was much higher, yet due to higher degree of yield and market risks, it was much preferred. Grapes also promise high return but the initial establishment cost in bower system is too high and there is difficult to go back in case of serious production and marketing problems. Therefore, on the whole, the weighted average net return worked out to Rs 74211/acre, almost Rs 40000 higher than that of cotton–wheat rotation.

Table 6: Number of farmers received guidance and planting orchards

NGO	Amla	Grapes	Mango	Papaya	Pome granate	Sapota	Total farmers
No. of farmers	3	2	7	8	53	3	76
Area covered (acres)	8.0	0.9	2.9	8.6	3.6	1.9	311.4
Profit-ability (Rs/acre)	8210	132143	15759	193506	47000	12914	74211

Taking into account the establishment cost and annual operational costs of pomegranate orchard, the average net return is estimated at Rs47000/acre. Yet there is need to standardize the technology such as planting distance, fertilizer requirements, plant protection, pruning, etc. Above all, developing orderly market by creating demand by processing into different forms, packing and sale in distant consuming markets is the requirement to sustain the enterprise in the area. Producer's share in consumer's rupee is only 40% which necessitates shortening of market channel through formation of self-help groups. Realizing the need of addressing marketing issues of fruits crop for sustainable farming under NGI, a farmers' producer company in the name of, "North Gujarat Agro Producers Company Limited" has already been registered with 300 members. Further, active networking with the fruit/agricultural produce marketing agencies in Gujarat and outside the state are underway recently, the outcome of which is yet to be seen.

Vegetable Cultivation

Vegetable cultivation was another intervention for improving the livelihood of the population in the area. It was initiated on farms of about 19.35% of respondents (Table 7). A large variety of vegetable crops such as potato, chillies, tomato, cucurbits, etc., were introduced in the cropping system. The increase in income was reported by most of such farmers but increase in employment was only on 58% of vegetable farms. For further improvement in this direction, market development and technical guidance were stated to be the potential areas.

Table 7: Number of farmers initiating vegetable cultivation and its impact

NGO	Sample size	Opting for vegetable cultivation	Employment enhanced	Reporting income increase
IWMIITP	95	9	8	7
MGP	43	16	8	16
Cohesion Foundation	29	9	3	9
Lok Vikas Area, Siddhpur	19	2	2	0
Overall	**186**	**36**	**21**	**32**
Percentage	**100.00**	**19.35**	**58.33**	**88.89**

Table 8: An estimate of addition economic gain due to interventions

Intervention	Annual net economic gain (Rs/acre)	Details
1. Water conservation	3533	• Rs 2769/acre by yield increase • Rs 660 by 2% increase in cropping intensity • Rs 104 due to cost reduction of traditional crops
2. Organic farming	430	43% area, 10% cost reduction of average cost of Rs 10000/acre
3. Orchard plantation	4533	Orchard giving net income of 74211/acre or additional income of Rs 41211 over cotton–wheat on 11% area.
4. Vegetable cultivation	2064	17.2% farmers, 10% area having additional income of Rs12000 over cotton–wheat
Overall	**10560**	

Overall Economic Impact: Estimation

Considering the four major technological interventions namely water conservation, Organic farming, Orchard plantation and Vegetable cultivation, estimation was made regarding annual economic benefits accruing to the respondents. It came out to Rs10560 per acre (Table 8). The probability of impact was made on the basis of coverage of technology in terms of percent farms, percent area of each farm and net gain to the beneficiaries. The details of each activity and the benefit realized by the

respondents are also summed up. Therefore, an average farmer with about 5 acre land holding got an added annual advantage of Rs 50000.

Resource poor and landless labor families having small pieces of land adjoining their residences were supplied with drum kits for water storage and vegetable seed packets for drinking water, kitchen gardening. This had impact of additional income of Rs 800–1200/annum depending upon area available, fresh vegetables, water for livestock and easy availability of water.

It is pertinent to enquire about the direction of expenditure in case significant economic improvements are brought about. Productive investment such as purchase of livestock and machinery were the priority areas. Purchase of and improvement in land was another avenue reported by about 36% farmers. Nearly 47% wanted to repay debts outstanding. Amongst the consumption expenditure, social ceremonies was the most preferred followed by education of children and house construction.

Summary

Gujarat agriculture has been thriving on traditional crops and was unable to shift to high value crops due to serious water constraint. "North Gujarat Sustainable Groundwater Initiative" (NGI) was launched in 2002 to explore approaches to protect and strengthen the livelihood of resource poor households as IWMI–Tata Programme in Banaskantha and Palan districts. Various interventions in this connection were made through some NGOs. This study was carried out with the objective to pinpoint and highlight the economic, social and environmental impact of such interventions.

The socio-economic background of the sample of 186 respondents selected for the study indicated that dairy farming was a potential supplementary enterprise of the respondents and it was on the expansion path with the improvement of water resource.

The water saving measures indicated no change in the total quantum of water use but definite saving in terms of reduced evaporation and wastage was obvious. The water thus saved and enhanced water supply created through check dams and well blasting helped in land use from traditional crops to high value crops, increasing cropping intensity and crop yields had significant positive impact on household livelihood in the area.

Of the four major types of interventions viz. water conservation, organic farming, orchard plantation and vegetable cultivation, the net economic gain estimated on the basis of perceptions of respondents worked out to Rs 3533, Rs 430, Rs 4533 and Rs 2064 respectively with an overall gain due to project as Rs 10560/acre. Apart from this increased employment of family and landless labor, increased drinking water for human and livestock, improvement in soil health were reported. Better quality of farm products, increasing possibility of taking early crop, less problem of herbs, less labor requirements for certain operations are some other indirect benefits accruing to the farmers. A strong need to go ahead with formation of self-help groups (SHGs) for marketing and value addition of emerging high value crops was felt such that these could be encouraged and even sustained in the area.

Acknowledgments: The authors are thankful to Sir Ratan Tata Trust, Mumbai for initiating, facilitating and financing the study.

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www.iwmi.org Groundwater management in North Gujarat: Sustainable Agriculture Improving Rural Livelihood and Hydrological Integrity of Groundwater

Productivity is being able to do things that you were never able to do before.

—Franz Kafka

Feature

Implementation of Green Supply Chain Management: A Microscopic Review

SUNIL LUTHRA, DIXIT GARG AND ABID HALEEM

Environmental Management in the supply chain has been receiving growing attention among researchers and Supply Chain managers through the Green Supply Chain Management. It covers product design, supply and material selection, manufacturing processes, final product delivery to consumers and management of the product at the end of its useful life. This paper discusses implementation of Green Supply Chain Management from microscopic perspective. This will help an organization manage their resources in effective manner keeping environmental issues in mind.

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Increasing environment consciousness has been noticed in the last few years. People are becoming aware of the world's environmental problems such as global warming, toxic substance usage and decreasing non-replenishable resources. Several organizations have initiated responding environmental issues by implementing green principles in their organization. The green principles may expand to many departments within the organization and the supply chain. Adding "green" concept to "supply chain" means the supply chain directly relates to the environment (Green et al., 1996; Srivastva, 2007). The main purpose of GSCM is to reduce environmental pollution by creating green products. It starts from adopting green materials, green manufacturing, green packaging and green transportation. Green supply chain improves operations by employing environmental solutions (Forte, 2009; Ho et al., 2009).

Green Supply Chain Management: An Overview

Green Supply Chain Management (GSCM) has been identified as an important research area in recent years. Green environmental issues have drawn an attention of researchers and Supply Chain (SC) practitioners at micro and macro levels. An overview of GSCM has been elaborated in the following subsections:

GSCM Definitions

Various definitions of "GSCM" have been reported in the literature by different researchers and are tabulated in Table 1.

Difference between the GSCM and Conventional SCM

GSCM takes considerations to ecology as well as economy as objective, while Conventional SCM is usually

Table 1: Various Definitions of Green Supply Chain Reported in the Literature

S. N.	GSCM Definition Reported in the Literature	Researcher(s)
1	Green Supply referred to the way in which innovations in SCM and industrial purchasing may be considered in the context of the environment	Green, Morton and New (1996)
2	GSCM is as the practice of monitoring and improving environmental performance in the supply chain	Godfrey (1998 p244)
3	Environmental GSCM consists of the purchasing function's involvement in activities that include reduction, recycling, reuse and the substitution of materials	Narasimhan and Carter (1998)
4	GSCM is integrating environmental thinking into SCM	Gilbert (2000)
5	GSCM is the set of SCM policies held, actions taken and relationships formed in response to concerns related to the natural environment with regard to the design, acquisition, production, distribution, use, re-use and disposal of the firm's goods and services	Zsidisin and Siferd (2001)
6	GSCM = Green Purchasing + Green Manufacturing /Materials Management + Green Distribution / Marketing + Reverse Logistics	Hervani, Helms and Sarkis (2005)
7	GSCM covers all phases of the product's life cycle from design, production and distribution phases to the use of products by the end users and its disposal at the end of the product's life cycle	Zhu and Sarkis (2006)
8	GSCM is adding 'green' component to SCM, including green operations, green design, green manufacturing, reverse logistics and waste management	Srivastva (2007)
9	GSCM is as an approach for improving performance of the processes and products according to the requirements of the environmental regulations	Hsu and Hu (2008)
10	GSCM is as a managerial approach that seeks to minimize a product or service's environmental and social impacts or footprint	Rettab and Ben Brik (2008)
11	GSCM (the integration of both environmental and SCM) is a proven way to reduce a company's impact on the environment while improving business performance	Torielli., Abrahams, Smillie and Voigt (2011)

concentrated on economy as a single objective. GSCM is green integrated and ecologically optimized, while

human toxicological effects (Beamon, 1999; Ho et al., 2009). Difference between GSCM and Conventional SCM [illegible] own in Table 2.

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concentrated on economy as a single objective. GSCM is green, integrated and ecologically optimized, while conventional SCM does not take into consideration of human toxicological effects (Beamon, 1999; Ho et al., 2009). Difference between GSCM and Conventional SCM are shown in Table 2.

Table 2: Difference between the GSCM and Conventional SCM

S.N.	Characteristics	GSCM	Conventional SCM	Researcher(s)
1	Objectives	Ecological and Economic	Economic	Beamon (1999)
2	Ecological Optimization	High Ecological Impacts	Integrated Approach Low ecological impacts	Gilbert (2000) Ho et. al. (2009)
3	Supplier Selection criteria	Ecological Aspects Long Term Relationship	Price Switching Suppliers Short Term Relationship	Hussain (2011)
4	Collaboration and Visibility	High	Low	
5	Cost Pressure	High	Low	
6	Reverse Logistics	Important Part of the Process	Integral Part of the Process	
7	Flexibility	Low	High	
8	Speed	low	High	

Table 3: Benefits of GSCM

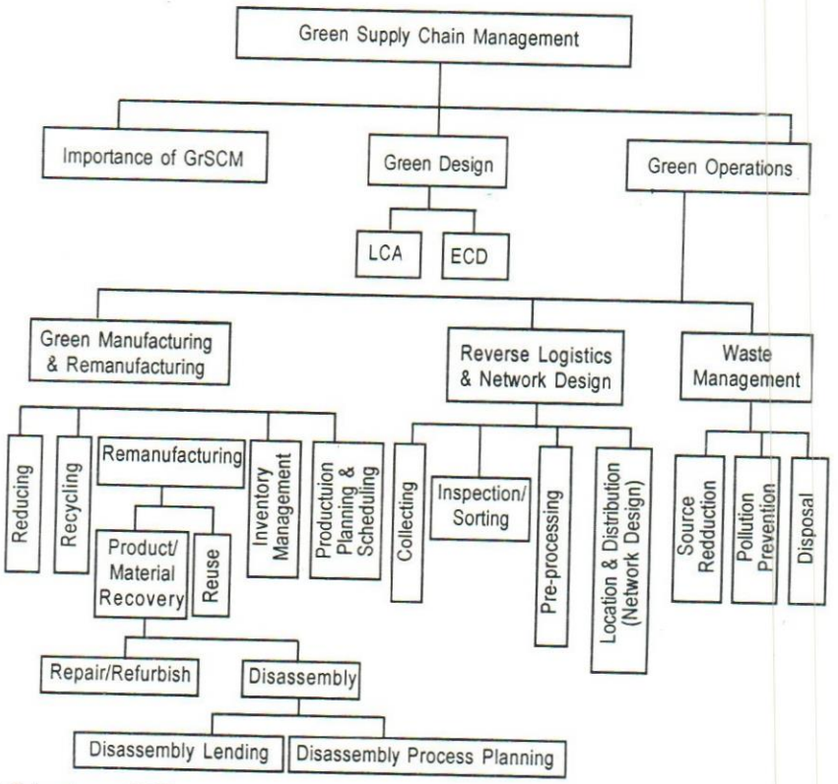
Environment	Supplier	Manufacturer	Customer	Society	Stakeholder	Supply Chain
Low Pollution	Low Cost Prices	Low Cost Prices	Low Cost of Ownership	Less Consumption of Resources	Motivation of Stakeholder for the Environment	Competitive Advantage
Overcoming Prejudice and Cynicism	Less Rejection Better Image	Easy to Manufacture Better Image	Convenience and Fun	Better Compliance		
		Sustainability of Resources/Increased Efficiency Adapting to Regulation and Reducing Risk Brand reputation Return on Investment Employee Morale	Feel Good and Quality of Life			

Benefits of GSCM

The effects of GSCM expand to all areas, both tangibly and intangibly. The benefits of GSCM have been identified for different members of supply chain, whole society and the environment and tabulated in Table 3 (Stevels, 2002; Duber-Smith, 2005).

IMPLEMENTATION OF GSCM: SOME MICROSCOPIC ISSUES

Studies have been reported in literature on many macroscopic and microscopic issues related to implementation of GSCM in (Figure 1).



Source: Srivastava, 2007

Figure 1: Implementation of GSCM

But we have limited our study up to microscopic issues related to implementation of GSCM. The microscopic issues related to implementation of GSCM are: Green Product Development; Green Design; Green Purchasing and Green Raw Materials Procurement; Green Process Planning; Green Manufacturing and Green Transportation and Distribution. These six microscopic issues related to implementation of GSCM are being briefly discussed hereafter:

Green Product Development

Green products are the products that are made in a way that generally puts less strain on the environment than conventionally manufactured goods of similar type. Green product development, addresses environmental issues through product design (Hendrickson and Tuttle., 1997; Mudgal et al., 2009). Green Product development should focus on entire production processes not only the product, but also all the market externalities of product must be considered. One of the most difficult steps in the initiation of a green product development strategy is where to get started. The green knowledge base for product development is widely distributed and not readily available within the organization, in the design or process teams (Ilgin and Gupta, 2010; Srivastva, 2007; Pujari et al., 2003; Mudgal et al., 2009).

Green Design

Green product design is a broad concept that attempts to reduce the impact of a product on the environment in a systematic and structured way. The literature emphasizes upon both environmentally conscious design (ECD) and life-cycle assessment/analysis (LCA) of the product. ECD is also known as Ecological Design/ DFE. Green designing focuses on the ecological balance between man and nature. It fully takes environmental effects into account to minimize damage in the whole designing process. Green product design is a broad concept that attempts to reduce the impact of a product on the environment in a systematic and structured way. Eco-design is a systematic way to include environmental life cycle considerations in the product design (Alhola, 2008). Eco-design aims at avoiding or minimizing environmental impacts of a product throughout its life cycle. It covers the whole product chain from materials extraction, through production processes, packaging, transport and product use phase to the end-of-life treatment (NRCC, 2003).

Life-cycle assessment/analysis is described as a process for assessing and evaluating the environmental, occupational health and resource-related consequences of a product through all phases of its life, i.e. extracting, processing raw materials, production, transportation, distribution, use and remanufacturing, recycling and final disposal (Gungor and Gupta, 1999; Ilgin and Gupta, 2010).

Green Purchasing and Green Raw Material Procurement

Green purchasing is adding environmental aspects of price and performance criteria when making purchasing decisions. The ultimate goal is to reduce environmental impacts of sourcing and to increase resource efficiency. A procurement manager who wants to purchase "green" products must be able to define the Products standards for "green" products like products made with recycled content, products that are more species-friendly, products that are more energy-saving, products that use fewer pesticides, involve less harmful effluents, or less toxic chemicals in the production process, or other intrinsic or extrinsic factors. The term green materials refers to those materials which have negligible or very less harmful effects on the environment throughout the product life cycle even after its disposal (Auger et al.2010; Eltayeb et al., 2009; Narasimhan and Das, 2001).

Green Process Planning

The term green process planning refers to the development of a comprehensive and integrated approach for achieving environmental and economic sustainability. Referred by a growing number of communities and businesses, green process planning serves as a means to assure the long-term viability of these human endeavors (Gungor and Gupta, 1999; Srivastva, 2007).

Green Manufacturing

Green manufacturing deals with technologies and solutions that provide Green Products (Environment friendly products). Recycling is the process of collecting used products, components, and materials from the field and separating them into categories of like materials and processed into recycled products, components, and materials. The success of recycling depends on that there is a market for the recycled materials and the quality of the recycled materials. Recycling processes reduces the actual value of the material from its original value. Reuse is the process of collecting used materials, products, or components from the field, and distributing or selling them as used. The ultimate value of the product is also reduced from its original value. The process of remanufacturing

consists of collecting a used products or components, assessing its condition, and replacing broken or obsolete parts with new parts. As a result, the identity and functionality of the original product is retained. Remanufactured product is then inspected and tested, with the goal of meeting or exceeding the quality standards of brand new products. Thus, sometimes, the remanufactured product may exceed the original product in quality and function. The advantage of remanufacturing is that, unlike recycling and re-use, the process of remanufacturing may not degrade the overall value of the materials used (Chung and Wee, 2011; Gungor and Gupta, 1999; Gilbert, 2000; Ilgin and Gupta, 2010).

Green Transportation and Distribution

Green Transportation or Sustainable transportation refers to any means of transport to low impact on the environment. Green Distribution is the process of moving a product from its manufacturing source to its customers with low impact on the environment (Srivastva, 2007; Yu and Hui, 2008).

Conclusions

Environmental issues have an increasing popularity among researchers and SC practitioners. In recent years, there is a significant increase in the number of studies on environment issues in national and international journals. Along with change in manufacturing, trend of making environment friendly products is increasing, environmental and social issues have become important for managing any business. An attempt has been made to provide an overview of literature on GSCM issues. Some microscopic issues to implement GSCM keeping environmental issues related to implementation of GSCM have been discussed from available literature. It has been observed that more research work is required to be carried out on Green concepts implementation in SCM in Indian context.

Scope of the Future Work

Being the latest and vast area, researchers, academicians and practitioners have so many opportunities. An attempt may be made to identify all critical success factors (macro and microscopic) to implement GSCM and performance measurement model of GSCM. The following general conclusions and directions for further research may be drawn from our literature review:

- It has also been reported that GSCM have two main disadvantages i.e. speed and flexibility. Researchers need to concentrate on this side to improve flexibility and speed.
- In the course of reviewing the literature, it has been observed that there are lot of research opportunities for a researcher's in GSCM macro and microscopic issues especially in Green Product development and Green Process Planning.
- GSCM practices implementation and performance evaluation needs to be explored however, some work has been reported in the literature.
- It has been also reported that very rarely validation techniques like Structure Equation Modeling (SEM) are used to validate the implementation models. So need arises to validate GSCM implementation models.
- Researchers may also focus on measurement models for GSCM performance improvement after GSCM practices implementation.

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The superior man acts before he speaks, and afterwards speak according to his action.

—Confucius

Feature

Development and Validation of Performance Measures for Lean practices in Small-and-Medium-Sized Enterprises

P. P. SHAH AND R. L. SHRIVASTAVA

This paper aims to develop and validate performance measures for Lean Six Sigma in Indian context by developing an instrument for facilitating the implementation process in small and medium scaled enterprises (SMEs) of Vidarbha region. Using a through synthesis of the various quality management systems i.e. Six Sigma, TQM, ISO, Lean etc. literature six performance measures which are Finance performance impact, Quality culture, Productivity, Customer satisfaction, Product/Process services, Human safety and Time impact. Total 39 attributes have been developed. Using the survey methodology, the data obtain from manufacturing as well as service industries in this region. The identified measures were subjected to appropriate statistical tests to establish reliability and validity.

On the basis of statistical evaluation which was carried out by using statistical computing software SPSS 18.0 for windows, the developed instrument was found to be valid as well as reliable which can be used for initiating the efforts to assess and implement LSS in SMEs.

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Performance measurement is important for every business organization to judge the situation of their business in this competitive market by benchmarking their performance with their objectives and with the competitors. The use of performance measures in the business is not new. There are various attributes for measuring the performance which are classified as customer satisfaction impact, quality of product, financial performance impact, operating performance impact, human resource, safety, quality culture change. In selection and implementation of the performance measurement system, there is a key role of top, middle, and low level management. There should be proper co-ordination and cooperation among the all level of management people. The simple model for performance measurement is shown in figure 1.

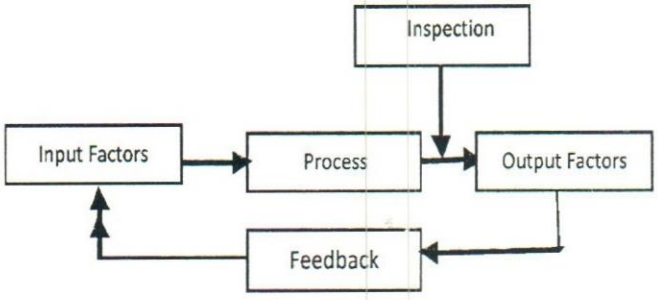


Figure 1: Model for performance measure (developed)

This is close loop activity, feedback is necessary to compare with (established) objectives to find out the deviation which helps to capture the opportunities for improvement. Input factors are those factors which are essential for the implementation of the system. Performance measurement system involves internal elements such as employees, machines, material and external elements such as customers, competitors,

suppliers, society, stake holders. Performance measurement system to be effective, there is a need of perfect linkage between these elements as the system and feedback mechanism is the central part of an organization.

Small and medium sized enterprises (SMEs) play an important role in the industrial development of any country. In view of the robust growth, the contribution of SMEs to the Indian economy can not be ignored. They are the life blood of modern economies, even though SME's have many constraints such as financial constraint, labor constraint, material constraint, which adversely affects quality and productivity as the implementation of new technology is difficult. In the backdrop of globalization, it has been observed that the big organizations are heavily dependent on SMEs for meeting their requirements of high quality products / services at the low costs. Large organizations, which put pressure over SMEs for implementation of modern quality management system such as TQM, ISO, Six sigma (SS), Lean Six Sigma (LSS), Kaizen, Quality function deployment, Zero defect program, Taguchi method, etc. All these quality improvement tools and techniques are extensively resource based, which makes SME's unable to implement them. However, the combination of lean principles along with six sigma can help the SMEs to manage all the quality related issues. Hence, it is apparent that there is a need for development of an SME focused model for its possible use for implementing LSS.

Literature Review

Extensive literature review was carried out for identification of various attributes of LSS and the performance measurement system. These critical factors were classified into various groups. CSF's are those attributes, which are essential for successful implementation of any quality improvement initiative.

Saraph et al. (1989) have used the data collected from 162 general managers and quality managers from 20 companies in the Minneapolis/St. Paul area to identify the critical factors for quality management practice. These authors identify eight factors which are defined by small number of evaluators: the role of management leadership and quality policy, role of quality department, training, product/service design, supplier quality management, process management, quality data and reporting and employee relation. These factors are identified based on the literatures which were validity empirically. Anderson Mary and Sohal Amrik S. (1999), their study uses the data collected from 62 small business in Australia and uses the Australia Quality Awards framework, specifically to examine the relationship between the quality management practices and business performance. Six performance measures were listed i.e. overall competitiveness, sales, market share, employment levels, cash flow and exports. The results show that the practices and principles of quality management have had the highest impact on the overall competitiveness of business and least impact on exports. Terziovski et al. (1999) study characteristics the organizational performance by 14 attributes which are customer satisfaction, employee morale, cost of quality, delivery in full, defect rates, warranty cost, productivity, cash flow, employee growth, market share growth, sale growth, export growth, innovation (new product) and organizational performance. Their finding shows that TQM has a significantly positive effect on operational and business performance, employee relations and customer satisfaction. Also concludes that there are significant differences in the relationship between TQM and organizational performance across the industrial sectors and different size companies, particularly on the effect of defect rate, warranty costs and innovation of new products. Shams-ur Rahman (2001) assessed the impact of quality management factors on organizational performance for SMEs in Western Australia with and without ISO 9000 certification. The attributes for performance measurement included in his study are profitability, quality improvement efforts and increase in customers. The result showed that there was no significant difference between SMEs with and without ISO 9000 certification with respect to TQM implementation and organizational performance. Brah et al. (2002) attempted an empirical study to test if there is any significant relationship between quality parameters (corporate planning, top management leadership, customer focus, human resource focus, process focus, information analysis and quality focus) and organizational performance (supplier performance, employee service quality, product/service process quality, product/service quality and customer satisfaction, employee satisfaction). The study finds that the nature of the company, whether manufacturing or service does not affect the rigor of quality management implementation and the resulting level of quality performance. Wali et al. (2002) suggests and classify the list of performance measures as within organization performance measures includes top management (impact on society, speed of change, level of commitment, quality of leadership, market change, business result, rapid innovation rate), middle management (speed of learning,

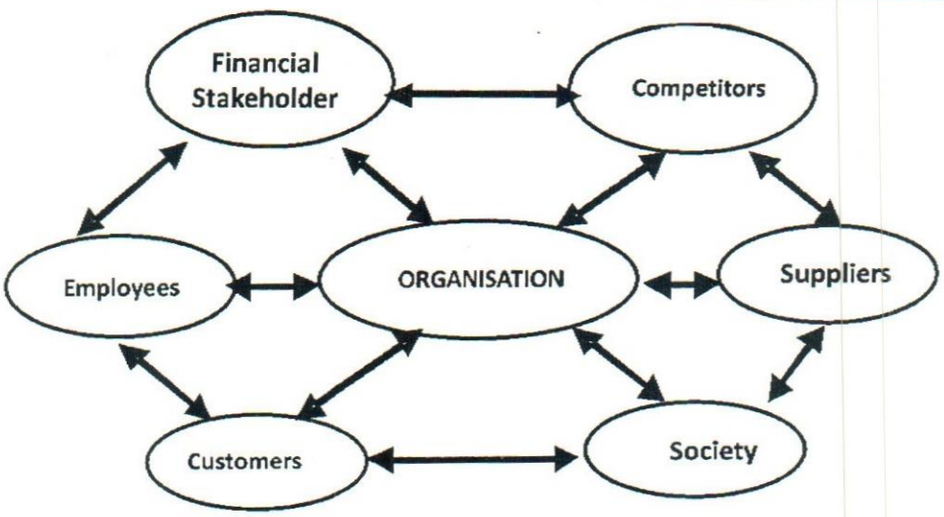


Figure 2: Various Agents involved in Performance Measurement System

Source: Wali et al. (2002)

speed of training, team format, level of process and function design, speed of communication between top and operational management), operational management (extent of adopting 7 QC tools, speed to solve problems, productivity growth, inventory turnover, customer deliveries, timeliness and response to new technology) and shop floor management (no. of defects, rate of output, rework/ scrap, total cycle time and absentees) and outside organization performance measures includes supplier (quality of incoming material, lead time, vendor rating, quality standards, inventory turnover, timeliness), customers (service level/after sale service, customer satisfaction). Authors suggest that, for effective implementation of QMS it is necessary to align the few CSFs with organizational philosophy and investment in quality must also transfer into business result for this it is essential to evolve a performance measurement system. Shrivastava et al. (2004) carried out the survey of small, medium and large Indian industries to establish a link between performance measures and TQM factors for an Indian environment. Their study suggests critical dimensions of organizational performance which are quality (product performance, delivery reliability, waste, dependability, innovation), time (lead time, process through time, process time, productivity, cycle time, delivery speed, labor efficiency and resource utilization), business result (cash flow, market share, overhead cost reduction, inventory performance, cost control, sales, profitability, efficiency and product cost reduction), customer satisfaction (market share, service, image, integration with customers, competitiveness, innovation and deliverability) and human resources (employee relationship, employee involvement, workforce, employee skill, learning, labor efficiency, quality of work life and productivity). Empirical evidence shows that the proactive business orientation (planning, policy, organizational goal, infrastructure, product design flexibility, financial position) has emerged as the strongest quality influencing all the five measures of organizational performance.

Methodology

Development of survey instrument

Research in common parlance refers to a search for knowledge. However, to gain the knowledge, correct data is required. In addition to this, the data generation needs reliable and valid instruments, which can stand the scrutiny by the scientific community. Development of research instrument is not a simple process, especially those where the human perception plays an important role. Literature reveals that most of the instruments were developed in the social science field and by the psychologists. To prepare these instruments, general psychological principles were used, similar to those principles were utilized in this study to develop the research instrument, which can aid in identifying CSF's of performance measures for LSS.

The attribute were identified based on the literature review. A total 57 attributes were developed. The questionnaire was finalized by rearranging the various attributes.

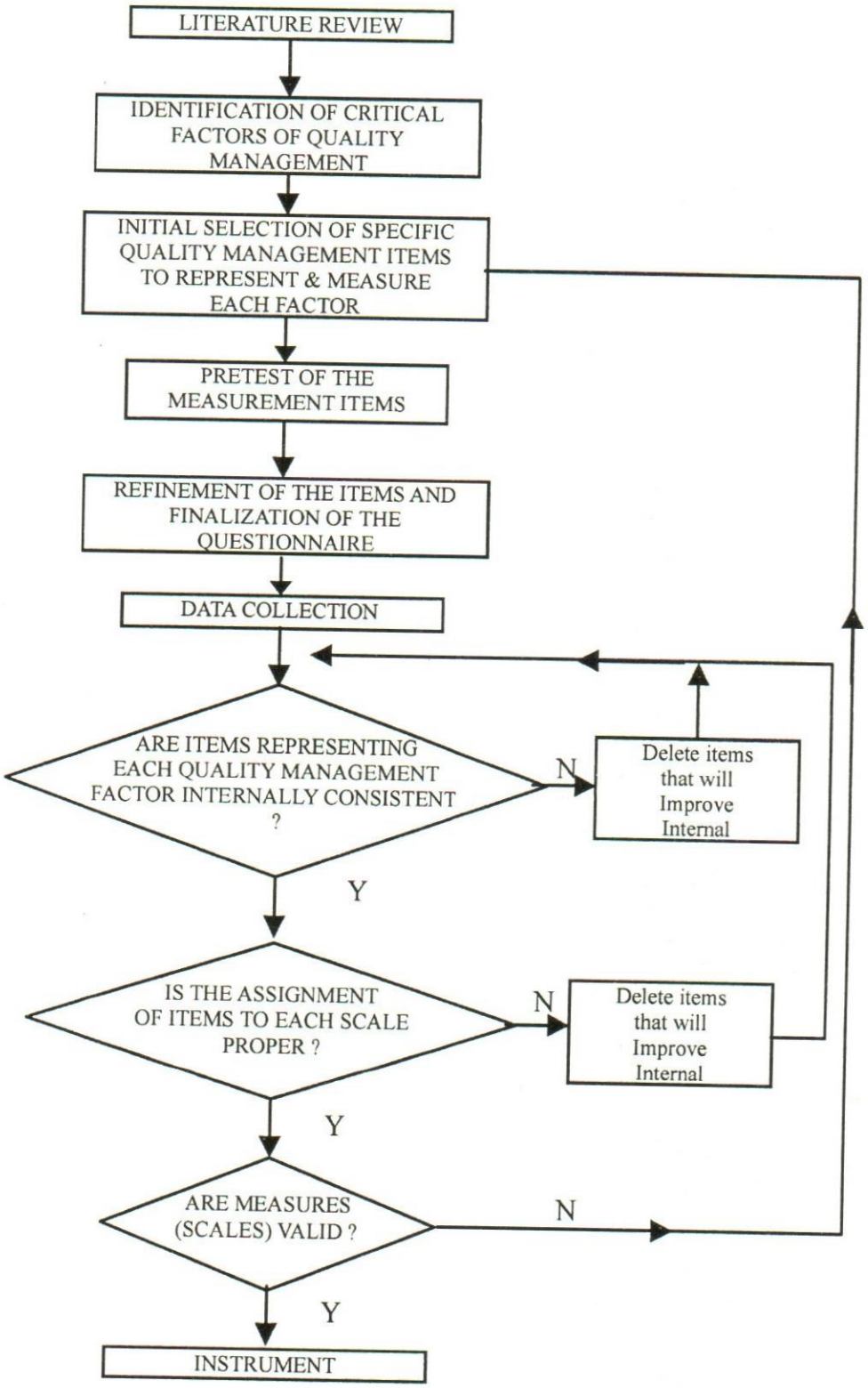


Figure 3.1: The Instrument Development Process

Source: Saraph et al., 1989

Identification of Performance Measures

Performance measurements are the important attributes for judging the progress of any quality management system (QMS) in large as well as smaller organizations. These measures, if properly identified, help the organization to gain remarkable profits. The performance measures were identified by the process of comprehensive review of literature. Various factors mentioned in the literature were selected for the initial or preliminary draft of the instrument. The factors which control the QMS and the benefits SMEs receive with respect to performance measures were given adequate importance.

Final selection of items (attributes)

In all a total of 57 attributes were selected from the published literature, which are then grouped under different subheadings by following the factor analysis procedure. The final selection of the items, however, was based on the results obtained from the Cronbach's alpha procedure.

Pilot study

The data gathering phase of research process typically begins with pilot testing. A pilot study was conducted to detect weaknesses in design an instrument and to provide proxy data for selection of a probability data. The selected variables (57) were framed in the research instrument (questionnaire). The respondents were asked to rate each attribute under the five point interval rating scale (1-very low, 2-low, 3-medium, 4-high, 5-very high) to indicate the extent of practices in their business unit.

For data collection and easy to draw meaningful conclusion the sample frame and sample size were decided based on the review. Sample frame consist of the all type of SMEs in Vidharbha region. A total of 108 questionnaires were distributed through mail, by post-mail and personally and a total of 59 valid questionnaires were received having response rate of 55% and sample size of 59 was considered good for present pilot study.

Data analysis

Unidimensionality

Byrne (1994) observed that, a comparative fix index (CFI) of 0.90 or above implies strong scale unidimensionality. The CFI values for all variables of developed instrument were 1.00 which signifies strong unidimensionality.

Reliability of instrument

Although there are many methods to measure the reliability of an empirical instrument, the internal consistency method is often recommended for use in the instrument development process involving the field studies. The internal consistency of a set of measurement variables is to the degree to which items in the set are homogeneous. Internal consistency can be estimated using reliability coefficient such as Cronbach's alpha. Nunnally (1971) suggested that a Cronbach's alpha value greater than 0.7 suggests good internal consistency. The overall Cronbach's alpha for independent variable was found to be 0.9769, which indicated that the developed instrument was of acceptable reliability.

Table 1: Reliability statistics (Performance measures)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.976	.976	57

Source: From data analysis

Based on the pilot study some variables are deleted due to uncertainty in understanding the meaning of question to the respondent, the questionnaire was modified. The final questionnaire consists of 39 input variables and ready for final survey.

Full Scale Survey

Sample size

Considering the nature of work to be carried out, it was decided to use random sampling technique to select the units from the universe. Here the word universe denotes the organization practicing QMS initiatives listed from the information obtained from various resources. These units are categorized as manufacturing, chemical and chemical based minerals and metal based agro, automobiles, machineries etc. Entire Indian industries following these initiatives were considered as population for the research. Samples from all the types, capacities and sectors of Indian industries are obtained. Sample size is the response in the form of the filled questionnaires obtained from the universe.

Manufacturing sectors selected for collecting data are automobile, chemical, textile, food, electrical and electronics, petro, chemical & chemical based furniture, and metal metallurgical mechanical /machinery technical service sector, textiles & others (leather, rubber, plastics, etc.) sectors were identified for collecting the data from respondents. The developed and pilot tested research instrument was administered to the mentors; CEO's managing directors, general managers, production

managers, quality managers and maintenance managers etc. of Indian manufacturing companies. They are supposed to be the think-tank with respect to quality management in their companies; therefore they were asked to participate in this study.

The questionnaire is designed in such a manner that only clicking on appropriate box can make a cross mark (X), this system facilitates the online response. An email and postal survey method was adopted to cover wide range of manufacturing companies throughout the country. A variety of techniques were used to boost the response rate such as return self addressed envelope, self-stamped, and personalization. Maximum responses were also collected through e-mail. Wherever possible the questionnaires were handed over personally to the respondent with prior appointment. To increase the response rate, a reminder was sent to each of the companies, Personal calls were also made in some cases. To ensure that the responding companies were from the above mentioned manufacturing sectors, respondents were asked to indicate the industry sector their firm belongs to. Only the responses, which indicated that they were from the above manufacturing sectors, were used in the final analysis. A total of 289 responses were used in the final analysis.

Response Rate

To collect the responses various ways were used such as postal mail, e-mail and personal relations. The continuous follow up through personal discussion and remainders with the respondents resulted in receiving 289 valid responses with the response rate of 72%. Table 2 shows data collection mode and respective responses.

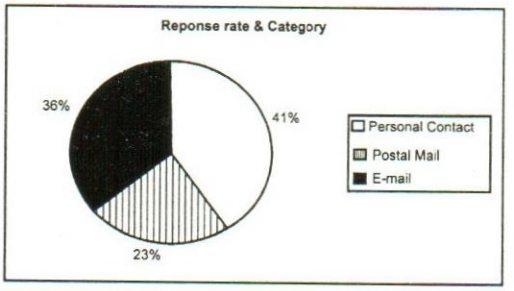
Table 2: Instrument receipt mode details.

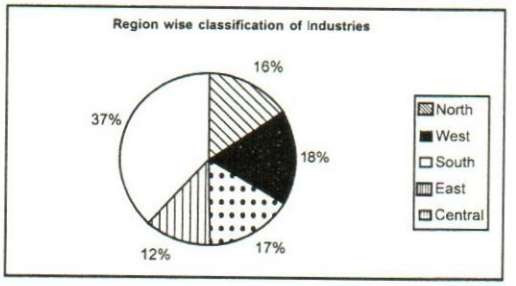
Sr.No.	Data Collection mode	No. of Responses	Percentage
01	Personal contacts	117	40
02	Postal mail	67	23
03	E-mail	105	36
04	Total	289	100

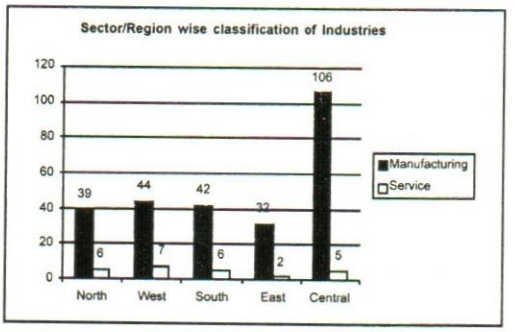
Source: From data analysis.

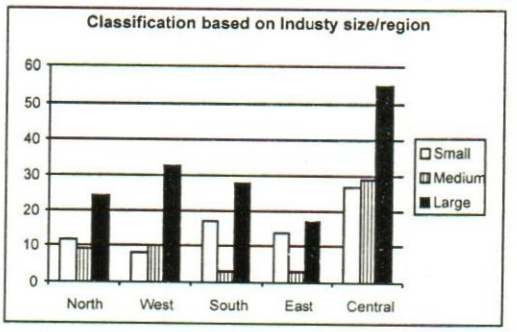
Profile of the respondents

The first part of the questionnaire consists of information of the respondent. The valid responses from the first section of the questionnaire were analyzed. This section consist of the information, such as designation of the respondent, experience, qualification about 88% of the respondents were rank of engineer/manager and above, 52% of respondents were highly experienced having experience of more than 10 year. 64% of the respondents were found to be engineer grade.









Descriptive statistics:

Standard descriptive statistics was used to summarize the responses for individual variables before performing multiple regression analysis and factor analysis.

This part of analysis involved the implementation of Lean Six Sigma which is the focus of this Research. Table 3 shows the summary of minimum score, maximum score, mean score and standard deviation of each item in the research instrument for dependent variables.

Table 3. Descriptive Statistics (Independent Variables)

	Descriptive Statistics				
	N	Min	Max	Mean	Std. Deviation
Customer's retention.(OutQ1)	289	2	5	4.05	.884
Customer's complaints or claims.(OutQ2)	289	2	5	4.07	.899
Overall customer satisfaction (Value for the money spent).(OutQ3)	289	2	5	4.15	.842
Low number of defects and errors.(OutQ4)	289	1	5	4.04	.836
Less rework and waste.(OutQ5)	289	1	5	4.01	.770
High reliability of the product/service. (OutQ6)	289	1	5	4.14	.840
Optimum Inventory Utilization.(OutQ7)	289	1	5	4.08	.847
Low Cost of Quality.(OutQ8)	289	1	5	3.98	.765
Return on Investment.(OutQ9)	289	2	5	4.15	.854
Top line growth.(OutQ10)	289	2	5	4.04	.773
Market share.(OutQ11)	289	2	5	4.07	.813
Bottom line growth.(OutQ12)	289	1	5	4.02	.785
Flexibility of operations / system.(OutQ13)	289	1	5	4.11	.841
Quality of products/ processes (yield, PPM, on time delivery etc.).(OutQ14)	289	1	5	4.15	.777
Equipment availability. (OutQ15)	289	1	5	4.02	.897
Optimum resource utilization.(OutQ16)	289	1	5	3.99	.805
Low product development time.(OutQ17)	289	1	5	3.83	.874
Low material procurement time.(OutQ18)	289	1	5	3.96	.921
Order – process time.(OutQ19)	289	2	5	4.00	.816
Process through time.(OutQ20)	289	1	5	4.12	.889
Machine line down time.(OutQ21)	289	1	5	4.02	.935
Man hours lost.(OutQ22)	289	1	5	3.98	.873
Supplier lead time (Supplier Performance). (OutQ23)	289	1	5	4.06	.889
Capital Productivity.(OutQ24)	289	1	5	4.03	.804
High productivity of People.(OutQ25)	289	2	5	4.14	.746
Productivity of Assets (Machines, equipments etc.).(OutQ26)	289	1	5	3.99	.742
Improvement in value added per employee.(OutQ27)	289	1	5	3.98	.794
Inventory turnover (Material Productivity).(OutQ28)	289	1	5	4.02	.835
High processes efficiency.(OutQ29)	289	1	5	4.06	.835
Less process variation.(OutQ30)	289	1	5	4.11	.910
Accuracy rate.(OutQ31)	289	1	5	4.14	.852
Product recall.(OutQ32)	289	1	5	3.97	.949
High employee satisfaction.(OutQ33)	289	2	5	4.09	.868
Employee efficiency.(OutQ34)	289	2	5	4.08	.858
Capacity building of employees.(OutQ35)	289	2	5	4.01	.805
Environmental compliance.(OutQ36)	289	2	5	4.01	.822
Safety of employees.(OutQ37)	289	2	5	4.11	.896
Positives changes to corporate culture.(OutQ38)	289	2	5	4.09	.836
Improvement towards quality of work life.(OutQ39)	289	2	5	4.01	.826
Valid N (listwise)	289				

Source: From data analysis

Dependent variable (Performance measures):

This research evaluates organizational performance by performance measures expressed as dependent variables. For evaluating the impact of LSS implementation, the respondent perceived overall customer satisfaction (value for money spend) as most significant performance indicator. It received the highest mean rating of 4.15. The two performance variables for same mean i.e. return on investment, quality of products/ processes (yield, ppm on time delivery etc). The lowest mean score of 3.83 is for "low product development time". The mean value of most of the variables is close to 4.

Data Analysis

Reliability of instrument:

The reliability of an instrument assesses its ability to yield the same results on repeated trials, Generally, Reliability co-efficient (Cronbach alpha) of 0.70 or more are considered good and it is advisable to eliminate those items that diminish the coefficient value. The overall reliability of the developed instrument (independent variables) for pilot survey was 0.979. After main survey the overall reliability of independent variables were found to be 0.968 which is the same as that of pilot survey which confirm the instrument ability to yield the same results on repeated trials Table 4.1shows the detailed of reliability analysis of data collected from main survey. The last column of the table 4.1 (a) present's alpha values if items deleted from questionnaire. After comparing all these values with the overall reliability of independent items, it was observed that these values are less than 0.970 and there is no scope for further improvement in reliability hence no items were deleted from the instrument. Accordingly the result provides strong evidence that the variables developed are judged to be reliable, indicating instrument is highly reliable hence the data collected is ready for further analysis.

Table 4.1: Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.968	.968	39

Source: From data analysis

Table 4.1(a) Item–Total statistics

	Item–Total Statistics				
	Scale Mean if Item Deleted	Scale VarianAce if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Customer's retention.(OutQ1)	153.86	459.535	.714	.	.967
Customer's complaints or claims.(OutQ2)	153.85	459.029	.715	.	.967
Overall customer satisfaction (Value for the money spent).(OutQ3)	153.76	464.420	.613	.	.967
Low number of defects and errors.(OutQ4)	153.88	464.688	.610	.	.967
Less rework and waste.(OutQ5)	153.90	466.760	.602	.	.967
High reliability of the product/service.(OutQ6)	153.77	461.360	.702	.	.967
Optimum Inventory Utilization.(OutQ7)	153.83	462.713	.657	.	.967
Low Cost of Quality.(OutQ8)	153.93	468.696	.546	.	.968
Return on Investment.(OutQ9)	153.76	460.482	.714	.	.967
Top line growth.(OutQ10)	153.87	464.976	.654	.	.967
Market share.(OutQ11)	153.84	464.009	.649	.	.967

	Item-Total Statistics				
	Scale Mean if Item Deleted	Scale VarianAce if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Bottom line growth.(OutQ12)	153.89	463.834	.678	.	.967
Flexibility of operations / system.(OutQ13)	153.80	464.566	.609	.	.967
Quality of products/ processes (yield, PPM, on time delivery etc.).(OutQ14)	153.76	466.657	.599	.	.967
Equipment availability.(OutQ15)	153.89	463.312	.602	.	.967
Optimum resource utilization.(OutQ16)	153.92	468.046	.536	.	.968
Low product development time.(OutQ17)	154.09	460.296	.702	.	.967
Low material procurement time.(OutQ18)	153.95	456.684	.758	.	.967
Order – process time.(OutQ19)	153.92	465.254	.610	.	.967
Process through time.(OutQ20)	153.79	461.796	.649	.	.967
Machine line down time.(OutQ21)	153.90	461.759	.616	.	.967
Man hours lost.(OutQ22)	153.93	462.086	.653	.	.967
Supplier lead time (Supplier Performance).(OutQ23)	153.85	459.194	.719	.	.967
Capital Productivity.(OutQ24)	153.88	464.679	.636	.	.967
High productivity of People.(OutQ25)	153.78	469.546	.534	.	.968
Productivity of Assets (Machines, equipments etc.).(OutQ26)	153.92	468.798	.561	.	.968
Improvement in value added per employee.(OutQ27)	153.94	463.766	.672	.	.967
Inventory turnover (Material Productivity).(OutQ28)	153.89	463.852	.635	.	.967
High processes efficiency.(OutQ29)	153.85	462.634	.670	.	.967
Less process variation.(OutQ30)	153.81	458.575	.718	.	.967
Accuracy rate.(OutQ31)	153.77	462.182	.668	.	.967
Product recall.(OutQ32)	153.94	459.537	.662	.	.967
High employee satisfaction.(OutQ33)	153.82	461.863	.663	.	.967
Employee efficiency.(OutQ34)	153.83	461.700	.677	.	.967
Capacity building of employees.(OutQ35)	153.90	462.460	.701	.	.967
Environmental compliance.(OutQ36)	153.91	464.420	.629	.	.967
Safety of employees.(OutQ37)	153.80	460.396	.681	.	.967
Positives changes to corporate culture.(OutQ38)	153.82	461.939	.689	.	.967
Improvement towards quality of work life.(OutQ39)	153.90	464.091	.635	.	.967

Source: From data analysis.

Factor Analysis

Factor analysis is a data reduction technique. It is used to uncovered the latest structure (admissions) of a set of variables. It reduced the attribute space from a large numbers of items to a smaller numbers of factors for modeling purposes, where the large number of variables preludes modeling all the measures individually. Exploratory factor analysis technique is used in this study where a priory assumption is that any indicator may associate with any factor. Principal components factor analysis was used to find out minimum numbers of factors to account for the observed co variation among the forty nine independent variables and thirty nine dependent variables. Only factors that accounted for a variance greater than one (that is eigen values greater than1) were extracted. The rationale behind this approach is that factors with a variance less than one are no better than single variables, Since every variable was standardized and has a variance was one Varimax rotation, an algorithm that minimizes the number of variables that have high loadings on the orthogonal factors was used to improve interpretability. Using principal component and varimax rotation six dependent factors were extracted that accounted for 62.487% of total variation in dependent variables in the observed ratings.

The various steps involved in factor analysis are described in next sections.

Kaiser-Meyer-Olkin (KMO) and Bartlett's Test for Spnerricity:

KMO statistics is a measure of sampling adequacy. It predicts if data are likely to factor well, based on correlation and partial correlation. KMO varies from 0 to 1.0 and KMO overall should be 0.60 or higher to proceed with factor analysis. KMO value above 0.90 is considered as marvelous.

KMO statistics was found to be 0.951 for dependent variables, thus indicates sufficient numbers of samples for factor analysis (Kim and Mueller, 1978) Bartlett's Test of sphericity tests hypothesis that correlation matrix is an identity matrix for this collected data, the Bartlett's test is highly significant (Approx. Chi square, 7359.219 and $P< 0.001$) and it indicated that the collected data is suitable for factor analysis.

Table 4.2.1 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.951
	Approx. Chi-Square	7359.219
Bartlett's Test of	df	741
Sphericity	Sig.	.000

Source: From data analysis.

Table 4.2.2 Communalities (Dependent Variables)

Communalities (Dependent Variables)		
	Initial	**Extraction**
Customer's retention.(OutQ1)	1.000	.637
Customer's complaints or claims.(OutQ2)	1.000	.664
Overall customer satisfaction (Value for the money spent).(OutQ3)	1.000	.542
Low number of defects and errors.(OutQ4)	1.000	.613
Less rework and waste.(OutQ5)	1.000	.558
High reliability of the product/service.(OutQ6)	1.000	.650
Optimum Inventory Utilization.(OutQ7)	1.000	.631
Low Cost of Quality.(OutQ8)	1.000	.517
Return on Investment.(OutQ9)	1.000	.605
Top line growth.(OutQ10)	1.000	.585
Market share.(OutQ11)	1.000	.568
Bottom line growth.(OutQ12)	1.000	.666

Communalities (Dependent Variables)		
	Initial	Extraction
Flexibility of operations / system.(OutQ13)	1.000	.648
Quality of products/ processes (yield, PPM, on time delivery etc.).(OutQ14)	1.000	.650
Equipment availability.(OutQ15)	1.000	.592
Optimum resource utilization.(OutQ16)	1.000	.705
Low product development time.(OutQ17)	1.000	.622
Low material procurement time.(OutQ18)	1.000	.671
Order – process time.(OutQ19)	1.000	.626
Process through time.(OutQ20)	1.000	.584
Machine line down time.(OutQ21)	1.000	.725
Man hours lost.(OutQ22)	1.000	.631
Supplier lead time (Supplier Performance).(OutQ23)	1.000	.649
Capital Productivity.(OutQ24)	1.000	.583
High productivity of People.(OutQ25)	1.000	.628
Productivity of Assets (Machines, equipments etc.).(OutQ26)	1.000	.665
Improvement in value added per employee.(OutQ27)	1.000	.540
Inventory turnover (Material Productivity).(OutQ28)	1.000	.561
High processes efficiency.(OutQ29)	1.000	.642
Less process variation.(OutQ30)	1.000	.667
Accuracy rate.(OutQ31)	1.000	.636
Product recall.(OutQ32)	1.000	.697
High employee satisfaction.(OutQ33)	1.000	.622
Employee efficiency.(OutQ34)	1.000	.739
Capacity building of employees.(OutQ35)	1.000	.605
Environmental compliance.(OutQ36)	1.000	.637
Safety of employees.(OutQ37)	1.000	.659
Positives changes to corporate culture.(OutQ38)	1.000	.581
Improvement towards quality of work life.(OutQ39)	1.000	.566
Extraction Method: Principal Component Analysis.		

Source: From data analysis.

Communality

It is the squared multiple correlation for the variable as dependent using the factors as predicators. The communality measures the percent of variance in given variables explained by all the factors jointly and may be interpreted as the reliability of indicator (Foster, 1998). In this study the extracted dependent factors explain over 73.9% of preferences for variable 34 and 51.7% for variable 8. The values of the extraction communalities were found to be fairly high indicating that variables fit well with the factor solution.

Table 4.2.3 Total Variance Explained (Dependent Factors)

Total Variance Explained (Dependent Factors)									
Compo-nent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17.674	45.317	45.317	17.674	45.317	45.317	5.945	15.243	15.243
2	1.740	4.462	49.778	1.740	4.462	49.778	5.280	13.539	28.782
3	1.461	3.746	53.524	1.461	3.746	53.524	3.443	8.827	37.609
4	1.311	3.361	56.885	1.311	3.361	56.885	3.385	8.679	46.288
5	1.180	3.025	59.910	1.180	3.025	59.910	3.295	8.449	54.736
6	1.005	2.577	62.487	1.005	2.577	62.487	3.023	7.751	62.487
7	.941	2.412	64.899						
8	.862	2.211	67.111						
9	.811	2.079	69.189						
10	.749	1.920	71.109						
11	.731	1.875	72.984						
12	.706	1.811	74.796						
13	.680	1.743	76.539						
14	.623	1.596	78.135						
15	.588	1.509	79.644						
16	.576	1.478	81.122						
17	.531	1.361	82.482						
18	.525	1.345	83.828						
19	.508	1.302	85.130						
20	.470	1.205	86.334						
21	.441	1.132	87.466						
22	.426	1.092	88.558						
23	.390	1.000	89.558						
24	.379	.972	90.530						
25	.366	.938	91.469						
26	.351	.899	92.367						
27	.318	.816	93.183						
28	.297	.762	93.945						
29	.282	.723	94.669						
30	.278	.712	95.380						
31	.258	.662	96.042						
32	.236	.606	96.648						
33	.228	.585	97.234						
34	.213	.547	97.780						
35	.200	.513	98.293						
36	.193	.495	98.788						
37	.169	.434	99.221						
38	.157	.401	99.623						
39	.147	.377	100.000						

Note: Extraction Method: Principal Component Analysis. *Source*: From data analysis.

Eigen Value

The sum of squared values of factor loadings relating to factor is referred as an eigen value. The eigen for a given factor measures the variance in all the variables which is accounted for by that factor (Foster, 1998). If the factor has low eigen value, then it is contributing little to the explanation of variances in the variables and may be ignored as redundant with more important factors. The eigen values associated with each linear component (factor) before extraction, after extraction and after rotation is shown in table 4.2.3. In this study before extraction 39 linear dependent components were identified within the data set. In case of dependent factor, factor 1 explains for 45.317% of total variance, it is observed that first few factors explains relatively large amount of variance (Especially factor 1) where as subsequent factors explains only small amount of variance. The Kaiser rule is to drop all components with eigen values under 1.0. All factors extracted have eigen values greater than one, which leaves 6 dependent factors.

The last column of Table 4.3.2(a) Shows eigen value after rotation, equalizing the relative importance of all the independent and dependent factors.

Table 4.3.2 (a) Extracted factors from sampled data- Principle Component Analysis

Factor	Eigen value	% of Variance	Cumulative %
1	5.945	15.243	15.243
2	5.280	13.539	28.782
3	3.443	8.827	37.609
4	3.385	8.679	46.288
5	3.295	8.449	54.736
6	3.023	7.751	62.487

Source: From data analysis.

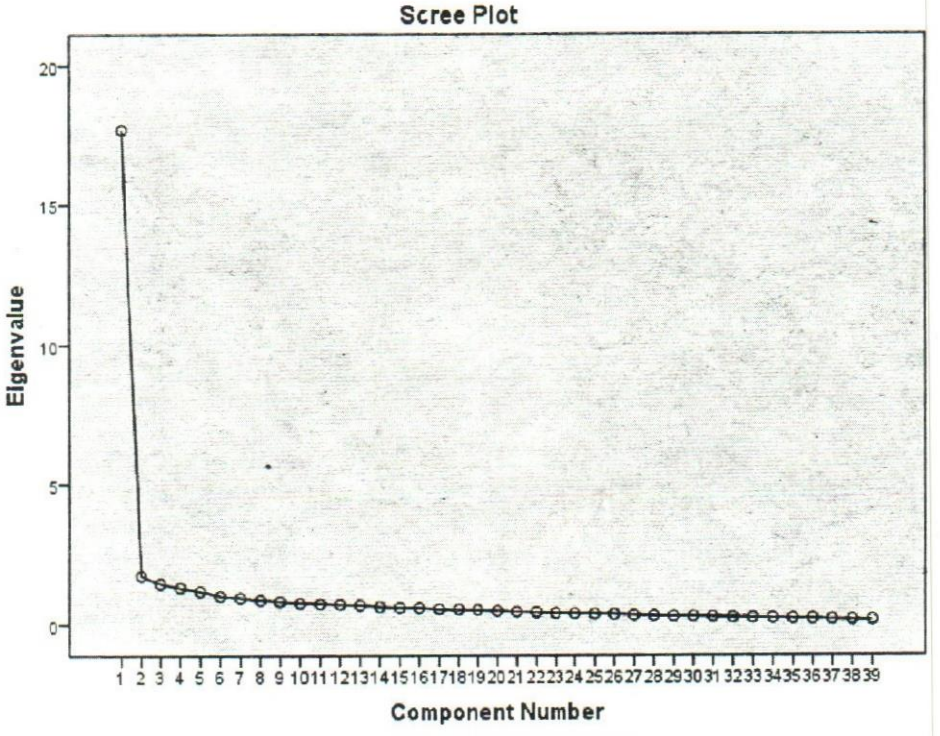


Figure 4.2.4 Scree plot

Source: From data analysis

Scree Plot

The Cattell scree test plots the components as the X-axis and corresponding eigen value on Y axis. As we move towards right, towards later components the eigen values drop. When this drop is cases and the curve – makes an elbow towards less step decline, this test says to drop all the factors after one starting the elbow. The scree plot shown in figure 4.2.4 represent 6 dependent factors having eigen value greater than one and represented in descending order based on their contribution to total variance.

Table4.2.5 Rotated Component Matrixa (Dependent Factors)

	Component					
	1	2	3	4	5	6
Low Cost of Quality.(OutQ8)	.652					
Top line growth.(OutQ10)	.648					
Bottom line growth.(OutQ12)	.626					
Optimum Inventory Utilization.(OutQ7)	.619					
Customer's retention.(OutQ1)	.598					
Customer's complaints or claims.(OutQ2)	.596					
Low number of defects and errors.(OutQ4)	.581			.409		
High reliability of the product/service.(OutQ6)	.570					
Return on Investment.(OutQ9)	.563					
Market share.(OutQ11)	.559					
Overall customer satisfaction (Value for the money spent).(OutQ3)	.509	.458				
Product recall.(OutQ32)		.711				
High employee satisfaction.(OutQ33)		.645				
High processes efficiency.(OutQ29)		.635				
Accuracy rate.(OutQ31)		.590			.408	
Employee efficiency.(OutQ34)		.585				.537
Improvement towards quality of work life.(OutQ39)		.572				
Less process variation.(OutQ30)		.531		.480		
Positives changes to corporate culture.(OutQ38)		.493				
Capacity building of employees.(OutQ35)		.476				
Improvement in value added per employee.(OutQ27)		.470				
Optimum resource utilization.(OutQ16)			.736			
Equipment availability.(OutQ15)			.635			
Flexibility of operations / system.(OutQ13)	.456		.592			
Inventory turnover (Material Productivity).(OutQ28)			.523			
Machine line down time.(OutQ21)				.669		
Man hours lost.(OutQ22)				.563		
Less rework and waste.(OutQ5)	.443			.530		
Supplier lead time (Supplier Performance).(OutQ23)				.523		
Low product development time.(OutQ17)			.430	.450		
High productivity of People.(OutQ25)					.692	
Order – process time.(OutQ19)					.575	
Capital Productivity.(OutQ24)					.528	
Low material procurement time.(OutQ18)					.464	
Quality of products/ processes (yield, PPM, on time delivery etc.).(OutQ14)					.439	
Productivity of Assets (Machines, equipments etc.).(OutQ26)						.646
Environmental compliance.(OutQ36)						.616
Safety of employees.(OutQ37)						.546
Process through time.(OutQ20)				.432		.473

Source: From data analysis.

Note: Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 11 iterations.

Factor Rotation:

After factor extraction it might be difficult to interpret and name the factors on the basis of their factor leadings as shown in component matrix. The criterion of principal component analysis that the first factor accounts for the maximum part of the variance; Most of variables having high loading, loaded in the first factor it indicates that variables are important and factors having lot loading, loaded in all other factors. So, the interpretation of the factors can be very difficult. The factor rotation alters the pattern of the factor loadings, and help in interpretation. Table 4.2.5 shows varimax rotated component matrix, with the items that load strongly on each of the six dependent extracted factors. Only the variables with factor loading ≥0.4, (H air, et al., 1998) were consider for further analysis.

Naming the factors

The factor is represented by the variables having loading ≥0.4 the factor name should broadly signify the variables contents within the factor. A common theme representation by different items was assessed for all the factors to get more insight about the respective factor. Table 4.2.6 lists the factor number, names assigned to the extracted factors and item contents of respective factor.

Table 4.2.6 Factor names of extracted dependent factors

Factor No.	Name of factor	Variables in the factor
1	Quality & Manpower Performance	• Product recall. • High processes efficiency. • Accuracy rate. • Less process variation. • Improvement in value added per employee. • Capacity building of employees. • Positives changes to corporate culture. • Improvement towards quality of work life. • Employee efficiency. • High employee satisfaction
2	Financial Performance	• Low Cost of Quality. • Top line growth. • Bottom line growth. • Optimum Inventory Utilization. • Return on Investment. • Market share. • Customer's retention. • Customer's complaints or claims. • Low number of defects and errors. • High reliability of the product/service. • Overall customer satisfaction (Value for the money spent).
3	Operational Performance	• Optimum resource utilization. • Equipment availability. • Flexibility of operations / system. • Inventory turnover
4	Time Performance	• Machine line down time. • Man hours lost. • Supplier lead time (Supplier Performance). • Low product development time. • Less rework and waste.
5	Productivity Improvement	• High productivity of People • Capital Productivity. • Quality of products/ processes (yield, PPM, on time delivery etc.). • Low material procurement time. • Order – process time.
6	Customer Satisfaction	• Customer loyalty and Reduced complaints • Safety of employees. • Environmental compliance. • Quick response to customer needs.

Source: From data analysis.

Internal Consistency Analysis

Internal consistency is one of the methods that can be used for assessing the reliability (Nunndlly, 1978). It indicates how well the different items of a scale measures the same concept can it is generally measured by means of reliability co-efficient such as eronbach's co-efficient alpha value of alpha ranges between 0 and 1.0, with a higher values indicating higher reliability, internal consistency was used to assess the reliability of the measurements i.e. (six dependent factors) depicting the degree to which they indicate a common latent (unobserved) factor. It relates to the extent to which an experiment yields the same results on repeated trials. Cronbach's alpha was calculated separately for each of the independent and dependent factors. The value of each factor, as measured by each item on the scale of 1 to 5, is computed using the reliability analysis procedure.

Table 4.3 Reliability of different scales (Dependent factors)

Sr. No.	Scale	No. of Items	Cronbach's Alpha
01	Quality and Manpower performance	10	0.916
02	Finance Performance	11	0.918
03	Operational Performance	04	0.778
04	Time Performance	05	0.847
05	Productivity Improvement	05	0.821
06	Customer Satisfaction	04	0.795

Source: From data analysis.

The alpha values for each dependent factor are shown in Table 4.3, the values range from 0.795 to 0.918 which indicates are internal consistency of more than 0.70, so no items were dropped from each dependent factor. Thus, the instrument has been proven to be an acceptable through this test.

Validity

The validity of measure refers to the extent to which it measure what it was intended to measure. Based on the studies of (Flynn et al., 1994, Black and Porter, 1996, Ahire et al., 1996) three different types of validity are generally considered 1) Content Validity 2) Criterion – related validity and construct validity.

Content Validity

Content validity depends on how well the researcher created measurement variables to cover the content domain of the variable being measured. A measure has content validity if there is general agreement among the subjects and the researchers that research instrument have measurement variables that cover all the aspects of the variable being measured. It is not evaluated numerically but subjectively judged by researchers that research instrument has measurement variables that cover all the aspects of the variable being measured it is not evaluated numerically but subjectively judged by researchers. Since the selection of measurement variables was based on extensive literature review and detailed evaluation by interviewing and discussing with academicians and experts from industries who practicing the quality management systems, hence it demonstrates content validity.

Criterion-related validity

Criterion related validity, some time called predictive validity or external validity is concern with the extent to which a measuring instrument is related to the independent measure of the relevant criterion. A set of quality management constructs has criterion related validity if the collective measure of constructs is highly and positively correlated with the measure of performance. Therefore, criterion related validtity of eight independent factors was evaluated by examining the multiple correlation co-efficients computed for the eight independent factors and the organizational performance (Saraph et al, 1989). The multiple correlation co-efficients obtained in most of the cases were above 0.5 ($p<0.05$), providing strong evidence of criterion related validity.

Construct Validity

It measures the extent to which the items in a scale measure the same construct. It is established through the use of principal component factor analysis and varimax rotation technique (Flynn et al., 1994). Firstly, each factor

Table 4.4.3 Summary of factor analysis result for each success factor

Sr. No.	Factor	KMO	% of variance	eigen value	Nos. of factor extracted
1	Factor 1	0.945	51.945	5.195	01
2	Factor 2	0.941	55.045	6.055	01
3	Factor 3	0.778	60.136	2.405	01
4	Factor 4	0.847	62.079	3.104	01
5	Factor 5	0.820	58.448	2.922	01
6	Factor 6	0.788	62.142	2.486	01

Source: From data analysis.

was subjected to an individual principal component analysis. If each factor has valid as a construct, then its set of variables would form a single factor once again (Nunnaly, 1978; Black and Porter, 1996). The percentage variance explained by each factor over its variables in the unifacterial test are listed in table 4.4.3, thus the finding indicates that the scale contained in the instrument has construct validity.

Correlation

One of the objectives of this research is to evaluate impact of extracted factors of QMS on performance indicators. Person's correlation coefficient (r) between the QM implementation factors (independent variables) have been calculated using multiple item scales in this research. The correlation coefficient indicates the strength of the association between the variables. There is significant correlation between all the independent variables as listed in correlation matrix Table 5. Almost all correlation coefficients are significant at 0.01 levels. The highest correlation (0.721) is quality and manpower performance and finance performance lowest correlation (0.550) is between time performance and productivity improvement. The absence of high correlations suggests that we are dealing with different constructs. There are no high correlations of 0.90 or above. Bryman and Cramer (1997) suggest 0.80 instead of 0.90 as the threshold: "The person's coefficient between each pair of independent factor should not exceed 0.08". Otherwise the independent variables that show a relationship at or in excess of 0.80 may be suspected of exhibiting multicollinearity". The highest coefficient of correlation in this research, however, is 0.721 which is below the cut-off of 0.80 for the multicollinearity problem, indicating no problem of multicollinearity (Hair et al., 1998).

Conclusions

Global competition and economic liberalization have created opportunities for the industrial sector India; it also poses significant challenges, especially in view of quality management issues. Through this study the various factors on quality management tools and techniques proposed by different authors were organized into a set of eight critical factors. Statistical tests showed that the eight factors identified were valid. The present study represents a snapshot of the extent of the awareness and adoption of different QMS in India. We found that the familiarity of QMS is low in small and medium scaled organizations, however a more general awareness of the environmental and economical advantages of implementing QMS is fairly high, which provide base for QMS implementation. The empirical investigation carried out for instrument development indicated accepted level of reliability. Besides, the instrument was found to be valid. The developed instrument can be effectively used to initiate LSS implementation in the SMEs. The wider use of the instrument will give impetus to the quality improvement strategies across India. However, further refining of the instrument is warranted, especially in light of the continuous technological innovations in the SME sector.

Limitations and Direction for Future Research

This study covered limited sectors of the companies, Moreover, critical factors of QMS were developed based upon self-reported information from the respondent's .The items in the questionnaire were subjective in nature.

Table 5 Correlation matrix-Implementation factors

Correlations						
	Quality & Man power performance	Financial Performance	Operating Performance	Time performance	Productivity improvement	Customer Satisfaction
Quality & Man power	1					
performance						
Financial Performance	.721**	1				
Operating Performance	.628**	.637**	1			
Time performance	.620**	.641**	.588**	1		
Productivity improvement	.644**	.607**	.584**	.550**	1	
Customer Satisfaction	.652**	.622**	.567**	.626**	.581**	1

Source: From data analysis.
**Note. Correlation is significant at the 0.01 level (2-tailed).

Respondents were asked to rate items based on their perception, as to the extent to which the items were applicable in their respective companies. It is also recognized that construct validation based on factor analysis has its limitation. The wordings of the respective items might have certain impacts on the results of factor analysis. Thus apart from these limitations, there are issues critical for QMS beyond the conventional implementation factors. Thus still there is room for further research in the field of QMS.

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I know the price of success : dedication, hard work and a devotion to the things you want to see happen.

—Frank Lloyd Wright

Feature

Economic Growth in India and its Regional Convergence in the Liberalized Era

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The large-scale structural reforms initiated since 1991 have augmented the growth process in India along with widening disparity at regional context. Not only growth divergence augmented in India in general, the expanding growth process of richer regions is at the cost of backward regions. Majority of central, eastern and north-eastern states are sidelined as peripheral and laggard states under the mercy of the spill-over effects of growth emanating from the former developed states of southern, western and northern regions. Within the sectors, the contribution of non-primary sectors particularly service sector has increased. States having a high growth momentum in the service sector activities were able to reap a better result from the implementation of long term structural reforms in India.

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The reduction in regional disparity in economic growth is one of the avowed objectives of planning in India. Alleviating regional inequality and maintaining balanced growth were also considered as a strategy for inclusive spatial development in all five-year plans. As India is a land of diversity in all aspects including geographical, political, social, economical and cultural, the regional disparity issue gets more focus as compared to any other nations in the world. The Constitutional provision for constituting finance commissions for recommending the resource allocation from the centre to States in various forms and the establishment of Planning Commissions for preparing and implementing planning programs at centre and state levels are intended to tackle the issue of regional inequality in economic growth in the country. As the issue is critical and relevant for all time, there has been no dearth for literature in theoretical and empirical angles to examine this problem in India. Since many studies are unique in their own methodology to understand and delineate the factors and trend of regional disparity in economic growth in India, the results are not strictly comparable. The growth of literature on this issue gets momentum particularly since 1991 when India embarked upon the implementation of large-scale short-run and long-run structural reforms. These reform measures have far-reaching ramifications and impacting spatial, sectoral, and social dimensions of growth and development of the nation.

The ethos of reforms in the name of globalization, privatization, and liberalization were based on neoliberal thinking which emphasized the gradual convergence of development between regions. It emphasized on differing marginal productivities and the tendency of diminishing marginal productivity of factors in the spatial spectrum, which finally reduced the growth in richer regions and increased the growth in backward regions. This tendency

may finally lead to convergence of the entire spatial spectrum in growth. All these neoclassical paradigms will come true provided there is the existence of conditions suitable for their practical attainments. Whether India has achieved the prerequisite for this paradigm shift is highly questionable and debatable. The present study tries to focus on the convergence or divergence trends in economic growth process since the large-scale reforms initiated during 1990s. It also examines the sectoral contribution in widening or lessening the disparity in growth process at state- and regional-levels in India.

The remaining portion of the study is arranged as illustrated in the following sentences. The second section gives a brief review on literature on regional inequality in India. The third section deals with the objectives and methodology. This section also contains the broad measures of convergence/divergence adopted in the study. The next section shows the trends in per capita income at state level in a regional perspective. The fifth section examines the sectoral contribution in regional disparity in economic growth in India and the last section summarizes the study with policy implications.

Literature review on regional inequality in the post reform period and its measurement

In the theoretical explanation of regional divergence/ convergence, there exist three hypotheses suitable in different situations (Nair, K.R.G., 2004). They are the self-perpetuation hypothesis propounded by Hughes (1961) and Booth (1964), which argues that the forces of divergence dominate over those of convergence and as a result, interregional differences in the levels of economic development keep on widening over time. The second is the convergence hypothesis popularized by Hanna (1959), Perloff (1960), Sala-i-Martin (1996) etc., which highlights that the rate of economic growth is inversely related to the level of per capita income and hence with given identical technologies, preference and rates of population growth, contemporaneous differences in per capita incomes between any two regions will be transitory. The third hypothesis is put forwarded by Williamson (1965), which highlights that interregional differences diverge initially to converge later on, thus tracing out the famous Kuznetian inverted U-shaped curve over time in the process of national economic development.

A large number of studies on regional inequality have emerged in India at national and regional context particularly during the post-reform period. These studies lie on a wide spectrum differing in objectives, methodology, data sources, and inferences and a detailed critical review in all its ramifications is beyond the scope of the present study. In this context, only certain relevant studies of inequality with regional dimensions during the post-reform period are highlighted from which the methodology and objectives of the study is formulated.

Evaluating the economic performance of 15 major states in India during 1960–61 to 2006–07 (Ghosh, 2011) identified that there is a clear divergence in economic performance during the liberalized era as compared to pre-reform period. Dholakia (2009) identified certain states which contributed to the acceleration of growth process in India during the post-reform period and causality test supports the hypothesis of spread effects of the reforms. Ahluwali (2000) received the result of growing Gini Coeffcient of inequality at state and identified that the varying private investment is a factor for this varying growth differential at state level. Pal and Ghosh (2007) find this growing regional imbalance during post-reform period in trade liberalization, regressive tax and subsidies and liberalization in FDI within the country. Raghbendra Jha (2005) explained the rise in inequality in terms of an increase in the relative share of output going to capital as compared to labor, a drop in the rate of labor absorption and the rapid growth of the services sector. Though there has been widening disparity in state domestic product during post-reform period, inequality lessened with respect to human development indices, credit, and consumption parameters (Singh et al., 2003). In the study of Douglas J. Young, and Vinish Kathuria (2009), in addition to income and consumption inequality, other indicators of development such as education and health are also considered. They showed that while inequality among individuals is recently on the rise, most indicators of regional inequality among the poor suggest movement toward convergence. Tatiana Khomiakova (2008) showed that GSDP per capita in 30 states in India continue to diverge in the post-reform period 1993–2004 and there is the evidence of spatial clustering of growth and the positive spatial autocorrelation of income from services and industry persists. Yanrui Wu (2008) shows that variations in urbanization and infrastructure development are found to be major contributors to regional disparity. Kurian N.J. (2000) remarked that meaningful decentralization of decision making and financial powers with appropriate accountability at all levels will facilitate faster socio-economic development of the backward regions where people are likely to take up considerable share of the developmental responsibilities. Kshamanidhi

Adabar (2004) attempts to re-examine the issue of convergence and economic growth by focusing on the differences in the steady state of 14 major states of India from 1976–77 to 2000–01 by employing dynamic fixed effects panel growth regression. The study identified that population growth rate and human capital along with state-specific effects could explain around 93% variation in the growth rate of per capita real income across states. Bhattacharya and Sakthivel (2005) indicate that while the growth rate of gross domestic product has improved only marginally in the post-reform decade, the regional disparity in state domestic product has widened much more drastically. Dholakia (2005) examined trends in regional disparity in human and social development and found that there is no evidence in increasing disparity particularly during the post-reform period.

Cashin and Sahay (1995) shows that while per capita incomes in the states of India are quite diverse, they have been slowly converging in recent decades. Convergence has been aided by grants from the central government to the states; however, the contribution of internal migration to this process appears minimal. Angus Deaton and Jean Drèze (2002) presents a new set of integrated poverty and inequality estimates for India and Indian states for 1987–88, 1993–94 and 1999–2000. The poverty estimates are broadly consistent with independent evidence on per capita expenditure, state domestic product, and real agricultural wages. They show that poverty decline in the 1990s preceded more or less in line with earlier trends. Regional disparities increased in the 1990s, with the southern and western regions doing much better than the northern and eastern regions. Arjan de Haan (2006) shows that regional disparities in poverty levels are marked, with signs of *divergence* over the last two decades; human development indicators (health, education, knowledge, and voice) are equally unequally distributed, though with some signs of convergence. Social group disparities are large too, on all indicators, with adivasis more than two times more likely to be in poverty than non-deprived groups, usually suffering disproportionally from land alienation and displacement. Sabyasachi Kar and Sakthivel S. (2007) try to understand and measure the contribution of various sectors towards the divergence of regional output in India in the era of liberalization and show that while the services and industrial sectors are largely responsible for the divergence during this period, the agricultural sector offset some of this divergence.

Methodologically the above mentioned studies on regional disparity can be put under either (a) regression-based approach (Cashin and Sahay (1996), Nagaraj et al. (1998), Rao, Shand, and Kalirajan (1999), Singh et al. (2003)) or (b) approaches based on measures of inequality or standard deviation approach (Barro and Sala-i-Martin (1995), Ahluwalia (2000), Bhattacharya and Sakthivel (2004)). The regression-based approach is a corollary of the neoclassical growth theory, which argues that due to diminishing returns to capital, regional economies (which are assumed to have similar rates of savings and technical progress) should exhibit convergence over time. In other words, this approach defines convergence as a process through which the poorer regions grow at a faster rate compared to the richer regions, and hence have a tendency to catch up with them. This is known in the literature as beta convergence. There is an alternative approach to convergence that defines it as a reduction in the inequality of regional incomes over time. The simplest way to measure a reduction in regional income inequality is in terms of a fall in the standard deviation of the logarithm of regional (per capita) incomes. This standard deviation-based approach is also known in the literature as *sigma* convergence (Barro and Sala-i-Martin, 1995). In addition to these approaches, studies also used Gini coefficient and Theil's entropy index. (Ahluwalia (2000) (Gini coefficient) Das and Barua (1996) (Theil's entropy index).

In spite of extensive coverage of regional issues, most of the studies did not consider minor states having lower population coverage particularly eastern and north-eastern states. Also, these studies did not make an attempt for regionalization of states based on the level of development. To address these issues, all states under various regions in India are taken for the present study.

Objectives and Methodology

The important objectives of the study are:

1. To examine the convergence/divergence of inequality in economic growth at state level in India since the era of liberalization of 90s.
2. The extent and the concentration of inequality in economic growth of various states at regional level in India.
3. The sectoral contribution in creating the regional convergence/divergence in economic growth in India.

The period for the empirical analysis is 1993–94 to 2007–08. Per capita income at constant price 1993–94 is used as the indicator for representing the economic growth. The sources of data are mainly Central

Statistical Organisation (CSO) and RBI. The data on per capita income and sectoral contribution for the period 1993–94 to 1999–2000 are directly taken from the published CSO data series at constant price 1993–94 and the data since 2000–01 are spliced series at 1993–94 price level. All 29 states are taken for the analysis and grouped into southern, western, eastern, northern, central and north-eastern regions. Since the constant price estimation of Mizoram from 1993–94 to 2000–01 are not available, the NSDP deflator of neighboring state of Meghalaya was used to deflate the current series of Mizoram NSDP data into constant price.

To understand the regional concentration of richness/backwardness, the clustering of states is done based on their levels of development with respect to per capita income. The states are categorized into backward, moderately developed, and highly developed regions. The states, which have a per capita income less than mean per capita income, are considered as backward; the states whose per capita income is greater than mean income but less than mean plus standard deviation are considered as moderately developed; and those states whose per capita income exceeds mean plus standard deviation are categorized as highly developed.

Both σ-convergence and β-convergence are examined in the context. The methodology of estimation is illustrated in the concerned section. The sectoral contribution in creating the convergence/divergence is examined by separating the components of coefficient of variation into three components as (1) coefficient of variation of specific sectors, (2) relative share of the sector to the total regional income and (3) the interlinkage of that sector to the whole economy represented by the correlation coefficient. The detailed methodology as illustrated by Sabhyasachi Kar and S.Sakthivel (2004) is given in the correponding section.

Growth and Regional Divergence

The performance of the economy at state and regional level are examined in terms of real per capita income at 1993–94 constant price level. The year-on-year fluctuation in per capita income is smoothened with the calculation of triennium average measure. Table 1 shows the triennium average per capita income for 1993–96 and 2005–08 at state and regional level in India.

The real per capita income for all-India level has been growing steadily from Rs 8083 for the period 1993–96 to Rs 14320 in 2005–08, showing 77 percent hike in real per capita income from its initial value. Though there has been a high growth of per capita income at national level, the growth has not been uniform across various states in India. The relative position of states over the time is represented in the 5th and 6th column of the Table 1. The values greater than 100 shows the position of states whose per capita income is greater than the national average while the values less than 100 shows the states having per capita income less than the national average. During the period 1993–96, the richest states are Delhi, Goa, Punjab, Maharashtra, and Gujarat. The lowest developed states are Bihar, Orissa, and Uttar Pradesh. Out of the 29 states, 14 states are having per capita income greater than the national average and remaining eleven states have a per capita income lower than national average. All states in Eastern and Central parts of India are having per capita income lower than the national average. The developed states mainly belong to southern, western and northern India. Among the north-eastern states, the position of Arunachal Pradesh, Mizoram, Nagaland, and Sikkim are better than national average. The liberalization effort improved the per capita income at national level, however, the improvements are not shared uniformly across the various regions and states in India. During 2005–08 also, the highest developed states in terms of per capita income are Delhi, Goa, Maharashtra, and Gujarat. The position of Punjab was replaced by Haryana. Out of 29 states, only 11 states have per capita income greater than national average compared to 14 states during 1993–95. It implies that the number of backward states has increased over the period of reforms in India. Among the various regions, almost all developed states belong in southern, western and northern states in India. Except Nagaland, all states belonging in eastern, central and north-eastern regions are backward compared to the national average. Not only these positions remain as backward, most of these states' position has worsened as it is revealed from the relative change of these states over the period. The estimated Spearman's rank correlation of position of various states as compared to the national average over the period is 0.877 at one percent level of significance. It reveals that the relative position of states has not changed much over the period. The reform measures in India have led to a sharp regional growth polarization. The growth points are shifted more towards Southern, Western and Northern regions and all states belonging (except Sikhim) to central, eastern and north-eastern regions are pushed back as peripheral and laggard ones.

Table 1: Triennium averages of per capita income in India at 1993–94 price level (in Rs.)

	States	Absolute figures		Relative position		Relative change	Status of states	
		1993–96	2005–08	1993–96	2005–08		1993–96	2005–08
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Southern	Kerala	8483	16508	104.95	115.28	10.33	MD	MD
	Tamilnadu	9678	17762	119.73	124.04	4.31	MD	MD
	Andra Pradesh	7733	14733	95.67	102.88	7.21	BD	MD
	Karnataka	8101	16471	100.22	115.02	14.8	BD	MD
Western	Gujarat	10993	20875	136.00	145.78	9.78	MD	MD
	Maharashtra	12520	20147	154.89	140.69	–14.2	HD	MD
	Goa	17155	37027	212.24	258.57	46.33	HD	HD
Eastern	Bihar	3024	4636	37.41	32.37	–5.04	BD	BD
	Jharkhand	6017	9326	74.44	65.13	–9.31	BD	BD
	Orissa	5051	8514	62.49	59.46	–3.03	BD	BD
	West Bengal	7114	13150	88.01	91.83	3.82	BD	BD
Northern	Haryana	11407	20622	141.12	144.01	2.89	MD	MD
	Himachal Pradesh	8387	14660	103.76	102.37	–1.39	BD	MD
	Jammu and Kashmir	6631	8969	82.04	62.63	–19.41	BD	BD
	Punjab	12834	17458	158.78	121.91	–36.87	HD	MD
	Rajasthan	6844	11033	84.67	77.05	–7.62	BD	BD
	Delhi	18968	37178	234.67	259.62	24.95	HD	HD
Central	Chattisgarh	6486	10008	80.24	69.89	–10.35	BD	BD
	Madhya Pradesh	6641	8334	82.16	58.20	–23.96	BD	BD
	Utter Pradesh	5177	6506	64.05	45.43	–18.62	BD	BD
	Uttaranchal	7143	11529	88.37	80.51	–7.86	BD	BD
North Eastern	Arunachal Pradesh	8809	12476	108.98	87.12	–21.86	MD	BD
	Assam	5737	7136	70.98	49.83	–21.15	BD	BD
	Manipur	5673	8504	70.18	59.39	–10.79	BD	BD
	Meghalaya	7123	12849	88.12	89.73	1.61	BD	BD
	Mizoram	8725	13818	107.94	96.49	–11.45	MD	BD
	Nagaland	9395	12474	116.23	87.11	–29.12	MD	BD
	Tripura	5535	13786	68.48	96.27	27.79	BD	BD
	Sikkim	8500	14708	105.16	102.71	–2.45	MD	MD
All India (Spliced series to 1993–94)		8083	14320	100.00	100.00			

Note: BD-Backward, MD-Moderately Developed and HD-Highly Developed

Source: (1) Various reports of CSO, New Delhi (2) RBI (2011), Handbook on Indian Economy, Mumbai.

Table 2 shows the growth rate of real per capita income over the period 1993–2008. Similar to the absolute amount of per capita income, in growth rate also, the country has achieved a higher growth rate over the period. Over the entire analysis period, the country has achieved an average 4.55% of growth of real per capita income per annum. Out of 29 states, 15 states have achieved a growth rate higher than the national average. In terms of growth rate, the states of Delhi, Gujarat, Tripura, Karnataka, Kerala, and Tamilnadu achieved a higher growth rate. The process of economic reforms produced positive impacts on growth rates of all states, which is evident from a higher growth rate during 2005–08 as compared to 1993–95. As compared to the absolute per capita income, more number

Table 2: Annual averages growth rate of per capita income in India during the period 1993–94 to 2007–08 (in %)

	States	1993-96	2005-08	Annual average during 1993-2008	Relative position
Southern states	Kerala	5.42	9.93	6.04	132.80
	Tamilnadu	6.54	8.67	5.54	121.87
	Andhra Pradesh	4.32	9.53	5.79	127.26
	Karnataka	3.33	10.06	6.21	136.64
Western	Gujarat	9.37	10.85	6.52	143.53
	Maharashtra	4.26	7.77	4.28	94.09
	Goa	4.07	9.94	6.65	146.19
Eastern	Bihar	-4.31	9.59	4.50	99.00
	Jharkhand	1.75	6.02	4.31	94.71
	Orissa	3.10	9.31	5.00	109.96
	West Bengal	5.31	6.61	5.43	119.44
Northern	Haryana	2.11	8.75	5.20	114.45
	Himachal Pradesh	5.77	5.16	4.98	109.64
	Jammu and Kashmir	1.43	4.5	2.61	57.50
	Punjab	1.17	4.31	2.68	58.98
	Rajasthan	8.27	8.00	5.28	116.18
	Delhi	2.82	10.06	6.08	133.72
Central	Chattisgarh	-0.49	10.19	4.11	90.32
	Madhya Pradesh	1.57	3.40	2.07	45.54
	Utter Pradesh	1.86	4.64	2.22	48.91
	Uttaranchal	2.03	6.36	4.36	95.98
North Eastern	Arunachal Pradesh	3.82	4.01	3.38	74.32
	Assam	0.39	3.64	1.89	41.67
	Manipur	-1.94	3.02	3.09	68.05
	Meghalaya	4.63	7.07	5.07	111.54
	Mizoram	7.42	1.49	4.06	89.23
	Nagaland	2.79	-0.4	2.84	62.54
	Tripura	1.66	4.35	7.05	155.12
	Sikkim	2.55	7.00	4.58	100.82
All India		3.29	7.31	4.70	100.00

Source: (1) Various reports of CSO, New Delhi (2) RBI (2011), Handbook on Indian Economy, Mumbai.

of states has attained a growth rate above the national average as a consequence of reforms. However, the increased growth of per capita income is more cornered by already richer states and some backward states have suffered a great as compared to gain of improved states. In the process, the fruits of economic growth are more reaped by southern, western and northern states as compared to states belonging in other regions. The region-wise summary of growth rate of per capita income as given in the Table 3 exemplifies this fact. Thus, the improved growth performance in the country during the post liberalization period has been associated with widening disparity at regional level.

Table 3: Annual averages growth rate of per capita income in India during the period 1993–94 to 2007–08 (in percentage): Region-wise

Regions	1993–96	2005–08	1993–2008
Southern	4.90	9.55	5.89
Western	5.90	9.52	5.82
Eastern	1.46	7.88	4.81
Northern	3.60	6.80	4.47
Central	1.24	6.15	3.19
North-Eastern	2.66	3.99	4.01
All India	**3.29**	**7.31**	**4.70**

Source: (1) Various reports of CSO, New Delhi (2) RBI (2011), Handbook on Indian Economy, Mumbai.

Convergence of per capita income

Two types of convergences ie, σ-convergence and β-convergence of growth process are estimated by following the methodology adopted by Salai-i-Martin (1992, 1995, and 1996) in terms of per capita income. The σ-convergence shows the cross sectional dispersion of per capita income. The σ-convergence is said to exist if the dispersion of per capita income across the regions decreases over time. The existence of σ-convergence implies a tendency of per capita income to be equal across regions overtime. Whether the presence of σ-convergence in per capita income is due to higher growth rates of the poorer region than the richer ones can be examined by looking into the presence of β-convergence. Absolute σ-convergence is said to exist if the poorer regions tend to grow faster than the richer ones.

One of the general measure of β-convergence is standard deviation (SD). The estimated SD of the logarithms of per capita income displays an increasing trend, suggesting a discernible increase of per capita income disparity among the states (Ghosh, 2008). The following equation of time trend of SD of logarithm of per capita income suggests the direction of the trend.

$$SD = 0.372^{**} + 0.006^{**}\, t \qquad R^2 = 0.840 \qquad (1)$$

The estimation as given in the equation (1) displays an increasing trend of SD. The coefficient of time trend is positive and significant suggesting unambiguously that the regional disparity in per capita income has increased significantly during the post reform period in India. The absolute β-convergence is estimated by using the following regression equation.

$$G_t = \alpha + \beta \ln Y_0 \qquad (2)$$

where, G_{ti} is the i^{th} region's annual average growth rate of per capita income between the period 0 and t and Y_{0i} is the natural logarithms of the i^{th} region's per capita income in the initial period (i.e., period '0'). If the coefficient of initial level of per capita income bears a statistically significant negative sign i.e., if $\beta<0$, then we say that there exists absolute β-convegence. The negative coefficient of initial level of per capita income signifies that the regions with lower initial level of per capita income grow faster than the regions with higher initial per capita income. The existence of β-convergence is a necessary condition for the existence of σ-convergence. It implies that when an initially poor regions grows faster than a rich one, then the levels of per capita income of the two regions will tend to be equal over time. However, the existence of β-convergence is a necessary but not a sufficient condition for the existence of σ-convergence (Ghosh, 2008). For, whereas σ-convergence concerns with the question of whether or not the dispersion of cross sectional distribution of income decreases over time. β-convergence concerns with the question of mobility of different regions within the given distribution of income.

The test for absolute β-convergence hypothesis is performed by estimating the equation (2) by the Ordinary Least Square (OLS) method for the whole period. The result is given below as equation (3).

$$G_t = -0.05 + 0.010 \ln Y_0 \qquad R^2 = 0.088 \qquad (3)$$

In the above result both coefficients, the intercept and coefficient of initial per capita income are not statistically significant. However, the positive coefficient of initial per capita income highlights that there has been divergence of growth process since the large-scale implementation of reform process of 90s. In short, β-convergence has not occurred in India at state level as a consequence of economic reforms in India. The values

of σ-convergence and β-convergence highlight the fact that in India, there has been growing inequality in the distribution of income in the recent decade. Not only the differences in the per capita income between poor and rich states have increased, but also, the differences in growth rates between these states have grown. The growth rates of per capita income in richer states are more as compared to poorer states in India in the recent decades.

Decomposition of regional inequality at state level

The relative contribution of various sectors in creating or offsetting regional inequality can be better understood only by decomposing the sectoral inequality. The methodology to decompose the inequality element is as follows (Kar and Sakthivel, 2004).

Let there be 'n' regions such that the output of each region is given by X_i, i=1,2,..n. Let there be 'm' sectors

Table 4: Percentage contribution of SDP from various sectors (in %)

		Primary sector		Secondary sector		Tertiary sector	
	State	1993-96	2007-08	1993-96	2007-08	1993-96	2007-08
Southern	Kerala	31.89	13.92	20.84	16.22	47.27	69.85
	Tamilnadu	24.74	14.15	33.25	28.63	42.01	57.22
	Andra Pradesh	36.22	27.01	20.15	19.65	43.63	53.35
	Karnataka	36.31	20.46	24.21	27.12	39.48	52.42
Western	Gujarat	28.22	20.52	33.56	33.85	38.22	45.63
	Maharashtra	20.33	15.33	31.43	25.19	48.24	59.48
	Goa	20.08	9.75	29.01	37.93	50.91	52.32
Eastern	Bihar	51.70	34.99	7.80	6.74	40.51	58.27
	Jharkhand	41.80	22.06	29.20	27.94	28.99	50.00
	Orissa	46.82	31.74	16.85	21.25	36.33	47.00
	West Bengal	35.47	23.75	21.41	19.10	43.12	57.15
Northern	Haryana	41.89	23.81	26.18	24.28	31.93	51.91
	Himachal Pradesh	33.80	19.34	29.09	36.02	37.11	44.64
	Jammu and Kashmir	39.19	34.20	16.28	10.58	44.53	55.22
	Punjab	47.44	37.04	20.29	22.43	32.27	40.53
	Rajastan	37.74	26.88	24.25	23.12	38.01	50.00
	Delhi	2.62	0.86	24.31	17.23	73.07	81.90
Central	Chattisgarh	41.64	36.04	26.61	24.63	31.75	39.33
	Madhya Pradesh	43.96	34.94	20.11	22.60	35.93	42.46
	Utter Pradesh	40.97	33.11	20.23	20.17	38.80	46.72
	Uttaranchal	41.18	26.25	23.70	27.16	35.11	46.59
North Eastern	Arunachal Pradesh	45.76	25.49	24.14	26.78	30.11	47.73
	Assam	47.34	33.71	13.62	15.85	39.04	50.45
	Manipur	36.92	28.07	15.95	14.47	47.13	57.46
	Meghalaya	33.02	29.73	11.07	19.03	55.91	51.24
	Mizoram	32.10	25.13	12.03	7.03	55.87	67.85
	Nagaland	25.27	35.51	14.32	15.09	60.41	49.41
	Tripura	36.50	24.71	9.35	21.82	54.15	53.47
	Sikkim	36.97	21.56	19.72	19.53	43.32	58.91

Source: (1) Various reports of CSO, New Delhi (2) RBI (2011), Handbook on Indian Economy, Mumbai.

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