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Assessing Dairy Production Competitiveness In Rural Urban Interface Of Bengaluru North

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ABSTRACT
This research study assessed the impact of urbanisation on dairy enterprise in rural-urban interface of Bengaluru North in year 2018-19. Primary data was collected from the 30 dairy farmers each from rural, semi-urban and urban zones by the personal interview method. The total sample size is 90 small, medium and large dairy farmers from all zones based on farm herd size. The highest net return was recorded in rural large sized dairy farm (Rs. 2,37,421), the highest returns per cow was recorded in urban small sized dairy farm (Rs. 49,115) and the highest returns per rupee investment was recorded in rural large sized dairy farm (1.82). In rural zone, large dairy farms were technically, allocatively and cost efficient. In transition zone, large dairy farms were efficient in allocating resources. In urban zone, medium dairy farms were technically efficient and large dairy farms were efficient in allocating resources. All rural dairy farmers sold their milk through Milk Producer's Co-operative Societies (MPCS), In transition zone, majority of the dairy farmers sold their milk by MPCS (86.67%) and (13.33%) through private dairies and local sales. Seventy per cent of the urban dairy farmers sold their milk locally and rest of respondents sold it by MPCS. Sale of value added dairy products like curd, butter and ghee is noticed only in urban zone due to remunerative price obtained. Establishment of fodder markets in urban zone is suggested for quality milk production.
Keywords: *Dairy production competitiveness; Economics of dairy production; Dairy production and marketing.*

1.INTRODUCTION

India is known as "oyster" of the global dairy industry. Dairy farming has been practiced in India from very long time as rural cottage industry. Rapid progress has happened after Indian independence with the establishment of organised dairy farms who go for commercial production of milk and value-added dairy products (www.indianmirror.com).

India emerged as a global giant in milk production as dairy enterprise is owned by small, marginal and landless labourers of the country. They together account for about 70 per cent of the total milch animals thus dominating the industry. Milk attracts the highest value in the Indian agri and food sector which contributes approximately the 1/3rd of gross income of Indian rural households. Milk is the only agro based product with more than 75 per cent share of producers in consumer rupee. (www.business-standard.com).

The total livestock population in India is 512.05 million numbers in 2012 livestock census. The total exotic or crossbred cattle population has increased from 33,060 (2007) to 39,732 (2012) with a per cent change of 20.18 and the total indigenous cattle population has decreased from 1,66,015 (2007) to 1,51,172 (2012) with a per cent change of 8.92. The total buffalo population has increased from the 1,05,342 (2007) to 1,08,702 (2012) with a per cent change of 3.19 in the country. This provides a great scope for value addition to milk and export the surplus milk and value added products to other nations in the world and the milk processing industry is expected to grow at a Compound Annual Growth Rate (CAGR) of ~14.8 per cent between FY 2018 and FY 2023, and will reach INR 2458.7 billion in FY 2023. As of FY 2018, ~81.1 per cent of the Indian dairy and milk processing market was under the unorganised sector, which produces milk in unhygienic environmental conditions hence, there is a large scope for establishment of organised milk and value added dairy products supply chain and its marketing in both rural and urban areas of the nation (www.financeexpress.com).

Karnataka is the ninth largest state in cattle and buffalo population in the country, accounting for 4.3 per cent of the total population as per the latest Livestock Census, 2012. Indigenous cattle accounts for 50 per cent of total bovine population, crossbred cattle and buffalo population shares 25 per cent each in the state. The state is second in milk production under co-operative sector in the country only after Amul in Gujarat which procures about 12,500 Mt milk daily whereas, Karnataka Co-operative Milk Producer's Federation Ltd (KMF) procures on an average of 5000 Mt milk daily. Bengaluru rural district has 36,000, 1,22,000, 24,000 indigenous, crossbred cows and buffalo population, respectively. Bengaluru urban district has 21,000, 1,16,000 and 8000 indigenous, crossbred and buffalo population, respectively (19th Livestock Report, 2012).

2. METHODOLOGY

2.1 Sampling method and database

The entire Bengaluru city conglomerate was divided into two transects namely, Northern Bengaluru and Southern Bengaluru taking the Vidhana Souda as reference point which is situated in the center of the Bengaluru city. Each Northern and Southern transects were again divided into three zones namely rural, transition and urban areas. The distinction of the three zones into rural, transition and urban were made based on the percentage of built-up area and its linear distance from the center of the Bengaluru city. To classify the region into Rural-Urban Index, a simplified Survey Stratification Index (SSI) was developed.

2.2 Combined Survey Stratification Index (CSSI)

The distance to the center and the built-up area are considered as a proxy for urbanization. Since a high value of distance correlates to low urbanization, whereas a high value of density indicates high urbanization, the non-built-up area (100% minus percentage of built-up area) was used for constructing the SSI. $Z_i = (X_i - \min X) / (\max X - \min X)$ where, Z_i is the normalized variable, X is the distance or non-built-up area, min (X) is the minimum value in transect, max (X) is the maximum value in transect.

$$\text{SSI} = \sqrt{((Z_i \text{ distance})(Z_i \text{ non} - \text{built} - \text{up area}))}$$

The villages having CSSI value nearer to zero were considered as the urban area, the villages having CSSI value nearer to one were considered as the rural area.Northern Bengaluru was purposefully selected for the study in which four villages were randomly selected each from rural, transition and urban zones constituting a total of 12 villages. Villages selected under urban zone were Chikka bommasandra, Allalasandra, Atturu and Puttenahalli. From transition zone, Sugatta, Addiganahalli, Bettahalasur and Harohalli were selected and from rural zone Devrahalli, Sunaghatta, Sulakunte and Nagadenahalli were selected. The purposive multistage random sampling method was employed for the selection of dairy farmers 30 each from each rural, transition and urban zones of Bengaluru North, respectively.

2.3 Nature and source of dat In order to accomplish each objective of the study, primary data was collected from the selected dairy farmers of selected villages. For this a pre-tested schedule was prepared for data collection in the study area. Primary data was collected by personal interview method for the agricultural year 2018-19. The information collected has General information has data on personal information, institutional participation, agricultural land holdings, farm and household assets owned and cropping pattern. Specific information has data related to dairy experience, livestock inventories, dairy farm assets owned, variable and fixed expenditure of dairy farm, total income obtained from dairy farms and queries specific to dairy marketing chain.

2.4 Classification of dairy farmers

Sl. No.	Type of dairy farmer	Dairy cows owned (No.)
1.	Small	1-3
2.	Medium	4-5
3.	Large	>5

2.5 Analytical tools and techniques

2.6 Data Envelopment Analysis Programme (DEAP)

Dairy production competitiveness was assessed with the help of DEAP, a non-parametric method to measure the production efficiency of dairy farms across three zones. It is used to find the most efficient dairy farm existing across the gradient among the sample respondents. DEAP was employed by using classic models like CRS (Constant Returns to Scale) with input orientation, to seek input minimization to obtain a specific output level (Coelli and Battese, 1998).

2.7 Measurement of technical efficiency

Min θ, λ θ, Subject to $-y_i + Y\lambda \geq 0$ $\theta X_i - X\lambda \geq 0$ $\lambda \geq 0$..... (1) where, y_i is a vector (mx1) of output of the i^{th} dairy farms Total Productivity Factor, (TPF) x_i is a vector (kx1) of inputs of the i^{th} TPF. Y is an output matrix (n x m) for n TPFs. X is an input matrix (n x k) for n TPFs.

θ is the efficiency score, a scalar whose numerical value will be the efficiency measure for the i^{th} TPF. If θ=1, TFP (Total Factor Productivity) will be called efficient; otherwise, it is said to be inefficient farm.

λ is a vector (n x 1) whose numerical values are computed to get the optimum solution. For an inefficient TPF, the λ values shall be the weights utilized in linear combination of other efficient TPFs, which affect the projection of an inefficient TPF on the computed frontier.

2.8 Measurement of allocative efficiency and cost efficiency (Economic Efficiency)

Information relating to price was collected and a behavioural objective, like cost minimization or profit maximization was analyzed to measure allocative efficiency and cost efficiency was done by the DEAP software. One would run the below DEAP formula for measuring the efficiencies as follows:

Min λ, X_i^* Wi X_i^*, Subject to $-y_i + Y\lambda \geq 0$, $X_i^* - X\lambda \geq 0$, $N1\lambda \geq 1\lambda \geq 0$, ... (2)

Where, W_i is a vector of input prices for the i^{th} Total Productivity Factor (TPF), X_i is the cost minimizing vector of input quantities for the i^{th} TPF (which is computed by the LP).The input prices are W_i and the output levels are Y_i. The total Cost Efficiency (CE) or Economic efficiency (EE) of the i^{th} TPF would be computed as

$CE = W_i X_i^* / W_i X_i$. .....(3) i.e., the ratio of minimum cost to observed cost. After that the following formula is utilized to compute the allocative efficiency.

$AE = CE/TE$. .....(4)

It may be noted that this method may contain any slacks into the allocative efficiency measure. These slacks can be justified on the basis that it indicates an appropriate input mix. The analysis stated that all the models showed above should be solved n times, i.e., the model is solved for each TPF in given sample. Total milk yield (litre /dairy farm) was used as an output(Y) in the study and total feed cost (Rs), total man days (wage/day), veterinary cost (Rs) and total fixed cost were used as inputs (X). The usage of the DEAP version 2.1 model led to the estimation of competitiveness undertaking an input orientation to get the efficiency levels.

2.9 Concepts and terminologies used in the study

1. Variable costs: includes cost of feed, fodder and concentrates fed to dairy animals, cost of labour employed in dairy farming, cost of veterinary services, miscellaneous costs and interest on variable cost

2. Fixed costs

a) Depreciation: It's value of cattle shed was calculated by the straight-line method. The life of cattle shed was assumed as 10 years.

Depreciation = (Purchase value-Junk value) / (Life of shed (years)) Where, junk value is the salvage value of cattle shed, after its economic life.

b) Amortization of investment on equipment and animals: The study found that some of the large dairy farmers in the urban and transition zones had milking machines which form the fixed cost of dairy farms. They also had made investments on building cattle shed, chaff cutter and small equipment in different

years which was compounded to the year 2019 by taking the interest rate of 10 per cent. The amortized value of initial investment was calculated by the following formula
Compounded value of earlier investment = Historical investment X $(1+i)^{(\text{present year-year of purchase})}$ $A = P \; i (1+i)^n / (1+i)^n - 1$ Where, A is payment amount per period, P is principal amount, 'i' is the interest rate per period and 'n' is total number of payments or periods.

c) Interest on fixed capital: The interest on fixed capital was calculated at 10 per cent per annum based on the belief that the dairy farmers had taken loan from the banks for this purpose.

3. Total cost= Variable cost+ Fixed cost

4. Gross returns: a)Income from sale of milk and value-added dairy products: The income obtained from sale of milk and value added products like curd, butter and ghee was calculated by multiplying quantity marketed into price per unit quantity of the product.

b) Income from sale of dung: The quantity of dung produced in the dairy farm per dairy animal per year was documented and its value was calculated based on the existing market value of dung in the study area.

c) Income from sale of male calf and unproductive dairy animals: The number of male calves and unproductive dairy animals marketed in the year was valued based on the existing market value of the animals.

5. Net return: It was calculated by subtracting total cost from total income per annum.

6. Net return per dairy animal: It was computed by dividing the total income from the farm by the size of herd maintained in the farm.

7. Net revenue per rupee of investment: It was calculated by taking the ratio of gross returns to the total cost incurred by the dairy farm.

8. Descriptive statistics

The data collected from dairy farmers was analyzed by calculating averages and percentages. This approach was used to examine the institutional linkage of dairy farmers. The milk marketing cost per year across three zones was worked out by taking average values. Tabular analysis was also employed to know the average returns realized per year from the sale of value-added dairy products in urban zone of the study area

IV RESULTS AND DISCUSSION

4.1 Socio-economic profile of the sample dairy farmers across the Bengaluru North gradient: This has age, gender, income, educational status and information are used to classify sample respondents.

4.1.1 Distribution of sample dairy farmers on the basis of gender: The results found that 90 per cent of respondents were men in rural and transition zone while only 40 per cent were women in urban zone as women were interested to take up dairy farming in urban zone to earn supplementary income is presented in (Table 4.1).

4.1.3 Distribution of sample dairy farmers on the basis of age

Only 10 per cent of dairy farmers across the gradient were found to be 15 to 30 years of age. 55.55 per cent of the dairy farmers across the gradient were found to be >30 to 50 years of age as this age group of dairy farmers are capable of managing dairy enterprise more efficiently. 34.45 per cent of the sample respondents across the gradient were found to be more than 50 years of age is presented in (Table 4.1).

Table 4.1: Socio-economic profile of sample dairy farmers across the Bengaluru North gradient

Sl. No.	Particulars	Rural (n=30)	Transition (n=30)	Urban (n=30)	Total (N=90)
A.	Gender				
1.	Male	27 (90.00)	27 (90.00)	18 (60.00)	72 (80.00)
2.	Female	3 (10.00)	3 (10.00)	12 (40.00)	18 (20.00)
B.	Age (in years)				

1.	**<15**	0 (0)	0 (0)	0 (0)	0 (0)
2.	**15-30**	0 (0.00)	1 (3.33)	2 (6.66)	3 (10.00)
3.	**>30-50**	14 (46.66)	12 (40.00)	24 (80.00)	50 (55.55)
4.	**>50**	16 (53.34)	17 (56.67)	4 (13.34)	37 (34.45)
C.	**Family type**				
1.	**Joint**	20 (66.66)	19 (63.33)	18 (60.00)	57 (63.33)
2.	**Nuclear**	10 (33.34)	11 (36.67)	12 (40.00)	33 (36.67)
D.	**Educational status**				
1.	**Illiterate**	9 (30.00)	7 (23.33)	7 (23.33)	23 (25.55)
2.	**Primary school**	10 (33.33)	13 (43.33)	9 (30.00)	32 (35.55)
3.	**High school**	6 (20.00)	6 (20.00)	14 (46.67)	26 (28.90)
4.	**PUC**	5 (16.67)	4 (13.34)	0 (0.00)	9 (10.00)

Note: Figures in parentheses indicate percentage to the respective total.

4.1.4 Distribution of sample dairy farmers on the basis of family type

The family size had direct impact on the supply of labour force to the dairy enterprise across the gradient. Effective implementation of family planning programmes across the country had resulted in the decrease of population growth rate. Thus, reduction in the family size was noticed in the study area. The number of joint families was found to be 20 (66.66 %), 19 (63.33 %) and 18 (60.00 %) in rural, transition and urban zones, respectively. The total of 63.33 per cent belonged to joint and 36.67 per cent were nuclear families across the gradient. Thus, the result showed that the majority of the families were joint in all three zones in Bengaluru North is presented in (Table 4.1).

4.1.5 Distribution of sample dairy farmers on the basis of educational status

The results showed that 30 per cent of sample respondents in the rural zone had no formal education, 33.33, 20 and 16.67 per cent were found to have studied primary school, high school and PUC, respectively. In the transition zone, 23.33 per cent had no formal education, 43.33, 20 and 13.34 per cent were found to have studied primary school, high school and PUC, respectively. In the urban zone, 23.33 per cent were illiterate, 30.00, 40.67, and 0 per cent were found to have studied primary school, high school and PUC, respectively is presented in (Table 4.1).

4.2 Household inventory owned by sample dairy farmers across the gradient: It is noted from the table that across the gradient all the dairy farmer households in Bengaluru North had residential houses. Only two dairy farmers owned and maintained gobar gas plant in transition zone. 33.33, 50.00 and 73.33 per cent of the sample dairy farmers owned household furniture in rural, transition and urban zones, respectively. 3.33, 0 and 1.00 per cent of the sample dairy farmers owned radio in rural, transition and urban zones, respectively. All respondents in rural zone owned television, whereas, 80 and 93.33 per cent of the respondents owned it in transition and urban zone, respectively. 70.00, 60.00 and 63.33 per cent of respondents owned refrigerator in rural, transition and urban zones, respectively. 80.00, 80.00 and 83.33 per cent of respondents owned motorcycle in rural, transition and urban zones, respectively. Car was owned by only 6.67, 23.33 and 33.33 per cent in rural, transitions and urban zones of the study area, respectively.

Table 4.2: Inventories of household assets owned by sample dairy farmers across the gradient in Bengaluru North

Sl. No.	Particulars	Rural n=30	Transition n=30	Urban n=30	Total N=90
1.	Residential house	30 (100)	30 (100)	30 (100)	90 (100)
2.	Gobar gas plant	0 (0.00)	2 (6.67)	0 (0.00)	2 (2.22)
3.	Furniture	10 (33.33)	15 (50.00)	22 (73.33)	47 (52.22)
4.	Radio	1 (3.33)	0 (0.00)	1 (3.33)	2 (2.22)
5.	Television	30 (100)	24 (80.0)	28 (93.33)	82 (91.11)
6.	Refrigerator	21 (70.00)	18 (60.00)	19 (63.33)	58 (64.44)
7.	Motor cycle	24 (80.00)	24 (80.00)	25 (83.33)	73 (81.11)
8.	Car	2 (6.67)	7 (23.73)	10 (33.33)	19 (21.11)

Note: Figures in parentheses represents percentage to the respective total.

4.3 Inventories of cross-bred cow dairy enterprise across the Bengaluru North gradient: The results showed that average number of calves owned was the largest (03) in rural dairy farms, the average number of heifers owned was the largest (03) in rural and urban dairy farms and the average number of milking cow owned was the largest (06) in urban dairy farms.

Table 4.3: Dairy inventory across the gradient in Bengaluru North (Value in Rs.)

Sl. No.	Particulars	Rural zone		Transition zone		Urban zone	
		Average Number of dairy animals per farm	Average Value of dairy animals per farm	Average Number of dairy animals per farm	Average Value of dairy animals per farm	Average Number of dairy animals per farm	Average Value of dairy animals per farm
1.	Calf	3	30,000	2	20,000	1	10,000
2.	Heifer	3	1,50,000	2	1,00,000	3	1,50,000
3.	Milking cow	4	2,80,000	5	3,50,000	6	4,20,000

4.4 Reasons for taking up dairy enterprise in all three zones of Bengaluru North

Table 4.4: Reasons for taking up dairy enterprise in the three zones of Bengaluru North

Sl. No.	Particulars	Rural		Transition		Urban	
		Average Score	Rank	Average Score	Rank	Average Score	Rank
1	Profitable enterprise	49.90	II	75.60	I	49.80	III
2	Supplements family income	30.70	V	32.60	V	39.90	V
3	Easy availability of bank loan	74.70	I	55.20	III	78.00	I

4	**Family occupation**	34.40	IV	38.40	IV	40.60	IV
5	**Availability of Farm Yard Manure (FYM)**	45.10	III	57.10	II	54.60	II

4.5 Economics of managing small dairy farm in rural, transition and urban zones of Bengaluru North

The table reveals that in rural, transition and urban zones of Bengaluru North, the average herd size was found to be two in numbers. The number of small dairy farms out of the total sample dairy farms in rural, transition and urban zones were 10, 9 and 11, respectively. The data showed that dairy farms in urban zone were predominantly of small by category.

The highest share in the total variable cost was contributed by the human labour followed by cost of concentrates. The percentage share of labour cost in the total cost incurred was found to be 22.18 per cent, followed by 20.59 per cent towards cost of concentrates (20.59 %), In transition zone, the percentage share of labour cost in the total cost was found to be 23.03 per cent, followed by share of concentrates (22.36 %). In urban zone, the percentage share of labour cost in the total cost incurred was found to be 23.18 per cent, followed by the share of concentrates (21.44 %). This was observed in the study area as a greater number of family members were involved in managing dairy farming and concentrates were used in large quantity to get higher milk yield. The share of total fixed cost was inversely related to the extent of urbanization. It was found to be the highest in rural dairy farm (5.56 %), followed by transition (5.22 %) and then urban (4.98 %) dairy farms. This was because of higher fixed investments on dairy animals and dairy farm shed structures.

The net returns from small dairy farms across rural, transition and urban zones were found to be ` 46,948, ` 35,085 and ` 49,115, respectively. The net return was found to be the highest in the case of the urban dairy farms as compared to transition and rural dairy farms. This was mainly due to the higher returns from sale of milk and value-added dairy products in urban zone.

The returns per cow were found to be the highest in the urban dairy farms (` 24,557.5), followed by rural (` 23,474) and then transition zone (` 17,542.5). This was observed as the returns from sale of milk in urban zone is the highest (` 1,60,003) of all zones. The returns per rupee of investment was the highest in the rural dairy farm (1.47), followed by urban (1.41) and transition dairy farms (1.31). This was because of relative advantage to rural dairy farmers who grow fodder crops like maize in their own agricultural fields so that imputed cost of green fodder is less than that of purchased cost of green fodder in urban and transition zones.

Table 4.5: Economics of managing small dairy farms in the rural, transition and urban zones of Bengaluru North (Rupees per annum)

Sl. No.	Particulars	Rural farm	% n_1=10	Transition farm	% n_2=9	Urban farm	% n_3=11
1.	**Percentage of small dairy farms**		(33.33)		(30.00)		(36.67)
2.	**Average herd size**	2		2		2	
3.	**Variable cost**						
a)	Dry fodder	15,345	15.36	16,554	14.98	18,087	15.42
b)	Green fodder	19,546	19.56	20,255	18.33	22,064	18.81
c)	Concentrates	20,569	20.59	24,708	22.36	25,155	21.44
d)	Labour	22,155	22.18	25,455	23.03	27,189	23.18
e)	Veterinary charges	9564	9.58	9892	8.95	10,155	8.65
f)	Miscellaneous cost	455	0.46	485	0.44	990	0.85
g)	Interest on variable cost at 7 %	6134	6.15	6814	6.17	7255	**6.18**
4.	**Total variable cost ***	**87,634**	**87.73**	**97,349**	**88.09**	**1,03,640**	**88.35**
5.	**Fixed cost**						

i)	Amortized cost of animal	3000	3.00	3034	2.74	3325	2.84
ii)	Amortized cost of building	2209	2.21	2366	2.14	2198	1.87
iii)	Depreciation	354	0.36	365	0.33	308	0.27
iv)	Interest on fixed capital at 10 %	556	0.55	576	0.52	583	**0.49**
6.	**Total fixed cost ****	**5563**	**5.56**	**5765**	**5.22**	**5831**	**4.98**
7.	**Total cost**	**99,887**	**100**	**1,10,504**	**100**	**1,17,309**	**100**
8.	**Returns (`)**						
a)	Returns from milk	1,40,645	95.78	1,39,334	95.70	1,60,003	96.14
b)	Returns from sale of Manure	4035	2.75	4255	2.92	4366	2.62
c)	Returns from sale of male calf	2155	1.47	2000	1.38	2055	1.24
9.	**Gross returns**	**1,46,835**	**100**	**1,45,589**	**100**	**1,66,424**	**100**
10.	**Net returns**	**46,948**		**35,085**		**49,115**	
11.	Returns per cow (`)	23,474		17,542		24,557	
12.	Returns per rupee investment	1.47		1.31		1.41	

Note: Number in bracket indicates the percentage of small dairy farms in Bengaluru North, * indicates summation from a to f, ** indicates summation from i to iii and $n_1+n_2+n_3=30$.

4.6 Economics of managing medium size dairy farms in the rural, transition and urban zones of Bengaluru North

The table revealed that in rural, transition and urban zones of Bengaluru the average herd size in medium dairy farms was found to be four, four and three dairy cows, respectively. The number of medium dairy farms out of the total sample dairy farms in rural, transition and urban zones were 10, 14 and 6, respectively. The data showed that medium sized dairy farms were found more in transition zone. The total cost incurred was worked out for medium dairy farms across the gradient. In rural zone, the highest share of percentage in the total variable cost was contributed by the cost of concentrates followed by the labour cost. The percentage share of cost of concentrates in the total cost incurred was found to be (24.41 %), followed by the next highest percentage share of labour cost (19.76 %), In transition zone, the highest share of percentage in the total variable cost was contributed by the cost of concentrates followed by the labour cost. The percentage share of cost of concentrates in the total cost incurred was found to be (23.47 %), followed by the next highest percentage share of labour cost (21.04 %). In urban zone, the highest share of percentage in the total variable cost was contributed by the labour cost followed by cost of concentrates. The percentage share of cost of labour in the total cost incurred was found to be (21.39 %), followed by the next highest percentage share of cost of concentrates (21.00 %). The share of total fixed cost increases as the size of the dairy farm increases. It was found to be the highest in urban (6.20 %), followed by transition dairy farm (6.16 %) and then rural (6.14 %) dairy farms. Out of total cost, the share of total fixed cost was the highest in urban dairy farms because of higher fixed investments on dairy animals and dairy farm shed structures.The net returns from medium dairy farmers across rural, transition and urban zones was found to be ` 83,721.5, ` 1,64,307.18 and ` 61,223.50, respectively. The net returns and returns per rupee of investment were found to be the highest in case of the transition dairy farms as compared to rural and urban dairy farms.

Table 4.6: Economics of managing medium size dairy farms in the rural, transition and urban zones of Bengaluru North (Rupees per annum)

Sl. No.	Particulars	Rural farm	% n_1= 10	Transition farm	% n_2=14	Urban farm	% n_3=6
1.	Percentage of medium dairy farms		(33.33)		(46.67)		(20.00)
2.	Average herd size	4		4		3	
3.	Variable cost						
a)	Dry fodder	30,341	18.12	31,886	15.56	36,465	15.50
b)	Green fodder	25,432	15.19	35,886	17.51	44,823	19.05
c)	Concentrates	40,876	24.41	48,112	23.47	50,554	21.00
d)	Labour	33,082	19.76	43,122	21.04	50,623	21.39
e)	Veterinary charges	15,245	9.10	18,225	8.89	22,459	9.54
f)	Miscellaneous cost	954	0.56	1345	0.66	1490	0.63
g)	Interest on variable cost at 7 %	10,215.1	6.11	12,500.32	6.10	14,449	6.14
4.	Total variable cost *	1,45,930	87.14	1,78,576	87.13	2,06,414	87.11
5.	Fixed cost						
i)	Amortized cost of animal	6300	3.76	7499	3.66	8589	3.64
ii)	Amortized cost of building	3164	1.90	4262	2.08	5092	2.16
	Depreciation	780	0.48	854	0.42	964	0.40
iii)	Interest on fixed	1024.4	0.61	1261.5	0.61	1314.5	0.55
iv)	capital at 10 %						
6.	Total fixed cost **	10,244	6.14	12,615	6.16	13,145	6.20
7.	Total cost	1,67,413	100	2,04,952	100	2,35,322	100
8.	Returns (`)						
a)	Returns from milk	2,40,100	95.60	3,57,003	96.68	2,84,488	95.94
b)	Returns from sale of Manure	7085	2.82	8433	2.28	8899	3.00
c)	Returns from sale of male calf	3950	1.58	3824	1.04	3159	1.06
9.	Gross returns	2,51,135	100	3,69,260	100	2,96,546	100
10.	Net returns	83,721		1,64,307		61,223	
11.	Returns per cow (`)	20,930		41,076		20,407	
12.	Returns per rupee investment	1.50		1.80		1.26	

Note: Number in bracket indicates the percentage of small dairy farms in Bengaluru North, * indicates summation from a to f, ** indicates summation from i to iii and $n_1+n_2+n_3=30$.

This was mainly due to the higher returns from sale of milk, manure and unproductive animals in transition zone and here the good quality Holstein- Friesian (HF) crossbred cattle was maintained in medium dairy farm of transition zone to get higher productivity.

The returns per cow was found to be the highest in the transition zone dairy farms (` 41,076.80), followed by rural (` 20,930.37) and then urban zone (` 20,407.83). The returns per rupee of investment was the highest in the transition dairy farm (1.80), followed by rural (1.50) and urban dairy farms (1.26). The above observations were due to the fact that the total returns from sale of milk, manure and male calf is the highest (` 3,69,260) of all zones. Here milk is marketed to MPCS, nearby households and also to private dairies like mother dairy for 244 days in a year.

4.7 Economics of managing large size dairy farms in the rural, transition and urban zones of Bengaluru North

The table revealed that the economics of large dairy production was assessed in the rural, transition and urban zones of study area. In rural, transition and urban zones of Bengaluru North, it was found that the average herd size in large dairy farms was found to be seven, seven and six in numbers, respectively. The number of large dairy farms out of the total dairy farms in rural, transition and urban zones were 10, 7 and 13, respectively. The data showed that large dairy farms were found more in urban zone.

The total cost incurred was worked out for large dairy farms across the gradient. In rural zone, the highest share of percentage in the total variable cost was contributed by the cost of concentrates followed by the cost of dry fodder. The percentage share of cost of concentrates in total cost incurred was found to be (23.85 %), followed by the next highest percentage share of dry fodder cost (20.23 %), In transition zone, the highest share of percentage in the total variable cost was contributed by the cost of concentrates followed by the cost of labour. The percentage share of cost of concentrates in the total cost incurred was found to be (24.30 %), followed by the next highest percentage share of cost of labour (21.19 %). In urban zone, the highest share in the total variable cost was contributed by the cost of concentrates followed by the labour cost. The percentage share of cost of concentrates in the total cost incurred was found to be (23.27 %), followed by the next highest percentage share of labour cost (21.84 %). The share of total fixed cost increases as the size of the dairy farm increases. It was found to be the highest in rural dairy farm (5.80 %), followed by transition (5.14 %) and then urban (4.22 %) dairy farms. Out of total cost, the share of total fixed cost was the highest in rural farm because of higher fixed investments on dairy animals and dairy farm shed structures.

The net returns from large dairy farmers across rural, transition and urban zones were found to be ` 2,03,232, ` 2,37,421 and ` 1,25,230, respectively. The net returns were found to be the highest in case of the transition dairy farms as compared to urban and rural dairy farms. This was mainly due to the higher milk production and its sale for better price (Rs. 29/litre) in nearby milk co-operative societies and private dairies by HF crossbred cattle maintained in dairy farms.

The returns per cow were found to be the highest in the transition dairy farms (` 33,917.28), followed by rural (` 29,033) and then urban zone (` 20,871.66). The net returns were found to be the highest in transition zone hence, returns per cow was also found to be the highest of all zones. This was mainly due to the higher milk production by HF crossbred cattle and its sale for better price (Rs. 29) in nearby milk co-operative societies and private dairies. The returns per rupee of investment was the highest in the rural dairy farm (1.82), followed by transition (1.71) and urban dairy farms (1.32). This was mainly because of two reasons, Viz., relative advantage of rural dairy farmers as their total cost of feed is the lowest of all zones. Rural dairy farmers grow their own fodder like maize, ragi to feed their dairy animals in the farms. Another reason is the cheap availability of labour in rural zone when compared to transition and urban zones, veterinary services were made available to rural dairy farmers from MPCS for relatively lower prices, as the veterinary doctors visit the dairy animals every friday in a week to check the health of the lactating and pregnant cows.

Table 4.7: Economics of managing large size dairy farms in the rural, transition and urban zones in Bengaluru North (Rupees per annum)

Sl. No.	Particulars	Rural farm	% n_1=10	Transition farm	% n_2=7	Urban farm	% n_3=13
1.	Percentage of large dairy farms		(33.33)		(23.33)		(43.34)
2.	Average herd size	7		7		6	
3.	Variable cost						
a)	Dry fodder	50,124	20.23	53,122	15.94	62,608	16.04
b)	Green fodder	40,331	16.28	50,002	15.00	65,236	16.72
c)	Concentrates	59,114	23.85	80,969	24.30	90,784	23.27
d)	Labour	45,334	18.29	70,588	21.19	85,208	21.84
e)	Veterinary charges	20,332	8.20	36,874	11.06	41,345	10.60
f)	Miscellaneous cost	1623	0.65	2245	0.68	2545	0.65

g)	Interest on variable cost at 7 %	15,180	6.12	20,566	6.17	24,341	**6.24**
4.	**Total variable cost ***	**2,16,858**	**87.50**	**2,93,800**	**88.17**	**3,47,726**	**89.12**
5.	**Fixed cost**						
i)	Amortized cost of animal	11,000	4.44	13,092	3.92	11,289	2.89
ii)	Amortized cost of building	2371	0.96	3046	0.92	4000	1.03
	Depreciation	969	0.40	1002	0.30	1142	0.30
iii)	Interest on fixed	1434	0.58	1714	0.52	1643.1	**0.42**
iv)	capital at 10 %						
6.	**Total fixed cost ****	**14,340**	**5.80**	**17,140**	**5.14**	**16,431**	**4.22**
7.	**Total cost**	**2,47,812**	**100**	**3,33,220**	**100**	**3,90,141.1**	**100**
8.	**Returns** (`)						
a)	Returns from milk	4,31,864	95.75	5,50,993	96.55	4,96,334	96.31
b)	Returns from sale of Manure	12,336	2.73	13,968	2.45	14,005	2.72
c)	Returns from sale of male calf	6844	1.52	5680	1.00	5032	0.97
9.	**Gross returns**	**4,51,044**	**100**	**5,70,641**	**100**	**5,15,371**	**100**
10.	**Net returns**	**2,03,232**		**2,37,421**		**1,25,230**	
11.	Returns per cow (`)	29,033		33,917		20,871	
12.	Returns per rupee investment	1.82		1.71		1.32	

Note: Number in bracket indicates the percentage of small dairy farms in Bengaluru North, * indicates summation from a to f, ** indicates summation from i to iii and $n_1+n_2+n_3=30$.

4.8Technical, allocative and economic efficiency of small, medium and large dairy farms across rural, transition and urban zones in Bengaluru North

The technical, allocative and economic efficiency of small, medium and large dairy farms across rural, transition and urban zones is furnished in Table 4.8. The table revealed that technical efficiency levels of each dairy farm were computed by Data Envelopment Analysis (DEA) for rural, transition and urban zones using the linear programming technique. The criterion employed by Ferreira (2005) was adopted in the study to decide on the cut-off score for efficient farms across the gradient. Dairy farms which had a score of 0.90 and above were considered to be the efficient farms.

In rural zone, all dairy farms were found to be technically efficient. This was observed due to better technical information available to them at Milk Producer's Co-operative Societies (MPCS). Allocative efficiency was found to be the highest in large dairy farms (1.00). This was due to better resource use efficiency like growing green fodder in their own agricultural land and veterinary services provided to dairy farmers at relatively lower price from MPCS. Cost efficiency was also found to be the highest in the large dairy farms (1.00). This was observed due to scale of economy. In transition zone, the technical efficiency was found to be the highest in medium dairy farms (0.91), allocative efficiency was found to be the highest in large dairy farms (0.90) and cost efficiency was found to be the highest in large dairy farms (0.56). No dairy farmers in this zone were found to be efficient in cost efficiency (0.90 and above). This was observed as higher costs was incurred for purchase of green and dry fodder which accounts for poor cost efficiency. In urban zone, the technical efficiency was found to be the highest in medium dairy farms (1.00), allocative efficiency was found to be the highest in large dairy farms (0.99) and cost efficiency was found to be the highest in medium dairy farms (0.87). In urban zone no dairy farms were found to be

cost efficient because of higher cost incurred for purchase of both green and dry fodder, veterinary cost and fixed cost on dairy cows.

Table 4.8: Technical, allocative and economic efficiency of small, medium and large dairy farms across rural, transition and urban zones in Bengaluru North

Sl. No.	Zones	Rural			Transition			Urban		
1.	Efficiency	TE	AE	CE	TE	AE	CE	TE	AE	CE
2.	Small	1.00	0.33	0.33	0.53	0.63	0.34	0.78	0.50	0.39
3.	Medium	0.97	0.68	0.67	0.91	0.46	0.28	1.00	0.87	0.87
4.	Large	1.00	1.00	1.00	0.62	0.90	0.56	0.65	0.99	0.65

Note: TE: Technical Efficiency; AE: Allocative Efficiency; CE: Cost / Economic Efficiency.

1. Total cost of feed, labour costs, veterinary costs and fixed costs are the inputs considered for analysis.

4.9 Distribution of sample dairy farms according to technical efficiency index

The table revealed that in small dairy farms, across the gradient the number of technically efficient farms were found to be eight, six and seven in rural, transition and urban zones, respectively. In medium dairy farms, across the gradient the number of technically efficient farms were found to be five, eleven and eight in rural, transition and urban zones, respectively. In large dairy farms, across the gradient the number of technically efficient farms were found to be six, five and nine in rural, transition and urban zones, respectively. The percentage of technically efficient small dairy farms in rural, transition and urban zones were 72.73, 66.67 and 70.00 per cent, respectively. This was observed due to better input use efficiency in small dairy farmers of rural and urban zones. The percentage of technically efficient medium dairy farms in rural, transition and urban were 90.00, 78.57 and 80.00 per cent, respectively. This was observed as medium dairy farmers in transition zone were found to be landless. Hence, they purchased green and dry fodder for higher prices to feed the animals. The percentage of technically efficient large dairy farms in rural, transition and urban were 90.00, 57.15 and 46.15 per cent, respectively. Similarly, urban dairy farmers also procured green and dry fodder for relatively higher prices locally and fixed costs were found be the highest in urban dairy farms.

Table 4.9: Distribution of sample dairy farms according to technical efficiency index

Sl. No.	Technical efficiency	Small dairy farmers			Medium dairy farmers			Large dairy farmers		
	Zones	R	T	U	R	T	U	R	T	U
1.	0.5-0.6	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
2.	0.6-0.7	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
3.	0.7-0.8	0 (0)	1 (11)	0 (0)	0 (0)	0 (0)	1 (10)	0 (0)	0 (0)	1 (8)
4.	0.8-0.9	3 (27)	2 (22)	3 (30)	1 (10)	3 (21)	1 (10)	1 (10)	3 (42)	6 (46)
5.	0.9-1.0	8 (73)	6 (67)	7 (70)	5 (90)	11 (79)	8 (8)	9 (90)	5 (58)	6 (46)
Total		11 (100)	9 (100)	10 (100)	6 (100)	14 (100)	10 (100)	10 (100)	7 (100)	13 (100)
Average		0.93	0.93	0.93	0.95	0.91	0.95	0.97	0.93	0.91

Figures in the parentheses indicate percentage to the respective total Note: R- Rural zone, T- Transition zone and U- Urban zone.

4.10 Institutional participation of dairy farmers in rural, transition and urban zones of Bengaluru North

The table reveals that in rural zone, cent per cent of dairy farmers had participated in activities of co-operatives and milk co-operatives, respectively. 90.00 and 93.33 per cent of dairy farmers had participated in activities of Farm Service Societies (FSS) and KVK/ZARS/RSK, respectively. In transition zone, 90.00 and 96.66 per cent of dairy farmers had participated in activities of co-operatives and milk co-operatives, respectively. 86.66 and 96.66 per cent of dairy farmers had participated in activities of Farmers Service Societies (FSS) and KVK/ZARS/RSK, respectively. In urban zone, 100 and 10.00 per cent of dairy farmers had participated in activities of co-operatives and milk co-operatives, respectively. This was observed as dairy farmers of urban zone sold their milk for higher price (Rs. 40) in nearby urban households. Hence, veterinary services were not provided from milk co-operatives which eventually results in technical inefficiency. None of the dairy farmers had participated in any of the activities of Farm Service Societies (FSS) or KVK/ZARS/RSK and thus lacked technical guidance to manage dairy farms efficiently.

Table 4.10: Institutional participation of dairy farmers in rural, transition and urban zones of Bengaluru North

Sl. No.	Institutions	Rural zone (n=30)		Transition zone (n=30)		Urban zone (n=30)	
1.	Membership	P	NP	P	NP	P	NP
2.	Co-operative Societies	30 (100)	0 (0)	27 (90)	3 (10)	30 (100)	0 (0)
3.	Milk Co-operative	30 (100)	0 (0)	29 (96)	1 (4)	3 (10)	27 (90)
4.	Farm Service Societies	27 (90)	3 (10)	4 (13)	26 (87)	0 (0)	30 (100)
5.	KVK/ZARS/RSK	28 (93)	2 (7)	1 (3)	29 (97)	0 (0)	30 (100)

Figures in the parentheses indicate percentage to the respective total.

Note: P- Participated, NP-Not participated.

4.11 Disposal of milk by dairy farmers across the gradient in Bengaluru North

The table reveals that in rural zone, all (30) dairy farmers marketed milk at an average price of Rs. 24.00 for 224 days to milk co-operatives only. In transition zone, 26 dairy farmers marketed milk for an average price of Rs. 26.00 for 244 days to milk co-operatives and 2 dairy farmers marketed milk for an average price of Rs. 28.00 each for 244 days to local sales and private dairies like mother dairy unit, respectively. In urban zone, 9 dairy farmers marketed milk for an average price of Rs. 29.00 for 214 days to milk co-operatives and 21 dairy farmers marketed milk for an average price of Rs. 40.00 for 214 days to local sales like home delivery to urban households.

Table 4.11: Disposal of milk by dairy farmers across the gradient in Bengaluru North

Sl. No.	Particulars	Number of dairy farmers			Average days milk marketed (per annum)			Price per litre of milk (Rs/ Litre)		
	Zones	R	T	U	R	T	U	R	T	U
1.	Milk Co-operatives	30 (100)	26 (86.67)	9 (30)	224	244	214	24	29	24
2.	Local Sales	0 (0)	2 (6.66)	21 (70)	0	244	214	0	28	40

3.	**Private Dairies**	0 (0)	2 (6.67)	0 (0)	0	244	0	0	28	0

Note: R- Rural zone, T- Transition zone and U- Urban zone.

4.12 Primary value addition and sale of milk products in urban zone of Bengaluru North:

The table reveals that in urban zone, 10 dairy farmers had done value addition to milk and sold products like curd, butter and ghee in the locality as the market for it is easily available in urban zone and gives remunerative price for their products sold. Value added products like 120 litre of curd was sold at Rs. 40 per litre with an average return of Rs. 480 per year. 30kg of butter was marketed at Rs. 500 per kg with an average return of Rs. 15,000 per year. 20 litre of ghee was sold at Rs. 600 per litre with an average return of Rs. 1200 per year.

Table 4.12: Primary value addition and sale of milk products in urban zone of Bengaluru North (per year)

Sl. No.	Particulars	Number of dairy farmers	Quantity sold	Average price/ unit (`/ unit)	Average returns realized (`)
1.	**Curd (litre)**	10	120	40	480
2.	**Butter (kg)**	10	30	500	15,000
3.	**Ghee (litre)**	10	20	600	12,000
				Total (Rs)	27,480

SUMMARY AND CONCLUSION:

5.5 Major findings of the study

- In urban zone more number of female respondents (40%) owned dairy farms as compared to transition and rural zones.
- About 50 per cent of the sample respondents belong to 30-50 years age group.
- About 25.55 % of the sample farmers were noticed to be illiterate across the gradient.
- All the sample respondents across the gradient had owned almost all basic requirements of modern and comfortable living.
- Majority (98 %) of the dairy farmers owned crossbred cows in their livestock farms as the milk productivity of the crossbred cows was much more than that of indigenous cows and buffaloes.
- Cost of concentrates forms the major share (68.85 %) in total variable cost followed by the cost of labour (60.23 %) in dairy production in rural zone of the study area.
- Cost of concentrates forms the major share (70.13 %) in total variable cost followed by the cost of labour (65.26 %) in dairy production in transition zone.
- Cost of labour forms the major share (66.41 %) in total variable cost followed by the cost of concentrates (65.71 %) in dairy production in urban zone.
- Returns per cow was the highest in transition-medium size dairy farm (Rs. 41,076) and returns per rupee of investment was found to be the highest in rural-large size dairy farm (1.82).
- All the landless respondents in urban and transition zone had depended on purchase of the dry fodder whereas, small and marginal dairy farmers across the gradient had depended on both own production and purchase of dry fodder.
- Rural-large dairy farmers were found that they were technical, allocative and cost efficient across the gradient.
- In rural zone, the technical efficiency was computed and found that the highest in small and large size dairy farms (1.00), allocative efficiency was calculated and found that highest in large size dairy farms (1.00) and cost efficiency was calculated and found to be the highest in large size dairy farms (1.00).
- In transition zone, the technical efficiency was calculated and found that the highest in large size dairy farms (0.62), allocative efficiency was calculated and found to be the highest in large size dairy farms (0.90) and cost efficiency was calculated and found to be the highest in large size dairy farms (0.56) but, no dairy farmers in this zone were found to be efficient in technical and cost efficiency (0.90 and above).

- In urban zone, the technical efficiency was computed and found that the highest in medium size dairy farms (1.00), allocative efficiency was found to be the highest in large size dairy farms (0.99) and cost efficiency was found to be the highest in medium size dairy farms (0.87). In urban zone, none of the dairy farms were found to be cost efficient.
- In small dairy farms, the technical efficiency was calculated to find the highest (8) number of efficient farms to be in rural zone.
- In medium dairy farms, the technical efficiency was computed to find the highest (11) number of efficient farms to be in transition zone.
- Among large dairy farms, the technical efficiency was computed to find the highest (9) number of efficient farms to be in rural zone.
- In rural zone, all respondents took part in the activities of co-operatives and milk co-operatives accounting for 100 per cent, respectively.
- In transition zone, 90.00 and 96.00 per cent of sample respondents took part in the activities of co-operatives and milk co-operatives, respectively.
- In urban zone, 100 and 10.00 per cent of respondents took part in the activities of co-operatives and milk co-operatives, respectively.
- In rural zone, milk marketing is done through the milk co-operatives only. In transition zone 86.67per cent of milk marketing is done through milk co-operatives and the rest is sold locally or through private dairies. In urban zone,70.00 per cent of milk marketing is done by local sale and the rest through milk co-operatives.
- Value added dairy products were marketed only in the urban zone and butter is the major value-added product, where returns was Rs. 15,000 followed by ghee Rs.12,000.

Policy Implications

- The returns per rupee investment in dairy farming across the gradient ranges from 1.31 to 1.47 in small dairy farmers. This shows that there exists a need to increase the returns on investment.
- Suggestion is made to take up extension activities to encourage better management practices in dairy farms of transition and urban zones.
- It is noticed that hardly any urban dairy farmers have access to quality fodder. Therefore, organised sale of fodder in suitable locality would improve the efficiency of urban dairy units.

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