Biological Forum – An International Journal **15(10): 1022-1027(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Technical Efficiency of Dairy Farms in Rural – Urban Interface of Bengaluru: An Application of Stochastic Frontier Function

Kadli Veeresh[1*], B.V. Chinnappa Reddy[2] and Ganeshagouda I. Patil[3]
[1]Department of Agricultural Economics, College of Horticulture, Bidar (Karnataka), India.
[2]Rtd. Professor, Department of Agricultural Economics, UAS, GKVK, Bangalore (Karnataka), India.
[3]Assistant Professor, Department of Agricultural Economics, UHS, Bagalkot (Karnataka), India.

(Corresponding author: Kadli Veeresh)*
(Received: 14 August 2023; Revised: 15 September 2023; Accepted: 30 September 2023; Published: 15 October 2023)
(Published by Research Trend)

ABSTRACT: This study is the modest attempt to explore the influence of urbanization on dairy farming households, dairy profitability and economy of the village. As influenced by urbanization, there have been changes in the herd size in rural, transition and urban areas around Bengaluru. In this attempt, the patterns of emergence of allied agricultural activities and non-farm activities across the Rural-Urban interface have been analyzed and study carried out in north and south transects of Bengaluru across three gradients from each transect to estimate the efficiency of dairy farmers revealed that total variance as well as inefficiency was more among the dairy farmers in Rural gradient in both transects. More than 85 per cent of the total variance of rural gradient in both transects was due to farmers inefficiency whereas in urban gradient less than 70 per cent of the total variance was caused by farmers inefficiency in north as well as south transacts. Farms with efficiency score more than 0.90 was also more among the urban gradients compared to rural and transition. Number of farms with efficiency score less than 0.50 were more among south transect across all gradients than that of north transect. Herd size, concentrate and roughage feeds and number of man days were the main inputs which influence the production and concentrate feeds were more significant in urban gradient while roughage feed was significant in rural gradient. Organizational members and trained farmers are operating more efficiently than non-members.

Keywords: Maximum likelihood estimates, Stochastic Frontier Production, Production Efficiency.

INTRODUCTION

The livestock sector has been one the most important and integral parts of Indian agriculture, and hence of the Indian economy. India has the largest population of cattle and buffalo in the world, and its breeds are well adapted towards heat tolerance, local disease pressures, and local weather conditions. Though the significance of agriculture in Indian economy is coming down, the livestock sector still continues to contribute consistently to the nation's GDP. Livestock has a significant role in maintaining the welfare of rural farming communities of India.

As per the report of the working group on animal husbandry and dairying, 11th five-year plan: 2007-12, the livestock sector employs eight percent of the countries labour force, including many small and marginal farmers, women and landless agricultural workers. Milk production alone involves more than 30 million small producers, each raising one or two cows or buffaloes. The organic fertilizer produced by the sector is an important input to crop production, and dung from livestock is widely used as fuel in rural areas. Livestock also serves as an insurance substitute, especially for poor rural households; it can easily be sold during time of distress.

With annual milk production of 132.4 million, India ranks first in the world and contributes about 16% to the world milk production (BAHS, 2014). India's milk production continuously increased right from 1950-51, when the total milk production was 17 million tones. Share of livestock sector in nation's GDP was 4.00 per cent in 2011-12 and it was consistent over the years with a slight increase to 4.50 per cent in 2015-16 (National Accounts Statistics-2016). However, dairy productions in India involves a smallholder production system in which most of the milk produced is consumed on the farm or distributed through informal channels. This system of production, combined with Indian policies that encourage self-sufficiency and restrict dairy imports, leaves much unused potential in the Indian dairy market (Edward *et al.*, 2006).

The country has witnessed around eight percent growth in GDP in the last couple of years and India's urban population is increasing at a faster rate than its total population (Kalamkar, 2009). Urbanization process effects farming practices, reduction in available land leads to a more intensified crop-livestock farming practices and also the dependence on concentrates. In developing countries' agriculture farm efficiency is an important subject. In case of inefficient farming practices output could be increased with less cost through extension and education to enhance farm efficiency (Ali, 2013).

Though the rate of urbanization in India is very high, the share of livestock to economy was showing a consistent trend. In this context it is necessary to analyse the effect of urbanization on efficiency of farmers as well as to increase the competitiveness of the livestock sector especially dairy sector in Indian economy it's essential to rise the technical and economic efficiency of the dairy farms as technical inefficiency of the farmers is one of the major reason for low production of milk in India.

This study aims to estimate the technical efficiency of farms in in north and south transects of Bengaluru across rural, transition and urban gradients of both transects.

METHODOLOGY

To investigate the socio-ecological transformation of dairy farmers in Rural – Urban interface of Bengaluru, North and South transects of Bengaluru were defined as common space. Considering *Vidhana Soudha*, the building of the state legislature that is located in the heart of the Bengaluru city as reference point, Bengaluru was divided into North of Bengaluru and South of Bengaluru. There were 93 villages and urban units in the N-transect and 98 in the S-transect defining the populations (Hoffmann *et al.*, 2017).

Both north as well as south transects were further subdivided in to three gradients namely rural, transition (Peri-urban) and urban gradients. This classification of transects in to these three layers is based on an index (SSI), which was formulated by taking percentage of built-up area and its distance from Vidhana Soudha. Region within 20-25 kilometers from the city center has higher percentage of built up area which is highly correlated to distance (nearer to city, higher will be the building density). Beyond that, two parameters were negatively correlated (Hoffmann *et al.*, 2017).

For this efficiency analysis 50 households from each gradient were selected, which constitutes 150 farmers from each transect. Altogether, 300 sample respondents were interviewed for this study from north and south transects of Bengaluru.

Efficiency Analysis. The analysis of technical efficiency and its potential determinants requires the estimation of a production frontier. The explicit introduction of a composed error term in the SFA approach allows for the simultaneous estimation of a random error component $\nu$and a systematic error component u. The latter is interpreted as a measure of technical inefficiency, i.e., the shortfall of output that a given farmer experiences given the observed input use and the estimated frontier technology. SFA requires the choice of a specific functional form, and for the estimation by Maximum Likelihood (ML) methods, an assumption about the distribution of the composed error term. The basic model is shown in equation (1) below.

$$\ln Y_i = \beta_0 + \sum_{j=1}^{4} \beta_j \ln X_{ji} + \frac{1}{2}\sum_{j=1}^{4}\sum_{k=1}^{4} \beta_{jk} \ln X_{ji} \ln X_{ki} + \nu_i - u_i \quad (1)$$

where ln denotes natural logarithm; Y_i is annual milk production of farm *i* measured in litres; X_{1i} is the herd size in number of cows, X_{2i} is the annual consumption of roughage feed in kilograms (equals consumption of green fodder plus dry fodder, assuming a dry matter content of 30 per cent and 90 per cent, respectively (Binici *et al.*, 2006), X_{3i} is the annual consumption of purchased dairy concentrate in kilograms, and X_{4i} is farm labour in man-days. The random errors $\nu_i$are assumed to be symmetric, identically and independently distributed $N(0, \sigma_v^2)$, and the errors u_i are assumed to follow a truncated normal distribution with location parameter μ and scale parameter σ_v^2, accounting for technical inefficiency relative to the stochastic frontier.

We use the model parametrization as proposed by Battese and Corra (1977), i.e., the likelihood function is modelled in terms of $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$.

While γ is bounded between zero and one, it must not be interpreted as a variance decomposition since the variance of the one-sided error is not equal to the parameter σ_u^2.

Factors Affecting the Technical Inefficiency Scores. We are also interested in the factors that explain the differences in the estimated technical efficiency among the farmers. In order to simultaneously estimates the efficiency scores and their association with a set of candidate variables (denoted by Z_j), we follow Battese and Coelli (1995) and replace the parameter μ of the truncated normal distribution with a linear function of the *Z*-variables.

$$\mu_i = \delta_0 + \sum_{m=1}^{5} (\delta_m Z_{mi}) \quad (2)$$

Z_{mi} are socio-economic characteristics. Z_{1i} is age of farmer. Z_{2i} *is* education attainment of farmer in years. Z_{3i} is a binary variable equal to one if the farmer is a dairy co-operative member and to zero otherwise. Z_{4i} is a binary variable equal to one if the farmer cultivates fodder crop and to zero otherwise. Z_{5i} is total number of cows in the herd.

RESULTS AND DISCUSSION

Table 1 contains stochastic production frontier estimates along with the numerical values of $\sigma^2 = \sigma_v^2 + \sigma_u^2$ (total variance) and gamma (γ) parameter of the model. Total variance explains the variation in the output due to factors other than the inputs included in the estimated efficiency model. Inefficiency component of total variance is explained by gamma which meansγ parameter indicates the proportion of total variance that is attributed to technical inefficiency of farmers in the estimated model. Remaining part of total variance is due to the random shocks which are not under the control of farmers.

The value of γ rural (0.89) gradient indicates that 89 per cent of the total variance (67 per cent) in rural gradient was due to inefficiency of farmers in the rural area and remaining 11 per cent was due to random shocks which cannot be controlled by the farmers (Table 2). Similarly for urban and transition gradients in north of Bengaluru 67 per cent and 84 per cent of the total variance was attributed to farmer's inefficiency, respectively and random shocks explains 33 and 16 per cent of the total variance of urban and rural gradients, respectively. The significance of γ indicates that technical inefficiency effects are significant in determining the level and variability of milk production.

One per cent increase in herd size and feed both roughage and concentrate from their geometric mean level were seen to be contributing positively to the milk production by 0.31, 0.66 and 0.10 per cent over and above the geometric mean level of milk yield in rural whereas in transition the milk production increases by 0.27, 0.60, and 0.13 per cent, respectively. Magnitude of contribution of increase in herd size (0.40 %) and concentrate feed (0.48 %) were more among urban households this is because in urban area they go for more intensive farming with more usage of concentrates that in turn may be due to higher income and higher purchasing power of urban households.

Maximum likelihood estimates of stochastic frontier production function for south of Bengaluru are given in Table 2. As expected, here also all the production inputs have a positive coefficient, implying that the milk production increases with an increases in use of these inputs. 57.00 per cent of the variance in efficiency model was attributed to farmer's inefficiency and inevitable random shocks in the production and marketing. The value of γ is 0.95, 0.85 and 0.66 respectively for rural, transition and urban gradients and are significant at one percent level. Farmer's inefficiency level was observed to be highest in rural gradient which may be due to lower education status, low risk bearing ability and comparatively less purchasing power of the farmers in rural area. As expected, inefficiency level of the estimated model of urban gradient (66.00 per cent) was less than other two gradients. The null hypothesis that $\gamma = 0$ is rejected at the 99% level of statistical confidence, indicating that technical inefficiency. In rural gradient of south constant, herd size and concentrate feed were not contributing significantly to the output but one unit increase in roughage feed from its geometric mean level, output will increase by 0.83 per cent over and above the geometric mean level of milk yield, whereas in Urban only feeds are significant with a contribution of 0.30 per cent by both concentrate as well as roughage feeds with one unit increase from their geometric mean.

Table 3 presents the distribution of production efficiency scores. Only 8.00 percent of the total sampled dairy farms had a production efficiency score more than 0.90 in rural gradient of North of Bengaluru, that meant the farm was operating at 90 percent or more of their potential production efficiency based on the estimated production efficiency frontier. Number of farms with production efficiency score was least in transition (4.00 %) and highest in Urban (22.00 %). More than 50 per cent of the farms were operating with an efficiency score of more than 0.70 in all the three gradients of north Bengaluru.

Production efficiency scores of dairy farms in South Bengaluru are presented Table 4. Unlike the north, more than half of the farms were operating with less than 0.70 efficiency score in all the three gradients of South transect. Only 4 percent of the total sampled dairy farms were operating with 90 percent or more of their potential production efficiency based on the estimated production efficiency frontier in Rural and transition gradients of South of Bengaluru. Number of farms with least production efficiency score less than 0.50 was more in Transition (28.00 %) and lowest in Urban (18.00 %). On par with the a priori expectations, least minimum score was observed in Rural gradient (0.32) and highest score was seen in urban (0.96), this could be attributed to better managerial skills of the educated farmers in urban gradient. If a farmer in rural gradient with average efficiency increased the farm's efficiency to that of the most efficient farm in the sample, this average dairy farmer could realize a 34 percent (i.e., 1- (61/93) saving in costs, which is 32 and 25 per cent respectively in case of transition and urban gradients.

Results for the regression analysis of the factors associated with the variation in production efficiency among the sampled farms in North of Bengaluru are presented in Table 5. The dependent variable is the degree of production efficiency. In this analysis a variable with negative sign means that it was positively related to the efficiency of the farm. Herd size and fodder crop had a positive relationship with the production efficiency and were significant at 5 per cent level in transition gradient of north Bengaluru, which imply that as the size of the herd increases by one unit from its geometric mean the production efficiency also increases by 0.17 units. Variation in education was comparatively important in Urban gradients. This may be due to comparatively higher educational status of the people who resides in urban area and also education rises the managerial skills and risk bearing ability of the farmers. More modernized and intensive farming practices in urban area makes education more relevant. Age and co-operative membership were significant only in rural and urban gradients. Though fodder crop was positively associated with efficiency, its effect is statistically insignificant. Similar results were reported for farmers in Bangladesh, Ethiopia (Weier, 1999), and Cameroon (Binam *et al.*, 2004).

According to Table 6 that, all the variables had positive effects on production efficiency though some of them were not statistically significant. Education was the only variable which is significant in all three gradients. Fodder crop was a significant input in transition and rural gradients, but not in urban farms. This may be due to the dependence of urban farms on concentrates for feeding the cattle whereas, rural and transition farms depends more on cultivated fodder crops. Magnitude of coefficient of education was more in urban farms than rural and transition, this result was also similar to that of south of Bengaluru. Old farmers gain knowledge and skill through experience but usually they are unwilling to invest in modern technologies or practices. Abdulai and Huffman (1998) find that young rice farmers in Ghana were more efficient than old farmers while Coelli *et al.* (2002) find the same result in Bangladesh. Binici *et al.* (2006) in their study revealed that age was not a significant factor among cotton farmers in Turkey. Similar to this result, Ali (2013) also reported that Farmer's level of education, experience, contact with an extension services and herd size are the main determinants associated with TE in the sampled dairy farms. Technical efficiency can be further improved through provision of education, training and orientation of the farmers toward dairy farming practices.

Maximum likelihood estimates of stochastic frontier production function for south of Bengaluru are presented Table 2.

Table 1: Maximum Likelihood estimates of stochastic frontier production function for North of Bengaluru.

Variable	Parameters	Rural		Transition		Urban	
		Coefficients	t-ratio	Coefficients	t-ratio	Coefficients	t-ratio
Constant	β_0	2.63**	4.29	1.89**	2.73	3.56**	5.28
ln(herd size)	β_1	0.31**	4.72	0.27**	2.19	0.40**	3.68
ln(roughage feed)	β_2	0.66**	7.40	0.60**	5.05	0.01	0.28
ln(concentrate feed)	β_3	0.10**	2.09	0.13**	2.13	0.48**	6.70
ln (man days)	β_4	-0.03	-0.49	0.15*	1.86	0.21**	2.83
Variance parameters $\sigma^2 = \sigma_v^2 + \sigma_u^2$		0.67	3.32	0.57	3.16	0.52	3.97
$\gamma = \frac{\sigma_u^2}{\sigma^2}$		0.89	9.13	0.84	6.72	0.67	
LR statistic		18.7		17.87		19.78	

Note: ∗,∗∗significant at the 10 and 5% level respectively

Table 2: Maximum Likelihood estimates of stochastic frontier production function for South of Bengaluru.

Variable	Parameters	Rural		Transition		Urban	
		Coefficients	t-ratio	Coefficients	t-ratio	Coefficients	t-ratio
Constant	β_0	1.26	1.32	2.46**	3.46	4.71**	4.16
ln(herd size)	β_1	0.11	0.62	0.26**	2.27	0.47	1.19
ln(roughage feed)	β_2	0.83**	6.95	0.61**	5.57	0.30**	2.27
ln(concentrate feed)	β_3	0.17	-0.03	0.15**	2.65	0.30**	2.63
ln (man days)	β_4	0.16*	1.66	0.03	0.42	0.27	2.94
Variance parameters $\sigma^2 = \sigma_v^2 + \sigma_u^2$		0.57	3.66	0.53	3.50	0.45	4.06
$\gamma = \frac{\sigma_u^2}{\sigma^2}$		0.95	17.99	0.85	15.91	0.66	23.40
LR statistic		16.17		17.56		21.28	

Table 3: Distribution and summary statistics for production efficiency scores of dairy farmers in North of Bengaluru.

	Rural		Transition		Urban	
Production Efficiency Score	Number of Dairy Farms	Percent of Dairy Farms	Number of Dairy Farms	Percent of Dairy Farms	Number of Dairy Farms	Percent of Dairy Farms
$x \leq 0.50$	7.00	14.00	5.00	10.00	2.00	4.00
$0.50 < x \leq 0.60$	5.00	10.00	6.00	12.00	8.00	16.00
$0.60 < x \leq 0.70$	8.00	16.00	12.00	24.00	4.00	8.00
$0.70 < x \leq 0.80$	15.00	30.00	15.00	30.00	13.00	26.00
$0.80 < x \leq 0.90$	11.00	22.00	10.00	20.00	12.00	24.00
$0.90 < x$	4.00	8.00	2.00	4.00	11.00	22.00
Mean	0.72		0.70		0.89	
Minimum	0.47		0.24		0.48	
Maximum	0.92		0.91		0.99	

The proportion of total variance that is attributed to technical inefficiency in the estimated model were 0.85 and 0.94 respectively for north and south respectively, and were significant at one percent level. South region had more gamma value, implies out of total variance in milk production, 94.00 per cent of the variation in milk production was attributed to the variation in output among the dairy farmers and it was due to differences in production efficiency that was caused by factors like poor management which could be controlled by farmers while the 6.00 per cent of total variance was due to uncontrollable factors like price fluctuations. This dictates that farmers in south transect were more inefficient than that of north transect. The null hypothesis that $\gamma = 0$ is rejected at the 99% level of statistical confidence, indicating that technical inefficiency. In line with the a priori expectations, in the north-south interface all the inputs have a positive relationship with milk output, this shows that milk output from the dairy farm will be more if the farmer chooses to increase these inputs in the production process. LR values were more than 15.00 in both the cases which implies that the model is a good fit.

Production efficiency scores of dairy farms in north and south interface of Bengaluru are presented Table 3 & 4. 19.34 per cent of the farms in south interface of Bengaluru were operating under 50 per cent efficiency of their total capacity but only 11.22 farms had less than or equal to 0.50 efficiency score in North interface. In north interface (17.34) number of farms with more than 90 per cent or more of their potential production efficiency based on the estimated production efficiency frontier was higher than that of south interface (10.66).

Table 4: Distribution and summary statistics for production efficiency scores of dairy farmers in South of Bengaluru.

	Rural		Transition		Urban	
Production Efficiency Score	**Number of Dairy Farms**	**Percent of Dairy Farms**	**Number of Dairy Farms**	**Percent of Dairy Farms**	**Number of Dairy Farms**	**Percent of Dairy Farms**
$x \leq 0.50$	13.00	26.00	14.00	28.00	9.00	18.00
$0.50 < x \leq 0.60$	3.00	6.00	6.00	12.00	4.00	8.00
$0.60 < x \leq 0.70$	15.00	30.0	8.00	16.00	7.00	14.00
$0.70 < x \leq 0.80$	9.00	18.00	9.00	18.00	13.00	26.00
$0.80 < x \leq 0.90$	8.00	16.00	11.00	22.00	9.00	18.00
$0.90 < x$	2.00	4.00	2.00	4.00	8.00	16.00
Mean	0.61		0.64		0.70	
Minimum	0.32		0.39		0.44	
Maximum	0.93		0.94		0.96	

Table 5: Maximum Likelihood estimation results of technical inefficiency model variables for North of Bengaluru.

		Rural		Transition		Urban	
Variable	**Parameter**	**Coefficients**	**t-ratios**	**Coefficients**	**t-ratios**	**Coefficients**	**t-ratios**
Constant	δ_0	0.2128**	2.52	0.2745**	2.38	0.1460*	1.94
Age	δ_1	-0.1109**	-2.93	-0.0074	0.38	-0.0108**	-2.96
Education	δ_2	-0.02163*	-1.95	-0.0961**	-2.21	-0.2069***	-4.43
Co-operative Member	δ_3	-0.1664***	-4.54	-0.038	-1.97	-0.1152**	-2.89
Fodder Crop	δ_4	-0.0808	-0.87563	-0.1124***	-4.22	-0.0287*	-1.88552
Herd size	δ_5	0.0061	0.142839	-0.1741**	-2.97	0.0010	0.34

Note: *,** & *** significant at the 10, 5 and 1 % level respectively

Table 6: Maximum Likelihood estimation results of technical inefficiency model variables for North of Bengaluru.

		Rural		Transition		Urban	
Variable	**Parameter**	**Coefficients**	**t-ratios**	**Coefficients**	**t-ratios**	**Coefficients**	**t-ratios**
Constant	δ_0	0.6475**	3.82	0.5622**	3.77	0.9719**	2.11
Age	δ_1	-0.0332*	-1.64	-0.0014	-0.42	-0.0247*	-1.73
Education	δ_2	-0.0269**	-2.34	-0.0717*	-1.97	-0.1352***	-4.31
Co-operative Member	δ_3	-0.1918*	-1.96	-0.0609	-0.03	-0.0581**	-2.65
Fodder Crop	δ_4	-0.1652**	-2.29	-0.1277**	-2.56	0.0121	0.09
Herd size	δ_5	-0.0172	-0.41	-0.1734***	-4.31	-0.0138	-0.71

Note: *,** & *** significant at the 10, 5 and 1 % level respectively

More than 20 per cent of the farms in both the interfaces were working in a range of 70 to 80 per cent efficiency. If a farmer in south interface with an efficiency of 64 per cent increased the farm's efficiency to 92.00 per cent, this average dairy farmer could realize a 30.50 percent saving in costs, which is 21.00 per cent in north interface. It was noted in the Table 5 & 6 that, all the variables had a positive effect on production efficiency and except for forage feeds, all the coefficients were significant at least at the 90 percent level of statistical confidence in both north and south interfaces of Bengaluru. As the size of the herd, age and education increases the production efficiency also increases. The decreasing effect of herd size on technical inefficiency is attributed to the operation of economies of scale. Masilamani (2000); Shalini (2017) reported that net income realized by all types of farms varied positively with size of the dairy unit. Thus, large sized dairy units reaped the benefit of scale economies.

CONCLUSIONS

The study results shows that total variance as well as inefficiency per cent were more among farmers in rural gradient in both north and south transects. Farms with efficiency scores more than 0.90 was low in all the gradients whereas, number of farms operating with more than 0.90 score was more among urban gradient in both north and south transects. This inefficiency can be attributed to the low educational level, poor management practices and disproportionate use of feeds. These results implicit that the average dairy farmer in this sample in all gradients across both transects has the potential to increase their efficiency considerably without changing their production frontier because these major proportion of total variance in the estimated models were due to farmers inefficiency which can be controlled by the farmers and can improve the efficiency by going for appropriate management practices like balanced feed supply norms and organizational participation. The study also revealed that production inputs which are included in the model were contributing significantly to the production efficiency of the farms. Increase in herd size will lead to operation of economies of scale and there by increases the profitability of farm. The variable fodder crop also has the positive relationship with the efficiency of farms. Both as the farmers in rural gradients are more dependent on roughage feed, cultivation of fodder crops has more significance in the production efficiency of farms in rural gradient. Organizational participation and training of the farmers had significant influence on the production efficiency of sampled farmers so it is essential create awareness about the benefits of organizational membership and training activities among the dairy farmers.

Acknowledgement. I wish to express my deepest sense of gratitude and profound indebtedness to my guide and chairman of the major advisor, Dr. B. V. Chinnappa Reddy Professor and University Head (Rtd.) of Department of Agricultural Economics, UAS, GKVK, Bengaluru. I also thank all the farmers who responded calmly and helped me during data collection. I would also acknowledge Indo-German Collaborative Project & DBT, GoI, for awarding Junior Research Fellowship to carry out to my Ph. D. research work.

Conflict of Interest. None.

REFERENCES

Abdulai, A. and Huffman, W. E. (1998). An examination of profit inefficiency of rice farmers in Northern Ghana, Swiss Federal Institute of Technology, Department of Agricultural Economics.

Ali, Al-Sharafat (2013). Technical Efficiency of Dairy Farmers: A Stochastic Frontier Application on Dairy Farms in Jordan. *Jn. of Agric. Sci., 5*(3), 45-53.

Battese, G. E. and Coelli, T. J. (1995). A Stochastic Frontier Production Function Incorporating a Model for Technical Inefficiency Effects. Working Paper in Econometrics and Applied Statistics No 69. Department of Econometrics. University of New England.

Binam, J. N., Tonye, N. W., Nyambi, G. and Akoa, M. (2004). Factors affecting the technical efficiency among smallholder farmers in the slash and burn agriculture zone of Cameroon, *Food Policy, 29*, 531–545.

Binici, T., Demircan, V. and Zulauf, C. R. (2006). Assessing production efficiency of dairy farms in Burdur Province, Turkey. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, *107(*1), 1–10.

Coelli, T., Rahman, S. and Thirtle, C. (2002). Technical, allocative, cost and scale efficiencies in Bangladesh rice cultivation: A non-parametric approach, *Jn. of Agric. Econ., 53,* 607–626.

Edward, V. J., Louis, A. and Dobson, W. D. (2006). The Dairy Sector of India: a Country Study, Babcock Institute Discussion-2, 1-35.

Kalamkar, S. S. (2009). Urbanisation and Agricultural Growth in India, *Ind. Jn. of Agric. Econ., 64*(3), 443-461.

Masilamani, R. (2000). A study on the performance efficiency of the Salem district cooperative milk producers' union limited (Salem District) Tamil Nadu. *Ph. D. Thesis, (Unpub)*, Chennai, Madras University.

Rajani, M. M. (2015). Value chain analysis in dairy enterprise in Belgaum district, *M.Sc. Thesis (Unpub.)*, Univ. Agric. Sci., Dharwad.

Shalini, N. (2017). An economic analysis of influence of urbanization on structure and profitability of dairy farming, *M. Sc. Thesis (Unpub.)*, Univ. Agric. Sci., Bangalore.

Weier, S. (1999). The effects on education on farmer productivity in Rural Ethiopia; Working paper CSAE WPS99-7. Center for the study African Economics, University of Oxford.

How to cite this article: Kadli Veeresh, B.V. Chinnappa Reddy and Ganeshagouda I. Patil (2023). Technical Efficiency of Dairy Farms in Rural – Urban Interface of Bengaluru: An Application of Stochastic Frontier Function. *Biological Forum – An International Journal, 15*(10): 1022-1027.