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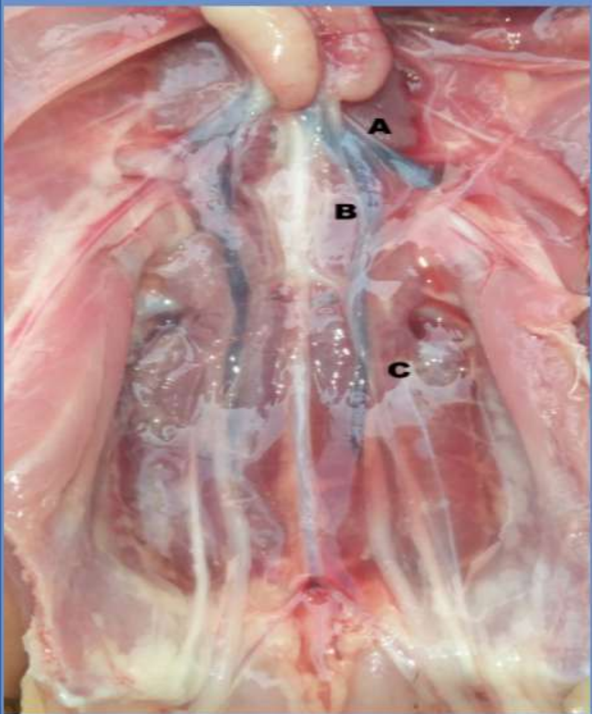

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Full length articles

Short Communications

Synergistic effect of farmyard manure on soil organic carbon and carbon sequesration potential in fodder cowpea (*Vigna unguiculata*) in different agroclimatic zones

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ABSTRACT

The experiment was conducted to study the influence of inorganic fertilizer (Treatment 1) and its synergistic effect with organic fertilizer (Treatment 2) on soil organic carbon (SOC) and carbon sequestration potential (CSP) in Fodder Cowpea (Vigna unguiculata) crop field in North Eastern and Western Zones of Tamil Nadu, India during summer season of 2012. In Western zone two districts viz., Coimbatore and Erode districts and in North Eastern Zone Tiruvannamalai and Vellore districts were selected for the field experiments. From each district, two villages were randomly selected for field experiments totaling to eight experimental sites for the study.

Fodder cowpea was planted as per standard agronomic practices with soil samples collected on 0, 30 and 60th day (harvest) of the trial. Soil samples were dried and subjected to analysis using Analytikjena multi N/C2100S carbon analyzer.

The SOC on 30th day of the experimental period varied from 0.25% to 0.37% for treatment 1 (T1) and 0.27% to 0.41% for treatment 2 (T2) in the experimental zones. The SOC on 60th day varied from 0.29% to 0.42% for T1 and 0.32% to 0.46% for T2. Carbon sequestration potential in the soil for the fodder cowpea crop varied from 0.62 to 0.99 t/ha on 60th day of the trial period. The results indicated that synergistic use of farm yard manure could be a viable option to sequester carbon than inorganic fertilizer alone which has a definite impact on carbon mitigation.

Key Words: Carbon sequestration, Farm yard manure, Fodder Cowpea, Inorganic fertilizer,

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INTRODUCTION

Legumes are the most important forage plants that substantially improve the feed available for livestock providing the essential protein for animals, improving soil fertility, food crop production and household nutrition. Cowpea is an annual legume grown throughout the semiarid tropics, where it is valued as both human and livestock food. It is grown under rain-fed conditions in the tropics (Sangakkara, 1998), for its high protein value and is consumed as dry seeds, green pods or leaves. Cowpea fixes atmospheric nitrogen up to 240 kg/ha and leaves about 60 to 70 kg nitrogen for succeeding crops. Cowpea is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation (Sanginga *et al.,* 2003).

Agriculture activities serve both as sources and sinks for greenhouse gases. Agriculture sinks of greenhouse gases are reservoirs of carbon which have been removed from the atmosphere through the process of biological carbon sequestration. Carbon sequestration is the process of removal of carbon di-oxide from atmosphere in to green plants and plays an important role in carbon capture, storage mediating stabilization and consequently mitigating greenhouse gas emission (Watson *et al.,* 2000). Farm yard manure plays an important role in enhancement of soil organic carbon by sequestering carbon from the atmosphere in to plants and then to the soil.. Combined organic and inorganic fertilization could enhance carbon storage in soils and reduce emission from nitrogen fertilizer use, while contributing to high productivity in agriculture (Pan *et al.*, 2009). Promoting soil carbon sequestration is an effective strategy for reducing atmospheric carbon di-oxide and improving soil quality.

Organic manure and inorganic fertilizer are the most common materials applied in agricultural management to improve soil quality and crop productivity (Verma and Sharma, 2007). Continuous use of inorganic fertilizers leads to deterioration in soil chemical, physical, biological properties and soil health (Mahajan *et al.,* 2008). Balanced fertilizer use along with organic manure like farm yard manure (FYM) is considered as promising agro-technique in restoring soil fertility.

Hence the present study was undertaken to determine the effect of inorganic fertilizer and synergistic effect of inorganic fertilizer with organic fertilizer (farm yard manure) on soil organic carbon and carbon sequestration potential in Fodder Cowpea (*Vigna unguiculata*) in two agro climatic zones of Tamil Nadu.

MATERIALS AND METHODS

Field experiment was carried out using the annual fodder crop, Fodder Cowpea (*Vigna unguiculata*) in Western and North Eastern agro climatic zone of Tamil Nadu. From each zone two districts viz., Coimbatore, Erode district (Western Zone) and Tiruvannamalai, Vellore district (North Eastern zone) were selected for the above study. Further, from each district two villages were randomly selected based on the farmer’s interest for cultivation of leguminous fodder crop, soil condition and irrigation totaling to eight experimental sites.

In Coimbatore district the experimental villages selected were Kondaiyampalayam (V1) and Idigarai (V2) and in Erode, the villages were Velankattuvalasu (V3), Velliyampalayam (V4) respectively. In the North Eastern Zone of Tiruvannamalai district, the selected experimental villages were Vannankulam (V5) and Kolathur village (V6) and in Vellore, Saduperi (V7) and Thirumani (V8) were selected for the study purpose. Soil samples were collected as per the standard agronomic practices in all the experimental villages prior to the study and analysed for the physico chemical properties and presented in Table 1**.** The study was carried out in summer season of 2012. The land was ploughed twice by a tractor with chisel ploughing followed by harrowing in all the experimental fields. The field was brought to fine tilth, leveled with a wooden plank and laid out in to the proper plot size (6 x 4 m).The experiment was laid out with six replications per treatment in all the study fields.

Table 1. Physicochemical properties of the soil at experimental sites

Zone	District	Villages	Soil Properties						
			pH	Soil type	Electrical conductivity (EC)	Organic Carbon (%)	Nitrogen (kg/acre)	Phosphorus (kg/acre)	Potassium (kg/acre)
Western	Coimbatore	Kondaiyampalayam (V1)	7.1	Black	0.57	0.28	92.34	13.5	114.7
		Idigarai (V2)	7.3	Black	0.56	0.29	91.23	13.7	116.5
	Erode	Velankattuvalasu (V3)	7.5	Red loamy	0.60	0.34	94.01	14.5	120.6
		Velliyampalayam (V4)	7.4	Black	0.58	0.32	92.18	14.1	118.9
North Eastern	Tiruvannamalai	Vannankulam (V5)	7.0	Dark brown sandy loan	0.58	0.25	91.72	12.8	112.1
		Kolathur (V6)	7.1	Red sandy loam	0.56	0.27	90.16	13.1	115.4
	Vellore	Saduperi (V7)	6.9	Red sandy loam	0.54	0.23	91.43	13.4	106.5
		Thirumani (V8)	6.8	Dark brown sandy loam	0.53	0.24	89.22	13.2	109.8

Fodder Cowpea was planted at 60 x 30 cm intervals on either side of the ridges. The experiment consisted of two treatments viz., Treatment 1 (T1) which is control with recommended dose of NPK fertilizers (25 N, 40 P_2O_5 and 20 K_2O kg/ha) alone and Treatment 2 (T2) which included Farmyard Manure (Organic – Recommended dose - 12.5 t/ha) along with NPK fertilizer (inorganic – Recommended dose). The fertilizers were applied in the form of urea (N), Di-ammonium Phosphate (P_2O_5) and Muriate of Potash (K_2O). In all, 50 per cent of nitrogen and entire dose of P_2O_5 and K_2O were applied at the time of sowing and remaining 50 per cent of nitrogen was top dressed in the form of urea at 30 days after sowing (DAS) in all the experimental sites. . The necessary after care operations such as hand weeding were done as per the requirement. The plant protection measures have been adopted to control the pest and disease. Irrigation was carried out immediately after sowing (0^{th} day), on 3^{rd} day and thereafter once in 7 days. All the cultural practices were followed as per the recommended package of practices for the Fodder Cowpea crop (Crop Production Guide, 2012).

Soil Sampling

Soil samples were collected from the experimental plots at 30 days interval during the crop growth at a depth of 15 cm on 0th, 30th and 60th day (Harvest). The soil samples were dried in oven (at 80°C) overnight, ground in wooden pestle and mortar to pass through < 2 mm mesh and subjected to analysis using Analy tikjena multi N/C 2100S carbon analyzer. The equipment is crafted with a focus radiation NDIR detector and can with stand furnace temperature of 950°C.Also this equipment uses oxygen as supportive gas for estimation of soil $C_{Org.}$ Soil bulk density was calculated using the Manrique and Jones (1991) equation. Carbon sequestration potential (CSP) in NPK and Farmyard manure treatment over the NPK treatment was calculated as per standard procedure (Pathak *et al.*, 2011). The data collected were subjected to 't' test to find out the significant difference between treatments for all villages. In addition, One-Way ANOVA was performed using SPSS 13.0 to evaluate the significant difference between districts and zones.

RESULTS AND DISCUSSION

Soil Organic Carbon

The Mean values of Soil Organic Carbon (SOC) in Fodder Cowpea for both the zones are presented in Table 2. The SOC for Fodder Cowpea varied from 0.29 to 0.42 per cent in T1 and 0.32 to 0.46 per cent in T2 on 60th day. Also, on 60th day of the trial V3 had significantly (P<0.01) higher SOC content (0.42% and 0.46%) than V4 (0.39% and 0.42%), V2 (0.35% and 0.38%), V1 (0.33% and 0.36%), V6 (0.34% and 0.37%), V5 (0.32% and 0.36%), V8 (0.30% and 0.33%) and lower in V7 (0.29% and 0.32%) respectively in decreasing order for T1 and T2. It was evident from the results that there was a steady increase of soil organic carbon (SOC) in T1 and T2 from 0 day to 60th day (harvest) of Fodder Cowpea.

Table 2. Soil Organic Carbon (in %) in Fodder Cowpea field in Western and North Eastern zones of Tamil Nadu

Zone	District	Villages	0th day		t value	30th day		t value	60th day		t value
			T1	T2		T1	T2		T1	T2	
			Mean ± S.E	Mean ± S.E		Mean ± S.E	Mean ± S.E		Mean ± S.E	Mean ± S.E	
Western	Coimbatore	V1	0.24 ± 0.03^{a}	0.26 ± 0.02^{ab}	0.33^{NS}	0.27 ± 0.01^{a}	0.30 ± 0.01^{ab}	2.24^{*}	0.33 ± 0.01^{cd}	0.36 ± 0.01^{b}	3.95^{**}
		V2	0.26 ± 0.02^{a}	0.28 ± 0.02^{bcd}	0.95^{NS}	0.31 ± 0.01^{bc}	0.34 ± 0.01^{bc}	3.23^{**}	0.35 ± 0.01^{d}	0.38 ± 0.02^{b}	2.30^{**}
	Erode	V3	0.32 ± 0.01^{b}	0.31 ± 0.02^{cd}	0.87^{NS}	0.37 ± 0.01^{d}	0.41 ± 0.02^{d}	2.24^{*}	0.42 ± 0.01^{f}	0.46 ± 0.02^{d}	2.89^{*}
		V4	0.29 ± 0.01^{ab}	0.31 ± 0.01^{d}	2.14^{NS}	0.33 ± 0.01^{c}	0.37 ± 0.01^{cd}	2.71^{*}	0.39 ± 0.01^{e}	0.42 ± 0.01^{c}	2.94^{*}
North Eastern	Tiruvannamalai	V5	0.24 ± 0.03^{a}	0.23 ± 0.01^{a}	0.57^{NS}	0.30 ± 0.01^{b}	0.33 ± 0.01^{bc}	2.32^{*}	0.32 ± 0.01^{bc}	0.36 ± 0.01^{b}	2.99^{*}
		V6	0.27 ± 0.01^{ab}	0.26 ± 0.01^{abc}	0.32^{NS}	0.33 ± 0.01^{c}	0.35 ± 0.01^{c}	2.25^{*}	0.34 ± 0.01^{d}	0.37 ± 0.01^{b}	2.33^{*}
	Vellore	V7	0.23 ± 0.02^{a}	0.25 ± 0.01^{ab}	0.55^{NS}	0.25 ± 0.01^{a}	0.27 ± 0.01^{a}	2.37^{*}	0.29 ± 0.01^{a}	0.32 ± 0.01^{a}	3.31^{**}
		V8	0.25 ± 0.01^{a}	0.27 ± 0.01^{abcd}	0.94^{NS}	0.26 ± 0.01^{a}	0.28 ± 0.01^{a}	2.37^{*}	0.30 ± 0.01^{ab}	0.33 ± 0.01^{a}	3.16^{*}
		F value	2.54^{*}	4.02^{**}		34.70^{**}	7.45^{**}		31.25^{**}	19.46^{**}	

Means bearing same superscripts within columns do not differ significantly NS – Non Significant * - Significant (P<0.05)** - Highly Significant

($P<0.01$) The increase in SOC might be due to the growth of plants which generally sequesters atmospheric CO_2 in to plants and in turn return of the organic carbon in to the soil (Ghosh *et al.,* 2006). The application of chemical fertilizer increased the soil organic carbon and addition of well decomposed farm yard manure (organic manure) significantly increased the Soil Organic Carbon level to a greater extent (Gong *et al.,* 2009). The increase in SOC could be attributed with its application the soil organic matter (SOM) accumulation and biological activity would have increased due to the increased plant biomass and organic matter returns to soil in the form of decaying roots, litter and crop residues. Moreover, addition of soil organic matter enhanced soil organic carbon content, which is an important indicator of soil quality and crop productivity (Hati *et al.,* 2007; Kundu *et al.,* 2001). Also application of organic manures to soil widens the C: N ratio, while additions of inorganic fertilizers to soil quickly narrow down the C: N ratio and hastens the process of decomposition. (Thind *et al.,* 2002). The root biomass along with farm yard manure acted as a source of organic matter, which contributed towards enhancing soil organic carbon content (Purakayastha *et al.,* 2008). The increase of SOC was in agreement with the findings of Okpefa *et al.,* (2010) who conducted a field experiment on growth and yield of cowpea under different mulch materials and observed that the soil organic carbon increased from initial values of 14.50 g/kg to 15.80 g/kg for cassava peels, 15.90 g/kg for cocoa pod husk and 18.50 g/kg for empty fruit brunch at harvest. Also, the increase of SOC in fodder cow pea at 60th day could be due to dropping of crop residues especially the leaves at maturity have added organic matter to the soil and increased the soil organic carbon. This was in agreement with the findings of Amba *et al.,* (2011). Moreover, the increase in SOC might be due to the growth of plants which sequesters atmospheric CO_2 in to plants and return of the organic carbon in to the soil. This was in agreement with the findings of Ghosh *et al.,* (2006). The application of chemical fertilizer increased the soil organic carbon and addition of well decomposed farm yard manure (organic manure) significantly increased the Soil Organic Carbon level to a greater extent (Gong *et al.,* 2009). Plants take carbon di-oxide from the atmosphere and through photosynthesis the energy was trapped in organic molecules and used by the plants themselves. Hence, by this process a number of organic substances are stored temporarily as constituents of standing vegetation and most of which would have eventually added to the soil as plant organic litter and then to the soil as SOC by microbial activity (Ramachandran *et al.,* 2007).

It could be observed that the soil organic carbon was significantly ($P < 0.05$ or 0.01) higher for T2 compared with T1 throughout the trial period from 30th day to 60th day. Inorganic fertilizers increased the soil organic carbon due to growth of plants (Zewdu *et al.,* 2002) and in particular addition of well decomposed farm yard manure (organic manure) significantly increased the soil organic carbon level to a greater extent (Gong *et al.,* 2009). The application of farm yard manure along with recommended doses of NPK fertilizer would have reduced the bulk density of the soil, increased the soil organic carbon content, hydraulic conductivity and infiltration rate thereby improving the soil structure. This was in accordance with the findings of Katyal *et al.,* (1997). Also, the addition of organic matter through farmyard manure would have enhanced the crop growth concomitantly with higher root biomass production and in turn increased the soil organic carbon content (Benbi *et al.,* 1998). Combined application of organic manure and inorganic fertilizers would have increased the activity of soil invertase and available nutrient content and in turn increased the Soil Organic Carbon (He and Li., 2004).

Application of chemical fertilizer also increased the soil organic carbon and addition of well decomposed farm yard manure (organic manure) significantly increased the soil C_{Org} level to a greater extent (Ghosh *et al.,* 2006; Gong *et al.,* 2009). The soil organic carbon was significantly ($P < 0.05$ or 0.01) higher in T2 compared with T1 throughout the trial period. Farm yard manure along with inorganic fertilizer had a significant effect ($P \leq 0.01$ or 0.05) in increasing soil organic carbon than individual inorganic fertilizer application in all the villages on 30^{th} and 60^{th} day. The higher amount of soil C_{Org} in T2 was due to addition of carbon through farm yard manure, increased root biomass and crop residues (Kaur *et al.,* 2008). The increased soil C_{Org} in T2 is due to the effect of manure which decomposed slowly and resulted in more accumulation of the carbon. The high lignin content of the organic manure has contributed to the higher soil C_{Org} content (Pathak *et al.,* 2011).

Soil Carbon Sequestration Potential (CSP) in Fodder Cowpea compared with control

The Soil Carbon Sequestration Potential (t/ha) in Fodder Cowpea compared with control revealed (Table 3) that there was a steady increase in soil carbon sequestration potential from 30^{th} day to 60^{th} day with plant growth. The soil CSP varied from 0.62 t/ha to 0.99 t/ha at harvest stage (60^{th} day) with corresponding cumulative CSP varying between 1.01 t/ha to 1.81 t/ha for all the villages. The cumulative CSP values were higher for V3 followed by V4, V2, V1, V6, V5, V8 and V7 in the descending order of magnitude within zones.

The increase of CSP was due to biomass of root and rhizodeposition of Fodder Cowpea which contributed more of C input in to the soil and application of organic matter through FYM resulted in improved physico chemical and biological environment suitable for crop growth which ultimately helps in sequestering atmospheric CO_2. This was in accordance with the findings of Ghosh *et al.,* (2006).

Table – 3 Soil Carbon Sequestration Potential (t / ha) in Fodder Cowpea compared with control in Western and North Eastern zone of Tamil Nadu

Zone	District	Villages	Fodder Cowpea (t / ha) (compared with control)		
			30^{th} day	60^{th} day	Cumulative CSP
Western	Coimbatore	V1	0.65^{x}	0.75^{y}	1.40^{z}
		V2	0.68^{x}	0.78^{y}	1.46^{z}
	Erode	V3	0.82^{x}	0.99^{y}	1.81^{z}
		V4	0.72^{x}	0.82^{y}	1.53^{z}
North Eastern	Tiruvannamalai	V5	0.50^{x}	0.72^{y}	1.22^{z}
		V6	0.54^{x}	0.75^{y}	1.29^{z}
	Vellore	V7	0.39^{x}	0.62^{y}	1.01^{z}
		V8	0.40^{x}	0.65^{y}	1.05^{z}
		F value	0.11^{NS}	0.17^{NS}	0.23^{NS}

Means bearing same superscripts within columns do not differ significantly NS – Non Significant (P>0.05)

Organic matter application in the form of farm yard manure would have promoted aggregate formation. Polysaccharides, aliphatic and aromatic compounds in the farm yard manure could bind soil particles and create organo-mineral complexes important for flocculating aggregates. In addition, manure was an excellent source of energy and nutrients for soil microorganisms and plant roots which produce extracellular polysaccharides known to flocculate soil mineral particles into aggregates (Sleutel *et al.,* 2006).

The farm yard manure contained polysaccharides, aliphatic and aromatic compounds which could bind soil particles and create organo-mineral complexes important for flocculating aggregates. The higher organic matter present in the soil could have increased soil respiration (Enke Liu *et al*., 2010). Apart from that, higher humification rate constant, direct application of organic matter through farm yard manure would have enhanced the CSP from 30th to 60th day (Bhattacharya *et al.,* 2007). In addition, the increase in soil CSP during the trial period was due to improved physico chemical and biological environment suitable for crop growth resulting in more addition of root biomass carbon in to the soil. Increased levels of long term stabilized humic material in organically amended plots and high content of soil carbohydrates in fertilized and farm yard manure treated plots would have played a crucial role in building SOC content. This was in agreement with the findings of Kaur *et al.,* (2008) who studied the maize-wheat cropping system and observed increasing levels of soil CSP as the plant growth progressed.

As far as villages are concerned, it could be observed that on 60th day the cumulative CSP in Fodder Cowpea (compared with control) was numerically higher in V3 followed by V4, V2, V1, V6, V5, V8 and

V7 in descending order. This might be due to lower temperature and relative humidity observed in V3 than V4, V2, V1, V6, V5, V8 and V7 respectively. SOC content decreased with increase of temperature as observed from the present study, which could have resulted in reduction of soil pH which in turn decreased the soil Cation Exchange Capacity (CEC). This was in agreement with the findings of Fissore *et al.,* (2008) who stated that combination of lower pH and CEC at high mean monthly temperature reduced the SOC. Moreover, SOC increased with rainfall and decreased with increase in mean annual temperature (Lal, 2004). CSP conversion rate was significantly correlated with annual precipitation and active accumulative temperature indicating higher conversion rate under lower precipitation and temperature conditions (Zhang *et al.*, 2010).

The results of the study concluded that use of inorganic fertilizers alone or synergistically with organic fertilizers resulted in significant buildup of soil organic carbon in fodder cowpea treated plots. Also the farm yard manure helped in significantly increasing the soil organic carbon of the fodder cowpea test crop which in turn could achieve higher carbon sequestration potential with a beneficial effect on carbon mitigation.

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Factors influencing economic losses due to ketosis in dairy farms

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ABSTRACT

Ketosis is the common disease and one among the important metabolic disorder in lactating dairy animals. It is a condition marked by increased levels of circulating ketone bodies with or without the presence of the clinical signs. It causes severe economic losses through reduction in milk yield. For the study, 30 ketosis affected dairy animals (both cows and buffaloes) were selected through multistage random sampling technique from Namakkal and Karur districts of Tamil Nadu. Data were collected from the respondent farmers through personal interviews, using pretested interview schedule. A multiple linear regression function model was fitted to study the factors influencing economic loss due to ketosis in dairy farms. The estimated regression coefficient of three variables viz., order of lactation, season summer and number of days illness included to explain the variations in the losses due to ketosis were found to be significant at one per cent level (P≤0.01) and the other factors such as season winter and milk yield were found to be significant at five per cent level (P≤0.05).

The coefficient of order of lactation was 62.811 which implied that the economic losses due to ketosis would increase by Rs.62.81 as the order of lactation increases by one unit from its mean value.

Key Words: Ketosis, Metabolic diseases and multiple linear function

INTRODUCTION

The livestock sector particularly dairy farming plays a significant role in securing the livelihood of rural farmers by providing income and employment generation in rural areas. However, this sector is facing several disease problems due to introduction of exotic germ plasm for higher productivity and changing global climate which cause huge economic loss resulting from mortality and low productivity of animals (Singh and Shivprasad, 2008).

Livestock diseases particularly metabolic disorders in dairy animals causes reduction in production efficiency leading to severe economic losses (John Christy and Thirunavukkarasu, 2006). Among metabolic diseases, ketosis is the common disease in lactating dairy animals (Kaneene and Scott, 1990 and Thirunavukkarasu *et al.*, 2010). Ketosis is marked by increased levels of circulating ketone bodies without the presence of the clinical signs, causing severe economic losses in terms of heavy reduction in milk yield and impaired

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reproductive performance (Ardavan Nowroozi *et al.*, 2011). Analyzing the various causative factors involved in ketosis is important to help in understanding the effective management and prevention of this disease, which can aid in losses to be avoided in dairy farming. Keeping the above facts in view, this study was conducted in Karur and Namakkal districts of Tamil Nadu State.

MATERIALS AND METHODS

For the study, 30 ketosis affected female bovines were selected through multistage random sampling technique from Namakkal and Karur districts, five animals from each block. Affected dairy animals were identified by case registers of veterinary dispensaries and clinics of Veterinary College and Research Institute, Namakkal and practicing private veterinary doctors in both districts. This study is based on the primary data collected through personal interviews with the farmers using pre tested interview schedule. The data collected from the sample respondents included information on size of animal holdings, breed, parity, stage of lactation, frequency of occurrence, stage of calving, feeding practices, number of days illness, system of rearing, milk yield, season of disease occurrence and production losses were also collected.

A multiple linear regression function of the following form was fitted to study the factors influencing economic loss due to ketosis in dairy farms.

$$Y_j=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+U_j$$

Where, Y_j = Per animal annual economic loss due to metabolic diseases (Ketosis)

(j = ketosis)

a, b_i = Coefficients to be estimated

U_j = Error term

The description of variables used in multiple linear regression analysis for ketosis in dairy animals is presented in Table 1. Based on the principles of ANOVA, linear regression models (Rothamsted Experimental Station, UK, 31.12.1995) were fitted for assessing (Y) the contribution of different factors to the economic loss arising due to ketosis in dairy animals. (a)

Table 1. Description of variables used in Multiple Linear Regression analysis for Ketosis in dairy animals

Explanatory variables	Levels	Specifications	X_i
Stage of lactation [a]	Early stage; Mid stage; Late stage	1-if Mid; 0-Otherwise	X_1
		1-if Late; 0-Otherwise	X_2
Breed	Non-descript; Crossbred cow / Graded buffalo	1-Crossbred Cow/ Graded Buffalo; 0-Otherwise	X_3
Parity (Order of lactation)	Continuous	In number of calving	X_4
Season [b]	Summer; Winter; Monsoon	1-if Summer; 0-Otherwise	X_5
		1-if Winter; 0-Otherwise	X_6
Number of days illness	Continuous	In number of days ill	X_7
Average daily milk yield	Continuous	Litres per day	X_8
Species of dairy animal	Cow; Buffalo	1-if Cow; 0-Otherwise	X_9

[a] *reference category: Early lactation* ; [b] *reference category: monsoon.*

RESULTS AND DISCUSSION

Based on the results of ANOVA, linear regression models were fitted for ketosis to assess the contribution of different factors to the economic loss arising due to ketosis in dairy animals and the results are presented in Table 2.

Table 2. Regression Coefficients of Linear models fitted to analyse the factors influencing Ketosis in dairy animals (Dependent variable: Ketosis in dairy animals)

Variables	Coefficients
Constant	561.745 (53.861)
Breed	2.024 (25.921)
Order of lactation	62.811** (8,648)
Stage of lactation 2	44.843 (23.533)
Stage of lactation 3	32.158 (24.055)
Milk yield	4.938* (2.363)
Season summer	-110.221** (23.362)
Season winter	-72.912* (27.863)
Number of days illness	80.716** (22.163)
Species	4.855 (20.062)
Coefficient of multiple determination (adjusted R^2)	0.851
F statistic	19.389
N	30

** - Significant at five per cent level (P≤0.05)*
** *- Significant at one per cent level (P≤0.01)*
(figures in parentheses indicate standard errors) (d)

The coefficient of multiple determination (adjusted R^2) in the model fitted for ketosis was 0.851 which implied that the model was a good fit. About 85.10 per cent of the variation in the dependent variable, i.e., economic losses due to ketosis might have been explained by the chosen independent variables. The 'F' statistic also showed that the fitted regression model was founded to be significant.

The estimated regression coefficient of three variables viz., order of lactation, season summer and number of days illness included to explain the variations in the losses due to ketosis were found to be significant at one per cent level (P≤0.01) and the other factors such as season winter and milk yield were found to be significant at five per cent level (P≤0.05). The coefficient of average daily milk yield per animal (4.938) indicated that the economic loss due to ketosis would increase by Rs.4.938 per affected animal as the average daily milk yield of the animal increases by one litre of milk from its mean level. Herdt *et al*. (1981) found higher milk yields put cows at an increased risk of developing subclinical ketosis. Increased milk production might be associated with increased fat mobilization and a greater risk of hyperketonemia (Lean *et al*., 1992). The coefficient of order of lactation was 62.811 which implied that the economic losses due to ketosis would increase by Rs.62.81 as the order of lactation increases by one unit from its mean value. Bendixen *et al*., 1987 and Grohn *et al*., 1989 observed similar scenario and stated that the incidence of ketosis increased with age of cattle and the peak incidence might be in lactation number from third to six. The coefficient of duration of illness (80.716) indicated that as the duration of illness extends by one day from its mean level, the economic losses are liable to increase by Rs.80.716. The variables of summer and winter seasons dummy were found to be significant and negative, which implied that they had inverse relationship with the economic loss when compared to the monsoon season. This may be due to farmer taking extra care to feed greens to dairy animals by purchasing outside source and feeding mineral mixture to overcome heat stress especially during summer, hence these seasons having negative influence.(b)

CONCLUSIONS

The results of this study, as it analyzing the factors involved in ketosis in dairy farms, will aid the researchers, planners and policy makers to design suitable policy decisions and appropriate preventive measures to combat this disease. Creating awareness about the important of this disease and nutritive values of various commonly used feed ingredients at field level through extension programmes to minimize this disease loss. Disseminating knowledge about the clinical signs of this disease to take early measures to avoid heavy economic loss during and after the course of the disease. These metabolic diseases are common problem in early lactation. Hence, the farmers advised to go for dry cow management and monitoring programmes during the first few weeks of lactation to avoid metabolic diseases. (c)

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Technical efficiency of chicken layer farms in Tamil Nadu

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ABSTRACT

The study intended to examine the technical efficiency of poultry layer farms in Namakkal district of Tamil Nadu. Purposive sampling was followed for the selection of study area and sample respondents. Ninety layer farmers were contacted for the study. Stochastic Frontier Production function model was used to assess the technical efficiency of layer farms. The variables such as flock size, feed intake, labourers employed were found to be significantly influencing the egg production across the group I and II. Poultry farmers could be able to increase the efficiency of the farm by 79 per cent given the current level of technology. Both the size of the farms were technically efficient, however, larger farms (group II) were more efficient than small farms. Farmers' age, experience and credit access were the most important determinants which would reduce the poultry farmer's technical inefficiency. The study suggested that periodical training may be given to the layer farmers by veterinary colleges or KVKs for effective utilization of feed and other inputs to enhance the technical efficiency of farmers.

Moreover, Poultry insurance scheme may be insisted among the farmers to reduce losses and strengthening of research and development on feed for provision of a least-cost combination of inputs to the layer farmers by the veterinary universities may be done reduce the technical inefficiency.

Key Words: Poultry layers, technical efficiency, Stochastic Production function

INTRODUCTION

The global egg production was 800.9 billion in 2017. China is the largest egg producing country in the world; it accounts 39.13 per cent of total egg production, followed by USA (7.82 per cent), India (6.06 per cent), Mexico (3.46 per cent) and Brazil (3.17 per cent). The global egg production is expected to increase by 24 per cent in 2025. World per capita consumption of eggs increased from 4.55 kg in 1961 to 10.12 kg in 2017 (FAO STAT, 2017).Indian poultry industry is one of the fastest growing segments of the agricultural sector in India. The annual per capita availability of eggs in the country has increased from 5 eggs per annum in 1950-51 to 69 eggs per annum in 2016-17 (INDIA STAT, 2017). Annual growth rate of egg production was increased from 4.63 per cent in 1950 to 5.75 per cent in 2016(India stat, 2017). Tamil Nadu ranks the first and accounts for 16.15 billion (18.9

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per cent), followed by Andhra Pradesh (18 per cent) and Telangana (13.4 per cent) of the total production in the country. Namakkal is the largest egg producing place in Tamil Nadu, accounts for 77.83 per cent during 2016-17 (Department of Animal Husbandry and Veterinary Services). The annual growth rate of egg production was 3.5 per cent in Tamil Nadu during 2016-17. Per capita availability of egg was 237 eggs per annum in Tamil Nadu during 2016-17 (Tamil Nadu State, 2017)). Namakkal is the biggest exporter of eggs, especially to the Gulf region.

Poultry is an income intense enterprise and provides more or less a regular flow of income throughout the year. But despite of all, poultry farming is considered as a risky enterprise. The main reasons are increasing the cost of production due to higher inputs cost , low price of eggs due to inefficient marketing system, high mortality of birds and lack of adequate knowledge and incapability of the farmers to make egg production an economically viable business proposition. Currently, poultry sector is facing a number of problems such as high cost of feed (Adepoju, 2008), persistent outbreak of disease Anja and Temkatu (2016) and Praveena and Bojiraj (2017) and inability of the marketing system to meet the demand of the poultry producers. The monopoly control of the market by middlemen coupled with un-remunerative prices for eggs has further worsened the situation. These problems seem to occur frequently among the poultry farmers in Tamil Nadu when compared to other parts of the country. Despite these problems, the majority of poultry farmers in Namakkal district of Tamil Nadu continue to operate in the poultry industry. They are exploring all the avenues for expanding the poultry enterprise to minimize the risks. They are hesitant to leave the industry in view of the lack of an alternative source of income. Poultry enterprise offers both incentives for investors and at the same time pose a risk of economics losses to the farmers. This paper aims to analyze the technically efficiency of poultry farms in Namakkal district of Tamil Nadu.

MATERIALS AND METHODS

Sampling

Namakkal district was purposively selected for the study because of its largest egg production capacity in the state (77.83 per cent), Namakkal block (38 per cent) and Mohanur block (15 per cent) were purposively selected, 10 revenue villages in Namakkal block and 5 revenue villages in Mohanur block were selected. Finally, from each village, six farmers those who registered in Tamil Nadu Poultry Farmers Association, Namakkal were randomly selected to tune of 90 as total sample size. The post stratification of selected sample farms were categorized into two groups viz., Group I (below 50000 birds) and Group II (above 50000 birds) for further analysis.

Data Collection

The primary data was collected through personal interview method using well-structured interview schedule considering socio-economic features of poultry layer farmers in the study area. The required information was collected from sample poultry farmers which includes age, family size, education status, cropping pattern, flock size, capital invested, quantity of inputs used and their value, experience in layer farming, details on cost and returns, marketing practices, constraints in production and marketing of eggs, etc. The primary data was related to the agriculture year 2017-18.

Tools of Analysis

Estimation of Technical Efficiency

Technical efficiency is the ratio of output to input which represents the ability of a farm to produce maximal output from the given resources available in the farm. The linearized Cobb - Douglas form of the Stochastic Production Frontier was used to analyze the technical efficiency of layer farms which is represented in Equation (1).;

$$\ln Y = a_0 + a_1 \ln FS + a_2 \ln FQ + a_3 \ln LAB + a_4 \ln VMC + Vi - Ui \text{ -------- } (1)$$

Where,

Y = Production of eggs (kg)

FS = Flock Size (Nos.)

FQ = Feed Quantity (kg)

LAB = Labour (Man-days)

VMC = Vaccine and Medicine Cost (Rs.)

ln = Natural logarithm

a_0 = intercept

a_1 to a_4 = parameters to be estimated

Vi-Ui = e = error term

Technical inefficiency model

Some of the socio-economic characters of the sample farmers were added into the frontier function, assumes those factors are directly affecting the inefficiency of production. The efficiency function is specified as

$$R = \sigma_0 + \sigma_1 AGE + \sigma_2 EDU + \sigma_3 HHS + \sigma_4 EXP + \sigma_5 TRA + \sigma_6 CRE + e$$

Where,

R = Technical Inefficiency (Score value)

AGE = Age of household head (Years)

EDU = Educational dummy variable indicating 1 if educated, 0 otherwise

HHS = Household size (Nos.)

EXP = Experience in poultry farming (Years)

TRA = Training dummy variable 1 if attended training, 0 otherwise

CRE = Credit availed from banks 1 if Yes, 0 otherwise

σ_0 = intercept

σ_1 to σ_6 = parameters to be estimated

e = error term

The technical efficiency of layer farms and the factors determining technical inefficiencies were assessed for group I and group II farms, separately. The frontier analysis was estimated using STATA 11 econometric tool.

RESULTS AND DISCUSSION

The sample layer farms contacted for the study in Namakkal district was 90 which were classified into two groups viz., the group I (below 50,000 birds) and the group II (above 50,000 birds). Of the sample layer farms (Table 1), nearly 64 per cent of them were having less than 50000 birds (Group I) and around 36 per cent of them were having more than 50000 birds (Group II) with an average number of 25260 and 125656 layer birds per farm, respectively which is five times higher than group I. The average number of birds per batch in layer stage in group I and group II were 10129 and 25491. Overall, the average layer birds' capacity of the farm was 1.51 lakh whereas the average number of birds in the laying stage was 35260.

Table 1. Classification of Sample Layer Farms

Layer Farm Size	No. of Farms	Farm Size	Mean Layers (Nos.)
Group I (Below 50,000 birds)	58 (64.44)	25620.69	10129
Group II (Above 50,000 birds)	32(35.56)	125656.25	25491
Total	90(100.00)	151276.94	35620

(Figures in the parenthesis indicate per cent to the total farms)

Table 2 revealed that the average age was 51 years. Majority of the sample poultry growers were educated up to the secondary school education (57 per cent in group-I farms and 53 per cent in group II farms). Overall, 27 per cent of them were graduated. The average family size of the sample farm households was 4.0.The average experience of the sample farmers in poultry layer farmers was 15 years.

Table 2. Profile of Sample Layer Farmers

Particulars	Group I	Group I	Overall
Average Age (Yrs)	50	52	51
Education			
Illiterate	7 (12.07)	8 (25.00)	15 (16.67)
Primary	24 (41.38)	9 (28.13)	33 (36.66)
Secondary	10 (17.24)	8 (25.00)	18 (20.00)
Graduate	17 (29.31)	7 (21.87)	24 (26.67)
Average Family Size (Nos.)	3.95	3.97	4.00
Experience in Poultry farming (Yrs)	13	14	15

(Figures in the parenthesis indicate per cent to the total)

Table 3 revealed that the majority of sample farmers belonged to the medium farmers (49 per cent), followed by large farmers (34 per cent) and small farmers (13.33 per cent). The average size of land holding of the sample farmers was 3.52 ha.

Table 3. Operational Landholding of Sample Farm Households

Particulars	Group I	Group I	Overall
Marginal farmer (< 1 ha)	6(10.34)	3(09.38)	9 (3.33)
Small farmer (1 to 2 ha)	8(13.79)	4(12.50)	12(13.33)
Medium farmer (2 to 4 ha)	34(58.62)	18(56.25)	52(48.89)
Large farmer (> 4 ha)	10(17.24)	7(21.88)	17(34.44)
Average Farm Size	3.40	2.85	3.52

(Figures in the parenthesis indicate per cent to the total)

It was observed that (Table 4), the most of the farmers were employed both in poultry and farming around 94.83 per cent in the group-I and 81.25 per cent in the group-II farms. As a whole, 90 per cent of the sample farmers engaged in farming along with poultry.

Table 4. Employment status of the farmer

Particulars	Group I	Group I	Overall
Poultry alone	3(5.17)	6(18.75)	9(10.00)
Poultry and Farming	55(94.83)	26(81.25)	81(90.00)
Total	**58**	**32**	**90**

(Figures in the parenthesis indicate per cent to the total)

The Cobb Douglas Stochastic frontier production function (SFPF) was used to analyze the technical efficiency of layer farms and to identify the determinants of technical efficiency of layer farms. The results are presented in Table 5. In the stochastic frontier production function, the variables such as (1) stock size (Numbers), (2) feed quantity (kg), (3) labour used (Man-days) and (4) vaccine and medicine cost (Rs.) were used to assess the technical efficiency of farms in terms of production of eggs. The results revealed that the coefficient of flock size in group- I farms was positive and significant at one per cent level, which indicates that for every one percent increase in flock size will increase the output by 0.32 per cent. Whereas in group II farms, flock size and feed intake were positively significant at one per cent level of probability. The result clearly shows that the coefficient of feed was positively significant, representing that an increase in feed intake by one per cent will increase their output by 0.12 per cent. Similarly, flock size was positively significant, indicating that an increase in flock size by one per cent will lead to an increase in the output of layers by 1.01 per cent. The results are accepted with other studies such as Sarker *et al.,* (1999) and Ajibefun (2000). The results and positive sign fulfilled the priori expectations. Increase in flock size means using more outputs efficiently and get higher output under good management. Medication cost was negative indicating that expenses on medication reduce the output of layers.

Table 5. Maximum Likelihood Estimates of Stochastic Frontier Production Function of Layer Farms

Variables	Group I		Group II		Overall	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Production Model						
Constant	9.87**	10.24	1.09***	5.29	3.56***	5.68
Flock size (Nos.)	0.32***	4.95	1.01***	2.58	0.36***	6.21
Feed Quantity(Kgs)	0.054	1.29	0.12***	2.34	0.19***	2.89
Labour (Man-Days)	0.077	1.22	0.03	0.25	0.06***	2.24
Cost of Vaccine & Medicine (Rs.)	0.049	1.01	-0.02	-1.18	-0.01	-0.53

*** = Significant at 1 % level; ** = Significant at 5 % level

In overall farms, the estimated coefficients of flock size, feed intake and labour was positive and found to be significant at one per cent level of probability. It indicates that an increase in flock size by one per cent would increase the output by 0.36 per cent. In the same way, increase in feed intake by one per cent productivity would increase by 0.19 per cent. As in the case of labour use, an increase in one labour man-days by one per cent will increase the output by 0.06 per cent. The coefficient of cost of vaccine and medicine was negative and insignificant.

Distribution of technical efficiency among the two groups of farms (Table 6) shows that majority (37.93 per cent) of the group I sample farmers were working at a technical efficiency ranges between 0.61 to 0.70 whereas, in Group II, the most of the farmers (31.25 per cent) were operating at 0.41 to 0.50 level of technical efficiency. The mean technical efficiency of group I and group II farms were 0.66 and 0.83 per cent.

Table 6. Distribution of technical Efficiency of Poultry Farmers

Efficiency Score	Group I		Group II		Overall	
	Nos.	Per cent	Nos.	Per cent	Nos.	Per cent
0.21-0.30	5	8.62	0	0	7	7.78
0.31-0.40	6	10.34	3	9.38	11	12.22
0.41-0.50	12	20.69	10	**31.25**	19	21.11
0.51-0.60	13	22.41	2	6.25	26	**28.89**
0.61-0.70	22	**37.93**	7	21.88	20	22.22
0.71-0.80	…	…	6	18.75	4	4.44
0.81-0.90	…	…	4	12.50	3	3.33
Total	58	100.00	32	100.00	90	100.00
Maximum	0.74		0.85		0.97	
Minimum	0.25		0.34		0.29	
Mean TE	0.66		0.83		0.79	
Mean TI	0.34		0.17		0.21	

In overall farms, 29 per cent of the farmers fall in the range of 0.51 to 0.60. The mean technical efficiency of 0.79 per cent implies that the poultry farmers could be able to increase the efficiency by 79 per cent given the current level of technology if the available resources are efficiently utilized and they could increase their output when efficient use of inputs by 21 per cent. Therefore, vast opportunities still exist for increasing productivity. This result matches with Ohajianya *et al.*, (2013), shows that the individual technical efficiency indices range between 16.23 per cent and 94.17 per cent with a mean technical efficiency of 62 per cent.

The MLE estimates of stochastic frontier production function were used to assess the determinants of technical inefficiency among the farmers in the study area and the results show that the variance factors such as sigma square (σ^2) and gamma (□) were estimated to be statistically significant at 1 per cent level in group I, group II and overall farms.

Table 7. Factors contributing to Technical Inefficiency

Variables	Group I		Group II		Overall	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Inefficiency model						
Constant	3.54***	0.15	0.92***	2.89	1.04***	8.67
Age (Yrs)	-0.56	-0.11	0.01	0.07	-0.01***	-5.62
Education (1 for aboveprimary; 0 otherwise	0.16	0.02	-0.03	-1.05	-0.001	-0.44
Experience (Yrs)	0.17***	9.57	-0.04	-1.02	-0.01***	-2.18
Family Size (Nos.)	-0.37	-1.23	-0.16	-0.66	0.002	1.28
Formal Training (Yes=1;No=0)	0.29	0.32	-3.42	0.08	0.54	0.98
Access to credit (Yes=1;No=0)	-0.49***	2.21	0.02**	1.98	-0.062***	3.98
Variance						
Sigma square (σ^2)	1.112***	2.28	0.001***	3.18	0.005***	4.52
Gamma (γ)	0.78***	2.02	0.75***	4.48	0.6***	3.12

*** = Significant at 1 % level; ** = Significant at 5 % level

Table 7 indicated that the sigma square and gamma were estimated to be 0.005 and 0.6, respectively, and are significant at one per cent level. The sigma square is the systematic component which captures variations in output due to exogenous random shock and measurement error. The sigma square (0.60) is the one sided error which specifies the effect of variation in output due to inefficiency in the production function i.e. 60% of shortfall below the frontier output was due to the technical inefficiency of the farmers.

In group I farms, experience and credit access were significant which affect farmer's efficiency. Also shows that poultry farming experience is positively related to technical efficiency, thereby increasing efficiency. A farmer having higher experience in poultry farming will be more efficient in taking his decisions also he is willing to adopt a better practice of technologies. Whereas, access to credit was negative but significant in influencing the technical efficiency, which implies that if a farmer has access to credit for poultry business it will influence the egg production. The farmers who availed the credit was very less because the farmers in group I farms are small scale poultry farmers and they may not have enough collateral to avail loan from banks and also it involves less investment rather than group II farms. The result is matching with that of Okike (2000) who found a negative relationship between credit and technical efficiency of poultry farms in northern Nigeria. Though, it differs with Ohajianya *et al.,* (2013) they found that access to credit is significant and positively related to technical efficiency. Whereas in group II farms, access to credit (i.e) who availed loan was positively significant at one per cent level which means that availing credit from financial institutions had significant influence on egg production. In overall farms, coefficient of farmers' age, experience in layer farming and access to credit were negative and significant, implies that these factors led to a decrease in technical inefficiency.

CONCLUSION

Based on the results of the study, it is inferred that the variables such as flock size, feed intake, labourers employed were significantly influencing the egg production across group I and II. Poultry farmers could be able to increase the efficiency of farm by 79 per cent given the current level of technology. Both the size of the farms were technically efficient, however, larger farms (group II) were efficient than small farms. The study proves that the 'null hypothesis of different layer farm sizes are technically efficient' can be accepted. Farmers' age, experience and credit access were the most important determinants which would reduce the poultry farmer's technical inefficiency. The study suggested that the periodical trainings may be given to the layer farmers by veterinary colleges or KVKs for effective utilization of feed and other inputs to enhance the technical efficiency of farmers. Moreover, Poultry insurance scheme may be insisted among the farmers to reduce losses and strengthening of research and development on feed for provision of least-cost combination of inputs to the layer farmers by the veterinary universities may be done to reduce the technical inefficiency.

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Comparative morphological and morphometrical studies on the kidney in broiler chicken and broiler duck

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ABSTRACT

The present study was conducted on the kidneys of six each of adult broiler chicken and broiler ducks. The colour of kidney in chicken was reddish brown while in duck it was slightly greyish. In both broiler chicken and broiler duck, each kidney was incompletely divided into three lobes; cranial, middle and caudal of which caudal lobes were the largest. The shapes of kidney lobes in broiler chicken and duck showed some differences. The kidneys of broiler duck were larger than that of broiler chicken. Length of three lobes on both sides in chicken showed significant difference (P<0.01) while in broiler duck, there was no significant difference in the length of cranial and middle lobes. But, the length of both these lobes differed significantly from that of the caudal lobe (P<0.01).

Total weight of kidney as well as total weight of right and left kidneys in chicken showed significant correlation with the body weight at 0.05 percent level while these parameters in ducks showed a significant correlation with the body weight at 0.01 percent level. Except in the case of the width, all other parameters like length, width, thickness and weight of right and left kidneys in chicken and duck showed significant difference at 1 percent level.

Key Words: Kidney, Lobes, Morphology, Morphometry.

INTRODUCTION

Poultry industry in India that includes chicken, duck, Japanese quail, turkey and guinea fowl farming is regarded as the fastest growing agricultural sector. India has made considerable progress in broiler production in the last two decades and ranks as fifth largest producer of poultry broiler in the world. Broiler farming has been given considerable importance in the national policy and has a good scope for further development in the years to come.

In birds the homeostasis of fluid and ions needs the proper functioning of several organ systems and is a more complex phenomenon than in other vertebrates. Kidneys in birds are very important organs that help to maintain water and electrolyte balance. Literature pertaining to the comparative gross anatomical features of kidney in broiler chicken and ducks are scanty. Hence, the present study was undertaken.

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MATERIALS AND METHODS

The present programme of study was conducted on the kidneys of six each of adult broiler chicken and broiler ducks. The body weight of each bird slaughtered at the Meat Technology Unit, Mannuthy of Kerala Veterinary and Animal Sciences University was recorded using digital weighing balance.

After opening the abdomen of cadavers, topography, colour, shape and relations of kidney with other visceral organs in broiler chicken and broiler duck were studied and were recorded in a digital camera. Kidney samples from the cadavers of broiler chicken and broiler duck were carefully dissected out of the renal fossa. After separating the kidneys, weight of the whole kidney and different lobes of kidney was measured by using an electronic balance. Length, width and thickness of the whole kidney and individual lobes of kidney were measured by using a Vernier caliper.

Statistical analysis of data obtained was done using Statistical Product and Service Solutions Version 24.0. One way ANOVA was performed to test the difference between various parameters within each species and independent t-test was performed to test the difference between various parameters of chicken and duck. Pearson's correlation coefficient was used to find out the relationship between body weight, weight of kidney and various parameters of kidney in chicken and duck.

RESULTS AND DISCUSSION

In the present study it was noticed that the kidneys of broiler chicken and broiler duck were located in the renal fossa on the ventral surface of the pelvic bones as noticed by Nabipour *et al.*, (2009) in rock dove and Abood *et al.*, (2014) in Mallard duck. In male birds, ventral to anterior end of kidneys, testes were seen. Two major branches of abdominal aorta *viz.* external iliac artery and is chiatic arteries crossed the kidney on each side. Each kidney was flattened and elongated and was divided into three lobes *viz.* cranial, middle and caudal similar to the findings of Abood *et al.*, (2014) in the kidneys of Harrier species, chicken and Mallard duck.. The present study revealed that caudal lobe was the largest among the three lobes in both broiler chicken and broiler duck similar to the observations made by Nabipour *et al.*, (2009) who observed that the each kidney from Rock dove**,** collared dove and owl consisted of three divisions *viz.* a large caudal, a small middle and a cranial division somewhat larger than the middle division. Abood *et al.*, (2014) noticed that each kidney of Harrier species, chicken and mallard duck was incompletely divided into three lobes; cranial, middle and caudal of which caudal lobes were the largest.

The present study showed that the kidneys of broiler chicken and duck were morphologically differing in size, shape, and colour (Figs. 1 and 2) similar to the findings of Morild *et al.*, (1985).The kidneys of broiler duck were larger than that of broiler chicken similar to the findings of Abood *et al.*, (2014) who reported that the kidneys of Mallard ducks were larger than that of chicken. In chicken, colour of kidney was reddish brown while in duck it was slightly greyish. The shapes of kidney lobes in broiler chicken and duck showed some differences. In broiler chicken, cranial lobe was oval shaped; middle lobe was elongated while caudal was triangular in shape. In broiler duck, cranial lobe was oval shaped and middle elongated while caudal was the largest in size and round in shape.

Biometric observations of right and left lobes of kidney in broiler chicken are presented in table 1. Length of three lobes on both sides showed differed significantly (P<0.01). There was no significant difference between the width of cranial and caudal lobes on both sides, but the width of both cranial and caudal lobes differed significantly from that of the middle lobe on both sides. Thickness of cranial, middle and caudal lobes of kidney on right side differed significantly (P<0.01) whereas on left side, there was no significant difference in thickness between cranial and caudal lobes, but the thickness of both these lobes differed from that of the middle lobe. There was no significant difference in the weight of cranial and middle lobes on both sides. But, the weight of both these lobes on both sides differed significantly from that of the caudal lobe on both sides.

Table 1.Comparison of right and left cranial, middle and caudal lobes of kidney in chicken, mm (Mean± standard error) (n=6)

Parameters	Cranial	Middle	Caudal	F value
Length of right lobe	1.8 ± 0.0577^{a}	1.4 ± 0.0632^{b}	2.4 ± 0.0632^{c}	67.059^{**}
Width of right lobe	1.233 ± 0.0558^{a}	0.917 ± 0.0477^{b}	1.183 ± 0.0792^{a}	7.452^{**}
Thickness of right lobe	1.15 ± 0.0428^{a}	1.417 ± 0.0654^{b}	0.85 ± 0.0563^{c}	25.988^{**}
Weight of right lobe	0.91 ± 0.01915^{a}	1.0267 ± 0.05619^{a}	2.195 ± 0.10317^{b}	106.915^{**}
Length of left lobe	1.9 ± 0.0365^{a}	1.25 ± 0.0428^{b}	2.217 ± 0.0601^{c}	107.500^{**}
Width of left lobe	1.217 ± 0.0307^{a}	0.967 ± 0.0558^{b}	1.2 ± 0.0683^{a}	6.720^{**}
Thickness of left lobe	0.95 ± 0.0428^{a}	1.35 ± 0.0563^{b}	0.95 ± 0.0428^{a}	23.415^{**}
Weight of left lobe	0.9 ± 0.01366^{a}	1.1067 ± 0.08682^{a}	2.3567 ± 0.08713^{b}	121.677^{**}

*(Means bearing different letters as superscripts differ significantly within a row). (**significant at 1% level, * significant at 5% level, ns-non significant)*

In the case of the right kidney of broiler duck, there was no significant difference in the length of cranial and middle lobes (table 2). But, the length of both these lobes differed significantly from that of the caudal lobe (P<0.01). In the case of left kidney, length of three lobes showed a significant difference at 1% level. The width of cranial and middle lobes of right kidney did not differ significantly but the width of caudal lobe differed significantly from that of cranial and middle lobes (P<0.01). In the case of left kidney, width of all three lobes showed significant difference at 1 percent level. There was no significant difference in the thickness of right cranial and middle lobes. But, the thickness of both these lobes differed significantly from that of the caudal lobe (P<0.01). In the case of left kidney, thickness of three lobes showed a significant difference at 1 percent level. On both sides, weight of all three lobes of kidney differed significantly at 1 percent level. It was observed that except in the case of the width, all other parameters of right and left kidneys in chicken and duck showed significant difference at 1 percent level (table 3).

Table 2.Comparison of right and left cranial, middle and caudal lobes of kidney in duck, mm (Mean± standard error) (n=6).

Parameters	Cranial	Middle	Caudal	F value
Length of right lobe	2.150 ± 0.0428^{a}	2.033 ± 0.0494^{a}	3.383 ± 0.0601^{b}	212.782^{**}
Width of right lobe	0.783 ± 0.0477^{a}	0.833 ± 0.0333^{a}	1.550 ± 0.0428^{b}	105.691^{**}
Thickness of right lobe	0.567 ± 0.0333^{a}	0.617 ± 0.0307^{a}	0.783 ± 0.0307^{b}	12.870^{**}
Weight of right lobe	1.1450 ± 0.0480^{a}	2.0417 ± 0.0969^{b}	2.8150 ± 0.07187^{c}	124.144^{**}
Length of left lobe	2 ± 0.0577^{a}	2.050 ± 0.0671^{b}	3.300 ± 0.0730^{c}	123.608^{**}
Width of left lobe	0.783 ± 0.0307^{a}	0.817 ± 0.0307^{b}	1.650 ± 0.0428^{c}	194.328^{**}
Thickness of left lobe	0.483 ± 0.0477^{a}	0.617 ± 0.0477^{b}	0.833 ± 0.0307^{c}	22.626^{**}
Weight of left lobe	1.1750 ± 0.0450^{a}	2.1083 ± 0.1356^{b}	3.0250 ± 0.0430^{c}	115.216^{**}

*(Means bearing different letters as superscripts differ significantly within a row). (**significant at 1% level, * significant at 5% level, ns-non significant).*

Table 3. Morphometric parameters of right and left kidneys in chicken and duck, mm (Mean± standard deviation) (n=6)

Parameters	Chicken	Duck	t value
Length of right kidney	5.600±0.3406	7.567±0.2875	10.808^{**}
Mean width of right kidney	1.1050±0.12062	1.0533±0.07763	0.882^{ns}
Mean thickness of right kidney	1.1367±0.08406	0.6533±0.04502	12.415^{**}
Weight of right kidney	4.0667±0.37601	6.0033±0.41225	8.502^{**}
Length of left kidney	5.367±0.2733	7.360±0.3146	11.658^{**}
Mean width of left kidney	1.1233±0.08618	1.0817±0.04579	1.046^{ns}
Mean thickness of left kidney	1.0800±0.03633	0.6583±0.08208	11.507^{**}
Weight of left kidney	4.3133±0.20675	6.3083±0.40455	10.756^{**}
Total kidney weight	8.3800±0.54384	12.3117±0.81005	9.87^{**}

*(Independent t test **significant at 1% level, * significant at 5% level, ns-non significant)*

Total weight of kidney as well as the total weight of right and left kidneys in chicken showed significant correlation with the body weight at 0.05 percent level (table 4). Pearson's correlation coefficients (r) of kidney parameters revealed that the total weight of kidney in chicken showed significant correlation with the total weight of right kidney at 0.01% level while the weight of left kidney had 0.05% level significance (table 5). Other parameters of right and left kidneys *viz.* length, width and thickness did not show any correlation with the body weight and weight of kidney.

Table 4.Pearson's correlation coefficients (r) of kidney parameters and body weight in duck and chicken.

Sl. No.	Kidney parameters	Body Weight in duck	Body Weight in chicken
1	Total Kidney weight	0.973**	0.911*
2	Length of right kidney	0.252ns	0.416ns
3	Length of left kidney	0.591ns	0.034ns
4	Mean width of right kidney	0.896*	0.312ns
5	Mean width of left kidney	0.254ns	0.639ns
6	Mean thickness of right kidney	0.617ns	0.701ns
7	Mean thickness of left kidney	0.580ns	0.466ns
8	Weight of right kidney	0.947**	0.886*
9	Weight of left kidney	0.983**	0.784*

*(**Correlation significant at 0.01% level, *Correlation significant at 0.05% level,ns-non significant)*

Total weight of kidney as well as the total weight of right and left kidneys in ducks showed a significant correlation with the body weight at 0.01% level (table 4). Pearson's correlation coefficients (r) of kidney parameters and kidney weight showed that total weight of right and left kidneys had a significant correlation with the total weight of kidney at 0.01% level (table 5).

Table 5.Pearson's correlation coefficients (r) of kidney parameters and weight of kidney in duck and chicken.

Sl. No.	Kidney parameters	Kidney weight in duck	Kidney weight in chicken
1	Length of right kidney	0.225ns	0.657ns
2	Length of left kidney	0.583ns	0.295ns
3	Mean width of right kidney	0.805ns	0.578ns
4	Mean width of left kidney	0.456ns	0.663ns
5	Mean thickness of right kidney	0.559ns	0.635ns
6	Mean thickness of left kidney	0.446ns	0.665ns
7	Weight of right kidney	0.992**	0.964**
8	Weight of left kidney	0.992**	0.877*

*(**Correlation significant at 0.01% level, *Correlation significant at 0.05% level, ns-non significant)*

The findings of present study would provide a baseline data regarding the contribution of various morphological parameters of kidneys in broiler chicken and duck to their body weight and would form a basis for further functional studies.

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Forecasting of milk production in Tamil Nadu: an application of Arima model

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ABSTRACT

A study was made to forecast the milk production in Tamil Nadu, using the milk production data of the State from 1978-79 to 2018-19 and the Auto Regressive Integrated Moving Average (ARIMA) model for estimating future milk production. The autoregressive (p) and moving average (q) parameters were identified based on the significant spikes in the correlogram plots of Partial Auto Correlation Function (PACF) and Auto Correlation Function (ACF) of time series data. The adequacy of the fitted model was verified by the test of significance of residuals using Box-Ljung statistic. The results indicated that ARIMA (0, 1, 0) model was found to be the good model, based on the minimum values of selection criteria, viz., Akaike Information criteria (AIC) and Bayesian Information Criteria (BIC). The results also indicated the non-significance of Box-Ljung statistic and that the residual was normally distributed. Based on the model, the predicted figures of milk production for the next five years will be viz., 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24 are 8529, 8696, 8863, 9030 and 9197 thousand tons in the State, respectively.

Key Words: Milk Production, Tamil Nadu, Forecasting, ARIMA model

INTRODUCTION

Dairy subsector plays a vital role in sustaining rural livelihood in India. Although the per capita availability of milk in Tamil Nadu is currently (2018-19) 322 g per day, greater than the Indian Council of Medical Research (ICMR) recommendation of per capita milk consumption (300 g/day), there is a continuous rise in the demand for milk and milk products, due to the increasing per capita income, changing food consumption pattern and rapid urbanization. Hence, predicting milk production in the future is important for the scientists, planners and administrators to frame suitable policy plans, so as to achieve the supply requirement of milk for the State. Hence, this study was attempted to forecast the milk production in Tamil Nadu for the next five years (2019-20 through 2023-24).

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MATERIALS AND METHODS

Data

To achieve the objective of the study, secondary data on annual milk production in Tamil Nadu relating to the period of four decades (from 1978-79 to 1999-2000) were collected from various reports of Integrated Sample Survey, Directorate of Animal Husbandry and Veterinary Services (Govt. of Tamil Nadu) and National Dairy Development Board (from 2001-02 to 2018-19).

Analytical tools

Annual Compound Growth Rate (ACGR) Analysis

The ACGRs of milk production in Tamil Nadu were estimated by as detailed below:

$$\text{Log } Y_t = \text{Log } Y_0 + t \text{ Log } (1+G)$$

Where, G=Annual Compound Growth Rate, Y_o=Production in base year, Y_t = Production in t^{th} year, t=Time in series (1978-79, 1979-80, ..., 2018-19).

Hence, G= (Antilog (1+r) -1) × 100, r = Regression coefficient.

Auto Regressive Integrated Moving Average (ARIMA) model

Pal *et al.* (2007) and Deshmukh and Paramasivam (2016) had earlier found that ARIMA (1, 1, 1) model was the best model for forecasting milk production in India. Hence, in the present study, forecasting of milk production was done using Auto Regressive Integrated Moving Average (ARIMA p, d, q) model. Box and Jenkins (1976) suggested ARIMA (p, d, q) model for forecasting using a specific time series dataset. Where 'p' is the number of autoregressive terms, 'd' is the number of non-seasonal differences needed for stationarity and 'q' is the number of lagged forecast errors in the prediction equation. The lags of the stationary series in the forecasting equation are called as Auto Regressive (AR) terms and lags of the forecast errors are called as Moving Average (MA) terms. The time series which need to be differenced to be made stationary is said to be an integrated version of a stationary series.

The Box-Jenkins methodology for analyzing and modeling a time series involves following steps of model identification, parameter estimation and model validation:

Auto Regressive Process of order (p) is

$$Y_t = \mu + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \ldots + \phi_p Y_{t-p} + \varepsilon_t$$

Moving Average Process of order (q) is

$$Y_t = \mu - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \ldots - \theta_p \varepsilon_{t-q} + \varepsilon_t$$

The general form of ARIMA model of order (p, d, q) is

$$Y_t = \mu + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \ldots + \phi_p Y_{t-p} + \mu - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \ldots - \theta_p \varepsilon_{t-q} \varepsilon_t$$

where, Y_t - milk production at t^{th} year,

ε_{t-} independently and normally distributed with mean zero and constant variance for t = 1, 2, 3, …, n

ϕ_p and θ_p - coefficients to be estimated

Trend and stationarity of data

The first step in the time series analysis is the trend test for assessing the trend present in the data by using the Mann-Kendall test. The next step in identifying the perfect model is to find out the stationery of data, which is assessed by Augmented

Dickey-Fuller (ADF) Test. If the test statistic is significant, we can conclude that the data set is stationary, otherwise we need to go in for differentiation to make it stationary. In case the data are found to be non-stationary, stationarity is achieved by differencing technique. For instance, the differencing first order is $Y_t - Y_{t-1}$. If the first differences do not convert the series to stationary form, then the second differences can be created. It is called as the second order differencing ($Y_t - Y_{t-2}$). Further, the seasonality of the data series was also checked by the Webel- Ollech (WO) test. If the data series has the linear trend, stationarity and non-seasonality, then the ARIMA model is considered to be the best model for future projection.

Parameter estimation and diagnostic checking

In order to identify the order of Auto Regressiveness for the value 'p' and the order of Moving Average for the value of q', correlograms of PACF and ACF, respectively were examined. According to Tripathi *et al.*, (2014), the parameters 'p' and 'q' were obtained by looking for significant spikes in autocorrelation and partial autocorrelation functions. The lowest value of AIC and BIC were used as selection criteria for identification of the best fit ARIMA model.

AIC = $-2\log L + 2m$, where, $m = p + q$ and L is the likelihood function (Akaike, 1974)

In addition, the lower values of MSE (Mean Square Error) RMSE (Root Mean Square Error) and MAPE (Mean Absolute Percentage Error) also indicated that identified model was the most appropriate model to forecast milk production.

$$\text{MAPE} = \frac{1}{n}\sum\left|\frac{Y_t - F_t}{Y_t}\right| X100$$

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t - F_t)^2}$$

$$\text{BIC} = \ln v\,(p, q) + (p + q)\,[\ln(n)/n]$$

where, Y_t is original milk yield in different years (t),

F_t is the forecasted milk yield in the corresponding years (t),

p is order of autoregressive (AR),

q is order of moving average (MA),

v is the estimate of variance, and

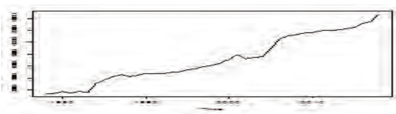
n is the number of observations.

Finally, the model verification is concerned with checking the residuals of the model using Box- Ljunk statistic. If the residuals are normally distributed, it can be concluded that the model is the best fit, otherwise unfit for forecasting. Forecasting for the next five years starting from 2019-20 to 2023-24 was done using the best fit ARIMA model. The 'R' software version 3.6.3 was used for time series data analysis for developing ARIMA models and forecasting of milk production in Tamil Nadu.

RESULTS AND DISCUSSION

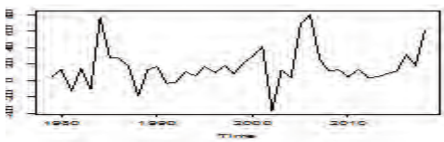
The original series of milk production are represented in Figure 1, which implied that the production showed an increasing trend over the years. Various tests for the presence of trend, stationarity and seasonality of data series were performed and these results are presented in Table 1. The Mann Kendal test for trend analysis was performed to test the significance of the trend. The value of the test statistic showed a significant and positive trend (Table 1). Trend analysis also showed a considerable increase in all the years in milk production in Tamil Nadu from 1681 thousand tons in 1978-79 to 8362 thousand tons in 2018-19. In addition, the overall Annual Compound Growth Rate (ACGR) for the period starting from 1978-79 to 2018-19 for milk production was estimated as 3.97 per cent and presented in Table 4. The highest ACGR (8.48 per cent) was observed during the period 1978-79 to 1987-88. Whereas, the ACGR for the periods 1988-89 to 1997-98, 1998-99 to 2007-08, 2008-09 to 2018-19 were 2.38, 4.83 and 1.90 percentages respectively (Table 4).

Figure 1: Line diagram of original milk production



Estimation of ARIMA model was performed after checking the stationarity of original data series. The most common method to check stationarity is Augmented Dicky Fuller (ADF) test. The ADF test revealed a non-significant test statistic of original data series and concluded that the data were non stationary. Hence, the first order differentiation was performed and made a stationarity of the data. The test statistic of ADF test revealed a significant value and confirmed that first order differenced data were stationary and the line diagram is depicted in Figure 2. Thus, the value of d was fixed as 1 in ARIMA (p, d, q) model.

Figure 2: Line diagram of diffrenced data series



The seasonality of the data series was checked by the WO test. The non-significant test statistic found in WO test confirmed the absence of seasonality (Table 1). Based on the results, it was confirmed that there was a positive trend, stationarity in first order differentiation and non-seasonality of the data series and hence, it was concluded that the usage of ARIMA (p, d, q) model was the best model for projection of milk production in Tamil Nadu.

Table 1. Test of significance for the presence of trend, stationarity and seasonality of data

S. No.	Particulars	Name of the test	Test statistics	P value	Result
1	Test for Trend	Mann- Kendal test	8.92	<0.01	Presence of trend
2.	Test for Stationarity	Augmented Dicky Fuller test (ADF)for original data	-1.72	0.68	Data were non-stationary
		Augmented Dicky Fuller (ADF) test for 1 differenced data (d=1)	-3.85	0.03	Data were stationary
3.	Test for Seasonality	Webel-Ollech (WO) test	0.00	0.59	Absence of seasonality

The next step in ARIMA model was identification of the parameters of p and q. The p and q parameters were identified based on the significant spikes in the plots of PACF and ACF of the different time series. According to Figures 3 and 4, there were no significant spikes found and the value of p and q were fixed as 0, for both the parameters p and q.

Figure 3

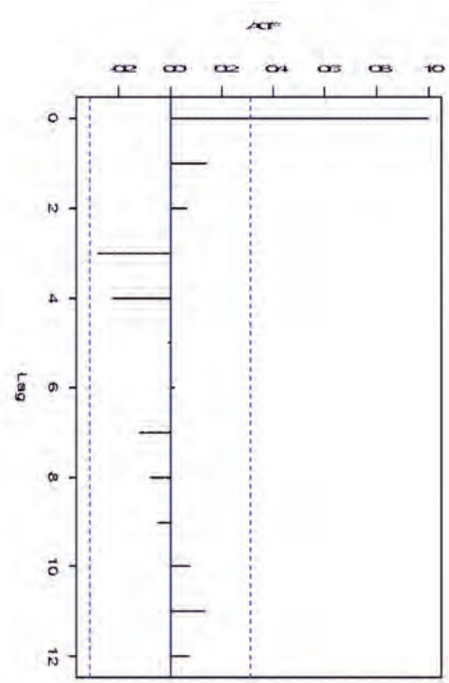
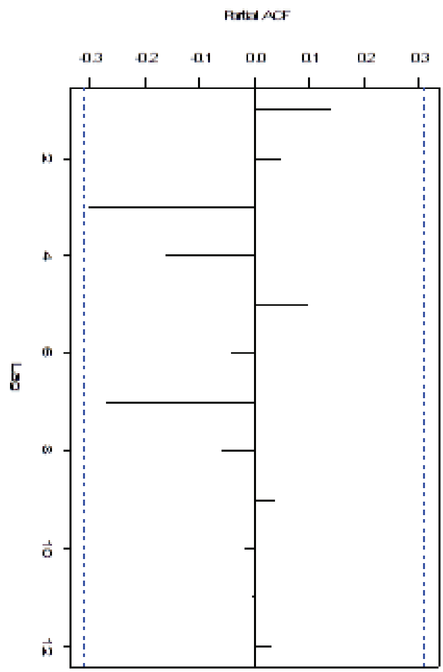


Figure 4



Further, various combinations of ARIMA models were fitted and their AIC and BIC values are presented in Table 2. The model which had minimum AIC and BIC values were chosen as the best fit model. From Table 2, it was observed that the lowest BIC value 556.63 was found in ARIMA (0, 1, 0) model and hence, it was the best fit model for prediction of milk production. Additionally, the auto. arima ( ) function used for data analysis in 'R' software also showed that ARIMA (0, 1, 0) model was the fitted model. Pal *et al.* (2007) and Deshmukh and Paramasivam (2016) found that ARIMA (1,1,1) model was the best fit model for forecasting milk production in India, for the periods 1980-81 to 2004-05 and 1961 to 2012-13, respectively.

Table 2. Goodness of fit statistics of various ARIMA (p, d, q) models

ARIMA (p, d, q)	MSE	RMSE	MAPE	AIC	BIC
ARIMA (1, 0, 0)	9.74	220.39	4.50	567.81	574.67
ARIMA (1, 1, 0)	0.52	226.63	3.91	554.39	559.46
ARIMA (1,1,1)	0.57	226.58	3.90	556.37	563.13
ARIMA (0, 1, 0)	**0.04**	**229.14**	**4.10**	**553.25**	**556.63**
ARIMA (0, 0, 1)	3.78	265.86	5.80	582.71	589.57
ARIMA (1, 0, 1)	8.49	215.98	4.34	568.23	576.80
ARIMA (0, 1, 1)	0.36	227.05	3.93	554.53	559.60

The adequacy of the fit model was verified by the test of significance of residuals tested by Box-Ljung statistic and the estimated parameters are provided in Table 3. As the results indicated non significance of Box-Ljung statistic, it was concluded that the residual was normally distributed. This finding proved that the selected ARIMA (0, 1, 0) model was an appropriate model for forecasting milk production in Tamil Nadu. Based on the best fitted model ARIMA (0, 1, 0), actual and predicted milk production are presented in Table 4 and Figure. According to the figure, the trend lines for actual and predicted milk productions were closer to each other in Tamil Nadu. Hence, by using ARIMA (0, 1, 0) model, the next five years' milk production was forecasted with 95% confidence interval and which is presented in Table 5. As the results indicated, the milk prediction for the years 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24 would be 8529, 8696, 9030 and 9197 thousand tons, respectively.

Table 3. Estimates of the ARIMA model fitted for forecasting milk production in Tamil Nadu

Parameters	Estimates	SE	Log likelihood	Box-Ljung test	
Constant	167.03	36.68	-274.62	16.04	P value= 0.59

Table 4. ACGR, Actual and Predicted Milk Production in Tamil Nadu (in '000' tons)

Year	Actual	Predicted	Residuals
1978-79	1681	1679	1.51
1979-80	1727	1848	-121.03
1980-81	1860	1894	-34.03
1981-82	1738	2027	-289.03
1982-83	1886	1905	-19.03
1983-84	1788	2053	-265.03
1984-85	2562	1955	606.98
1985-86	2846	2729	116.98
1986-87	3118	3013	104.98
1987-88	3295	3285	9.98
ACGR (1978-79 to 1987-88)=8.48%			
1988-89	3109	3462	-353.03
1989-90	3238	3276	-38.03
1990-91	3410	3405	4.98
1991-92	3375	3577	-202.03
1992-93	3357	3542	-185.03
1993-94	3468	3524	-56.03
1994-95	3524	3635	-111.03
1995-96	3694	3691	2.98
1996-97	3791	3861	-70.03
1997-98	3977	3958	18.98
ACGR (1988-89 to 1997-98)=2.38%			
1998-99	4061	4144	-83.03
1999-00	4273	4228	44.98
2000-01	4574	4440	133.98
2001-02	4988	4741	246.98
2002-03	4622	5155	-533.03
2003-04	4752	4789	-37.03
2004-05	4784	4919	-135.03
2005-06	5474	4951	522.98
2006-07	6277	5641	635.98
2007-08	6540	6444	95.98
ACGR (1998-99 to 2007-08)=4.83%			
2008-09	6651	6707	-56.03
2009-10	6787	6818	-31.03
2010-11	6831	6954	-123.03
2011-12	6968	6998	-30.03
2012-13	7005	7135	-130.03
2013-14	7049	7172	-123.03
2014-15	7132	7216	-84.03
2015-16	7244	7299	-55.03
2016-17	7556	7411	144.98
2017-18	7742	7723	18.98
2018-19	8362	7909	452.98
ACGR (2008-09 to 2018-19) =1.90% Overall ACGR(1978-79 to 2018-19)=3.97%			

ACGR - Annual Compound Growth Rate estimated for actual milk production in Tamil Nadu

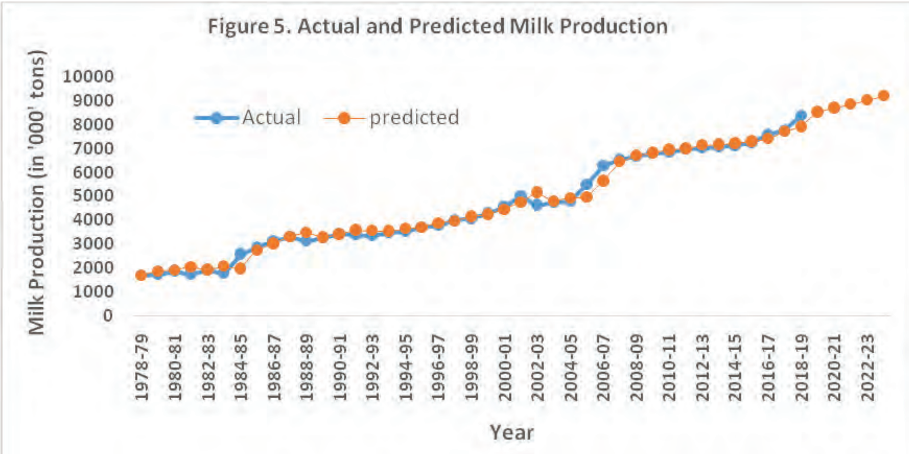


Table 5. Forecasted milk production in Tamil Nadu (in '000' tons)

Year	Forecasted Milk production	95 % LCL	95 % UCL
2019-20	8529	8069	8989
2020-21	8696	8045	9347
2021-22	8863	8066	9661
2022-23	9030	8109	9951
2023-24	9197	8167	10227

CONCLUSION

Based on the goodness of fit statistics and selection criteria that the ARIMA (0, 1, 0) model was found to be the most appropriate model for forecasting milk production in Tamil Nadu. Using this model for forecasting, it could be concluded that milk production in Tamil Nadu would increase from 8529 thousand tons in 2019-20 to 9197 thousand tons in 2023-24. These future projections of milk production in the State would be helpful for policy making, formulation of various schemes for improving milk production, strengthening the infrastructure for the potential export of dairy products and improving rural livelihood in the State.

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Short Communications

Pasture larval burden – an indirect method to count strongyle helminth larvae in grazing land of sheep

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ABSTRACT

An approximate amount of 250 g of fresh pasture samples were collected in the "W" shaped sampling method from five beneficiary villages of Network Project on Sheep Improvement (NWPSI) in and around of Kancheepurm District of Tamil Nadu at weekly interval before sunrise during winter and summer months. The samples were processed by Modified Baermann's apparatus technique. The results revealed that non-parasitic soil larvae alone during the months of December 2013 to March 2014. It might be due to unfavourable environmental conditions like dearth of rainfall and high temperature during the period of pasture sample collection. Hence, it was inferred that ideal environmental condition was needed for development of strongly larval stage.

Key Words: Sheep, grazing area, pasture larval count

INTRODUCTION

Most of the sheep farmers rear their animals by grazing in the pasture land. Pasture contamination was found to be the major mode for strongly helminth infestation in sheep (Singh *et al.*, 1997). *Modified Baermann's apparatus* technique was used to assess the level of pasture contamination with strongly helminth larvae.

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MATERIALS AND METHODS

A. Pasture sampling technique

An approximate amount of 250 g of pasture sample was hand plucked and collected in separate polythene bags from the common grazing land of every beneficiary village under study, in the "W" shaped sampling method and also from near and far off areas of the dried faecal pats in the pasture, as per the methods followed by Sanyal and Gour (1988).

B. Modified Baermann technique

Baermann apparatus was made up of a large sized (20 cm diameter and capacity of 2 L) plastic funnel with its narrow end attached to a 15 cm long rubber tube. Free end of the tube was blocked using pinch cork. The setting was assembled on a funnel holder and a 60W bulb was hung above the funnel.

Figure 1. Modified Baermann's apparatus

An approximate amount of 250 g of grass sample collected from pasture were placed in the funnel and tap water was filled up to the brim of funnel and allowed to remain overnight. The next day, about 10 to 20 ml of filtrate was drained by opening the cork of the rubber tube. The filtrate was centrifuged at 2000 rpm for 3 minutes. The supernatant was siphoned off and saturated sodium chloride solution was added to the sediment till a positive convex meniscus was formed at the mouth of the tube. After 10 minutes, the top of the fluid was touched with a cover slip and placed on a drop of Lugol's iodine on a slide.

The parasitic nematode larvae were identified, counted and expressed as number of larvae per kg of pasture on dry matter basis using the formula,

$$= \frac{\text{No. of larvae x 1000}}{250}$$

= No. of larvae x 4

= No. of larvae per kg of forage in DM basis.

C. Estimation of dry matter per cent of pasture

Per cent dry matter of pasture grass was analyzed during summer and winter. One hundred gram of pasture grass (n=5) in each season were dried in hot air oven at 100 ± 5^{o}C for 8 h and weight of ash was expressed in terms of per cent.

RESULT AND DISCUSSION

Non-parasitic soil larvae alone were identified by modified Baermann's technique during summer and winter.

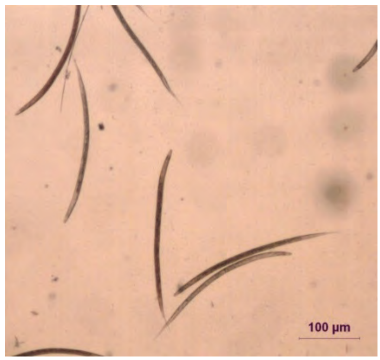

Figure 2. Non-parasitic soil larvae

In this study, pasture samples were collected during winter and summer and processed by *Modified Baermann's apparatus* technique and only soil nematode larvae could be identified in all the five villages.

The failure to detect pre-parasitic stages of strongly in pasture samples might be due to the dearth of rainfall during the monsoon and the high temperature prevalent during sample collection. It was understood that ideal environmental conditions like temperature, humidity and rainfall are necessary essential for the development of larval stages.

Bukhari and Sanyal (1989) reported that the availability of infective larvae of *H. contortus* on pasture was more and for longer duration in rainy (June, July and August) and autumn (September, October and November) seasons, whereas, it was very poor in winter (December, January and February) and spring (March, April and May). The cooler winters probably prevented the development of the pre-infective stages of the strongly larvae and due to low rainfall during the summer resulting in the non-availability of moisture for their survival. It was very clear that rainy and autumn seasons are the most important seasons of pasture contamination.

Sanyal and Gour (1988) reported that in Tamil Nadu, during the month of September, October and November, pasture larval count was zero in four plots of sheep grazing land whereas during the month of December all the grazing plots showed zero pasture larval count due to harsh climate as a result of low temperature and sparse rainfall.

Singh *et al.* (1997) reported that from December 1994 until early March 1995, no infective larvae could be recorded. He attributed the results to the absence of warm and humid climate, which favors the development and survival of pre-parasitic stages.

Kaur and Lakshmi Devi (2012) recorded that the total pasture larval count on dry matter basis with strongly was higher during the month of August and September 2010, whereas, total pasture larval count remained lower between the months of November 2010 and January 2011.

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Successful per-vaginal delivery of a schistosomus reflexus monster fetus in a crossbred cow – a case report

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ABSTRACT

Nine years old crossbred cow was presented to the TVCC, CVAS, Bikaner with dystocia of about 9 hours duration. Intestine parts and abdominal visera of the fetus were protruded from the vulva of the cow. Vaginal examination confirmed deformed fetus (schistosomus reflexus) in the pelvic cavity. The dystocia was relieved through vaginal passage by mutation and forced traction.

Key Words: Dystocia, Cow, Monster, Schistosomus reflexus

Schistosomus reflexus is a rare congenital defect primarily seen in ruminants. It may occurs either due to genetic aberrations and defects in the embryological development of the fetus resulting in failure of the abdominal wall to close and exposure of the abdominal contents (Laughton *et al.*, 2005) or may be due to teratogens causing abnormalities in the developing embryo or fetus (Azawi *et al.,* 2012). The monster usually causes dystocia in bovines and the incidence of schistosomus reflexus was recorded as 1.3% (Knight, 1996). The dystocia can be relieved by either mutation or fetotomy or laparohysterotomy operation. The present communication describes the successful vaginal delivery of schistosomus reflexus through mutation and forced traction in a crossbred cow.

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Nine years old crossbred cow was presented with dystocia of about 9 hours duration at Teaching Veterinary Clinics Complex, College of Veterinary and Animal Science, Bikaner with history of protruding intestine part and abdominal visera of deformed fetus from the vulva of the cow. Clinically, the rectal temperature, 101.5 °F, heart rate (70 beats/min) and respiratory rate (32 breaths/min) were within normal ranges.

Based on vaginal examination, the case was diagnosed as dystocia due to schistosomus reflexus. The intravaginal exploration done under an epidural block using 2% xylocaine. Dilatation of birth canal was sufficient and dystocia was due to malpresentation and malpositioning of fetus. Mutation procedure including extension and adjustment of extremities and forced traction were employed to relieve a schistosomus reflexus moster with arthrogyposis in limbs (Fig 1).

Fig.1.Schistosomus reflexus fetus with exposed visceral organs/intestine and arthogyposis in limbs

After care of the cow includes IV infusion of fluids (2 liters Ringer lactate, 2 liters 5% dextrose and 450 ml calcium borogluconate) and administration of antibiotics (Inj- Mofoi25 ml I/M, Bovion), anti-inflammatory (Inj-Meglulast 7ml I/M, Vet Mankind) and antihistaminic drugs(Inj-Avilin10 ml I/M, MSD). Intrauterine passaries (Bol-Cleanex 8 boli, Bohrenger) and herbal uterine cleanser (Liq-Uterivive100ml orally for 5 days, Virbac) were also given. The owner was advised to follow up the treatment for next 3 days and there was an uneventful recovery.

The present report is a documentation of a case of dystocia due to true schistosomus reflexus in a crossbred cow. Generally fetal monster causes dystocia in animals while Mehrotra *et al*., (2016) reported a unique case of eutocia with schistosomus reflexus monster fetus in cattle. In fully dilated birth canal, if fetal size is small than vaginal delivery is successful through mutation in cattle (Napolean *et al*., 2018). In one report, cervicotomy was attempt in cattle to save from cesarean section complications (Manokaran *et al*., 2014). Partialfetotomy of fetus and caesarean section is usually performed to relive the dystocia from schistosomus reflexus monster. However, in the present case of schistosomus reflexus in crossbred cow was successfully relieved through birth canal by well performed mutation operation and forced traction similarly Napolean *et al*., (2018) also reported per vaginal delivery of schistosomus reflexus monster in crossbred cow.

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EDITOR

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