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Modelling and Forecasting of Milk Production in Chhattisgarh and India

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ABSTRACT

India is accounting for almost 20 percent of total milk production in the world and 70 percent of this share is coming from small, marginal farmers and landless people of the country residing in rural areas and this shows that dairy industry has an important role in social and economic development in India. Dairy is growing with a positive rate as per capita availability has reached to 375 (gms/day) in 2017-18 from 178 (gms/day) in 1990-91. In this study, time series data (2001-02 to 2015-16) on milk production and different milching species population of Chhattisgarh have been used to find out the suitable forecasting models for milk production and population of these mulching animals of Chhattisgarh. To meet the objective of study different Autoregressive Integrated Moving Average (ARIMA) models have been tried and among all ARIMA (0,2,0) model has been found more suitable for production of milk in India and Chhattisgarh both. Availability of milk is forecasted suitably by ARIMA (0,2,1) and ARIMA(0,1,1) for India and Chhattisgarh respectively. Similarly different ARIMA models have been fitted for population of different species animals. By this study milk production is expected to reach 219.73 MMT and 1.599 MMT by 2022-23 in India and Chhattisgarh respectively.

Key words: ADF, ARIMA, Milk availability, Milk Production, Projection.

INTRODUCTION

Dairy sector plays an important role in the country's socio-economic development and constitutes an important segment of the rural economy. The world milk production growth reached an average of 2.2% growth (January-September 2018), India Milk production registers a growth of 6.7% in 2017-18 (Ministry of Agriculture and Farmers Welfare, 2018). India is the largest milk-producing country in the world by a wide margin over the United States, the second-largest producer (Landes *et al.* 2017). Milk production in India is showing a growth of about 4.8 percent CAGR during last 10 years. Forecasting of milk production is required to know the availability and need of milk so that necessary policy formations can be done to meet this gap. The main occupation of most rural families of Chhattisgarh State is agriculture and animal husbandry. In Chhattisgarh there are 627 dairy cooperatives in the state and the milk production is expected to reach 3.7 million tonnes by 2020-21 (GoI 2018). (Deshmukh and Paramasivam 2016) is Studied about milk production forecasting using ARIMA and VAR time series model. Chaudhari and Tingre (2015) forecasted the egg production of India using ARIMA model. It is necessary to find out what will be the future milk production so that appropriate policy implications are made to cope up with increasing demand. Hence this, study was conducted.

MATERIALS AND METHODS

The data used for present study is secondary data. It is collected from *Livestock Statistics-Chhattisgarh,* (*http://ahd.cg.gov.in/*) from 2001-02 to 2015-16. Data is related to milk production and availability of India and Chhattisgarh collected for the above mentioned period. Also data used of livestock population of Chhattisgarh during 2001-02 to 2015-16.For ARIMA models. Statistical analysis has been performed using "R" Statistical software.

ARIMA Models Based on Box-Jenkins Approach

In the great majority of statistical models, it is widely accepted that observations vary independently of each other. So much so that, in several applications, an interdependence of these observations, however small, is considered to be detrimental to the quality of the model. However, such a situation is still ideal because in everyday reality, data, whatever their nature or acquisition process, are always

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linked to each other. Trying to quantify this temporal dependency within a data set is the goal of the Box and Jenkins method in this article. (Box-Jenkins, 1976).

Auto-Regressive process AR (p)

A process is said to be *auto regressive* when the value of the random variable *Z* at a given instant *t* is a linear combination of the *p* prior values of this same random variable. We then say that we have an autoregressive process of order *p* and we write it AR (p). The general equation of an autoregressive process of order *p* is written:

$$Z_t = \sum_{i=1}^{p} \beta_i Z_{t-i} + \epsilon_t \quad (1)$$

With:

$$\beta_i \in \mathbb{R} \quad , \quad \epsilon_t \rightsquigarrow \mathcal{N}(0, \delta_\varepsilon).$$

This equation will read as follows: The value of the random variable *Z* at time is significantly related to the previous *p* values of this same random variable.

Moving-Average process MA (q)

A process is called a *moving average* if the value of the random variable *Z* at a given moment is a *linear combination* of the values of the regression error E_t up to the order *q*. It is said that this process is a moving average of order *q* and it is noted MA (q). The general equation of a moving average process can then be written in the following form:

$$Z_t = \sum_{i=1}^{q} \varphi_i \varepsilon_{t-i} + \mu \quad (2)$$

ARMA model (mixture of AR and MA processes)

These models consist of combining the two models of the self-regression model and the moving media model. This model is the most popular models of the Box Jenkins for its flexibility and suitability for various data types. This model is represented by the symbol ARMA(p,q), where p, q: represents the two model orders and the general shape of this model can be written as follows:

$$\sum_{i=1}^{p} \beta_i Z_{t-i} = \sum_{i=1}^{q} \varphi_i \varepsilon_{t-i} \quad (3)$$

With:

$$\beta_i \ (i = 1, \dots, p), \quad \varphi_i \ (i = 1, \dots, q) \in \mathbb{R} \quad , \quad \epsilon_t \rightsquigarrow \text{WN}(0, \delta_\varepsilon).$$

By introducing the backshift operator, which has the characteristic: $L^n Z_t = Z_{t-n}$, the relation (3) is written:

$$\beta(L) Z_t = \varphi(L) \varepsilon_t$$

With: $\beta(L) = 1 - \beta_1 L - \cdots - \beta_p L^p$ and $\varphi(L) = 1 - \varphi_1 L - \cdots - \varphi_q L^q$

The methodology of Box and Jenkins essentially comprises five Steps:

Step 1: Transformation of the data to stabilize the *variance* (log, sqrt ...) and differentiation of the data to make them stationary; we use the Augmented Dickey-Fuller (ADF) test for check stationnarity.

Step 2: Visualize the Autocorrelation functions (ACFs) and empirical Partial Autocorrelation functions (PACFs) to identify the appropriate *p* and *q* parameters. At the end of this identification step, one or more models have been selected. It is now necessary to estimate each selected model.

Step 3: Estimate the parameters of the model (s) selected. For the estimation of *ARMA*(*p*,*q*) process, we use the Maximum Likelihood method; we suppose that the errors e_t follow a normal distribution, with zero mean $E(e_t) = 0$ and constant variance s^2_e. The log-likelihood function of an ARMA(p, q) model is given as:

$$\text{Log } L_t = -\frac{T}{2} \log 2\pi - = -\frac{T}{2} \log \sigma_\varepsilon^2 - \frac{1}{2} \log\left(det\left[\psi' \psi\right]\right) - \frac{\varpi(\beta, \varphi)}{2\sigma_\varepsilon^2} \quad (6)$$

With:

- T: number of observations ,
- ψ a matrix of (p + q + T, p + q) dimensions, dependent of β_i (i = 1,...,p) and φ_i (i = 1,...,q),
- $\varpi(\beta, \varphi) = \sum_{t=-\infty}^{T} (\mathbb{E}[\varepsilon_t X_t, \beta_i, \varphi_j, \sigma^2_\varepsilon]$, with: i=1,.., p; j =1,., q.

Table 1: Descriptive statistics of milk availability and production data.

		Mean	Minimum	Maximum	Standard deviation	Skewness	Kurtosis
Milk Production (in '000 t)	India	120631.94	84406.00	176347.00	28451.57	0.50	-0.74
	Chhattisgarh(C.G.)	1031.35	795.00	1469.00	220.89	0.60	-0.97
	Local Cow(C.G.)	1388.47	1176.00	1508.00	78.13	-1.16	3.21
	Goat(C.G.)	556.27	513.00	644.00	42.59	0.93	-0.42
	Buffaloes(C.G.)	226.27	190.00	271.00	34.83	0.38	-2.00
	C B Cow(C.G.)	43.87	35.00	54.00	6.40	-0.07	-1.69
Population (in '000)	Local Cow(C.G.)	549.46	442.90	815.10	120.52	-0.15	1.01
	Goat(C.G.)	44.47	38.00	51.30	3.83	-0.88	0.18
	Buffaloes(C.G.)	313.96	264.00	375.10	40.27	-1.36	0.44
	C B Cow(C.G.)	71.52	49.50	106.40	20.09	-1.25	0.47
Availability (in g)	India	265.13	225.00	329.00	33.37	0.59	-0.87
	Chhattisgarh(C.G.)	119.13	104.00	132.00	10.62	-0.10	-1.89

Note: Population of four animal species (Local Cow, Cross Breed Cow, Buffaloes and Goat for Chhattisgarh), Milk Production data for India and Chhattisgarh cover the period of 2001-02 to 2017-18, Rest of data covers the period of 2001-02 to 2015-16.

For maximization of Log L_t according to the coefficients: β_i, φ_j , σ^2_e we calculated (*analytically or by iterative methods*) the follows quantities:

$\frac{\partial \text{Log } L_t}{\beta_i} = 0$, $i = 1, \ldots, p$, $\frac{\partial \text{Log } L_t}{\varphi_j} = 0$, $j = 1, \ldots, q$ and $\frac{\partial \text{Log } L_t}{\sigma^2_\varepsilon} = 0$.

To the estimated coefficients: $\hat{\beta}_i$, $\hat{\varphi}_j$, $\hat{\sigma}^2_\varepsilon$.

Step 4: Diagnosis and testing of the model: Often, it is not easy to determine a single model that represents the data-generating process and it is not uncommon to estimate multiple models in the initial stage. The model that is ultimately chosen is the one considered the best based on a set of control and diagnostic criteria. These criteria include:

• The t-tests of significativity of the estimated parameters: $\hat{\beta}_i : i = 1, \ldots, p$ we calculate the Student's statistics of the coefficients: $\left(t_{\hat{\beta}_i} = \frac{\hat{\beta}_i}{\hat{\sigma}_{\hat{\beta}_i}}\right)$, if $\left|t_{\hat{\beta}_i}\right| < t_{1-\frac{\alpha}{2}}$, if we accept the hypothesis that: $\hat{\beta}_i = 0$. Otherwise we reject it.Residuals analysis (Normality, Absence of Autocorrelation: (Durbin and Watson 1950) and (Hyndman and Athanasopoulos, 2018). Homoskedasticity: **(**Test of Breusch and Pagan 1979), (Breusch, 1978) ARCH Test, (Engel 1982). The information criteria and errors measures: the most used criteria are: (Akaike 1979), (Pincheira and Medel.2016), information criterion; Bayesian Information Criterion, (Schwaz 1978). Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), Mean Absolute Percent Error (MAPE).

Step 5: Forecast: The last step is the prediction of future values of through the chosen model.

RESULTS AND DISCUSSION

Table 1 reveals that milk production has been increased from 795 and 84406 thousand tones in 2001-02 to 1469 and 176347 thousand tones in 2017-18 in Chhattisgarh and India respectively. Per capita milk availability have been 104 (gms/day) and 225 (gms/day) in 2001-02 and reached upto 132 (gms/day) and 329 (gms/day) in 2015-16 for India and Chhattisgarh. These figures show that as overall milk production and availability is growing with a good pace but Chhattisgarh is lacking to match this growth. Chhattisgarh was sharing about 0.94 percent of overall milk production in 2001-02 which has decreased to 0.82 percent in 2015-16. Further, livestock populations of four species that are taken under consideration, shows that there is very low increment in the population of local cow and goat in Chhattisgarh over the years. However, population of local breed cows and buffaloes have been decreased during the study period.

On the whole, we have 12 time series, for the stage of identification of the integration orders of the time series: of milk production, milk availability and population, by using the tests of ADF, all the series are not stationary, except the population local cow time series. All the series are of deterministic non-stationarity (DS), after the first differentiation and the application of (ADF and KPSS) unit

Table 2: Models fitting for Milk production, Population Livestock and Milk Availability time series in India and Chhattisgarh over the period (2001-2015).

		Model	drift	AR	MA	LL	AIC	AICc	BIC	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1	LB(*)
Production (in '000 t)	India	ARIMA (0,2,0)	----	----	----	-115.83	233.65	234.02	234.22	490	1668	1188	0.41	1.02	0.23	-0.30	0.192
	Chhattisgarh	ARIMA (0,2,0)	----	----	————	-56.98	115.97	116.33	116.53	2.38	18.04	13.09	0.28	1.24	0.37	-0.10	0.581
	Local Cow	ARIMA (0,2,0)	----	----	----	-59.89	121.77	122.14	122.34	6.43	22.56	13.26	0.96	2.03	0.49	-0.28	0.282
	Goat	ARIMA(0,1,0)	----	----	----	-34.39	70.78	71.11	71.42	0.67	2.72	1.95	1.40	4.24	0.93	-0.35	0.01
	Buffaloes	ARIMA(0,1,0)	----	----	----	-60.06	122.12	122.45	122.76	3.13	17.05	11.71	0.96	3.62	0.93	0.43	0.271
	C B Cow	ARIMA(0,1,0)	3.85 (1.2)	----	----	-40.75	85.51	86.60	86.78	0.01	4.29	3.42	-0.61	4.71	0.8	0.07	0.559
Population (in '000)	Local Cow	ARIMA(1,0,0)	348.9(11.8)	0.644(0.27)	----	-84.26	174.52	176.7	176.6	1.14	65.4	41.8	0.17	3.11	0.88	0.14	0.595
	Goat	ARIMA(0,1,0)	----	----	----	-69.65	141.31	141.64	141.94	6.63	33.84	21.43	1.01	3.66	0.93	-0.21	0.01
	Buffaloes	ARIMA(0,1,0)	----	----	----	-61.92	125.83	126.16	126.47	-4.71	19.47	9.81	-2.51	4.83	0.93	-0.10	0.730
	C B Cow	ARIMA(0,1,0)	----	----	----	-35.93	73.87	74.2	74.51	1.01	3.04	1.93	2.17	4.09	0.93	0.06	0.380
Availability (Ing)	India	ARIMA(0,2,1)	----	----	-0.714(0.17)	-41.32	86.63	87.83	87.76	1.56	5.26	3.21	0.52	1.14	0.43	-0.23	0.262
	Chhattisgarh	ARIMA(0,1,1)	2.064(0.73)	----	0.843(0.31)	-26.44	58.87	61.27	60.79	-0.03	1.47	1.07	-0.02	0.89	0.50	-0.11	0.302

(*) It correspond to the P-value of Ljung-Box test.

Note: Population of four animal species (Local Cow, Cross Breed Cow, Buffaloes and Goat for Chhattisgarh).

root tests has indeed shown that all these series are stationary; to model them using ARMA-type processes, followed by the steps of the Box and Jenkins approach cited above. All the criteria (LL, AIC, BIC…etc) lead us to select the models (column 2, Table 1) to represent the dynamics of the 12 time series, the results are detailed in the Table 2.As indicated in the theoretical section, the last step of the Box and Jenkins methodology is to forecast the series studied on the basis of the selected (validated) processes in the second column of Table 2. The best models selected is an ARIMA (0,2,0): for milk production in India, milk production in Chhattisgarh and milk production from Local Cow in Chhattisgarh time series. The model equation is given by:

$$Z_t = 2 * Z_{t-1} - Z_{t-2} + \varepsilon_t \quad , \mathbb{E}(\varepsilon_t) = 0$$

According to the forecasts of our study see Table 2, milk production continues its upward trend in India and Chhattisgarh; it is expected to record (respectively) 201376 thousand tones and 1507.2 thousand tones in 2020-21 and 219730 thousand tones and 1600 thousand tones in 2022-23. Also for validation of this forcaesed values are very close to actual values for year 2016-17 and 2017-18(Ministry of Agriculture and Farmers Welfare, GoI, 2018). This is well explained in part, also by the forecasts of augmentation of the population of: Local Cow, Buffaloes, Cross Breed Cow and Goat. Table 3. Chhattisgarh state is still in primitive stage in dairy farming though the state has good number of cattle population compared to other leading milk producing states. In Chhattisgarh are 627 dairy cooperatives in the state and the milk production is expected to reach 3.7 million tonnes by 2020 (Ministry of Food processing Industry, GoI 2018).

For the milk production form Cross Breed Cow (CBC), the best model is a random walk with drift (or an ARIMA (0,1,0) with drift), Pincheira and Medel. (2016). the process is defined as:

$$CBC_t = \alpha + CBC_{t-1} + \varepsilon_t \Rightarrow CBC_t - CBC_{t-1} = \alpha + \varepsilon_t \Rightarrow \Delta(CBC_t) = \alpha + \varepsilon_t$$

So, the prevision equation is given by: $\widehat{CBC}_{t+1} = \alpha + CBC_t$ α = 3.85.according to our forecast results, milk production from Cross Breed Cow is expected to reach the threshold

Table 3: Production Forecasting: in India and in Chhattisgarh (according to different species), (PF: Point Forecast).

	Buffaloes Production Milk					Local Cow Milk Production				
Years	P F	Lo 80	Hi 80	Lo 95	Hi 95	P F	Lo 80	Hi 80	Lo 95	Hi 95
2016	310.8	288.2	333.4	276.2	345.4	913.4	882.3	944.4	865.9	960.9
2017	310.8	278.1	342.8	261.8	359.7	1011.7	942.2	1081.1	905.5	1117.9
2018	310.8	271.6	349.9	250.8	370.7	1110	993.8	1226.2	932.3	1287.7
2019	310.8	265.5	356.1	241.6	380.1	1208.3	1038.2	1378.4	948.2	1468.4
2020	310.8	260.2	361.4	233.4	388.2	1306.6	1076.3	1536.9	954.3	1658.8
2021	310.8	255.4	366.2	226.1	395.5	1404.9	1108.6	1701.2	951.8	1857.9
2022	310.8	250.9	370.6	219.2	402.3	1503.2	1135.7	1870.7	941.2	2064.2
	Cross Breed Cow Production Milk					Goat Milk Production				
Years	P F	Lo 80	Hi 80	Lo 95	Hi 95	P F	Lo 80	Hi 80	Lo 95	Hi 95
2016	107.25	101.33	113.16	98.20	116.29	48.1	44.48	51.71	42.56	53.63
2017	11.10	102.73	119.46	98.31	123.88	48.1	42.98	53.21	40.27	55.92
2018	114.95	104.70	125.19	99.28	130.61	48.1	41.83	54.36	38.52	57.67
2019	118.80	106.97	130.62	100.71	136.88	48.1	40.86	55.33	37.03	59.16
2020	122.65	109.42	135.87	102.71	142.89	48.1	40.01	56.18	35.73	60.46
2021	126.50	112.01	140.98	104.34	148.65	48.1	39.24	56.95	34.55	61.64
2022	130.55	114.70	145.99	106.42	154.27	48.1	38.53	57.66	33.46	62.73
	Total Milk Production in India					Total Milk Production in Chhattisgarh				
Years	P F	Lo 80	Hi 80	Lo 95	Hi 95	P F	Lo 80	Hi 80	Lo 95	Hi 95
2016	164668	162371	166964	161156	168180	1323.3	1298.4	1348.1	1285.3	1361.3
2017	173845	168710	178979	165992	181698	1369.3	1313.7	1424.8	1284.3	1454.3
2018	183022	174429	191614	169881	196162	1415.3	1322.3	1508.2	1273.2	1557.5
2019	192199	179621	204776	172963	211434	1461.3	1325.2	1597.4	1253.2	1669.4
2020	201376	184345	218406	175330	227421	1507.2	1323.1	1691.5	1225.5	1789.1
2021	210553	188647	232458	177051	244054	1553.6	1316.3	1790.3	1190.8	1915.7
2022	219730	192559	246900	178176	261284	1599.5	1305.3	1893.2	1149.7	2048.8

Milk Production (in '000 t)

Lo 80 and Hi80 are (respectivily) the lower and higher bounds of predictive interval for an error terme alpha = 0.2.

Lo 95 and Hi95 are (respectivily) the lower and higher bounds of predictive interval for an error terme alpha = 0.05.

Note: Population of four animal species (Local Cow, Cross Breed Cow, Buffaloes and Goat for Chhattisgar.

of 120 thousand tones in 2020-21 and the level of 130 thousand tones in 2022-23. In Chhattisgarh nearly 370 new dairy cooperative societies were set up in the past two years taking the total of number of cooperatives to 627 from 257.

Relating to the milk production form Buffaloes, milk production from Goat, Buffaloes Population, Cross Breed Cow Population, Goat population and local cow population time series, the selected processes are (respectively): ARIMA (0,1,0) and AR (1) with draft for the last one . For the local cow population (LCP), the fitted model is given by:

$$LCP_t = 348.9 + 0.644 * LCP_{t-1}$$

$$Z_t = Z_{t-1} + \varepsilon_t \Rightarrow Z_t - Z_{t-1} = \varepsilon_t \Rightarrow \Delta(Z_t) = \varepsilon_t$$

We know that this process is unpredictable; all next (or future) values are estimated to equal the last value; we call this a naive forecast. This is clearly shown in Table (4, 5), in "Point Forecast" column. All predictive values over the period (2016-2022) are equal the value of 2015.

The average level of availability of milk in India and Chhattisgarh over the period (2001-2016) is (*respectively*): 265.13 and 119.12 g. in India, this level was factored by 1.46 since 2001, but in Chhattisgarh the milk availability is increased by a factor of 1.27. The forecasts for milk availability in India and Chhattisgarh are shown in Table (5) for India milk availability (IMAV), the best model was an ARIMA (0, 2, 1), it takes the mathematical equation:

$$IMAV_t = 2 * IMAV_{t-1} - IMAV_{t-2} + 0.714 * \varepsilon_t, \quad t: 1,2,\ldots,15.$$

The ARIMA (0,2,1) is nearly equivalent to a Linear Exponential Smoothing (LES) model, Holt,(1957), the MA(1) coefficient equivalent to the value 2 * (1 - a) in the LES model. In ARIMA with two orders of differencing, the distant future is much more uncertain than the model with a single order of differentiation.

For Chhattisgarh milk availability (CMV) time series, we select an ARIMA (0,1,1) model, (we can notice it

Table 4: Population Forecasting in Chhattisgarh (according to different species), (PF: Point Forecast).

	Buffaloes Population					Local Cow Population				
Years	P F	Lo 80	Hi 80	Lo 95	Hi 95	P F	Lo 80	Hi 80	Lo 95	Hi 95
2016	190	164.16	215.83	150.49	229.50	1242.7	1152.6	1332.7	1105	1380.4
2017	190	153.46	226.53	134.12	245.87	1285.7	1178.6	1392.7	1121.9	1449.4
2018	190	145.25	234.74	121.56	258.43	1313.3	1199.9	1426.8	1139.8	1486.8
2019	190	138.33	241.66	110.98	269.01	1331.2	1215.2	1447.1	1153.8	1508.5
2020	190	132.23	247.76	101.65	278.33	1342.6	1225.7	1459.6	1163.7	1521.6
2021	190	126.71	253.28	93.22	286.77	1350.1	1232.7	1467.2	1170.5	1529.6
2022	190	121.64	258.35	85.46	294.53	1354.8	1237.3	1472.4	1175.1	1534.7
	Cross Breed Cow Population					Goat Population				
Years	P F	Lo 80	Hi 80	Lo 95	Hi 95	P F	Lo 80	Hi 80	Lo 95	Hi 95
2016	50	45.96	54.03	43.82	56.17	612	567.10	656.89	543.33	680.66
2017	50	44.28	55.71	41.26	58.73	612	548.50	675.49	514.89	709.10
2018	50	43.00	56.99	39.30	60.69	612	534.23	689.76	493.07	730.92
2019	50	41.92	58.07	37.64	62.35	612	522.20	701.79	474.67	749.32
2020	50	40.97	59.02	36.19	63.80	612	511.61	712.38	458.46	765.53
2021	50	40.10	59.89	34.87	65.12	612	502.02	721.97	443.81	780.18
2022	50	39.31	60.68	33.66	66.33	612	493.21	730.78	430.33	793.66

Livestock population in Chhattisgarh (in '000).

Table 5: Milk Availability Forecasting in India and Chhattisgarh (in g), (PF: Point Forecast).

	India					Chhattisgarh				
Years	P F	Lo 80	Hi 80	Lo 95	Hi 95	P F	Lo 80	Hi 80	Lo 95	Hi 95
2016	339.84	332.30	347.38	328.31	351.37	133.80	131.68	135.92	130.56	137.05
2017	350.68	338.41	362.96	331.91	369.46	135.87	131.43	140.31	129.07	142.66
2018	361.53	344.47	378.58	335.45	387.61	137.93	132.02	143.85	128.89	146.98
2019	372.37	350.31	394.43	338.64	406.11	140.00	132.91	147.09	129.16	150.84
2020	383.22	355.88	410.55	341.42	425.02	142.06	133.97	150.15	129.68	154.44
2021	394.06	361.17	426.95	343.76	444.36	144.13	135.14	153.11	130.38	157.87
2022	404.90	366.18	443.63	345.69	464.12	146.19	136.39	155.99	131.21	161.17

Milk Availability (in g).

Lo 80 and Hi80 are (respectivily) the lower and higher bounds of predictive interval for an error terme alpha = 0.2.

Lo 95 and Hi95 are (respectivily) the lower and higher bounds of predictive interval for an error terme alpha = 0.05.

IMA(0,1,1), is defined as:

$$CMV_t = 2.064 + CMV_{t-1} - 0.843 * \varepsilon_{t-1} + \varepsilon_t, \quad t: 1,2,\ldots,15.$$

However, the model we have identified, yielding a forecast function: $\widehat{CMV}_t = 2.064 + CMV_{t-1}$

Hence the model implies that the forecast at any particular time is the same for one step ahead, two steps ahead and so on. In other words, the series contains information only on the future *level* of the series and nothing about slope. According to forecasts, milk availability levels continue to increase over the period (2016-2022), whether in India or Chhattisgarh. We can see, the confidence intervals (with error term and amplify more rapidly. The expected level in 2020-21 is 383.22 g per capita in India, with a forecast interval for Chhattisgarh, the level of milk availability is expected to exceed the 140 g per capita threshold ; therefore, milk availability in Chhattisgarh is far from the national level and the gap is growing with time. High consumption of milk was not in the culture of the State and connecting more children with milk will be beneficial in fighting malnutrition. The recently launched scheme for distribution flavoured milk in Anganwadi and Schools in Gariaband will definitely help in eradicating undernourishment and generating future demands.

CONCLUSION

Indian dairy industry makes up for a significant amount of world's dairy resources. Both the national economy as well as socio-economic growth of country is backed by the livestock sector. Present investigation bring out the salient features of the results obtained by employing various statistical modelling procedures to milk production and availability of Chhattisgarh and India and livestock population of Chhattisgarh collected for during 2001-02 to 2015-16. From the above, it is evident that ARIMA time – series modelling approach is the best one for the data sets under consideration. Accordingly, this approach is used to forecast the milk production, milk availability and population of different breeds population of Chhattisgarh. From the forecasted value, it is clearly visible that local cow population would be high 1354.4 in year 2022-23 compare to cross breed, goat and buffaloes population. Highest milk production would be 1.503 MMT for local cow in Chhattisgarh in 2022-23. So increment of local cow population would be visible in milk production of local cow in Chhattisgarh. From the study, it would conclude that total India and Chhattisgarh milk production would reach 219.730 and 1.599 000 MMT respectively in 2022-23. Also forecasting values give direction that cross breed population increasing more as per compare to local cow population would be in coming year. Goat population would be remains constant as per projection values. Milk availability would be also increase for total India as well as Chhattisgarh.

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