# A study on structural changes in dairy sector in Andhra Pradesh

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***Received: 13.05.2021/Accepted: 30.05.2021***

## ABSTRACT

The paper highlights the structural changes occurred in dairy sector in Andhra Pradesh. The prime factor of development in dairy sector is driven by milk production. A glaring decrease in the bovine population showed a significant negative impact on the milk production. The increase in the dairy cooperative societies and the procurement price provided by the societies has shown a positive and significant effect on the milk production. However the prominence of the services provided in the dairy sector is to be enhanced to bring about further transformation.

**Keywords:** Dairy sector; cooperative societies; milk production; structural change

## INTRODUCTION

Being one of the largest agricultural commodities, the milk production in India was 187.7 million tonnes in 2018-19 as against 176.3 million tonnes in 2017-18 with an increase of 6 per cent (Anon 2019) and persisted to be the largest milk producing nation in the world with its contribution of 23 per cent. The per capita availability of milk has increased from 176 grams per day in 1990-91 to 394 grams per day by 2018-19 which is higher than the world per capita availability of 229 grams per day. As milk constitutes 67 per cent share in the value of output from the livestock sector, it depicts a greater strength for the growing population (Jaiswal et al 2018).

Besides providing food security, the momentous contribution of dairy sector influences the employment generation opportunities and income supplementation to small and marginal farmers and landless labourers. As a major source of income, 27.6 million people depend on dairy sector out of which 65 to 70 per cent are small and marginal farmers and landless labour (Belhekar and Dash 2016). The dairy sector supports around 10 million members/farmers through one lakh cooperative societies existing in the country (Nargunde 2013).

Over the time period, dairy sector has been subjected to structural changes significantly and the process is popularly known as 'white revolution'. Various amusing patterns were being remarked as changes in composition of dairy species in favour of crossbred cows, expanding network of dairy cooperative societies and increased participation of private sector in milk collection and processing as reported by different workers (Rajendran and Mohanty 2004, Singh and Datta 2010, Kumar et al 2010, Birthal and Negi 2012). Yet several factors need to be spotted in order to develop strategic interventions for lifting the milk production and sustaining the growth of the dairy sector. In this point of view, the current study was undertaken to look into the structural changes of dairy sector in Andhra Pradesh.

## METHODOLOGY

The structural change that might have prevailed in the milk production of Andhra Pradesh during the period of 2000-01 to 2018-19 was studied. The entire period (2000-01 to 2018-19) was divided into two sub-periods viz sub-period I (2000-01 to 2010-11) and sub-period II (2011-12 to 2018-19) by considering the National Dairy Plan (NDP I) which was implemented during 2011-12. Chow test was employed to analyse the existence of structural stability (Gujarati and Porter 2009).

**Chow test**

The idea behind the application of Chow test was that there was no change in the two sub-periods. Restricted residual sum of squares and unrestricted residual sum of squares should not differ statistically. By assuming that there was no difference between the two sub-periods, the null hypothesis and alternative hypothesis were made as per below:

**Null hypothesis ($H_0$):** There is no structural change in the dairy sector between sub-period I and sub-period II

**Alternate hypothesis ($H_1$):** There is a structural change in the dairy sector between sub-period I and sub-period II

This can be tested using the Chow test for the following regression data set:

Sub-period I (2000-01 to 2010-11):

$$Y_t = \lambda_0 + \lambda_1 X_1 + \lambda_2 X_2 + \lambda_3 X_3 + \lambda_4 X_4 + u_1 t \ (n_1 = 11) \quad \text{.....1}$$

Sub-period II (2011-12 to 2018-19):

$$Y_t = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \gamma_4 X_4 + u_2 t \ (n_2 = 08) \quad \text{.....2}$$

Total period (2000-01 to 2018-19):

$$Y_t = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + ut \ (n = n_1 + n_2 = 19) \quad \text{.....3}$$

where, $\lambda_0$, $\gamma_0$ and $\alpha_0$ = Intercepts of the sub-period I, II and total period respectively, $\lambda_1$ to $\lambda_4$: Slope coefficients of sub-period I, $\gamma_1$ to $\gamma_4$: Slope coefficients of sub-period II, $\alpha_1$ to $\alpha_4$: Slope coefficients of total period, Y: Milk production (million tonnes), $X_1$: Bovine population (million), $X_2$: Dairy cooperative societies ('000), $X_3$: Artificial insemination done (million), $X_4$: Average procurement price per litre (Rs)

**Now there are three possible regressions**

The equations 1 and 2 above assume that the regressions in the two time periods are different ie intercept and slope coefficients are different. Regression 3 assumes that the intercept as well as the slope coefficient remain the same over the entire period which indicates that there is no structural change. Equation (1) and (2) are for the unrestricted model (two time periods) and equation (3) is for the restricted model (pooled data). The test statistic is given as follows:

$$F = \frac{(RSS_R - RSS_{UR})/k}{RSS_{UR}/(n_1 + n_2 - 2k)} \sim F_{[k,(n_1+n_2-2k)]}$$

where $RSS_R$ = Restricted residual sum of squares for pooled data, $RSS_{UR}$ = Unrestricted residual sum of squares for two time periods data, k = Number of parameters, $n_1$ = First time period, $n_2$ = Second time period

If the computed F-value does not exceed the critical F-value at the chosen level of significance (or the p-value), the null hypothesis of parameter stability is not rejected. Contrarily if computed F-value exceeds critical F-value, null hypothesis of parameter stability is rejected and it is concluded that the regressions were different.

Based on the Chow test, only the difference between the regression of dependent and independent variables between the periods can be known. The source of difference can be known through the dummy variable technique which is an alternative to Chow test.

**Dummy variable technique**

The dummy variable technique was performed to analyse whether the structural difference was due to the slope coefficient or the intercept coefficient. The multiplicative form of dummy variable shows the differentiation between slope coefficients of the two periods and the additive form distinguishes between intercepts of two periods. As there were two dummies present (0 and 1), only one dummy variable was introduced in the regression equation to avoid the dummy variable trap by including the intercept term in the equations. The model used in the study was as follows:

$$Y_t = \alpha_1 + \alpha_2 D_t + \beta_1 X_t + \beta_2 (D_t X_t) + u_t$$

where $D_t$ = Dummy value ie, 0 if the observation is from the time period 2000-01 to 2010-11, 1 if the observation is from the time period 2011-12 to 2018-19; $\alpha_2$ = Differential intercept, $\beta_2$ = Differential slope or slope drifter

Mean function for 2000-01 to 2010-11:

$$E(Y_t : D_t = 0, X_t) = \alpha_1 + \beta_1 X_t$$

Mean function for 2011-12 to 2018-19:

$$E(Y_t : D_t = 1, X_t) = (\alpha_1 + \alpha_2) + (\beta_1 + \beta_2) X_t$$

The difference can be analysed by using the dummy variable technique with the following regression equation:

Additive form:

$$Y_t = \alpha_1 + \alpha_2 D_2 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + u_t$$

Multiplicative form:

$$Y_t = \alpha_1 + \alpha_2 D_2 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 (D_2 * X_1) + \beta_6 (D_2 * X_2) + \beta_7 (D_2 * X_3) + \beta_8 (D_2 * X_4) + u_t$$

where t= Total period from 2000-01 to 2018-19, $\alpha_1$= Intercept, $D_2$= 1 for sub-period II (2011-12 to 2018-19) otherwise 0, $\alpha_2$= Differential intercept, $\beta_1$ to $\beta_4$= Slope coefficients, $\beta_5$ to $\beta_8$= Differential slope coefficients or slope drifter

## RESULTS and DISCUSSION

Chow test and dummy variable technique were employed to study the structural changes in dairy sector in Andhra Pradesh as follows:

Since F calculated value was greater than respective F table value at 5 per cent level of significance, the null hypothesis ($H_0$) was not accepted and it was concluded that there was a structural change in the two sub-periods of the dairy sector in Andhra Pradesh. Coefficient of determination ($R^2$) interprets the proportion of the variance in the dependent variable that is predictable from the independent variable. For two sub-periods, the coefficient of determination was 0.98 which explains that 98 per cent variation in Y was predictable from X variables (Table 1).

The overall period of regression shows that 96 per cent variation in the dependent variable was explained through all the explanatory variables included (Table 1). Based on the above analysis ie Chow test, it was confirmed that there existed structural change in the dairy sector of Andhra Pradesh. With the help of Chow test one cannot determine the difference in the two sub-periods which was due to intercepts or the slopes or the both.

Due to the dummy variable technique, both additive and multiplicative forms are given below:

The additive form equation can be written as:

$$Y_t = -6.24 + 0.49D_2 + 2.31X_1 + 0.96X_2 - 0.60X_3 + 0.09X_4$$

Sub-period I: $D_2$= 0

$$Y_t = -6.24 + 2.31X_1 + 0.96X_2 - 0.60X_3 + 0.09X_4$$

Sub-period II: $D_2$= 1

$$Y_t = -5.75 + 2.31X_1 + 0.96X_2 - 0.60X_3 + 0.09X_4$$

The multiplicate form can be written as:

$$Y_t = -1.14 - 12.38D_2 - 0.98X_1 + 1.05X_2 + 0.39X_3 + 0.40X_4 + 3.64 (D_2 * X_1) - 0.41 (D_2 * X_2) + 0.43 (D_2 * X_3) - 0.28 (D_2 * X_4)$$

Sub-period I: $D_2$= 0

$$Y_t = -1.14 - 0.98X_1 + 1.05X_2 + 0.39X_3 + 0.40X_4$$

Sub-period II: $D_2$= 1

$$Y_t = -13.52 + 2.66X_1 + 0.64X_2 + 0.82X_3 + 0.12X_4$$

Table 2 explains the reason for structural change in the dairy sector, whether due to slope coefficients or intercept terms. In the additive form, the only significance of the intercept term between the two periods could be known. The multiplicative form was enabled to differentiate between slope coefficients of two periods.

The intercept dummy ($D_2$= 0.49) was found to be significant at 5 per cent level of significance that indicates the existence of a structural break between the sub-period I and sub-period II. The computed significant F-value implies that the existence of structural change was due to intercept.

The positive intercept dummy (0.49) denotes that the positive change in milk production has taken place which was increased by 49 per cent. Mean production function of sub-period I was statistically different from the mean function of sub-period II. The statistically significant differential intercept depicts that the two sub-periods regression did not accept the null hypothesis by concluding that regressions did not have the same intercept.

Table 1. Outcome of the Chow test

| Period | $R^2$ | Residual sum of squares |
|---|---|---|
| Sub-period I (2000-01 to 2010-11) | 0.98 | 1,64,774.95 |
| Sub-period II (2011-12 to 2018-19) | 0.98 | 5,11,59.92 |
| Total period (2000-01 to 2018-19) | 0.96 | 70,75,092.46 |

$R^2$: Coefficient of determination, F calculated value= 57.18, F table value (5%, 5, 9), df = 3.48

Table 2. Structural relationship between the regression functions of two sub-periods

| Parameter | Sub-period I vs Sub-period II | |
|---|---|---|
| | With differential intercept | Differential intercept & differential slope |
| Intercept | -6.24 (5.35) | -1.14 (1.40) |
| Differential intercept | 0.49* (0.81) | -12.38** (2.46) |
| **Slope coefficients of X variables** | | |
| $X_1$ (Bovine population) | 2.31** (0.46) | -0.98* (0.40) |
| $X_2$ (DCS) | 0.96 (1.57) | 1.05* (0.43) |
| $X_3$ (AI done) | -0.60 (0.58) | 0.39 (0.22) |
| $X_4$ (Procurement price) | 0.09 (0.08) | 0.40* (0.06) |
| **Differential slope coefficients of dummy variables** | | |
| $D_2$*$X_1$ | - | 3.64** (0.41) |
| $D_2$*$X_2$ | - | -0.41 (0.75) |
| $D_2$*$X_3$ | - | 0.43 (0.29) |
| $D_2$*$X_4$ | - | -0.28** (0.06) |
| $R^2$ | 96.46 | 99.89 |
| Adjusted $R^2$ | 95.10 | 99.78 |
| F- Value | 70.87** | 899.67** |

Figures in parentheses denote standard errors, *Significant at 5% LoS (p <=0.05), **Significant at 1% LoS (p <=0.01)

It can be noticed that differential intercept was significant at 1 per cent level of significance with the value of -12.38 that indicated the existence of the structural change between the two sub-periods. The negative effect might be due to a greater decrease in the animal population in the sub-period II. Differential slope coefficient indicated how much slope coefficient of the sub-period II milk production differed from the sub-period I.

Differential slope coefficients of $X_1$ and $X_4$ variables were found to be positively and negatively significant with coefficient values of 3.64 and -0.28 respectively. The statistically significant differential slope coefficients indicated that the two sub-periods had a different slope. Thus the null hypothesis was not accepted and the alternate hypothesis of two sub-periods differing significantly was accepted.

Slope coefficients of bovine population, dairy cooperative societies and procurement price were found to be significant variables whereas artificial insemination was found to be insignificant. Dairy cooperative societies and procurement price were positively significant with a difference of 1.05 and 0.40 respectively. The positively significant coefficient of dairy cooperative societies facilitated the growth of milk production by encouraging farmers through providing services. The bovine population was found to be negatively significant with a slope coefficient of -0.98. Though the bovine population decreased over the years, findings suggest that shifting of indigenous to cross-bred population showed the growth in milk production.

Coefficient of determination ($R^2$) is a measure that assesses the ability of a model to predict or explain an outcome in the regression. $R^2$ indicated the proportion of variance in the dependent variable that was predicted by the independent variable. $R^2$ of 96.46 per cent indicates that much amount of variation in milk production was predicted through all of the explanatory variables.

In the multiplicative form of dummy variable technique, $R^2$ indicated that 99.89 per cent of the variation in milk production was due to the explanatory variables like bovine population, dairy cooperative societies, artificial insemination and procurement price. Adjusted $R^2$ adjusted the statistic based on the number of independent variables in the model. Adjusted $R^2$ and significant F-value indicate that the estimated equation was a good fit model.

## CONCLUSION

The results revealed that the state has made significant transition in enhancing the milk production during the past two decades. As the decrease in the bovine population contributes a negative impact on the milk production, the conspicuous changes in the milk production were due to considerable services provided by the cooperative dairy societies by increase in their number through providing facilitation between the rural producers and urban consumers and milk procurement price. Keep up of improved animal species is considered to be vital for enhancing the milk production. Strengthening of dairy cooperative societies with reliable amenities will make the dairying a sustained process.

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