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# DEVELOPMENT OF LIVESTOCK SECTOR MODEL: AN APPLICATION OF SIMULATION TECHNIQUES

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## ABSTRACT

*Econometric simulation is relatively a new technique that has been used in the management sciences as a complement to more conventional methods of analysis such as budgeting and linear programming. For simulating any system, an artificial environment is created in such a way that it resembles the real world. The output of a simulation is a set of system performance variables associated with each set of policies or strategies. The agricultural sector is influenced by a wide range of continuously changing forces. The agricultural economy can be characterized to remain constantly in disequilibrium. For this single reason itself, the non-optimization feature of simulation renders this approach as a desirable method of analysis.*

*But the foremost requirement of the use of simulation technique is to test the validity of the model developed for simulation or prediction purposes. Simulation is basically a computer assisted method of operating a model of a real economic system. The simulation technique permits the analysis of a large economic system through a series of sets of functional relationships. The simulation technique allows the researcher to investigate the influence of different sectors on the overall economic system. Simulation provides the modeler with a kind of 'data laboratory'. It generates as much data as required according to the objectives of any investigation. Experiments that could be otherwise too costly or completely impossible to perform on the real economic system can be conducted on a computer simulation model of the system. Various simulation experiments were performed on all the commodity sub-models as well as on the aggregate level model assuming various exogenous changes of interest in each case. A number of alternative policies were simulated in order to provide policy makers, scientists and others with information about the likely consequences of alternative policy changes. For this purpose, we will use 'static simulation' to simulate the endogenous variable-es of the entire Agro-Economic Model of Punjab in order to evaluate various policy alternatives for crop enterprises separately, and when crop sub-models will be integrated with the macro level model of the Agricultural Sector of the State.*

**KEYWORDS:** *simulation, linear programming, economic system, livestock*

## INTRODUCTION

The appearance of the endogenous variables along with the pre-determined variables leads to the problem that the endogenous variables on the RHS of the equations are correlated with the disturbance terms of the equations in which they appear. In this situation, the single-equation ordinary least squares models, if applied, would produce inconsistent and biased regression coefficient estimates. The instantaneous feedback mechanism, thus, requires a model that provides a simultaneous solution of the structural parameters. This task can appropriately be accomplished through the modeling of the simultaneous equations system, and hence the need of this approach, in this context efforts has been made to study the following objectives :

1. To formulate the livestock sector Model for Punjab.
2. To test the validity of the model.

## MATERIAL AND METHODS

Econometric simulation is relatively a new technique that has been used in the management sciences as a complement to more conventional methods of analysis such as budgeting and linear programming. For simulating any system, an artificial environment is created in such a way that it resembles the real world. The output of a simulation is a set of system performance variables associated with each set of policies or strategies. The agricultural sector is influenced by a wide range of continuously changing forces. The agricultural economy can be characterized to remain constantly in disequilibrium. For this single reason itself, the non-optimization feature of simulation renders this approach as a desirable method of analysis.

But the foremost requirement of the use of the simulation technique is to test the validity of the model developed for simulation or prediction purposes.Validity testing means whether the model tracks the past history fairly well or whether the forecasting power of the model is fairly good. The model builders are concerned with either the model's retrospective predictions (historical validation) or prospective predictions (forecasting).

To test the 'goodness of fit' of the 'control solution' (or baseline simulation or validation run) values, some tests based on the dispersion of 'control solution' or predicted values around the actual values of the endogenous variables are available. These tests are mentioned as under:

1. Mean Absolute Percentage Error:

$$MAPE = \frac{1}{T}\sum_{t=1}^{T}\frac{|A_t - P_t|}{A_t}$$

2. Root Mean Square Error:

$$RMSE = \frac{1}{T}\sqrt{\sum_{t=2}^{T}\left(\frac{P_t - A_t}{A_{t-1}}\right)^2}$$

3. Theil's Inequality Coefficient:

$$U = \sqrt{\frac{\sum_{t=1}^{T}(P_t - A_t)^2}{\sum_{t=1}^{T}(A_t)^2}}$$

for levels or absolute changes, and

4. Theil's Inequality Coefficient

$$U = +\sqrt{\frac{\sum_{t=2}^{T}\left(\frac{P_t - A_t}{A_{t-1}}\right)^2}{\sum_{t=2}^{T}\left(\frac{A_t - A_{t-1}}{A_{t-1}}\right)^2}}$$

for relative or percent changes, where,

$A_t$ =Actual or realized value of the relevant variable in period t.

$P_t$ =Predicted or forecast value of the relevant variable in period t.

T = Total number of years

$P'_t = \frac{P_t - A_{t-1}}{A_{t-1}}$ = predicted relative change in the endogenous variable.

$A'_t = \frac{A_t - A_{t-1}}{A_{t-1}}$ = Actual relative change in the endogenous variable.

The inequality coefficient lies between zero and infinity, $0 < U < \infty$.

The smaller the value of the inequality coefficient, the better is the tracking ability of the model.

If $P_t = A_t$, then U = 0, and we say that our forecasts are all perfect.

If $P_t = 0$ for absolute changes, and

$P'_t = 0$ for relative changes,

then U = 1, the prediction procedure leads to the same RMSE as naive no-change extrapolation (138).

If U > 1, the predictive power of the model is worse than the zero-chagne prediction. Thus, if U > 1, it is preferable to accept the zero change extrapolation. It is to be noted that the inequality coefficient has no finite upper bound, which is tentamount to saying that it is possible to do considerably worse than by extrapolating on no-change basis.The predicted and realized changes are measured from the level of the same preceding year because the level in the preceding year was known as reality, whereas the forecast made differs in general from the definitive level of the variable.

Since MAPE and RMSE test statistics do not possess any upper or lower bounds for acceptance or rejection of the validity of the model, there is a limitation for using them and relaying upon the decision based on these tests. We have, therefore, put a greater emphasis on the Theil's Inequality coefficients while testing the validity of various sub-models and the aggregate model involved in this investigation.

## RESULTS AND DISCUSSION

Simulation is basically a computer assisted method of operating a model of a real economic system. The simulation technique permits the analysis of a large economic system through a series of sets of functional relationships. The simulation technique allows the researcher to investigate the influence of different sectors on the overall economic system. Simulation provides the modeller with a kind of 'data laboratory'. It generates as much data as required according to the objectives of any investigation. Experiments that could be otherwise too costly or completely impossible to perform on the real economic system can be conducted on a computer simulation model of the system.

Various simulation experiments were performed on all the commodity sub-model as well as on the aggregate level model assuming various exogenous changes of interest in each case. A number of alternative policies were simulated in order to provide policy makers, scientists and others with information about the likely consequences of alternative policy changes. For this purpose, we will use 'static simulation' to simulate the endogenous variables of the entire Agro-Economic Model of Punjab in order to evaluate various policy alternatives for crop enterprises separately, and when crop sub-models were integrated with the macro level model of the Agricultural Sector of the State.

The livestock sector model contains relationships for farm supply of milk (i.e., through the equations on the number of milch animals and milk production), the price of milk represents the farm level supply price and total gross income as generated from the livestock sector. This model is linked with agriculture proper sector by adding a response equation on fodder area that competes with other crop enterprises for land. A general formulation of the system of simultaneous equations for this sub-model of agricultural sector has been presented in chapter III. These five equations were simultaneously fitted through the 3SLS method of estimation meant for over-identified models. The estimates of the structural parameters of the model area presented in Table 4.1 and the estimated elasticities of endogenous variables with respect to their respective explanatory variables are reported in Table 42.

## Gross Income Equation (Livestock Sector)

Milk production, number of artificially inseminated cows and buffaloes, number of dairy and milk supply cooperative societies and the state planned expenditure on dairy and animal husbandry development were included in this equation as determinants of gross income generated from the livestock sector in the economy of the State. These four variables together explained 99.06 per cent of the variatino in the gross income, that was good enough as our ultimate objective was to use the model for simulating the system variables. the value of the d-statistic has indicated no evidence of autocorrelation in the errors.

The parameter on milk production and number of crossbred animals came out to be highly significant at 0.01 probability level. The State has witnessed a steep rise in the number of artificially inseminated cows and buffaloes during the period of this investigation. The income of the livestock sector increased by about 20.48 lakh rupees in response to an increase of 10000 milch animals of the new breeds. The expenditure made available by the Government for the development of dairy and animal husbandry sectors out of plan outlays also played a significant role in increasing the livestock sector income. Its coefficient worked out to be 0.2181. The dairy and milk supply cooperative societies though positively influenced the income of this sector, yet the impact was not found to be statistically significant.

Table 4.2 shows that the livestock sector income with respect to total milk production in the State was highly elastic, the value of the elasticity being 1.5863. This implied that a 10-per cent increase in milk production would bring about 15.9 per cent increase in the gross income of the livestock sector. Another factor which has greatly influenced the livestock sector income was the improved technology of cross breeding cows and buffaloes. The State gross income would significantly increase by about 2 per cent in response to an increase of 10 per cent in the number of cross-bred milch animals. The increase of 10 per cent in the government expenditure for the development on dairy and animal husbandry would enhance the gross income of the livestock sector by 1.2 per cent.

## Equation for the Inventory of Milch Animals

Milch animals include both cows and buffaloes. The increasing or decreasing level of the inventory of milch animals would cause increasing or decreasing income and employment opportunities to the farming community. This inventory maintains the supply line of milk to the consumers. The total number of milch cows and buffaloes was endogeneously determined with four explanatory variables: livestock sector's gross income, area under fodders, number of cross bred cows and buffaloes and average price of foodgrains.

The explanatory variables included in this equation together explained 90.39 per cent of the variation in the milch animal numbers. The d-statistic was inconclusive to decide about the presence or absence of positive autocorrelation in the errors of this equation.

The parameters on the gross income of the livestock sector and number of cross-bred milch animals came out to be highly significant at 0.01 probability level. The increasing level of the aggregate income of the farmers would induce them to keep more milch animals in order to supplement their farm income. The area under fodders as an explanatory variable was incorporated in this equation assuming that if farmers allocated more area to fodder crops, it was an indication that the farmers were inclined to keep more productive animals with them. This relationship was found to be positive though lacked statistical significance. More interesting was the outcome that as the number of cross-bred milch animals has increased, the total number of milch animals has significantly declined at the aggregate level. This seemed to be an encouraging trend. Probably, the farmers have started realizing that keeping less number of high yielding milch animals was more remunerative than keeping more milch animals with low yielding capacities. The parameter on the price of feedgrains (lagged by one year) was not found to be significantly different from zero. However, it carried a positive sign. Likewise, the farm price of milk has not exerted any significant influence in increasing the number of milch animals. This might be due to the reason that most of the farmers used to keep a limited number of milch animals only to meet their domestic requirements of milk and not for commercial purposes. No interplay of market forces was, thus, visible in the so-called transactions of milk.

Table 4.2 shows that the elasticity of the inventory of milch animals with respect to gross income of the livestock sector worked out to 0.4954. This indicated that a 10-per cent increase in the sector's gross income would increase the number of milch cows and buffaloes by about 50 per cent, ceteris paribus. The number of total milch animals would significantly decrease by about 1.9 per cent in response to an increase of 10 per cent in the number of cross-bred cows and buffaloes in the state. The inventory of milch animals was inelastic to area under fodders, the elasticity being 0.1620.

## Milk Supply Function

The function for the macro level supply of milk was formulated by taking total number of milch animals, average farm price of milk, average price of foodgrains and the number of cross-bred cows and buffaloes lagged by one year as the pre-determined variables.

The explanatory power of this equation was quite high as indicated by the value of $R^2$ (=0.9963). The D-W test was inconclusive to decide about the presence or absence of positive autocorrelation in the errors of this equation.

The parameter on the determinants, viz., number of milch cows and buffaloes, price of farm milk and number of cross-bred cows all-found to highly significant at 0.01 probability level. Since the cross-bred milch animals tended to replace the indigenous milch animals as was quite evident from the previous analysis, it was thought proper to include a variable of new technology to find out its impact on the supply of milk. This variable was taken in the form of number of artificially inseminated milch animals with one year lag because the cows and buffaloes inseminated last year were assumed to be productive after atleast one year. It was found to be a significant determinant of milk supply. The farm price of milk played a very significant role in increasing the total milk supply in the state. Here the significant role in increasing the milk supply (production) displayed by the increase in milk prices has clearly revealed that whatever the increase was there in milk production, it was mainly due to increase was there in milk production, it was mainly due to increase in the yield of milk per animal and not due to increase in the number of milch animals. This fact has already been supported by the results of the inventory equation, wherein we have found that milk prices did not exert any significant influence on the milch animal numbers.

The price of foodgrains did not work out to be a significant factor. The data clearly showed that both supply of milk as well as price of foodgrains continued to move in the same direction over years. The farmers were probably prompted to increase milk supply (production) in order to meet the increased cost of production of milk. And, it is well known that the feedgrains constituted the major proportion of the cattle feed. Also, the majority of the farmers use their home-produced feedgrains to feed their milch animals. These foodgrains have been evaluated at the farm harvest prices. The market price of cattle-feed if taken would have shown a different result. We could not introduce this variable because the time series data on this were not readily available.

The elasticities of milk supply with respect to the total inventory of milch animals, farm milk price, number of artificially inseminated cows and buffaloes and price of foodgrains were estimated at 0.5231, 0.3080, 0.0738 and 0.0255, respectively (Table 4.2). The milk supply was increased by about 5.2 per cent in response to a 10-per cent increase in the total inventory of milch animals. A 10-per cent rise in milk price would increase milk supply by about 3.1 per cent. This clearly showed that when milk price was increased, the farmers increased milk production to increase their farm incomes. the supply of milk w.r.t. the number of cross-bred milch animals was though less elastic yet highly significant.

## Price Equation of Milk

Price of milk was endogenised taking production of milk, value of milk and milk products procured by cooperatives, general level of prices and per capita income of the people in the state as endogenous variables.

The five explanatory variables together explained as high as 99.04 per cent of variation in the average farm price of milk. The d-statistic suggested no evidence of autocorrelation in the errors of this equation.

The parameter on the supply of milk was found to be significant at 0.05 probability level. The value of milk and milk products as procured by the cooperative societies wasconsidered as a 'proxy' for the demand of milk for manufacturing purposes by milk plants. This variable, however, did not play a significant role in influencing milk prices though the parameter on this variable had the expected positive sign. The general price index had a significant and positive impact on the price of milk. Increase in per capita income did not show any significant impact on the increase in milk prices.

The elasticity of price with respect to milk supply was near to unity. This relationship was though unexpected on 'apriori' grounds, yet not uncommon in the real world especially when the demand of this commodity continuously increased due to increasing population over years. The price of milk would increase by about 3.0 per cent in response to a 10-per cent point increase in the index of general prices. The milk price was extremely inelastic with respect to the demand by cooperatives and per capita income, the elasticities being 0.0117 and 0.0705, respectively.

## Area Response Equation for Fodders

Since the time-series data on prices of different rabi and kharif fodders were not available, the area response function of fodders was primarily based on non-price variables such as gross cropped area of the state, net irrigated area of the state, total livestock units to be fed and lagged area of fodders. The farm price of milk and wholesale prices of agricultural commodities (foodgrains and non-foodgrains) were the price factors assumed to affect area allocation to fodders.

The six exogenous variables included in this equation have jointly explained 74.77 per cent of variation in the area under fodders. The value of the d-statistic indicated that the errors of this equation were nto autocorrelated. The value of h-statistic could not be worked out as the formula did not hold good in the present case.

The parameter on the price of milk was significant at 0.20 probability level. The increase in the price of milk would induce farmers to allocate more area to fodders. The low level significance of thiis price variable was due to aggregation bias since the area under fodders was the aggregate area meant to feed all types of animals and not only for milch animals.

The parameter of the net irrigated area of the State was found to be negatively significant at 0.01 probability level. Apparently, it was due to the reason that increased irrgation had attracted more area for cereal crops rather than crops of low-importance like fodders. Likewise, the impact of the increase in the gross cropped area of the State on the area allocation to fodders was significantly negative. This happened also due to the increased allocation of land to more remunerative cereal crops. The area of fodders would significantly increase with the increase in the total inventory of livestock, the parameter on this variable being significant at 0.025 probability level. Further, it was also observed that the increase in the prices of agricultural commodities (foodgrains and non-foodgrains) caused a decline in the area under fodders, though this decline lacked statistical significance.

The elasticities of fodder area with respect to the gross cropped area and the net irrigated area of the state worked out to -1.4848 and -1.3263, respectively, indicating that fodder area was negatively highly elastic to these two variables. The area was also found to be highly elastic to the increase in the total livestock inventory in the state. It was found that area under fodders would increase by about 1.5 per cent in response to a 10- per cent increase in the farm price of milk.

**Table 4.1 Three-stage lease squares (3SLS) parameter estimates, their SE's and other related statistics for simultaneous equations of the livestock sector model of Punjab, 1995-96 through 2015-16**

| Endogenous variables | Exogenous variables | Units of variables | Parameter estimates | Standard errors | t-values | other related statistics |
|---|---|---|---|---|---|---|
| QCN | Intercept | | -365.8783**** | 93.3106 | 3.921 | $R^2$ = 0.9906 |
| | QM | 000' tonnes | 0.2369**** | 0.0546 | 4.339 | F = 393.891 |
| | NAICB | 000' numbers | 0.2048**** | 0.0541 | 3.786 | p = -0.0587 |
| | NDMSCS | Numbers | 0.0066* | 0.0278 | 0.237 | d = 2.0809 |
| | PEXDAH | Rupees lakhs | 0.2181* | 0.1246 | 1.750 | |
| NMCB | Intercept | | 1179.7225** | 553.4517 | 2.132 | $R^2$ = 0.9039 |
| | YLS | Rupees Crores | 2.2778**** | 0.6164 | 3.695 | F = 26.349 |
| | FPM | Rs/Quintal | -1.2786 | 1.6502 | 0.775 | p = 0.3272 |
| | AFD | 000' hectares | 0.3801 | 0.6716 | 0.566 | d = 1.2384 |
| | NAICB | 000' numbers | -0.9047**** | 0.2190 | 4.131 | |
| | PFEEDG-1 | Rs/quintal | 0.1295 | 1.4862 | 0.087 | |
| QM | Intercept | | 182.6433* | 122.6842 | 1.489 | $R^2$ = 0.9963 |
| | NMCB | 000' numbers | 0.7617**** | 0.0968 | 7.869 | F = 1010.593 |
| | FPM | Rs/quintal | 4.5359**** | 0.6557 | 6.918 | p = 0.3772 |
| | NAICB | 000' numbers | 0.5976**** | 0.1659 | 3.6032 | d = 1.1504 |
| | PFEEDG-1 | Rs/quintal | 0.7171[a] | 0.7060 | 1.016 | |
| FPM | Intercept | | -65.1300* | 45.8587 | 1.420 | $R^2$ = 0.9904 |
| | QM | 000' numbers | 0.0669** | 0.0357 | 1.874 | F = 387.765 |
| | VYMMPCS | Rupees lakhs | 0.0056 | 0.0074 | 0.757 | p = -0.2901 |
| | P | Index, base: 2014-15 to 2016-17 = 100 | 0.3017** | 0.1481 | 2.037 | d = 2.4662 |
| | PCI | | 0.6610 | 2.5015 | 0.264 | |
| AFD | Intercept | | 890.3356**** | 253.7616 | 3.509 | |
| | FPM | Rs/quintal | 0.6603[a] | 0.4990 | 1.323 | $R^2$ = 0.7477 |
| | A | 000' hectares | -0.1866** | 0.1030 | 1.812 | F = 6.420 |
| | NIRAS | Per cent | -13.6937**** | 4.9088 | 2.790 | p = -0.0687 |
| | TLSU | Lakh units | 25.1968** | 11.4846 | 2.194 | d = 2.0477 |
| | AFD-1 | 000' hectares | -0.2388[a] | 0.2568 | 0.930 | h = Not possible |
| | WPA-1 | Index, base : 2014-15 to 2016-17 = 100 | -0.5192 | 0.6369 | 0.815 | |

*, **, *** and *** Significant at 0.10, 0.05, 0.025 and 0.01 probability levels, respectively
a denotes significant at 0.20 probability level.

**Table 4.2 Estimated elasticities of endogenous variables of the livestock sector model with respect to their exogenous variables at the variable means, 1995-96 through 2015-16 period**

| Elasticity of | | With respect to | Elasticity estimates (Short-run) |
|---|---|---|---|
| Gross income | 1. | Supply of milk | 1.5863 |
| | 2. | No. of artificially inseminated cows and buffaloes | 0.1995 |
| | 3. | No. of dairy and milk supply cooperative societies | 0.0271 |
| | 4. | Govt. expenditure on the development of dairy and animal husbandary | 0.1202 |
| No. of milch cows and buffaloes | 1. | Gross income of the livestock sector | 0.4954 |
| | 2. | Farm price of milk | -0.1264 |
| | 3. | Area under fodders | 0.1620 |
| | 4. | No. of artificially inseminated cows and buffaloes | -0.1917 |
| | 5. | Price of foodgrains during the preceding year | 0.0064 |
| Supply of milk | 1. | No. of milch cows and buffaloes | 0.5231 |
| | 2. | Farm price of milk | 0.3080 |
| | 3. | No. of artificially inseminated cows and buffaloes | 0.0738 |
| | 4. | Price of foodgrains | 0.0255 |

| | | | |
|---|---|---|---|
| Farm price of milk | 1. | Supply of milk | 0.9852 |
| | 2. | Value of milk and milk products procured by the cooperative societies | 0.0117 |
| | 3. | General price index | 0.2973 |
| | 4. | Per capita income in Punjab | 0.0705 |
| Area under fodders | 1. | Farm price of milk | 0.1532 |
| | 2. | Gross cropped area of the state | -1.4848 |
| | 3. | Net irrigated area of the state | -1.3263 |
| | 4. | Total livestock inventory in the state | 2.8372 |
| | 5. | Area under fodders during the proceding year | -0.2403 |
| | 6. | Agricultural prices during the preceding year | -0.0978 |

## Testing of the Validity of Crop Models

The results of the statistics, viz., Thiel's U-Coefficients both for absolute and relative changes for 23 endogenous variables of 7 crop commodity sub-models are presented in Table 4.3.

The test coefficients of this table would suggest whether the performance of the model in tracking the inter-temporal path of the endogenous variables was reasonably good or not good.

Since no particular limits for acceptance or rejection of the validity for the Mean Absolute Percentage Error and Root Mean Square Error are prescribed, we cannot decide upon the good or bad tracking ability of the model on the basis of these test statistics.

In the ultimate choice, we have thus relied upon the Theil's Inequality Coefficient, the value of which through ranges

The estimated values of U-coefficients for the five endogenous variables of the livestock sector model are shown in Table 6.2.

**Table 4.3 Test Coefficients for Testing the Validity of the Livestock Sector Model, 1995-96 through 2015-16**

| | Model endogenous variables | U-coefficients (absolute changes) | U-coefficients (relative changes) |
|---|---|---|---|
| 1. | Gross income as originated from the IS sector | 0.5465 | 0.7328 |
| 2. | Inventory of milch animals | 2.2133 | 1.9314 |
| 3. | Milk supply (production) | 0.9268 | 1.0231 |
| 4. | Price of milk | 0.3885 | 0.5612 |
| 5. | Area under fodders | 0.6187 | 0.6324 |

The Thiel-U coefficients for gross income, price of milk and area under fodders were all less than unity indicating good forecasting performance of the tracking ability of the model for these variables. The U-coefficient for relative deviations in the predicted and actual milk supply values was slightly more than unity. However, the value of the inequality coefficient for absolute change was less than unity, which suggested that the change in the absolute levels of milk supply could be predicted better than the relative changes in the variable levels.

The inequality coefficients for both absolute and relative changes were greater than unity (U=2.2135 and 1.9314, respectively) for inventory of milch animals. This implied that the predictive power of the model for this variable was worse than the zero-change prediction. This outcome, however, did not seem to be surprising, since the time series on this variable was available only at different points in time and the gaps were filled up by compound growth rate method based on the Livestock Censuses figures.

Gross income of the livestock sector was highly elastic to total milk supply in the state. The increase in the cross-bred milch animals and government spending for the development of dairy and animal husbandry significantly increased the gross income of the livestock sector. The increasing level of the aggregate income of the farmers would induce them to keep more milch animals in order to further supplement their farm income. It was interesting to find that as the number of cross-bred milch animals increased, the total inventory of milch animals has significantly decreased. This has clearly revealed that farmers have started realizing that keeping less number of high-yielding milch animals was more remunerative than keeping more milch animals with low yielding capacities.

Total number of milch cows and buffaloes, number of artificially inseminated cows and buffaloes and farm prices of milk had positively and significantly affected the total supply of milk in the State. The price of milk was found to be nearly uniteryelastic to the supply of milk in the State. Though this relationship seemed to be unexpected on 'a priorl' grounds, yet it was not contrary to the fact that price of milk did not decrease as supply increased because of effective demand of milk from increasing number of consumers over years.

Increased irrigation in the state had attracted more area to cereal crops rather than crops of low importance like fodders. The area under fodders was found to be significantly highly elastic to both net irrigated area and gross cropped area of the State, the elasticises being -1.48 and -1.31, respectively. It was positively highly elastic to total livestock inventory, the elasticity being 2.84.

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