CHAPTER - VI

Supply Responses in Sugarcane Crop
Sugarcane, in India has a long and rich history, which makes the country second largest producer of sugar in the world. The demand for sweeteners and sugarcane based product is likely to grow steadily due to increasing production of mill sugar, Khandasari and sugar as a major industry. Sugarcane is an important commercial crop grown in the Andhra Pradesh state. It is mainly an irrigated crop. The Adsali variety crop is a long duration crop, which grown in the month of December/January and harvested in February/March of the succeeding year.

Sugarcane is one of the major commercial crops in India. The year 2005 will go down as the revival year in cash crop segment. It is in the form of higher income for growers due to rising prices but not higher production. Sugarcane is the most widely produced cash crop in India. However, of late, sugarcane production was seen disappointing. For instance, during 2000-2005, cane production increase is a negligible increase during 2005-06, it increased by 7 percent.

Production of sugarcane during 2006-07 was at an all-time record level of 355.52 million tonnes. The production declined marginally to 348.19 million tonnes in 2007-08. However, due to area shift to more profitable crops, there was sharp decline in the production of sugarcane to 285.03 million tonnes and 277.75 million tonnes respectively during 2008-09 and
2009-10. During the current year the area coverage under sugarcane has increased and its production is estimated at 324.91 million tonnes i.e. higher by 47.16 million tonnes as compared to 2009-10.

**Analysis:**

**Equation -- 3**

It was best fitted the log-linear regression models to study the supply response of sugarcane (selected oilseeds crop). The analysis was carried out for three regions namely Rayalaseema, Coastal Andhra, Telangana separately and Andhra Pradesh state as a whole. For convenient study, region-wise analysis was taken to evaluate and analyse the results. The inter-regional analysis was also given to compare the combined and individual effect of independent variables on dependent variable of sugarcane crop among the three regions and state as a whole. In the present study, the dependent variable was the area under sugarcane crop in current year \(A_t\), and the independent variables are lagged farm harvest price \(P_{t-1}\) and lagged year area \(A_{t-1}\). The results are drawn to study the combined and individual effect of both lagged price \(P_{t-1}\) and lagged area \(A_{t-1}\) on current year cropping area of sugarcane. The data was fed to equation -3 which is supply (area) response function and the results were shown in the following table.
Rayalaseema Region:

From the table 6.1, the value of multiple correlation coefficients ($R^2$) is 0.2988. It is observed that the combined effect of both independent variables i.e., lagged price ($P_{t-1}$) and lagged area ($A_{t-1}$) on dependent variable i.e., current year cropping area of sugarcane in the Rayalaseemaregion is nearly 30 per cent and tested by F-test statistic as significant. Only 30 per cent of variation in come area was recouped by the two independent variables which is significant also. The value of adjusted correlation coefficient ($\tilde{R}^2$) is 0.2378. The value of coefficient of constant term i.e., $b_0$ is 5.7049.

The coefficient of lagged price ($P_{t-1}$) is 0.0949. It shows that the current year cropping area of sugarcane is affecting positively by independent variable. It means as increases the lagged price it must raise the current year cropping area of sugarcane by its growers. This raise is insignificant. The coefficient of lagged area ($A_{t-1}$) is 0.3903. It indicates that there is a positive relationship between dependent and independent variable. A unit increase in lagged area will increase the cane area by 0.11 units. It means as the lagged area ($A_{t-1}$) increases the current year area under sugarcane crop may be raised significantly by its growers in the region.

Hence, it may possibly to draw conclusion that although lagged price ($P_{t-1}$) and lagged area ($A_{t-1}$) are affecting positively the current year area
under sugarcane \( (A_t) \) only the effect of lagged area on dependent variable is significant.

Table: 6.1
Estimated supply response function of Sugarcane crop for Equation-3

<table>
<thead>
<tr>
<th>Regions</th>
<th>Estimated Values</th>
<th></th>
<th>R²</th>
<th>R²</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( b_0 )</td>
<td>( P_{t-1} )</td>
<td>( A_{t-1} )</td>
<td>( R^2 )</td>
<td>( R^2 )</td>
</tr>
<tr>
<td>Rayalaseema</td>
<td>5.7049 (1.8409)</td>
<td>0.0949 (0.0825)</td>
<td>0.3903* (0.1970)</td>
<td>0.2988</td>
<td>0.2378</td>
</tr>
<tr>
<td>Coastal Andhra</td>
<td>3.5954 (1.6168)</td>
<td>0.0230 (0.0259)</td>
<td>0.6810* (0.1465)</td>
<td>0.6355</td>
<td>0.6038</td>
</tr>
<tr>
<td>Telangana</td>
<td>8.7770 (2.2495)</td>
<td>0.0605 (0.0844)</td>
<td>0.1535* (0.2073)</td>
<td>0.0499</td>
<td>-0.3267</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>6.6008 (2.3467)</td>
<td>0.1012 (0.0724)</td>
<td>0.4073* (0.2155)</td>
<td>0.4127</td>
<td>0.3617</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses are standard error of the estimates.
*Significant at five per cent probability level.

Coastal Andhra region:

From the estimated equation-3 for Coastal Andhra region, the value of the collective effect of both independent variables i.e., lagged price \( (P_{t-1}) \) and lagged area \( (A_{t-1}) \) on dependent variable i.e., current year cropping area of sugarcane \( (A_t) \) is 0.6355. It is observed to be the significant (20.0501) relation between independent variables and dependent variable. Over the 63.5 per cent of variation was noticed by these two variables who
estimate on the dependent variable sugarcane area in the coastal Andhra region. It is a significant variation. The value of adjusted multiple correlation coefficients ($R^2$) is 0.6038. The value of coefficient of constant term i.e., $b_0$ is 3.5954.

In continuation with the study individual effect of independent variables, the coefficient of lagged price ($P_{t-1}$) is 0.0230 and reveals that the effect of the lagged price on current year cropping area of cane is positively insignificant. This positive figure shows that there is only 2 per cent of increase in dependent variable due to increase in lagged price ($P_{t-1}$). This increase is insignificant. But the coefficient of lagged area ($A_{t-1}$) on current year cropping area of sugarcane is 0.6810. It means current year cropping area of sugarcane may increase by 68 per cent as increase in lagged area ($A_{t-1}$) during the study period. It is tested by t-test statistic as significant at 95 per cent of confidence. It observed that in coastal region, the cane area is significantly affected by lagged area but not by its lagged price.

**Telangana region:**

The results of estimated equation-3 are shown in the table 6.1 for Telangana region in Andhra Pradesh state relating to sugarcane crop. These results are drawn to study the effect of lagged price of sugarcane and lagged area of sugarcane on current year cropping area of sugarcane.
The coefficient of lagged price ($P_{t-1}$) is (0.0605) positive but not significant and it reveals that an increase in lagged price caused to increase in current year cropping area of sugarcane ($A_t$) by 6 per cent. This increase is positively insignificant. The coefficient of lagged area ($A_{t-1}$) is 0.1535. It indicates that current year cropping area of cane is nearly rising by 15 per cent due to increase in lagged area ($A_{t-1}$) during the study period. It is tested by t-test statistic as significant at 5 per cent probability level. The value of coefficient of constant term is 8.7770.

The combined effect ($R^2$) of both independent variables on dependent variable is 0.0499. It shows that the combined effect of lagged price ($P_{t-1}$) and lagged area ($A_{t-1}$) on current year cropping area of sugarcane ($A_t$) is 4 per cent during the study period and tested by F-test statistic and found as insignificant. The adjusted multiple correlation coefficients ($\bar{R}^2$) is -0.3267.

**Andhra Pradesh state:**

To study the effect of both independent variables (lagged price ($P_{t-1}$) and lagged area ($A_{t-1}$)) on dependent variable (current year cropping area of sugarcane ($A_t$)) in Andhra Pradesh state as a whole, it is used the equations-3, given in methodology and show in the table-6.8. The combined effect of lagged price ($P_{t-1}$) and lagged area ($A_{t-1}$), on current year cropping area of sugarcane is 0.4127. It is observed that the combined effect of all independent variables on dependent variable is 41.27 per cent.
during the study period and tested by F-test statistic and it is found as significant at 95 per cent of confidence. The value of coefficient $b_o$ is 6.6008.

To study the individual effect of two selected independent variables lagged price and lagged area on dependent variable current year current year cropping area of sugarcane in Andhra Pradesh state as a whole, it is analysed individually. The coefficient of lagged price ($P_{t-1}$) is 0.1012. It reveals that the effect of the lagged price on current year cropping area of cane is positively insignificant. Therefore, the cane area is not price responsive. But the coefficient of lagged area ($A_{t-1}$) is 0.4073. It is observed that the lagged area’s effect on current year cane area is positive. It indicates that 40 per cent of lagged area’s effect was noticed during the study period. It is tested by t-test statistic as significant at 5 per cent probability level.

**Inter-regional analysis:**

According to the equation-3, the combined effect of both independent variables on dependent variable is calculated by the multiple correlation coefficients ($R^2$). It is tested by F-test statistic as significant at 5 per cent probability level. The effect of lagged price ($P_{t-1}$) on current year cropping area ($A_t$) is positive and insignificant whole study area. The effect
of lagged area \(A_{t-1}\) on current year cropping area \(A_t\) is positive and significant in all regions and state as a whole in the study period.

**Equation -- 6**

To study the supply response of sugarcane the log-linear regression models are best fitted and are adopted. The study was carried out for three regions namely Rayalaseema, Coastal Andhra, Telangana separately and Andhra Pradesh state as a whole. For convenient study, region-wise analysis was taken to evaluate and analyse the results. The inter-regional analysis was also given to compare the combined and individual effect of independent variables on dependent variable i.e., sugarcane among the three regions and state as a whole. In the present study, the dependent variable is the current year cropping area of sugarcane \(A_t\), and the independent variables are lagged farm harvest price \(P_{t-1}\), lagged yield \(Y_{t-1}\), the coefficient of variation of preceding three years price \(CV_p\), the coefficient of variation of preceding three years yield \(CV_Y\), current year rainfall \(R_t\), current irrigated area \(I_t\), dummy variable \(D\) and lagged year area \(A_{t-1}\). The data feed to equation-6 which is supply response functions and the results were shown in subsequent table.

**Rayalaseema Region:**
To study the combined effect of all independent variables on dependent variable simultaneously, it is calculated the multiple correlation coefficients ($R^2$). The value of multiple correlation coefficients is 0.9959. It indicates that the collective effect of all independent variables namely, lagged farm harvest price ($P_{t-1}$), lagged yield ($Y_{t-1}$), the coefficient of variation of preceding three years price ($CV_p$), the coefficient of variation of preceding three years yield ($CV_Y$), current year rainfall ($R_t$), current irrigated area ($I_t$) dummy variable (D) and lagged year area ($A_{t-1}$) on current year cropping area of sugarcane ($A_t$) is roughly 99.6 per cent and is tested by F-test statistic as significant (15.2116). Hence, 99.6 per cent of variation in sugarcane area was recorded by all these independent variables. The value of adjusted multiple correlation ($\tilde{R}^2$) is 0.9739.

The coefficient of lagged price ($P_{t-1}$) is 0.0131; the coefficient of lagged yield ($Y_{t-1}$) is 0.0145; the coefficient of variation of preceding three years price ($CV_p$) is 0.0032; the coefficient of variation of preceding three years yield ($CV_Y$) is 0.0043 and the coefficient of lagged area ($A_{t-1}$) is 3.6599. These figures are shows that there is a positive relationship with current year cropping area of sugarcane. It means an increases in the lagged price ($P_{t-1}$), lagged yield ($Y_{t-1}$), the variation of preceding three years price ($CV_p$), the variation of preceding three years yield ($CV_Y$) and lagged area ($A_{t-1}$) it may be raised the current year cropping area of sugarcane ($A_t$).
by its growers in the region insignificantly. However, the independent variable i.e., irrigated area \( (I_t) \) is showing (0.9506) it’s positive and significant effect on current year current year cropping area of cane \( (A_t) \). It indicates that as the irrigated area of cane increases the current year cropping area under cane is raised up significantly by its growers is for every one unit increase in it will increase at by 0.95 units. This increase in sugarcane area in the region is a significant increase.

Contradictorily, the coefficient of current year rainfall \( (R_t) \) is -0.0308 showing its negative and insignificant effect on cropping area of sugarcane \( (A_t) \). It indicates as the current year rainfall increases the current year area under sugarcane declined by its growers. But this decline is insignificant. The coefficient of intercept term is 0.2715. So, it may infer that the dependent variable is primarily affecting positively and significantly with only one independent variable i.e., irrigated area \( (I_t; 0.9506) \) as certain as 95 per cent. Hence, it is concluded that the sugarcane area is responded irrigated area only but not the price.
Table: 6.2
Estimated supply response function of Sugarcane crop for Equation-6

<table>
<thead>
<tr>
<th>Regions</th>
<th>Estimated Values</th>
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<th></th>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b_0$</td>
<td>$P_{t-1}$</td>
<td>$Y_{t-1}$</td>
<td>$CV_p$</td>
<td>$CV_y$</td>
<td>$R_t$</td>
<td>$I_t$</td>
<td>$D$</td>
<td>$A_{t-1}$</td>
<td>$R^2$</td>
<td>$R^2$</td>
<td>$F$</td>
</tr>
<tr>
<td>Rayalaseema</td>
<td>0.2715 (0.2694)</td>
<td>0.0131 (0.0119)</td>
<td>0.0145 (0.0166)</td>
<td>0.0032 (0.0055)</td>
<td>0.0043 (0.0043)</td>
<td>-0.0308 (0.0163)</td>
<td>0.9506* (0.0193)</td>
<td>0.0038 (0.0017)</td>
<td>0.0246 (0.0213)</td>
<td>0.9959</td>
<td>0.9739</td>
<td>15.2116*</td>
</tr>
<tr>
<td>Coastal Andhra</td>
<td>-0.1860 (0.4267)</td>
<td>-0.0064 (0.0047)</td>
<td>-0.0355 (0.0281)</td>
<td>-0.0049 (0.0045)</td>
<td>0.0005 (0.0045)</td>
<td>0.0047 (0.0139)</td>
<td>1.0754 (0.0258)</td>
<td>0.0022 (0.0016)</td>
<td>-0.0273 (0.0249)</td>
<td>0.9976</td>
<td>0.9965</td>
<td>8.8331</td>
</tr>
<tr>
<td>Telangana</td>
<td>0.8663 (0.0783)</td>
<td>-0.0031 (0.0030)</td>
<td>-0.0034 (0.0046)</td>
<td>-0.0013 (0.0014)</td>
<td>-0.0009 (0.0016)</td>
<td>0.0017 (0.0049)</td>
<td>0.9285 (0.0046)</td>
<td>-2.9137 (0.0005)</td>
<td>0.0019 (0.0041)</td>
<td>0.9998</td>
<td>0.9997</td>
<td>10.4985*</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>0.3291 (0.2725)</td>
<td>0.0056 (0.0069)</td>
<td>-0.0012 (0.0137)</td>
<td>-0.0029 (0.0028)</td>
<td>0.0012 (0.0028)</td>
<td>-0.0035 (0.0081)</td>
<td>0.9894 (0.0125)</td>
<td>0.0004 (0.0008)</td>
<td>-0.0148 (0.0175)</td>
<td>0.9989</td>
<td>0.9985</td>
<td>20.3547*</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses are standard errors of the estimates.

*Significant at five per cent probability level.
Coastal Andhra region:

To study the collective effect of all independent variables on dependent variable, it was adopted the multiple correlation co-efficient ($R^2$). The coefficient of multiple correlations co-efficient is 0.9976. It shows that the combined effect of all independent variables on current year cropping area of sugarcane is roughly 100 per cent during the study period. It is tested by F-test statistic as significant at 5 per cent level of probability in the study period. More than 99 per cent of variation in cane area were recorded by these selected variables in the middle. The adjusted value of multiple correlation coefficients ($\bar{R}^2$) is 0.9965. The coefficient of $b_o$ (constant) is -0.1860.

As a part, to study the individual effect, the coefficients of lagged price ($P_{t-1}$), lagged yield ($Y_{t-1}$), the variation of preceding three years price ($CV_p$) and lagged area ($A_{t-1}$) are showing its negative and insignificant effects on current year this variation in sugarcane area is a significant variation in coastal Andhra region. Cropping area of sugarcane ($A_t$) as -0.0064, -0.355, -0.0049 and -0.0273 respectively. Those all figures indicate that any increase in above said independent variables causes to damaging effect. An increase in each of these independent variables will decrease the cane area. But this damaging effect is insignificant.
Contradictorily, The effect of the remaining independent variables i.e., the coefficient of variation of preceding three years yield ($CV_Y$) and current year rainfall ($R_t$) are showing its effect on current year cropping area of sugarcane ($A_t$) as (0.0005 and 0.0047 respectively). It means as increases in these variables $CV_Y$ and $R_t$, increasing a few width of area in current year current year cropping area of sugarcane. This increase is insignificant. However, irrigated area ($I_t$) is causing to effect much more in (1.0754) current year cropping area of sugarcane ($A_t$) in the study area. It means as increase in irrigated area ($I_t$) it is grounding to increase in cropping area of sugarcane by 107 per cent in the study period. This increment is significant at 5 per cent of probability level in Coastal Andhra region in the study period. So, it may draw finding that only the impendent variable, irrigated area ($I_t$) is affecting the current year cropping area of sugarcane ($A_t$) positively and significantly. Though the sugarcane is commercial crop its area is signify affected by its irrigated area not by its price.

Telangana:

In continuation with the study of collective effect of independent variables namely, lagged price ($P_{t-1}$), lagged yield ($Y_{t-1}$), the coefficient of variation of preceding three years price ($CV_p$), the coefficient of variation of preceding three years yield ($CV_Y$), current year rainfall ($R_t$) current irrigated area ($I_t$), the effect of the left out variables like new technology,
HYV, use of fertilisers and chemicals etc., is shown by the dummy variable (D) and lagged area (A_{t-1}) on dependent variable i.e., current year cropping area of sugarcane (A_t) in Telangana region, is estimated by adopting the equation-6. The findings of all variables are shown in table-6.2.

The value of multiple correlation coefficients (R^2) is 0.9998. It reveals that the aggregate effect of all independent variables on dependent variable is nearly 100 per cent during the study period and it was tested by F-test statistic (10.4985) and found significant at 5 per cent probability level. It is observed that the correlation between all independent variables and dependent variable is centper cent. The value of adjusted multiple correlation coefficients (\(\bar{R}^2\)) is 0.9698. The value of coefficient of constant term i.e., b_0 is 0.8663. It was recorded that almost 100 per cent variation in cane area by all independent variables in Telangana region, it is a significant variation.

From the above table, the values of coefficients of lagged price (P_{t-1}), lagged yield (Y_{t-1}), the variation of preceding three years price (CV_p) and the variation of preceding three years yield (CV_Y) are -0.0031, -0.0034, -0.0013 and -0.0009 respectively. All these variables each established a negative relationship with sugarcane area in the region. These effects are negatively insignificant. So, there is no possible to increase the current
year cropping area of sugarcane ($A_t$) by increasing the above said independent variables.

Adversely, the effect of current year rainfall ($R_t$) and lagged area ($A_{t-1}$) are showing its positive effect on the current year cropping area of sugarcane ($A_t$). It indicates that as increases the current year rainfall ($R_t$) and lagged area ($A_{t-1}$) it may raise the current year cropping area of sugarcane by its growers in significantly. However, independent variable i.e., irrigated area ($I_t$) is positively and significantly causing to increase by 92 per cent in the current year cropping area of sugarcane ($A_t$). It means as increase the provision of irrigation to cane there must be raise the current year cropping area of sugarcane by its growers significantly. The value of the left out variables like new technology, HYV etc., is shown by the dummy variable (D) and is -2.9137. It reveals that the result of dummy variable is negatively and significantly affects the dependent variable. The negative and significant effect of the variable reveals that these is a scope to raise the cane area by increasing the units of the dummy variable, the new teaching HYV seeds, fertilizing and pesticides, mechanization etc.,

So, it may assume that out of eight independent variables one and only is causing to increase in the current year cropping area of cane ($A_t$) as significantly in study period in Telangana region.
Andhra Pradesh state:

In addition to regional study, it was also planned to study the effect of all independent variables on dependent variable in the Andhra Pradesh state as a whole. For this she multiple regression equation-6 was estimated and the results are shown in the cane-6.2 analysed the individual effect of independent variables on dependent variable. The coefficient of lagged price ($P_{t-1}$) is 0.0056 and reveals that the effect of the lagged price on current year cropping area of sugarcane is positively insignificant. It means the cane growers can increase a few hectares as increases the lagged price($P_{t-1}$). This is considered as a negligible price effect cane area. The coefficient of variation of preceding three years yield ($CV_Y$) is 0.0012. It is also showing positively insignificant effect on dependent variable. However, the dependent variable, current year cropping area of sugarcane is positively affected by the irrigated area by 99 per cent. It reveals that any increase in irrigated area it must raise the current year cropping area of sugarcane by 99 per cent by its cultivators. This increase is significant at 5 per cent probability level in the study area.

To study the collective effect of all variables on dependent variables sugarcane area, the multiple correlation coefficients was calculated. The value of R2 is 0.9989. it expresses that the dominated effect of selected all variables in the model is 99.9 per cent. It is inferred that the aggregate
effect of all independent variables shared 99.9 per cent of variation in the
current year sugarcane area in the state of Andhra Pradesh.  

Inconsistently the coefficients of lagged yield ($Y_{t-1}$), the variation of
preceding three years price ($CV_p$), current year rainfall ($R_t$) and lagged area
($A_{t-1}$) are -0.0012, -0.0029, -0.0035 and -0.0148 respectively. These figures
indicate that these variables effects on current year cropping area of
sugarcane are negative but insignificant. The coefficient of the dummy
variable (D) is -0.0004. It reveals that the effect of left out variables is
positively insignificant. (Negligible)

**Inter-regional analysis:**

In continuation with the equation-6, in the view of inter-regional
analysis, the effect of lagged price ($P_{t-1}$) on cropping area of ($A_t$) is positive
and insignificant in Rayalaseema region and Andhra Pradesh state a whole.
But it is negatively insignificant in remaining study area. Similarly, the
dependent variable is negatively affected by lagged yield ($Y_{t-1}$) in Coastal
Andhra and Telangana regions and Andhra Pradesh state a whole.
Contradictorily, in Rayalaseema region is positively affected. But these
both positive and negative effects are certainly insignificant. Whereas, the
finding of coefficient of variation of preceding three years price ($CV_p$) is
negative in whole study area except Rayalaseema region. And this effect is
measured as insignificant. The coefficient of variation of preceding three
years yield ($CV_y$) is positively insignificant in Rayalaseema and Coastal
Andhra regions and Andhra Pradesh state a whole. But the effect of CV is negative and insignificant in Telangana region.

On the other hand the independent variable, rainfall (Rt) is also negatively and insignificantly affecting the cropping area (At) of sugarcane in Rayalaseema region and state as a whole. But it is positively affecting in Coastal Andhra and Telangana regions. The cropping area (At) of sugarcane (dependent variable) is positively caused by the irrigated area (It) for a lot in whole study area and is insignificant in whole study area. In continuation of the above variables, the consequence of the left out variables like new technology, HYV (dummy variable) on current year cropping area (At) of sugarcane is positively insignificant in Rayalaseema and Coastal Andhra regions except in remaining region (Telangana region) and state as a whole. The influence of lagged area (At-1) on current year of current year cropping area (At) of sugarcane in Rayalaseema and Telangana regions is positive and insignificant. But in Coastal Andhra region and state as a whole it is negatively insignificant affected the current year cropping area (At) of sugarcane.

It was found unique figures for multiple correlation coefficients (R^2) in all regions and state as a whole. It shows that the combined effect of all independent variables on dependent variable is in unique form and tested by F-test statistic as significant at 5 per cent probability level in all regions and state as a whole in the study period (1986-87 to 2010-11).