The paper seeks to examine the growth behaviour of area, yield and production of American cotton and their association with its most influential factor price. The correlation of area, yield and production with price has been examined in this paper as well as impact of lagged year’s price has also been observed. The contribution of area, yield, price and their interaction has also been discussed. The results indicated that during first and second period, the American cotton production has risen due to its area increment. The role of the yield has not found as major as expected. However, there has been drastic change in the situation regarding yield during this period. The new technology especially high-yielding varieties of seeds provided to farmers remained enough to motivate farmers of Haryana to replace the Desi cotton with American cotton but at the same time the correlation between price and other variables has not found very high during third period whether it has observed negative during all sub-study period regarding to yield. However, the lagged price of American cotton has succeeded to influence the current year’s area, yield and production. As far as contribution of price to the incremental output in value term is related, price has remained the major factor during all the periods except for the third period during which its position has been overtaken by the American cotton.

Key words: Acreage, Area, Price, Production, Yield.

INTRODUCTION

Every private producer in this world tries to maximise his gain as suggested by theories of economic world which study the behaviour of the producers. As agricultural production is largely a private business, carried on in millions of farms, efforts to promote agricultural progress must be persuasive and must work through the market forces. In order to boost up the crop production, either more area is to brought under the crop and thereby the total production is increased or the inputs may be used at economic optimum level and thereby increase the productivity of the crops. More prices may attract the farmers to make these efforts fruitful by attaining the goal of profit maximisation. Therefore, the price policy is an important instrument for positive change. Further the success of any policy depends on the behaviour response of those who are affected by it and the impact of this response on the objectives of the policy. It is in this content that the response of farmers to changes in prices of their products has attracted the attention of the economists and the policy makers. Broadly, with these objectives in mind, an attempt is made to estimate the response of farmers regarding area, yield and production of American cotton in Haryana in this study.

American cotton is an important cash crop of the people in Haryana state. It would be interesting to know that whether there were any structural changes in the area, yield and production of American cotton during the study period. The thirty years study periods tries to find out the structural changes in growth of area, yield and production of Haryana state.

MATERIALS AND METHODS

Period of the Study: The present study has been taken to draw the results for the period from 1978-79 to 2007-08 for the Haryana state. FHPs have been analyzed as they have a direct bearing on decisions of the farmers as what to produce. The data have been compiled and analyzed for the period 1978-79 to 2007-08 by dividing the entire study period into three periods as fist period from 1978-79 to 1987-88, second period from 1988-89 to 1997-98 and third period from 1998-99 to 2007-08. The related figures have also been computed for the entire study period.

Sources and collection of data: The present study is based on secondary data collected from various published issues. The data related to Farm Harvest Prices (FHPs) and yields...
have been obtained from different yearly published Statistical Abstracts of Haryana, various issues of ‘Package of Practices’ for Kharif and Rabi Crops published by Directorate of Extension Education, CCS HAU, Hisar and ‘Indian Agriculture at a Glance’ published by Ministry of Agriculture, Govt. of India, Krishi Bhawan, New Delhi for the study period. Income from different crops has been calculated by multiplying unit average yield with the FHP per quintal for the concerned crop. If we denote income by I, yield by Y and farm harvest price by P than \( I_n \) is equal to \( Y_0 \times P_n \) where \( I_0 \) is income of the base year, \( Y_0 \) is yield of the base year and \( P_n \) is price of the base year. Likewise \( I_n \) is equal to \( Y_n \times P_n \) where \( I_n \) is the income of the current year, \( Y_n \) is the yield of the current year and \( P_n \) is the price of the current year. Whole data used in the study have taken as triennium ending i.e. data for 1978-79 was taken as the average of 1978-79, 1977-78 and 1978-79 and so on.

**Analytical techniques:** To make analysis during different time periods, following statistical techniques has been applied to the data.

**Growth rates of farm harvest prices (FHP), Area, yield, Production of American Cotton:** Compound growth rates (C.G.R.) of the area, production, and yield of the American Cotton crop have been worked out by fitting exponential function. Using the least square method, the following form of exponential function has been used to calculate compound growth rates.

\[
Y = AB^t
\]

Where, \( Y \) = Area/Production/yield/Farm harvest price of the crop

\[
A = \text{Constant} \\
B = 1 + r
\]

\( r \) = Compound growth rate

\( t \) = time variable in years (1, 2 ——— 30)

The compound growth rate \( (r) \) is equal to \( (B-1) \times 100 \). In log form, \( B \) has been calculated by the following formula:

\[
\log B = \frac{\sum \log Y - \sum t \log Y/N}{\sum t^2 - (\sum t)^2/N}
\]

The growth rates have been tested for significance by calculating ‘t’ value where \( t = t/s \), ‘s’ is the standard error.

**Correlation between area, production, yield and prices with Farm Harvest Prices of American Cotton:** To examine the correlation between Farm Harvest Prices and area, production, yield of American cotton, correlation coefficient \( (r) \) has been worked out as follows.

\[
t_{cal} = \frac{\sum XY - (\sum X)(\sum Y)}{\sqrt{\sum X^2 - (\sum X)^2/N} \sqrt{\sum Y^2 - (\sum Y)^2/N}}
\]

Where \( X \): Farm Harvest prices in Rs. per Quintal

\( Y \): Area, Production, yield

The significance of the correlations has also been tested by comparing the calculated and table values of \( (t) \). The ‘t’ value of coefficient correlation has been calculated by using the following formula

\[
r = \frac{t_{cal} \sqrt{n-2}}{\sqrt{1-t^2}}
\]

**Impact of lagged harvest prices on area, production and yield of American cotton:** To study the impact of lagged farm harvest prices on the acreage allocation, production and yield, linear and logarithmic form of equations were fitted. As logarithmic type of function has found a better fit than linear function, the former has been presented here. The previous year harvest prices are being used here since these prices generally influence the farmers’ decision on acreage allocation for the current year.

In equation form, the following type of equation has been used as:

\[
\log A_t = \log a + b P_{t-1}
\]

\[
\log P_t = \log a + b P_{t-1}
\]

\[
\log Y_t = \log a + b P_{t-1}
\]

\( A_t \) = Area under American Cotton at \((t)\)th period

\( P_t \) = Production of American Cotton at \((t)\)th period.

\( Y_t \) = Yield of American Cotton at \((t)\)th period.

\( P_{t-1} \) = Harvest prices of American Cotton taken in per quintal at \((t-1)\)th period.

**Decomposition of effects of area, yield and price on income of American Cotton:** In order to decompose total change in the value of American Cotton production \((X)\), the price effect has also been studied in addition to the area and yield effects. Thus, to analyse price effect the model formulated by Sharma, (1977) has been used. Further, the interaction effects between area, yield and price have also studied by using the model given below:

\[
\Delta X = (P_o A_0 \Delta Y) + (P_o Y_o \Delta A) + (Y_o A_o P) + (P_o \Delta A \Delta Y) + (A_o \Delta P \Delta Y) + (Y_o \Delta P \Delta A) + (\Delta A \Delta Y \Delta P)
\]

Where, \( P_o A_0 \Delta Y \) shows the yield effect, \( P_o Y_o \Delta A \) give the area effect and \( Y_o A_o P \) give the price effect and these are divided by 100 for getting percentage contribution. Likewise \( P_o \Delta A \Delta Y, A_o \Delta P \Delta Y, Y_o \Delta P \Delta A, \Delta A \Delta Y \Delta P \) show the different interaction effects.

\( \Delta X \) was calculated by subtracting \( X_t \) from \( X_o \)
Impact of prices on the relative profitability of American Cotton: Paddy has been selected as the competing crop to show the impact of prices on the relative profitability.

The Nerlovian distributed lag analysis was performed on the basis of data collected to compute the acreage response function with regard to prices impact on relative profitability. Current year’s crop acreage was regressed on one year lagged acreage, yield, farm harvest price, relative price with respect to the competing crop and related yield. One year lag was used in acreage, yield and price assuming them as the basis of expectations influencing the current year acreage. The lag linear function of the following form was fitted:

$$Y_t = a + b_1X_{t-1} + b_2Y_{t-1} + b_3P_{t-1} + b_4RP_{t-1} + b_5RY_{t-1} + e_t$$

Where;

- $Y_t$ = area of the crop in thousand hectares in year $t$
- $X_{t-1}$ = area of the crop in thousand hectares in year $t-1$
- $Y_{t-1}$ = yield of the crop in quintals in year $t-1$
- $P_{t-1}$ = Price of wheat in rupees per quintal in year $t-1$
- $RP_{t-1}$ = relative harvest price of the crop in year $t-1$
- $RY_{t-1}$ = relative yield of the crop in year $t-1$

RESULTS AND DISCUSSION

Compound growth rates of Area, production, yield and prices: The period-wise results on compound growth rates of Area, production, yield and prices of American cotton crop are presented in Table 1.

The furnished results show that there has been significant increase in case of production, yield and prices of American Cotton crop. Regarding area, maximum growth rate has been found during third period in which it has increased at the rate of 10.88 per cent. With respect to production, the same holds true during the same period as 5.92 per cent growth rate has been recorded in this case and same situation has been found in case of yield as it has been maximum during the same period. But the growth rate of price has been remained maximum during second period. so, the rapid increase in production during the study period has associated with a considerable increase in area but it can also be concluded that due to the adoption of high yielding varieties and a substantial increase in fertilizer, irrigation and pesticides application and incremental area have played vital role in the total production progress except for the period first. But it is interesting that the growth rates of FHP have been relatively higher than those of production and yield. So, the role of price in increasing production is high than yield and area.

Linear growth rates of area, production, yield and prices: The period-wise results on linear growth rates of Area, production, yield and prices of American Cotton crop are presented in Table 2.

The linear growth rate for acreage, production, yield and prices on American cotton for the period from 1978-89 to 2007-08 as well as dividing the whole into three decades have been calculated and the results obtained are presented in Table 2. The area under American cotton in the state has significantly increased at the rate of 15.37 per cent. The calculated linear growth rate for yield has been -4.84 which has not been significant during first period. The situation has been similar as regard to area and yield during second period. Although during both the periods, the yield response has remained negative but this has been offset by the significant positive contribution of area resulted into the positive growth rate in production. During third period, yield and prices have increased at significant growth rate of 1 per cent level of probability. The growth rate of yield has not significant during overall study period. It shows that yield of cotton American is not of the nature of linear during the overall study period which are the clear cut indication of the ineffective government price policy as it could not motivate the farmers to grow American cotton crop and simultaneously used the new technique. The linear growth rates of farm harvest prices during all the study period have been found significant at 1 per cent level of probability.

Correlation between area, production, yield and prices with farm harvest prices of American Cotton crop: The period-wise results on Correlation between Area, production, yield with farm harvest prices of American Cotton crop are presented in Table 3.

Table 3 shows correlation between Farm Harvest prices with area of American cotton has been positive correlated at 1 per cent level of probability except for period third. Correlation between farm harvest prices with yield and production has not significant during first period. During second period, the almost same scene has emerged. During third period, the negative correlation has been found in case of area and yield but positive in case for production although it has been found insignificant. During overall study period, the significant correlation has found in case of area and
The significant positive contribution of area and price. During second period, the situation has not been changed because all the components which were found negative during previous period have not made some place for them by their positive contribution. The interaction effect between price and area has also shown impressive picture contributing by 34.87 per cent. This has resulted that price has not lost its first position in contributing in incremental production. During the third period, yield and interaction effect have been emerged successfully and yield effect got the position of price as yield effect has found a first position by showing 59.30 per cent contribution in the total production of American Cotton leaving the price effect at fourth position with 8.10 per cent. During Overall study period, the almost same situation has been noticed as has been observed in case of first period. The price effect was again relatively higher during this period as it contributed by 34.15 per cent to incremental production while yield has nothing for farmers to increase their income from American Cotton. It means that it was the increase in price what has been reflected in incremental income not the actual increment in productivity. The figures in the table are the reflection of the worst situation of the productivity found in case of American Cotton. The noteworthy thing during this period remains the 35.68 per cent contribution of area-price-effect.

**TABLE 3:** Correlation between area, production, yield with farm harvest prices of American Cotton crop (1978-79 to 2007-08)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>0.77*</td>
<td>0.89*</td>
<td>-0.46</td>
<td>0.48*</td>
</tr>
<tr>
<td>Yield</td>
<td>-0.27</td>
<td>-0.09</td>
<td>-0.11</td>
<td>0.29</td>
</tr>
<tr>
<td>Production</td>
<td>0.57</td>
<td>0.01</td>
<td>0.61</td>
<td>0.55*</td>
</tr>
</tbody>
</table>

* Significant at 1 per cent level of significance
TABLE 4: Impact of Lagged Harvest Prices on Area, Production and Yield of American Cotton

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Area</th>
<th>Production</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.422486</td>
<td>2.727713</td>
<td>2.541368</td>
</tr>
<tr>
<td>Reg. Coefficient</td>
<td>1.0003*</td>
<td>1.0005</td>
<td>1.1132</td>
</tr>
<tr>
<td>S. E.</td>
<td>0.10633</td>
<td>0.1858</td>
<td>1.0865</td>
</tr>
<tr>
<td>R2</td>
<td>0.3851</td>
<td>1.0865</td>
<td>4.2520</td>
</tr>
<tr>
<td>Cal ‘t’ value</td>
<td>4.2520</td>
<td>4.1880</td>
<td>1.5820</td>
</tr>
</tbody>
</table>

* Significant at 1 per cent level of probability

Acreage response and relative profitability function for the American Cotton: The estimated coefficients of lagged year area and yield of Cotton American have positive but non-significant (0.331), (0.481). The price of its competing crop has shown positive and insignificant impact on the area of Cotton American while the yield of the competing crop has been negative. The estimated function accounts for 93 per cent of the variation in the dependent variable during the period under reference (Table 6).

For the second period, the estimated coefficient of price and yield of the competing crop has been negative and not statistically significant. Thus, changes in paddy price and yield are likely to have much negative impact on Cotton American’s area in the state. As paddy and cotton American are quite different in their terms of their requirements of soil, water, weather conditions etc, the results of our analysis are not surprising. Thus, farmers are more attracted by the more profitable crop regarding area allocation of the crop. As per these results, one per cent increase in the yield of the paddy, holding other factors constant, will result in 4.7E-02 per cent contraction in Cotton American’s area in the next session.

During third period of the study, the coefficient implies that one per cent increase in the price of Cotton American holding other variables as constant, is expected the farmers to decrease its area by 0.109 per cent. The coefficient of the lagged yield of the competing crop has also negative figure implying that the last year yield of the crop has affected the current year area by -0.117 per cent. From the results, it appears that higher yield of Cotton American leads to larger area of the crop in the next year. This happens on two grounds: higher yield leads to greater income from the crop improving its competitiveness vis-à-vis other crops. Accordingly, farmers are motivated to expand its area in the next season either through planting new crop or through more rationing or through both these methods. As per estimated results, one per cent increase in the yield of the competing crop has caused to decrease the crop acreage by -0.117 per cent.

During study period, from the magnitude of R2, it can be inferred that the determinants of current acreage of allocation to paddy are adequately explain variance in it. For the individual influence of the variables included in the model, own acreage has significant positive impact on current acreage, own yield lagged by one year has found non-significant but positive influence on the current acreage of the crop. But the price of the Cotton American has negative impact on the current acreage of the crop. The yield of the competing crop also has negative influence on the acreage of Cotton American.

Summary and Suggestions: It is suggested by the study that the growth performance of the area, yield and production of American Cotton has been observed positive during almost all the periods. However, it is noticeable that growth rates of farm harvest prices have been remained relatively higher than that of area and yield. It is also indicated by the study that there has been positive correlation between farm harvest prices and area of American cotton during all the study periods except for the third period of the study. The elasticity for the variables

TABLE 5: Contribution of area, yield and price in the value of production of American Cotton (1978-79 to 2007-08)

<table>
<thead>
<tr>
<th>Time</th>
<th>Change in production (ΔX)</th>
<th>Yield effect (P₀ΔY)</th>
<th>Area</th>
<th>Price effect (Y₀ΔP)</th>
<th>Area and yield (P₀ΔAY)</th>
<th>Price and yield (A₀ΔPA)</th>
<th>Area, yield price (ΔΔAYΔP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Period</td>
<td>405246.34 (100)</td>
<td>-22602.43 (-5.57)</td>
<td>154331.66 (38.08)</td>
<td>185817.85 (45.85)</td>
<td>-17191.37 (-4.24)</td>
<td>141332.72 (34.87)</td>
<td>-20698.69 (-5.10)</td>
</tr>
<tr>
<td>(1978-79 to</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1987-88)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Period</td>
<td>2196298.92 (100)</td>
<td>-4064.31 (-0.18)</td>
<td>201081.77 (9.15)</td>
<td>159631.26 (72.68)</td>
<td>-1055.54 (-0.04)</td>
<td>414580.23 (18.87)</td>
<td>-8379.59 (-0.38)</td>
</tr>
<tr>
<td>(1988-89 to</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997-98)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Period</td>
<td>3930501.38 (100)</td>
<td>7</td>
<td>376383.45 (9.57)</td>
<td>318623.75 (8.10)</td>
<td>422946.35 (10.76)</td>
<td>57811.80 (1.47)</td>
<td>358041.12 (9.10)</td>
</tr>
<tr>
<td>(1998-99 to</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007-08)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Period</td>
<td>5400154.73 (100)</td>
<td>12184.60 (0.22)</td>
<td>29749.54 (0.55)</td>
<td>1844515.4 (34.15)</td>
<td>12775.63 (0.23)</td>
<td>1933985.63 (35.86)</td>
<td>764393.76 (14.15)</td>
</tr>
<tr>
<td>(1978-79 to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2007-08)</td>
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</tr>
</tbody>
</table>
### TABLE 6: Acreage response and relative profitability function for the American Cotton

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimates</td>
<td>ä value</td>
<td>Estimates</td>
<td>ä value</td>
</tr>
<tr>
<td>Constant</td>
<td>-109.996</td>
<td>0.252</td>
<td>61.737</td>
<td>0.413</td>
</tr>
<tr>
<td>Area of Cotton American lagged by one year</td>
<td>0.331</td>
<td>0.407</td>
<td>1.205</td>
<td>0.014</td>
</tr>
<tr>
<td>Yield of Cotton American lagged by one year</td>
<td>0.481</td>
<td>0.025</td>
<td>0.224</td>
<td>0.056</td>
</tr>
<tr>
<td>Price of Cotton American lagged by one year</td>
<td>-8.9E-02</td>
<td>0.699</td>
<td>0.128</td>
<td>0.233</td>
</tr>
<tr>
<td>Price of Paddy lagged by one year</td>
<td>1.307</td>
<td>0.260</td>
<td>-0.766</td>
<td>0.153</td>
</tr>
<tr>
<td>Yield of Paddy lagged by one year</td>
<td>-7.6E-03</td>
<td>0.814</td>
<td>-4.7E-02</td>
<td>0.131</td>
</tr>
<tr>
<td>Coefficient Of Determination (R²)</td>
<td>0.932</td>
<td>0.955</td>
<td>0.691</td>
<td>0.906</td>
</tr>
</tbody>
</table>

* Significant at 1 percent level of confidence

i.e., area, yield and production has denoted that current year area, yield and production very much explained by the explanatory variables Viz, previous year price. It is the price which has played a vital role in the incremental income of the farmers from the American cotton. But it worth mentioning here is that the state of Haryana has registered a considerable change in American cotton, s production during the different study periods as well as overall study period. Introduction of high yielding varieties and adaptation of advanced technology led to significant rise in American cotton area, yield and production as far as compound and linear growth rates are considered. There has been abrupt rise in yield during third period because high yielding varieties have been used by the farmers. So, the yield of cotton American has motivated the farmers to replace the cotton desi with American cotton.. However, the results of the overall study period have shown the different picture but the situation has improved during last 10 years. So, it is the need of the hour that effective efforts should be made in the relevant discipline by various agencies regarding imparting training to the farmers to inculcate expertise in the farmers in the crop production process thereby make them more stimulated towards progress. In addition to it, active participation of farmers are needed in the preparation of the actual planning for the enhancement of the growth performance of the crop. The upsurge talent, research, technology and implementation should be the polar around which the growth performance of crop as well as farmers situation revolved.

**REFERENCES**