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An economic analysis of production and marketing of cotton in Haryana

Gulab Singh, Aarti Bajwan and Veer Sain

Abstract
This study on "An Economic Analysis of Production and marketing of Cotton in Haryana" was conducted in Sirsa and Hisar district which were selected purposively due to more areas under Cotton Crop and more production compared to other districts of Haryana.
240 farmers were selected proportionately and randomly to farm's size. The category i.e. small, medium and large were found through cumulative total method. Primary data were collected for the year 2005-06 to calculate cost and returns yield gaps etc. of American, Desi and Bt cotton. Secondary data was obtained to find seasonal indices from 1980-81 to 2008-09 of arrivals and prices. Cobb-Douglas production function was fitted used to find regression coefficients and marginal value productivity, tabular and percentages were used for the study. Some production and marketing problems and constrains were examined through well knit questions in the schedule.
The net returns of overall farms of American, Desi and Bt cotton for Sirsa and Hisar district were found Rs.1312.20, Rs.705.33 and Rs.2789.08 and Rs.1222.45, Rs.550.10 and Rs.2341.91. However large farms were observed more profitable than small and medium farms. The yield gap I and II in Sirsa and Hisar district for American, Desi cotton were calculated as 3.29 qtls and 3.82 qtls per acres and 2.29 qtls and 2.32. The gaps were made in Desi cotton compared to American cotton in both the districts. Marketing channel I i.e. Production-Ginning mill was found more efficient than the other two channels i.e. producer-wholeseller-ginning mill and producer-commission agent- ginning mill.
Seasonal indices for both arrivals and prices were studied and found that from November to February the indices were more than hundred for arrivals and prices in all three periods for American and Desi cotton. Bt cotton was more income generating and less insecticide-pesticide using crop than American cotton. R^2 were found 93%, 66%, 85% and 83%, 74%, 91% in American, Desi and Bt cotton in Sirsa and Hisar district. Non-availability of quality seed and labour and insecticides- pesticides lack of technical knowledge were reported in very high percentage by the farmers. Low price of cotton, lack of infrastructure, lack of extension and marketing services were also existing. Storage facilities were lacking in both the districts. The study has wide policy implications like enhancing Bt cotton, and proper use of input and output mix to increase income of the farmers.

Keywords: Bt Cotton, Economic Analysis, productivity, marketing, constraints

Introduction
Cotton, the "White gold" is premier industrial crop of major cotton growing countries like China, India, United States, Pakistan, Brazil, Uzbekistan, Egypt, Argentina, Australia and Turkey which accounts for nearly 85 per cent of the total global production. Apart from the increasing production of synthetic fibre, cotton has maintained its reputation as "king of the fibre crops" (Shiva Kumar, C.L. 2007) [37].
It is the world's most important textile fibre and oil seed crop. During the year 2008-09, the cotton area, production and yield were 9.41 million hectares,
23.16 million bales and 419 kgs per hectare respectively in the country. The share of Haryana in area and production of cotton of India was 5.10 per cent and 7.30 per cent respectively during the year 2007-08. India also exported 4.58 lakh tones of cotton worth Rs. 2866 crore in 2008-09 (Agricultural Statistics at a Glance 2009) [4].
In Haryana state, five districts viz. Sirsa, Hisar, Fatehabad, Jind and Bhiwani account for about 97 per cent of area and 98 per cent production of cotton in the state. Among these, Sirsa district has the highest area 181.6 thousand hectares and the highest production 734 thousand tones followed by Hisar district 118.1 thousand hectares and 466 thousand tones respectively during the year 2007-08 (Statistical Abstract of Haryana 2008-09).
Wide fluctuations have been observed in both in area and production of cotton crop in the

Haryana state. It is observed that with favourable weather conditions crop production increased into the double average production markets are glutted and prices of cotton slump down. The increased production, does not result in increased income to the producers. The situation becomes reverse during the bad agricultural years. These conditions breed in malpractices in cotton marketing to disadvantages of producer seller. The substantial year to year fluctuations in cotton production also results into considerable variations in the marketable surplus. This has given rise to several marketing problems viz. unfavourable prices structure, lack of marketing information, high marketing cost and margins etc. For providing the farmers the full benefits of increase in production, the efficient marketing is an essential element (Gulab Singh 2003) [11].

Hence, visualizing the above facts, an attempt has been made to undertake a detailed study entitled "An Economic Analysis of Production and Marketing of Cotton in Haryana" with the following specific objectives:

1. To study the economics of cotton cultivation.
2. To work out the index of yield gaps and economic losses and reasons for such losses.
3. To study the price spread and price behaviour of cotton crop.
4. To examine the economic impact of Bt. cotton on farmers.
5. To examine the various factors affecting the productivity of cotton and marginal value productivity.
6. To identify the production and marketing constraints faced by cotton growers.

A comprehensive and critical review of past researches provides a sound basis for scientific investigation. It helps in deciding appropriate methods and procedures and lends support in the interpretation of the findings. In this chapter, the review of literature pertaining to related studies carried out in the past has been presented under the following three section:

1. Economics of cotton and other crops
2. Marketing of cotton and other crops
3. Resource use efficiency, yield gaps and constraints analysis

In order to gain a better understanding of technique, statistical tools employed, results and outcomes produced by past researchers on the same research subject, the researcher reviewed numerous literature and empirical evidences. The review of literature has been divided into three areas for ease of use:

Economics of cotton and other crops

Rawalji (1974) [32] studied economics of cotton production in Anand taluk of Gujrat. To study the costs and returns from hybrids cotton, the overall cost of cultivation per hectare of cotton came to be Rs. 2303 and Rs. 2324 in case of the tractor and non-tractor farms, respectively. The cost of cultivation was highest on the large farms followed by the small farms. The share of fertilisers, labour and pesticides formed more than 68 per cent of the total cost on the tractor farms and 60 per cent on the non tractor farms.

Rao (1979) [31] studied economics of cotton cultivation in Yavatmal district of Maharashtra. The study indicated the cost of inputs had been dramatically high for hybrid cotton producers but not for farmers growing L-147 or other varieties. Prices paid for cotton had tended to discourage farmers from increasing their acreage and investment in cotton in recent years. The price realized for hybrid cotton was around Rs. 361 per quintal. Outside Maharashtra prices received were somewhat higher.

Chakraborti (1984) [6] studied growth pattern of cotton production. In India, systematic improvement of cotton production started with the first five year plan when Indian Central Cotton Committee provided funds to the cotton growing states to step up production. Since then a large number of improved varieties has developed. From a derived time series of indices for the period (1962-64 to 1976-79 it was concluded that (i) cotton production was improving in absolute term and point growth rates of production were also increasing (2) productivity of cotton per hectare was increasing in absolute terms, but the point growth rates of productivity were not increasing, (3) the area under cotton cultivation was declining.

Koraddi *et al*. (1989) [15] reported low-cost production technology for rainfed cotton. In trials between 1981-84 to develop cultivation techniques for reducing production cost of rainfed cotton in Karnataka, effects of various fertilizer rates and plant protection schedules on seed cotton yields and net returns were studied. Crop growth at normal spacing (60x30 cm) with recommended NPK rates and 3 or 4 insecticide sprays gave the highest average yields (20.5 to 21.8 q/ha) and net returns, but also had the highest production costs. Crops grown in normal rows with full N rate only or at 60 x 15 cm with full NPK rate and given two insecticide sprays gave satisfactory yields (17.3 to 18.0 q/ha) with low production costs. These cultivation techniques were recommended for situations of low investment.

Pandurangadu and Raju (1990) [26] assessed the economics of pesticide use on cotton farms in Guntur district of Andhra Pradesh. It was found that expenditure on conventional insecticides was highest on large farms. The fungicides accounted for 4.43 per cent while pheromone cost claimed 2.53 per cent of total pesticide cost on pooled farms. The production elasticities of conventional insecticides was found to be non-significant on all the categories of farms except medium. In case of synthetic pyrethroids it was negative and significant, whereas same was positive and significant in case of pheromone traps. It was observed that farmers decisions regarding the quantities of pesticides used were moulded by some economic considerations like changes in the unit cost of pesticides, yield levels, farmers' expectation about future profit, availability of finance and size of operated holding.

Khunt and Antani (1991) [14] in their study on impact of weather and economic factors on acreage and production fluctuations in cotton in Gujarat state suggested that on the whole, price and non-price factors viz., yield and irrigation were found to had strategic role in acreage allocation decision, while rainfall had not exerted any significant influence on acreage all the cases barring the Rajkot district. Inspite of the improvements in the prices over time, the area under cotton had not responded positively in Baroda and Broach districts. This happened due to higher profitability of low input crops like tur as a competing crop. Production behaviour found to be sensitive to various factors viz., acreage, fertilizer, rainfall, irrigation etc. but the impact on production was not uniform across districts. Drought had shifted the production downwardly through decreasing the marginal productivity of factor inputs. High yielding varieties remained indifferent to the influence of production behaviour.

Basu *et al*. (1992) [5] in their study estimated the cost of production of cotton in different regions under both irrigated and rainfed conditions. The cost of cultivation per hectare varied between Rs. 10,200 in central zone to Rs. 7800 in north zone for irrigated verities. In case of irrigated hybrids the cost was higher (Rs. 14500/ha) as also yield (25-30 q/ha). In case of rainfed varieties the cost of cultivation ranged between Rs. 5400 to Rs. 4500 per hectare. The labour, expenditure on pesticides and fertilizer formed the main components of cost. The net income was highest from hybrid cotton seed production (Rs. 32800) followed by hybrid cotton (Rs. 8300) and other varities (Rs. 2550).

Jain (1993) [13] analysed the cost of production across different farm sizes, its trend over time and the factors responsible for efficient production of three crops, wheat, paddy and cotton in Punjab. To determine the role of different input factors in the determination of cost efficiency, a multiple linear regression model taking into account the variables - expenditure per hectare on irrigation, expenditure on insecticides and pesticides, the yield level of the crop, area under cultivation and fertilizer application were used. The dependent variable was the cost of production. The results indicated that in real terms per quintal cost of production had declined for wheat, paddy and cotton indicating benevolent effect of improved technology. Cost efficiency varied inversely to area under the crop for wheat and cotton.

Vishweshwar (1994) [46] studied economics of Hybrid cotton production with special reference to pest management in 3 taluks in Malaprabha command area of Karnataka. The growth rate of area under cotton in Navalagund and Naragund taluks ranged between 21.33 and 32.59 per cent while it declined in Saundatti taluk. The growth rate of productivity of cotton showed decreasing trend in all the three districts. The study revealed that conventional farmers incurred about 45 per cent more cost on pesticides (Rs. 3742.30) as compared to farmers who used integrated pest management (IPM) (Rs. 2579.34). The total cost of cultivation for conventional farmers was Rs. 14274.25 per hectare. IPM farmers realized about 20 per cent more yield (8.75 q) as compared to that of conventional farmers (7.30 q). The net returns per hectare earned by IPM farmers (Rs. 3 644) was more than four times that earned by conventional farmers (Rs. 700). IPM technology was found to be technically efficient and cost effective.

Lokhande *et al*. (1995) [16] in their study on economics of cotton production in India concluded that the returns from the hybrid cotton varieties were higher than the return from common varieties but the costs of cultivation were also quite high resulting into a relatively low cost-benefit ratios compared to other crops. The major cost components of cultivation were labour (about 60 per cent) followed by fertilizers and pesticides (22-33 per cent). The costs of cultivation were relatively higher for irrigated cotton in both North and South zones compared to the rainfed cotton of Central zone. Although costs of cultivation of hybrids were higher, the net profit and the cost benefit ratio were greater compared to other varieties. Among three cotton growing zones, the cost benefit ratio of North zone was highest with 1:2.45 followed by the Central zone with 1:2.35 and the lowest being in South with 1: 1.32.

Vinod Kumar (1997) [45] analysed the costs and returns of cotton-wheat rotation in Haryana. The results indicated that the returns from cotton wheat rotation was Rs. 9665, whereas the same in case of sugarcane and arhar-wheat rotation was Rs. 8152 and Rs. 7539 per hectare, respectively.

Iyengar *et al*. (2002) [12] conducted a study on Bt cotton in seven district of Gujarat taking 120 sample farmers. Snowball sampling method was used to identify respondents. The study revealed the performance of Bollgard-12 and Bollgard-184 varieties of Bt cotton yielded 6 quintals whereas regular American cotton varieties yielded 2.2 quintals.

Morse *et al*. (2004) [22] explored the impact of insect resistant Bt cotton on costs and returns over the first two seasons of its commercial release in three sub-regions of Maharashtra State, India. Data were collected for a total of 7793 cotton plots in 2002 and 1577 plots in 2003. Results suggest that while the cost of cotton seed was much higher for farmers growing Bt Cotton relative to those growing non-Bt cotton, the costs of bollworm spray were much lower, while Bt plots had greater costs (seed plus insecticide) than non-Bt plots, the yield and revenue from Bt plots were much higher than those of non-Bt plots (some 39 percent and 63 per cent higher in 2002 and 2003 respectively. Overall, the gross margins of Bt plots were some 43 percent (2002) and 73 per cent (2003) higher than those of non-Bt plots, although there was some variation between the three sub-regions of the state.

Narayanamoorthy and Kalamkar (2006) [25] studied economics of Bt cotton cultivation, using data collected from 150 sample farmers from two districts in Maharasthra, 100 Bt cotton and 50 non-Bt cotton farmers. The study reported that the profit realized from bt cotton crop is substantially higher than that of the non Bt cotton. While the average profit of the two districts comes to about Rs. 31,880/ha, it is only about Rs. 17790/ha for non-Bt cotton crop, indicating a difference of about Rs. 14090 ha. The profit realized by Bt cotton growers is nearly 80 per cent higher than that of non-Bt cotton cultivators. It is observed that both Bt cotton varieties used for cultivation found to be higher with MECH-162 variety (Rs. 34650/ha) as compared to MECH-184 (Rs. 30173/ha).

Singh *et al*. (2006) [42] has undertaken a study in Punjab state on the comparative economics of Bt cotton and non-Bt cotton cultivation and their impact on productivity, cost of production, extent of pesticides use, income and employment, in the state. A sample of 40 experimental plots containing 20 plots of Bt cotton and 20 plots of non-Bt cotton, was selected in the village Ramgarh Bunder of the district Bathinda. To check the performance of Bt cotton over hybrid cotton and unauthorized Bt cotton out of 20 plots of non-Bt cotton. The study has revealed the productivity to be higher on Bt cotton plots than all other plots and this difference was statistically significant. The Bt cotton has been found cost effective due to higher on Bt cotton. The study has revealed the productivity to be higher on Bt cotton plots than all other plots and this difference as statistically significant. The Bt cotton has been fond cost effective due to higher production and could reduce the per quintal production cost by Rs. 64. The Bt cotton has generated significantly more income and employment which have been observed as Rs. 4300 and 17 mandays per hectare. The extent of pesticides used for Bt cotton cultivation has been significantly lower than that of non-Bt cotton. The cost benefit analysis has conferred that Bt cotton is economically viable as the benefit cost ratio is found to be positive on these farms. The significant higher productivity, more returns and very less requirement of insecticides on Bt cotton, will sustain the cotton crop in the state, which, in turn, will protect the environmental health and economic condition of the debt-ridden cotton-growers.

Marketing of cotton and other crops

Singh *et al*. (1979) [39] in their study analysed the effect of area and yield on cotton production, marketing costs and margins and variations in price of cotton in Haryana state. They examined the existing structure and organization in the marketing of cotton in the state and suggested possible improvements. The area devoted to local and American cotton bad played a significant role in increasing cotton production. The cotton acreage response to rainfall, new farm technology and prices showed that only prices had a significant effect on area under cotton. Average returns per rupee of investment amounted to Rs. 1.18 for local cotton and Rs. 1.47 for American cotton.

Reddy (1985) [34] studied problems and prospects of production and marketing of cotton in Raichur district of Karnataka. The study was confined to two talukas of Raichur district *i.e.,* Raichur and Sindhanur. It was found that Raichur farmers had higher productivity in both varieties of cotton than Sindhanur farmers. In both the Talukas the proportion of area devoted to cotton declined with the increase in the size of holdings. The marketing margin for DCH-32 was found to be higher than that of Laxmi in both markets. The profit earned per quintal of DCH-H32 cotton was higher in Raichur than in Sindhanur for all categories of farmers. The productivity level of small farmers was found to be lower than that of other categories of farmers particularly in the use of DCH-32.

Nagaraj and Chandrakanth (1992) [24] observed various marketing channels for vegetables. Among them, the marketing channel I (producer – commission agent – retailer – consumer) was considered most important one as most of the transaction took place between producer and commission agent in early morning and producer has to pay a commission of up to thereafter 8 per cent. In this channel the producer's share was about 66 per cent with a marketing cost of 9 per cent in case of beans, cabbage, and brinjal. But for tomato the producer's share was only 49 per cent because of its higher perishable nature and character of forced sale.

Sharma (1997) [36] studied the production and marketing of cotton seed in Haryana. The study revealed that net returns per hectare was found to be higher in case of private agencies like Shiv Ganga Seeds (Rs. 4566), Prakash Seeds (Rs. 3383) in comparison to Government farms like Central Farm and HAU Directorate Farm (Rs. 3333) because of the premium given by the companies in comparison to Haryana Seed Development Corporation. Overall cotton seed production was found to be remunerative.

Mahapatra (1999) [21] observed that there were three types of marketing channels for marketing of onion in Sundargarh, Orissa. The channels identified where, producer è consumer; producer è trader è consumer; producer ètrader è wholesaler è retailerè consumer. He further reported that the producer received maximum share in channel I (97.9 per cent), where there was no middlemen than 77.1 per cent and 53 per cent in channel-II and channel-III, respectively.

Verma *et al*. (2002) [44] studied that economic analysis of hybrid cotton production and marketing in Khargone district revealed that though the average cost of cultivation (cost C3) was Rs. 21312.34 per hectare and Rs. 30163.20 per farm, respectively. On an average, the net returns of hybrid cotton was worked out to Rs. 21889.66 per hectare and Rs. 30864.42 per farm, respectively. Average cost of production per quintal, on an average came to Rs. 988.50. However, average input-output ratio was 1:2.02 for hybrid cotton. Marketing of cotton took place through two channels. The producer's share in miller's price was high in Channel I (88.05 percent) followed by channel II (87.01 percent). Total marketing cost incurred was lowest (9 percent of Miller's price) in channel II followed by 9.88 per cent in channel I. The total marketing margin was minimum in channel I (2.07 percent) followed by Channel II (3.99 percent), respectively.

Mehetre and Patil (2003) [20] reported that the cotton growers of Western Maharastra mostly sell their produce to the village traders, where accurate weighing facilities are not available, thus cheating in weights and price of produce. They faced constraints like low price, late start of cotton, monopoly procurement scheme and high transport charges. Cotton growers suggest that early procurement facility should be made available through cotton monopoly procurement scheme in the month of August-September. There is also a need to teach them new cost saving technologies of cotton production.

Resource use efficiency, yield gaps and constraints analysis

Mangat (1985) [18] studied the impact of weather and technology on cotton production in Punjab. The trends in yield determined by the moving average method increased till 1973-74 for upland cotton and until 1970-71 for desi cotton because of improved technology. Since then they have registered a drop because of non- availability of short duration cotton cultivar to fit with wheat, the drastic reduction in aerial spraying to control cotton pests, the rise in sub-soil water table and extension in the area under more remunerative crop of rice. High yields were associated with normal weather. Dry weather during July-September reduced the yield of upland cotton. Desi cotton was affected only by rainfall during July September. Humidity had no effect on either of the cotton.

Singh and Yadav (1989) [40] studied yield gaps and constraints in wheat productivity in Uttar Pradesh. The results showed that there was no significant differences between the yield of experimental station and potential. The difference between the potential and actually realized on the farmers' fields was statistically significant in all categories of farmers in both the regions. The constraints for research cum management gap were mainly management-cum-environmental factors/ physical parameters. The multiple regression model was used to analyze the relationship between extension gap and independent variables like technological gap, agronomic practices, input supply, socio-economic status etc. Among these constraints the technological gap and socio-economic status were the highest and lowest contributing factors.

Mannikar and Basu (1992) [19] examined the causes for low productivity of cotton in the rainfed regions of India. The main causes for low cotton productivity were found to be poor climate, unsuitable soils, inferior plant types, underutilization of certified seeds, limited weed control, poor nutrient management, high incidence of pests and diseases, non-avail ability of inputs in time, poor labour efficiency, lack of credit and infrastructure facilities, price and marketing inadequacies, illiteracy, lack of adoption of new technologies by farmers and unsatisfactory transfer of technology. The study suggested some measures for augmenting cotton productivity like, locating suitable areas for high production of cotton by land and soil surveys, development of improved varieties, increasing the area under certified seeds, emphasis on integrated nutrient management, low cost weed control measures, spread of IPM, improvement of credit facilities and crop insurance in cotton, improvement in storage, pricing and marketing and strengthening the transfer of technology in

cotton in rainfed region.

Sahu *et al*. (1993) [35] studied yield gaps in paddy production in Jabalpur districts of Madhya Pradesh. It was found that biological and socio-economic constraints had more impact on actual production figures than lack of research. The yield gap was greater in case of local varieties (57.4%) than high yielding varieties. The analysis of input use revealed that in general farmers were using more than recommended rate of seed in case of both, local and high yielding varieties.

Rao *et al*. (1994) [30] in their study on resource use efficiency in paddy observed a constant returns to scale in case of both adopter and non-adopted farms. The regression coefficient of human labour was positive and significant whereas the same in case of cattle labour and manure were negative but not significant. The overall picture indicated that the expenditure on cattle labour and fertilizer had to be curtailed as their ration of marginal value product (MVP) to opportunity cost was negative. The expenditure on cattle labour, seed and fertilizer had to be increased in case of non-adopter farms to increase the gross returns.

Gilham *et al*. (1995) [9] conducted studies on global problems facing cotton production and significance of government policies in promoting efficiency and effectiveness in the cotton sub-sector. The overall study was intended to identify and find appropriate solutions to technical problems to raise yields and increase incomes but was expanded to address the linkages between the technical, institutional and policy aspects of cotton production and marketing. The most common technical weaknesses revealed were in seed production and development of varieties with fibre attributes required by modern mills combined with high yielding potential and resistance to adversity. Irrigation, use of pesticides, labour costs and availability were also significant factors. Rising input costs had reduced returns from cotton.

Reddy *et al*. (1995) [33] studied yield gaps and constraints in cotton production in Guntur district of Andhra Pradesh. The results revealed that the yield gap between research station farms and sample farms was maximum followed by the yield gap between the demonstration and sample farms. The estimated yield gap function (demonstration farms vs. sample farms) indicated that yield gap had been positively and significantly associated with gaps in nitrogen, phosphorus, human labour, bullock labour and seed rate implying the less use of these inputs by sample farmers.

Singh and Beena (1996) [43] judged resource use efficiency in cash crops, viz., sugarcane and onion in Pune district by comparing Cost A, Cost B and cost C and comparing with respective prices. Output-input ratios were more than the in all the size classes of holdings and for both crops indicating that these crops were profitable proposition. For Cobb-Douglas production function analysis farm size (ha), human labour (man days) bullock labour (in pair days) and fertilizers and manures (N+P+K in kg) were used as independent variables with output in quintal as dependent variable. The land resource had shown a scope for increasing the area under sugarcane. The coefficient of human labour was positive and significant in onion indicating a scope to increase the levels of labour use. As regarding manures and fertilisers, the coefficient was negative in case of sugarcane indicating that there was an excess use of fertilizer in this crop. The comparison of MVP with rental value of land per hectare revealed that MVP to factor cost ratio was more than five for sugarcane and more than one for onion indicating sufficient scope for increasing the use of this resource in both crops to maximise profit. The MVP analysis indicated that bullock labour can be diverted from onion to sugarcane and manures and fertilizer from sugarcane to onion, as in both cases MVP to factor cost ratio was found to be significantly negative.

Nagabhushanam and Herle (1997) [23] conducted a study in the Kundapur taluk of Karnataka to analyse the yield gap in paddy. The difference in yield between research station and progressive farms was 8.63 per cent (Gap 1), whereas the gap between progressive farmers yield and average farmers yield was 26.1 per cent indicating non exposure of average farmers to the new technologies. The cultivation practices followed by farmers FYM, N, P_2O_5 and K_2O were found to have a highly significant relation with yield of paddy. However, the application of green leaf manure and weeding were not found significant. The data regarding relationship of characteristics with adoption level of farmers revealed that characteristics like social participation, extension participation, mechanisation of farms and yield level were highly significant with their adoption level.

Patil and Kunal (1998) [27] analyzed yield gaps and constraints in groundnut production in Dharwad district of Karnataka. The yield gap I *i.e.*, difference between research station yield and demonstration plots yield was to the tune of 1958 kg per hectare (50.22%). The yield gap II *i.e.*, difference between demonstration plot yield and actual farm yield was more in case of small farmers (26.12%) than large farmers (26%). The total yield gap was 63.17 per cent on overall farms. Labour scarcity, non-availability of quality seeds, soil problems, untimely rainfall, lack of technical knowledge, diseases and pests, shortage of funds and use of insufficient quantities of fertilizer were perceived to by the major constraints in that order.

Radha *et al*. (1998) [28] conducted a study to identify the yield gaps and constraints for low yields in rainfed groundnut in Karimnagar district of Andhra Pradesh. The study revealed that the difference between experimental yield and demonstration yield was 200 kg per hectare, which was 10.25 per cent less than maximum attainable yield. Yield gap II *i.e.*, the difference between potential farm yield and two groups of farmers was 1268 kg per hectare and 983 kg per hectare indicating that the second group of farmers had more adoption of improved technology. As per the opinion survey, 93 per cent of farmers in Group I and 84 per cent in group II felt that the marketing was the major problem followed by the constraints in seed, fertilizers, plant protection chemicals, agronomic practices, post harvest operations and sowing methods.

Raghuwanshi *et al*. (1999) [29] analysed the resource use efficiency in wheat cultivation, in Bundelkhand region of Madhya Pradesh. The study investigated costs and returns and efficiency of inputs used in wheat production by fitting Cobb-Douglas type of production function. The study had shown that the average cost of cultivation of wheat was estimated Rs. 6496 per hectare. The sum of elasticities of production ($\sum bi$) indicated decreasing returns to scale. Among the five independent variables, fertilizer and irrigation were found to influence the production of wheat positively and significantly. The coefficient of human labour was negative and significant in case of medium farmers. The independent variable explained 27 per cent of variations in wheat yield at the overall level.

From the foregone discussion it is clear that there is a strong need to improve the yield levels in agriculture in general and cotton in particular. Great strides have been made after the

Green Revolution of the 1960's. But there is still scope to improve the yields. The cost of production has been increasing over the years. Hence, there is a need to use the crucial inputs judiciously. It was observed that under Indian conditions in most of the cases resources are either under used or over used leading to less than potential returns. Keeping in view these facts, an attempt has been made in the present study to analyse the costs, returns, yield gaps and economic losses, marketing economic impact of Bt-cotton, marginal value productivity and constraints in cotton production and marketing in Haryana states.

Conclusion

It was concluded that the net returns per acre of American and Desi cotton in Sirsa and Hisar district were highest on large farms followed by small and medium farms. A wide yield gaps existed in the American and Desi cotton productivity between potential yield and sample farms average yield. The overall economic losses due to non adoption of recommended technology were observed to be 3.55 quintal and 3.84 quintal per acre. The marketing channel-I in which farmers directly sold the produce to cotton ginning mills found to be most efficient. The study of marketing pattern revealed that majority of the farmers prefer to sell their produce in the market rather than with in village itself. The economic impact of Bt cotton Among different categories of farms, the costs as well as returns from Bt cotton were highest in case of the large farmers followed by the medium and small ones. The production function analysis revealed that there existed a substantial scope to increase the production of cotton through making judicious use of critical inputs, seed, fertilizers, plant protection, human labour and irrigation in case of American cotton and seed and human labour in case of Desi cotton in Sirsa district. The study revealed that highly significant regression coefficients of Human Labour turned out to be 1.959 in American cotton and 1.149 in Desi cotton. The study also reveals that value of seed had direct relationship with value output of American and Desi cotton. The occurrence of unfavourable climatic conditions, non-availability of adequate good quality seed, lack of technical knowledge, non-availability of labour and non-availability of good quality insecticides / pesticides were found to be major constraints in cotton production. The low price of cotton produce, godown and storage facilities in market, lack of infrastructure facility and non-availability of ginning mills and lack of extension and marketing services were found to be the major problem in marketing of cotton.

Author contribution

G. S.: data collection, investigation, resources, methodology, formal analysis, visualization and writing of the manuscript; A.B. and V.S.: visualization, supervision, review and editing.

Conflict of interest

Authors declare that there is no conflict of interest among them.

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