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Growth and Economic Profitability of Rice Cultivation in Haryana

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An investigation on the growth and economic profitability of rice production was conducted in Karnal district of Haryana, India in 2019-20. A sample of 30 farmers from Karnal district were interviewed to collect relevant information related to various expenses incurred in the cultivation of rice and output attained as well as constraints encountered in production of rice. Compound annual growth rate (CAGR) results revealed an increasing trend in area, production and yield of rice in Haryana. Large instability suggests that there was more variability in area, production and yield in Haryana than in India during the period under study. Highest cost per output was incurred in variety Basmati CSR-30 (Rs. 30.50 kg^{-1}) cultivation. Similarly, highest net profit was realized in the cultivation of Basmati CSR-30 (Rs. 8.08 kg-^{1}). Lack of remunerative prices was the main constraint in rice cultivation. Thus, cultivation of rice could be made more profitable by upward review of per unit price of rice and looking into other avenues to incentivize the rice farmers. Similarly, research should be reoriented to reduce the production cost and improving yield which have direct effect on profitability.

Keywords: Cost; profit; trend; instability; production; rice.

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1. INTRODUCTION

Rice (*Oryza sativa) is* the most important and most widely consumed staple food for the vast majority of the world's population, particularly Asia and Africa. Rice also provides more than 50 percent of the daily calories ingested [1]. Rice is grown in all six continents of the world where field crop production is practiced except the icy continent of Antarctica, where no crop are grown [2]. Global rice production has been on a snowballing trend since the sixties and has risen from 605 million tonnes in 2005 [3] to 755.48 million tonnes in 2020 [4]. More than 90 percent of the world rice production takes place in Asia with China and India being the two largest producers contributing about 40 percent of world rice. In 2020, China and India produced 209.61 and 177.65 million tonnes of rice respectively [4]. The top five rice producers in the world in the year 2019-2020 are China, India, Indonesia, Bangladesh and Vietnam [4,5].

India ranked first in total area and second in production of rice in the world after China. In 2019-20, over 43 million ha (22% of total national cultivated area) was dedicated to rice cultivation which resulted into total output of 118.43 million tonnes of rice [6]. Pavithra *et. al.* [7] reported that India contributed about 20 percent share of global rice production. India rice has made its mark all over the world and it is famous for Basmati rice, which has penetrated all nooks and crannies of the world. Despite the devastating Covid-19 challenges in 2020, India exported rice worth USD 8 billion, making it by far, the leading rice exporter in the world [4]. India also ranked second only to China in rice consumption. Consumption estimates of rice has gone up steadily from 95,4 million tonnes in 2016- 17 to about 106 million tonnes in 2019-20 [8].

The stronghold of India in rice and other important crops should not come as a surprise as the nation is endowed with diverse agro-ecological conditions. This variability makes it favourable for the cultivation of diverse agricultural products and the reinforcement of its food and nutritional security for the ever-teeming population through steady production and distribution, particularly in the recent past. Haryana is one of rice producing state contributing large share in national food stock and 60 percent in export of basmati rice from India. At present in Haryana, rice is cultivated on about 1.45 million ha with production of 4.82 million tonnes contributing 4.07 percent of rice production in the country. In this study, an effort has been made to examine the growth and economic profitability of rice value chain in Haryana. Findings of this study will be relevant to stakeholders at all levels, particularly agricultural development planners and policy makers, farmers, processors, marketers and exporters. The study will further be useful to researchers, extension functionaries and also serve as a basis for expanded research in this area.

2. MATERIALS AND METHODS

The present investigation was conducted in Karnal district of Haryana during 2019-20. Selection of the district was done on the basis of larger acreage under rice. A total of 30 farmers were randomly selected from various villages in Nilokheri block of Karnal district. Relevant information regarding the extent of use of production resources such as seed, fertilizers, irrigation, plant protection chemicals, farm machinery, field preparation, crop planting, labour employed, etc., was obtained through interview and group discussion with the producers. The prevailing market prices of the purchased inputs, hired labour, selling prices of the product were obtained and used to calculate the economic viability of rice production enterprise. Similarly, twenty (20) years' time series data on area, production and yield of rice for the period 2001-2020 were collected to analyse the trends in area, production and yield.

2.1 Data Analysis

The data for the present study was analysed using appropriate statistical techniques as follows:
Trends and growth rates in area, production and yield.

For studying the trends and compound annual growth rate (CAGR) in area, production and yield, twenty years rice data for Haryana and India for the period 2000-01 to 2019-20 was collected from Statistical Abstracts of Haryana and Agricultural statistics at a glance respectively [9]. The trend was computed using quadratic function:

$$y = \alpha x^2 + \beta x + \mu t \quad \text{---------- (I)}$$

where:
X = Area / production / yield of rice in year t
α = Intercept / constant
β = Regression coefficient

μ = Error term
t = Time element (1, 2, 3, …., n)

Percentage change in area, production and yield

$$\%Change = \frac{X2-X1}{X1} \text{ ---------- (II)}$$

Where:
X_1 = Initial value
X_2 = Final value
For studying the compound annual growth rate (CAGR)

$$CAGR = \left(\frac{Vfinal}{Vinitial}\right)^{1}/_{t} - 1 \text{ ---------- (III)}$$

Where:
CAGR = Compound annual growth rate (%)
V *initial* = Initial value
V *final* = Final value
t = Time in years

Coefficient of Variation (CV %)

Karl Pearson coefficient of variation was used to analyse the instability in area, production and yield during the time period.

$$\text{Coefficient of Variation CV (\%)} = \frac{}{mean} \times 100 \text{ ----- (IV)}$$

Where:
= Standard deviation
Standard deviation was computed using the formula:

$$= \sqrt{\frac{1}{n}\sum(x_i{}^2 - \overline{x})^2} \text{ ---------- (V)}$$

Where:
x = Variables (area/ production/ yield)
n = Number of years
For calculating profitability

Net returns = Gross returns – total cost ----- (VI)

$$\text{Return on investment} = \frac{Net\ profit}{cost\ of\ investment} \times 100 \text{ ---- (VII)}$$

2.2 Garrett Mean Score Ranking

The method is widely used by many researchers due to its ability to rank constraints in order of importance. Accordingly, the constraints were ranked by the respondents in order of priority from the most important to the least important. The order of the constraints as given by the respondents was converted to percent position using the formula below:

$$\text{Percent position} = \frac{100\ (Rij-0.5)}{Ni} \text{ ---------- (VIII)}$$

Where:
R_{ij} = rank given for the i^{th} constraint by the j^{th} respondent
N_i = Number of constraints ranked by the j^{th} respondent

3. RESULTS AND DISCUSSION

Rice is cultivated both *Rabi* and *Kharif* seasons in India, However, it is largely grown in *Kharif* season with transplanting around June – July and harvested in between October and November. Rice in India is mainly cultivated through intensive irrigation, though rainfed cultivation is also practiced in some areas with occurrence of heavy precipitation particularly in eastern and coastal regions.

3.1 Trends in Area, Production and Yield of Rice in Haryana Vis-à-vis India

The total area under rice, production and yield in Haryana has increased during the period 2001-05 to 2016-20 from 1.01 million ha, 2.74 million tonnes and 2,660 kg/ha to 1.41 million ha, 4.56 million tonnes and 3,230 kg/ha, respectively (Table 1). Similarly, the area of rice, production and yield in India showed an increasing trend in which area improved from 43.06 million ha, 84.36 million tonnes and 1,957 kg/ha to 43.68 million ha, 112,68 million tonnes and 2,563 kg/ha, respectively from the period 2001-05 to 2016-20.

The percentage change in area, production and yield in Haryana were found to be increasing at 39.60 percent, 66.42 percent, and 21.44 percent, respectively during the period. Likewise, the percentage change in area, production and yield during the period has increased at 1.44 percent, 33.57 percent and 30.92 per cent, respectively. When compared, the percentage increase in area in Haryana (39.60%) has by far surpassed the percentage increase in India (1.44%), while the percentage increased rice production in Haryana (66.42%) has almost doubled that in the entire country (33.57%). However, the percentage yield in India (30.92%) has exceeded the percentage increase in yield in Haryana (21.44%) as large area in various provinces covered under improved production practices and use of quality seed.

3.2 Growth Rate of Rice in Haryana Vis-à-vis India

Compound annual growth rate (CAGR) was computed to assess if the growth performance of

rice has increased, decreased or stagnated during the period from 2001 to 2020. Growth performance of area, production and yield for both India and Haryana were calculated during the study period as outlined in Table 1. An increased positive and significant CAGR was recorded in area, production and yield of rice in Haryana (i.e., 1.71%, 3.10% and 1.41%). However, CAGR of area in India was negative (-0.11%), while CAGR of production (1.76%) and yield (1.87%) were found to be positive. In comparison, the rate of growth in rice area and production in Haryana was greater than that in India. However, growth rate in yield in India was observed to be higher than that in Haryana.

3.3 Instability of Total Rice in Haryana Vis-à-vis India

The coefficient of variation was computed to validate the variability in area, production and yield of rice during the period **(Table 1**). The results revealed that, highest variability in Haryana was recorded in terms of production (20.95%), followed by area (14.34%) and yield (8.17%). Similarly, highest variability at country level was observed in production figures (13.42%), followed by yield (11.18%). However, lowest variability in rice during the period was recorded in terms of area. In contrast, higher variability was observed in Haryana when compared to India. The findings are supported by Nain et al. [10].

Quadratic function was employed in fitting the equation to show the performance in the area, production and yield of rice in India and Haryana as outlined in Figure 1 and 2, respectively. It can be observed that though total rice area of India has experienced a decreasing trend during the period, it recorded a positive coefficient value (0.0006). However, both production and yield experienced inclining trend during the same period with coefficients of 0.1226 and 0.121, respectively. In contrast, the quadratic equations of area, production and yield in Haryana exposed an increasing trend during the period under study. The coefficients of area, production and yield were 0.1266, 0.2098 and 0.133, respectively. The coefficients of area, production and yield in India (0.006, 0.1226 and 0.121) were much lower than in Haryana (0.1266, 0.2098 and 0.133).

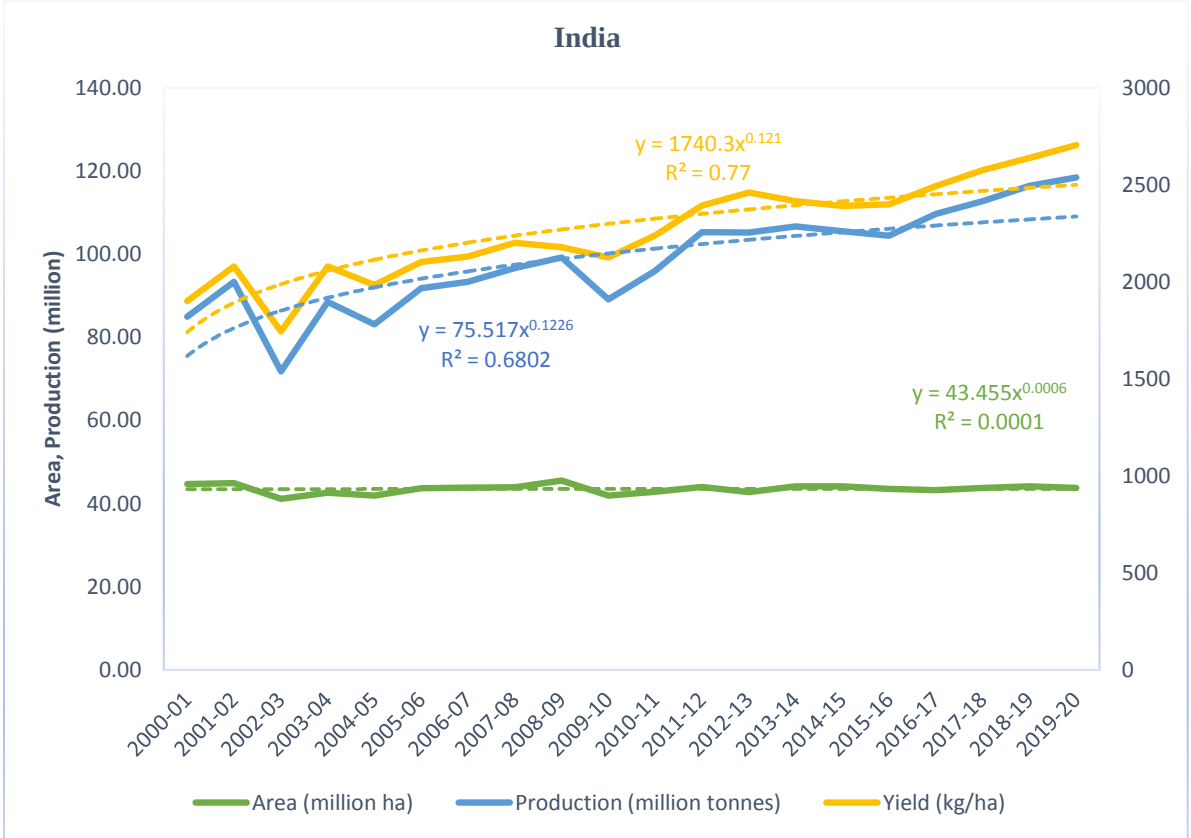

Fig. 1. Trends in area, production and yield of rice in India

Table 1. Area, production and yield of rice in Haryana and India: 2000-01 to 2019-20

	Haryana			India		
Period	**Area (M/ha)**	**Production (M/tonnes)**	**Yield (Kg/ha)**	**Area (M/ha)**	**Production (M/tonnes)**	**Yield (Kg/ha)**
2001-05	1.01	2.74	2,660	43.06	84.36	1957
2006-10	1.12 (10.89)	3.42 (24.82)	3,075 (15.59)	41.92 (-2.65)	89.06 (5.57)	2,125 (8.56)
2011-15	1.24 (10.71)	3.84 (12.28)	3,092 (0.57)	43.57 (3.94)	103.73 (16.47)	2,366 (11.34)
2016-20	1.41 (13.71)	4.56 (18.75)	3,230 (4.47)	43.68 (0.25)	112.68 (8.63)	2,563 (8.31)
% Change in 2016-20 over 2001-05	**39.60**	**66.42**	**21.44**	**1.44**	**33.57**	**30.92**
CAGR	11.76*	18.51*	6.69*	0.48*	10.13*	9.40*
CV (%)	14.34	20.95	8.17	1.87	13.42	11.81

Source: Indiastat (GoI) and Statistical Abstract of Haryana (GoH).
**Figures in parenthesis indicate percentage change *Significant at p<1%*

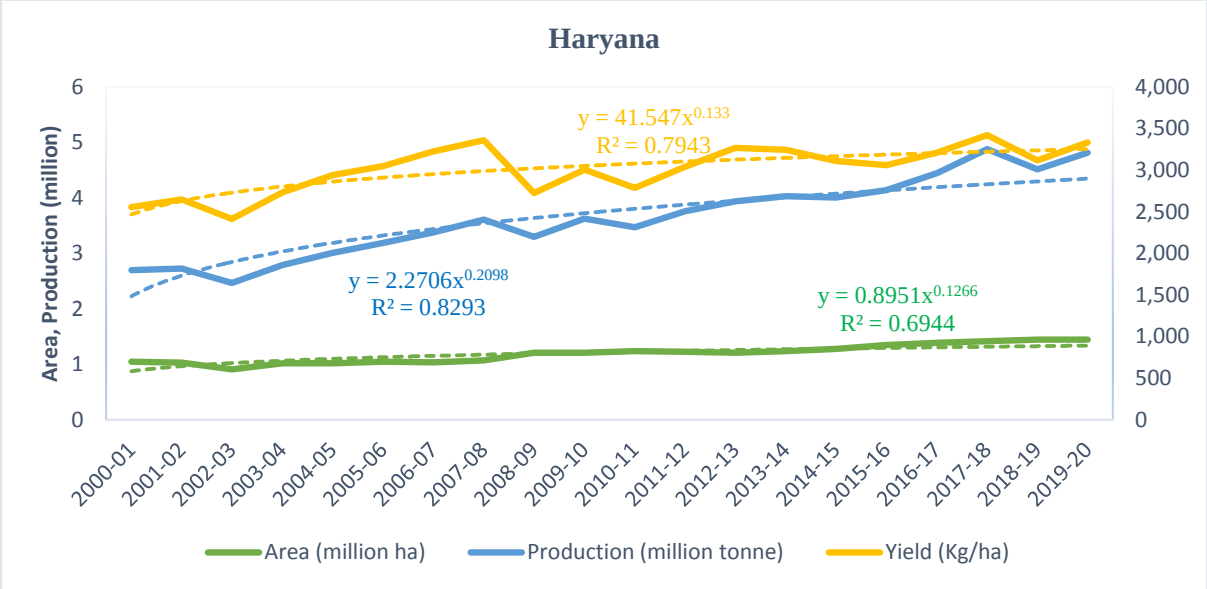

Fig. 2. Trends in area, production and yield of rice in Haryana

3.4 Cost and Returns of Rice Cultivation in Haryana

Four different varieties of rice were observed to be cultivated in the study area during the 2019-20 season. These varieties are Basmati (Pusa-1121 and Pusa-1509), Basmati (CSR-30) and rice PR (HYV). The cost and returns of cultivation of these rice varieties was outlined in Table 2. In Basmati (Pusa-1121) cultivation, total cost was calculated at Rs. 123,333 ha^{-1} out of which total variable and fixed costs accounted for 44.63 percent and 55.37 percent respectively. The rental of land contributed the highest share (45.25%) of the total cost of Pusa-1121 cultivation. The other items contributing to total cost of Pusa-1121 cultivation were management and risk factors (8.93%), irrigation (8.42%), harvesting (8.01%) and plant protection measures (7.68%). Hoeing / weeding accounted for the lowest cost of cultivation of Pusa-1121 (0.90%). Likewise, the total cultivation cost of Pusa-1509 was recorded at Rs. 128,919 ha^{-1}, out of which total variable and fixed costs accounted for 46.58 per cent and 53.42 per cent respectively. The rental of land contributed the highest share (42.94%) of the total cost of Pusa-

1509 cultivation. The other items sharing in total cost of Pusa-1509 cultivation were management and risk factors (9.32%), irrigation (8.06%), harvesting (8.03%), fertilizer (7.98%) and plant protection measures (6.93%). Hoeing / weeding accounted for the lowest cost of cultivation of Pusa-1509 (0.66%). Similarly, the total sum of Rs. 130,404 ha-^{1} was incurred in the cultivation of Basmati (CSR-30), out of which total variable and fixed costs accounted for 44.09 percent and 55.91 percent, respectively. The rental of land contributed the highest share (45.76%) of total cost of CSR-30 cultivation. The other items contributing to total cost of CSR-30 cultivation were harvesting (9.49%), management and risk factors (8.82%), irrigation (8.62%), and plant protection measures (6.29%). Hoeing / weeding accounted for the lowest cost of cultivation of CSR-30 (0.59%). Furthermore, the total cultivation cost of rice PR-HYV variety was Rs. 120,950 ha-^{1} out of which total variable and fixed costs accounted for 43.11 per cent and 56.89 per cent, respectively. The rental of land contributed the highest share (46.94%) of total cost of PR-HYV cultivation. The other items sharing in total cost of PR-HYV cultivation were irrigation (11.10%), management and risk factor (8.62%), and plant protection measures (7.60%). Hoeing / weeding accounted for the lowest cost of cultivation of PR-HYV (0.67%). When cost per output was compared, highest cultivation cost was incurred in CSR-30 (Rs. 30.50 kg^{-1}), followed by Pusa-1509 (Rs. 25.28 kg^{-1}) and Pusa-1121 (Rs. 23.83 kg^{-1}). Least total cost was incurred in the cultivation of PR-HYV (Rs. 16.07 kg^{-1}).

Table 2. Cost structure and returns of rice cultivation in Haryana: 2019-20 (□. ha^{-1})

		Pusa-1121		Pusa-1509		CSR-30		PR-HYV	
S.N.	**Particulars**	**Qty**	**Value**	**Qty**	**Value**	**Qty**	**Value**	**Qty**	**Value**
A	**Variable costs**								
1.	Preparatory Tillage	5.5	7,925 (6.43)	5.4	7,887 (6.12)	5.5	8,005 (6.14)	5.5	7,403 (6.12)
2.	Sowing		6,765 (5.49)		6,958 (5.40)		6,625 (5.08)		6,855 (5.67)
3.	Seed (Kg)	5.5	2,258. (1.83)	5.3	1,992 (1.54)	5.4	2,258 (1.73)	5.7	1,288 (1.06)
4.	Total Fertilizer Investment	81.4	5,370 (4.35)	124.55	10,282 (7.98)	83.8	5,738 (4.40)	90.8	6,843 (5.66)
5.	Irrigation	13.4	10,158 (8.42)	13.6	10,385 (8.06)	14.7	11,239 (8.62)	17.6	13,428 (11.10)
6.	Hoeing / Weeding		1,108 (0.90)		851 (0.66)		755 (0.58)		805 (0.67)
7.	Plant protection chemicals		9,473 (7.68)		8,929 (6.93)		8,207 (6.29)		9,198 (7.60)
8.	Harvesting		9,875 (8.01)		10,357 (8.03)		12,370 (9.49)		4,208 (3.48)
9.	Interest on working capital		2,118 (1.72)		2,411 (1.87)		2,294 (1.76)		2,115 (1.75)
	Total variable cost		**55,048 (44.63)**		**60,052 (46.58)**		**57,490 (44.09)**		**52,140 (43.11)**
B	**Fixed costs**								
1.	Transportation		1,473 (1.19)		1,500 (1.16)		1,739 (1.33)		1,610 (1.33)
2.	Management + Risk factor		11,010 (8.93)		12,010 (9.32)		11,500 (8.82)		10,430 (8.62)
3.	Rental value of land		55,803 (45.25)		55,358 (42.94)		59,674 (45.76)		56,770 (46.94)
	Total Fixed cost		**68,285 (55.37)**		**68,868 (53.42)**		**72,913 (55.91)**		**68,810 (56.89)**
C	**Total cost (A+B)**		**123,333 (100.00)**		**128,919 (100.00)**		**130,404 (100.00)**		**120,950 (100.00)**
	Returns								

(a) Main	20.70	138,285	20.40	137,850	17.1	158,861	30.1	136,128
(b) By-products		5,135		6,250		6,098		5,825
Total		**143,420**		**144,100**		**164,960**		**141,953**
Returns over variable cost		**88,373**		**84,048**		**107,470**		**89,813**
Net returns		**20,088**		**15,181**		**34,557**		**21,003**
Return on investment		**0.35**		**0.12**		**0.26**		**0.17**

Source: Department of Agricultural Economics, CCSHAU, Hisar, 2020.
**Figures in parenthesis indicate percentage total*

Table 3. Rice production and marketing constraints in Haryana

S. No.	Constraints	Garrett mean score	Rank
1.	Small operational holdings	69.67	II
2.	Lack of remunerative prices for output	79.00	I
3.	Natural disaster (Risk and Uncertainty)	35.73	XIV
4.	Incidence of insect pest and diseases	55.60	V
5.	High cost of inputs	37.67	XI
6.	Shortage of labour	24.73	XV
7.	Poor metalled road condition	63.20	IV
8.	High transportation cost	43.20	IX
9.	Low plant population	37.60	XII
10.	Lack of marketing information	52.73	VII
11.	Spurt in production and heavy arrivals	67.13	III
12.	Price fluctuation	54.67	VI
13.	Unfavourable government policies and regulations	41.53	X
14.	Difficulty in accessing institutional credit	48.67	VIII
15.	Difficulty in balancing between family consumption and investment	36.87	XIII

Source: Field Survey, 2021

The yield of rice varied among the different varieties cultivated. Highest yield of 3,010 kgha^{-1} was recorded by PR-HYV, followed by Pusa-1121 (2,070 kgha^{-1}), Pusa-1509 (2,040 kgha^{-1}) and CSR-30 (1,710 kgha^{-1}). The gross returns from the sale of the rice output were Rs.143,420 ha^{-1}, Rs.144,100 ha^{-1}, Rs. 164,960 ha^{-1} and Rs.141,953 ha^{-1} for Pusa-1121, Pusa-1509, CSR-30 and PR-HYV respectively. Similarly, the computed returns over variable cost and net returns were Pusa-1121 (Rs. 88,373 ha^{-1}and Rs. 20,088ha^{-1}), Pusa-1509 (Rs. 84,048 ha^{-1}and Rs. 15,181ha^{-1}), CSR-30 (Rs. 107,470 ha^{-1}and Rs. 34,557 ha^{-1}) and PR-HYV (Rs. 89,813 ha^{-1} and Rs. 21,003 ha^{-1}). Furthermore, the return to investment values were 0.35, 0.12, 0.26 and 0.17 for Pusa-1121, Pusa-1509, CSR-30 and PR-HYV, respectively. This indicates that for every rupee invested in the cultivation, Rs. 0.35, Rs. 0.12, Rs. 0.26 and Rs. 0.17, was realized as profit from Pusa-1121, Pusa-1509, CSR-30 and PR-HYV, respectively. Comparatively, highest net profit per total output was realized in the cultivation of Basmati CSR-30 (Rs. 8.08kg^{-1}), followed by Pusa-1121 (Rs. 3.88kg^{-1}) and Pusa-1509 (Rs. 2.98kg^{-1}). Least net profit was accrued in the cultivation of PR-HYV rice (Rs. 2.79kg^{-1}). This further proved that rice cultivation in the study area is a profitable venture. The results of this study are in conformity with the findings of Nirmala and Muthuraman [11] and Nkuba et. al. [12].

3.5 Constraints in Rice Production in Haryana

Rice farmers in the study area were faced with numerous production and marketing constraints including small-sized operational holding, high cost of production inputs, lack of remunerative prices for their rice, etc.as presented in Table 3. Perception of the farmers was recorded and analysed using Garrett mean score to examine the extent of these constraints The respondents were asked to rank the given constraints from the most important to the least important one. The

most pressing constraint in rice cultivation during the study period was lack of remunerative prices for rice output as judged by its first ranking and Garrett mean score of 79.00. The other important constraints were small operational holdings (ranked II), spurt in production and heavy arrivals (III), lack of good road network (IV), and incidence of insect- pests and diseases (V). Shortage of labour was the least rice production constraint in the study area with fifteenth ranking and Garrett mean score of 24.73. Similar rice cultivation constraints were reported by Thanh and Singh [13] Waddington et. al. [14] and Mustapha [15].

4. CONCLUSION AND POLICY IMPLICATIONS

Rice is not only a staple food, but a cash crop to farming households in Haryana and India. Results of growth rate revealed that the area, production and yield of rice in Haryana was trending upward with positive and significantly increasing values despite some production and marketing constraints. High instability suggests that there is more variability in area, production and yield in Haryana than in India during the period under study. Furthermore, profitability was found to be a function of both input and output costs indicating that the ability of farmers to limit their total cost and increase their level of total output, the better their chances of earning higher profits from rice cultivation. Rice production was found to be profitable in the study area. Total cost of cultivation was Rs. 123,333ha^{-1}, Rs. 128,919ha^{-1} Rs. 130,404ha^{-1} and Rs. 120,950ha^{-1} for Pusa-1121, Pusa-1509, CSR-30 and HYV rice respectively. Similarly, net profit was recorded at Rs. 20,088ha^{-1}, Rs. 15,181ha^{-1}, Rs. 34,557ha^{-1} and Rs. 21,003ha^{-1} for Pusa-1121, Pusa-1509, CSR-30 and PR-HYV respectively. This proved that rice cultivation is a worthwhile option as cash crop in kharif season for diversification and improved farm income and living standards of the farming households. Nonetheless, lack of remunerative prices was the biggest constraint of rice cultivation. Thus, cultivation of rice could be made more profitable by upward review of per unit price of rice and looking into other avenues to entice the rice farmers. Similarly, further research effort should be made to reduce the production cost, and evolve higher potential cultivars which have direct effect on profitability.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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