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Yash Gautam
Research Scholar,
Department of Agricultural Economics, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

OP Singh
Associate Professor,
Department of Agricultural Economics, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Corresponding Author:
Yash Gautam
Research Scholar,
Department of Agricultural Economics, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India

Analysis of costs and resource productivity in pearl millet production under solar irrigation system in Jaipur, Rajasthan

Yash Gautam and OP Singh

Abstract
Pearl millet is an important millet crop in India. It is an important source of energy, protein, vitamins, and minerals for millions of the poorest people. India is also considered to be the one of the centre of origin for pearl millet with many distinct cultivars growing throughout the country. Apart from dietary use it is also used in dairy and poultry, alcohol industry, starch industry, processed food industry and export demand. Rajasthan has the highest area under pearl millet cultivation. Cost analysis suggested that the total cost of pearl millet cultivation was ≠ 30,779.63. Highest contribution in the cost of cultivation was of human labour. Net return including irrigation charges was ≠ 4,347.89 per hectare. Input productivity was analysed using cobb Douglas production function and it was found that human labour was overused whereas inputs like seed and manure etc were underutilised. Although, pearl millet cultivation gave profit but it can be made more profitable by efficient utilisation of underutilised and overused inputs.

Keywords: Cost concept, Cobb douglas, solar irrigation pump, pearl millet, resource use efficiency, regression analysis

Introduction

Pearl millet, popularly known as “Bajra” is a coarse grain crops and considered to be the poor man’s staple nourishment. Moreover, it constitute the principal source of energy, protein, vitamins, and minerals for millions of the poorest people. It is one of the major crops of China, India, South Eastern Asia, Sudan, Pakistan, Arabia, Russia & Nigeria. In India, sorghum ranks third in area and production, after rice and wheat (Gautam and Singh, 2018) [3]. Pearl millet is an important millet crop in India in terms of area and production. Sorghum and pearl millet account for nearly 5 per cent (each) of the total cropped area, but this area is concentrated primarily in the arid and semi-arid regions of the country (Pray and Nagarajan, 2009) [6]. India is also considered to be the one of the centre of origin for pearl millet with many distinct cultivars growing throughout the country. With sufficient rainfall of just 400 to 600 mm per year, pearl millet is preferred over sorghum and is grown extensively in the dry western and northern regions of the country. In some parts of India, pearl millet is grown as a winter crop. It is primarily a fodder crop in parts of Rajasthan and Gujarat especially during the summer when green fodder is scarce. In arid regions of India, pearl millet is one of the major source of food. Because of its high tolerance towards difficult climatic conditions such as drought and high temperature, it is suitable to cultivate in dry land areas where other cereal crops, such as maize or wheat could not survive.

According to the fourth advance estimates of Government of India, area under pearl millet during 2018-19 in entire country was 6.93 million hectares producing 8.61 million tonnes. Yield was recorded to be 1243 Kg/Ha which was one of the highest in recent years (GoI, 2019). During 2018-19, highest area under pearl millet was found to be in Rajasthan followed by Uttar Pradesh, Maharashtra, Haryana, Gujarat and Madhya Pradesh. However, highest yield was recorded in Madhya Pradesh (2458 Kg/Ha) followed by Gujarat (2101 Kg/Ha), Haryana (20168 Kg/Ha) and Uttar Pradesh (2029 Kg/Ha) (GoI, 2019). Area under pearl millet has been showing a declining trend in the last decade. However, production level was supported significantly by the increasing yield. A continuous increase in yield could be attributed to the aggressive research and development conducted by various government, private and international agencies. Annual per capita consumption of pearl millet in India has declined by 57 percent, from an average of 14 kg in 1998 to only 6 kg in 2003 (Pray and Nagarajan, 2009) [6]. High consumption of pearl millet was observed in the areas where it is grown in significant areas and in arid and semi-arid regions like Rajasthan. A major portion of pearl millet is also demanded in poultry industry.

The increase in pearl millet production in contrast with its decline in use as food implies that its use in alternative enterprises has been increasing. Alternative uses largely comprise animal feed which includes mainly dairy and poultry, Alcohol industry, starch industry, processed food industry and export demand. The potential demand for food processing presents encouraging prospects for value addition (Basavaraj, 2010) [1]. In Rajasthan, due to fluctuation in rainfall pattern and frequent monsoon failure, farmers prefer irrigating the crop through irrigation pump sets. However, it adds significant amount of cost when irrigated by diesel irrigation pump in the form of diesel fuel. Environmentally, use of diesel pump is also harmful. Burning 1 litre of diesel will produce 2.6 Kg of carbon dioxide. Hence, it can be easily understood that the amount of carbon dioxide that would be released in the atmosphere only by irrigating pearl millet crop for one season. According to Klynveld Peat Marwick Goerdeler, India uses more than 4 billion litres of diesel and around 85 million tons of coal per annum to support water pumping for irrigation. If 1 million diesel pumps could be replaced with equal number of solar pumps then it would result in reduction of diesel use by 9.4 billion litres over the life cycle of solar pumps saving Rs 8,400 Crore on diesel subsidy and CO_2 emission abatement of 25.3 Mn Tonnes. (KPMG, 2014). Hence, government launched several schemes to promote the installation and use of solar irrigation pumps. Kisan Urja Suraksha Utthaan Mahabhiyaan scheme is an initiative taken by the government in the direction of promotion of solar energy. Under this scheme, individual farmers will be supported to install solar agriculture irrigation pumps of capacity up to 7.5 HP. Central finance assistance of 30 per cent of the benchmark cost of the solar irrigation pump will be provided. The State Government will give a subsidy of 30 per cent and the remaining 40 per cent will be provided by the farmer. Bank finance may be made available for farmer contribution. Individual farmers having grid connected irrigation pump will be supported to solarise their pumps. Also, farmers will be allowed to sell the excess solar power to DISCOM's. Considering the diverse use and importance of the crop and the environmental effects of diesel used for irrigation, an economic analysis of pearl millet production under solar irrigation system was conducted.

Research Methodology

Jaipur was selected as the study area. The study was based on primary data collected with the help of survey schedule. Cost of cultivation and return over different costs were calculated using cost concept suggested by CACP (Gautam, 2017) [2]. Cobb Douglas production function was used to analyse the resource use efficiency of the inputs.

a) Cost A_1 = All actual expenses in cash and kind incurred in production by the owner. It includes :
b) Cost A_2 = Cost A_1 + rent paid for leased in land
c) Cost B_1 = Cost A_1 + interest on value of owned capital asset (excluding land)
d) Cost B_2 = Cost B_1+ rental value of owned land
e) Cost C_1 = Cost B_1 + imputed value of family labour.
f) Cost C_2 = Cost B_2+ imputed value of family labour
g) Cost C_3 = Cost C_2 + 10% of C_2

Results and Discussion

1) Cost concept analysis

Per hectare operational cost and fixed cost incurred in the cultivation of pearl millet under solar irrigation system is presented in the Table 1. It was found that the average total cost of cultivation was ≠ 30,779.63, out of which operational cost was ≠ 19,855.80 and fixed cost amounted to ≠ 8,125.67. The percentage contribution of operational cost in the total cost was 64.51% and that a fixed cost was 26.4%. Managerial cost was estimated to be ≠ 6765.03.

Table 1: Item wise Breakup of Cost of Production (□ per Ha.)

	Costs		Amount
A	**Operational Cost**		**19,855.80**
1	Human Labour	Family	11,018.95
		Attached	0.00
		Casual	3,096.61
		Total	14,115.56
2	Animal Labour	Hired	0.00
		Owned	0.00
		Total	0.00
3	Machine Labour	Hired	2,105.35
		Owned	891.35
		Total	2,996.70
4	Seed		703.20
5	Fertilizer & Manure	Fertilizer	656.38
		Manure	1,044.53
		Total	1,700.91
6	Insecticides		0.00
7	Irrigation Charges		110.45
8	Miscellaneous		0.00
9	Interest on Working Capital		228.98
B	Fixed Costs		8,125.67
1	Rental Value of Owned Land		5,255.47
2	Rent Paid For Leased-in-Land		274.19
3	Land Revenue, Taxes, Cesses		4.62
4	Depreciation on Implements & Farm Building		2,329.27
5	Interest on Fixed Capital		262.12
C	Operational Cost + Fixed Cost [A+B]		27,981.48
D	Managerial cost		2,798.15
F	Total cost [C+D]		30,779.63

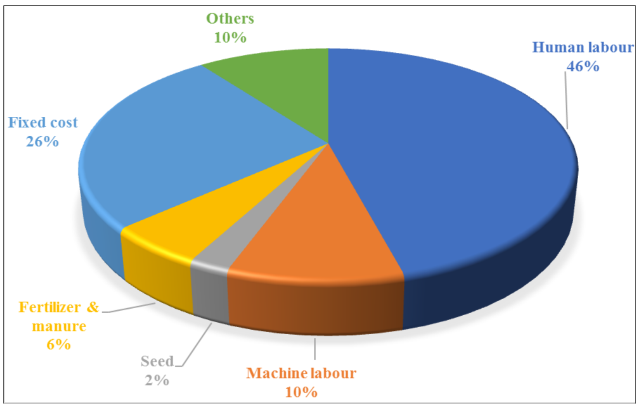

Fig 1: Share of different factors in cost of cultivation of pearl millet under solar irrigation system

Figure 1 shows the share of major inputs in the cost of cultivation of pearl millet under solar irrigation system. It was observed that highest contribution in the total cost was of human labour (46 per cent), machine labour (10 per cent), fertiliser and manual (6 per cent) and seed (2 per cent). The fixed cost contributed to the extent of 26 per cent in the total cost. Cost of cultivation as suggested by cost concept Commission on Agricultural Cost and Prices (CACP) is shown in table 2. It can be observed it was observed that Cost A1 and A2 were ≠ 11,170.75 and 11,444.94 respectively. Cost B1, B2, C1, C2, C3 were estimated to be ≠ 11,707.06, ≠ 16,962.53, ≠ 22,726.01, ≠ 27,981.48, and ≠ 30,779.63 respectively.

Table 2: Per hectare cost of cultivation of pearl millet under solar irrigation system

S. No.	Particulars	Amount (□)
1	Cost A1	11,170.75
2	Cost A2	11,444.94
3	Cost B1	11,707.06
4	Cost B2	16,962.53
5	Cost C1	22,726.01
6	Cost C2	27,981.48
7	Cost C3	30,779.63

Table 3 shows the returns of pearl millet under solar irrigation system. It was estimated that the return from main product and by product was equal to ≠ 15,906.83 and ≠ 19,110.24 respectively. The net return was ≠ 4,237.45. Under solar irrigation system, farmer didn't have to pay irrigation charges because farmer had installed solar pump on their own farm and operation of solar pump doesn't require any additional inputs or costs. Therefore, irrigation charges that farmer had to pay when they didn't install solar irrigation pump were saved. Hence, the irrigation charge which was saved was considered to be the addition in the income of the farmer. So, the net income of the farmer after including irrigation charges was estimated to be ≠ 4,347.90.

Table 3: Per hectare returns of pearl millet under solar irrigation system

S. No.	Particulars	Amount (□)
1	Main product	15906.83
2	By product	19110.24
3	Gross return	35017.07
4	COC	27981.48
5	Cost C3	2798.15
6	Net return	4237.44
7	Net Income = Irrigation charges + Net return	4347.89

2) Resource Use efficiency

The value of coefficient of multiple determination capital R square was 0.5956. It indicates that 59.56 per cent variation in logarithmic value of gross returns was explained by the independent variables (human labour, machine labour, seed, fertiliser and manure) included in the regression model.

The coefficient of elasticity of production of human labour turned out to be negative and significant. It means that for every 1 per cent increase in human labour there will be a decrease in the gross return by 1.0005 per cent keeping the other variable resources considered in the equation constant at their geometric mean level. Similarly, coefficient of elasticity of production of machine labour and fertilizer were positive and insignificant. However, the coefficient of elasticity of production of seed and manure were positive and significant.

Table 4: Regression coefficients of variables included in the regression model

Particulars	Intercept	Human Labour	Machine Labour	Seed	Fertilizer	Manure
Coefficients	1.0251	-1.0005	0.3775	0.1840	0.0198	1.4832
t Stat		-4.3284	1.7181	2.6071	0.1867	6.2284
P value		4.97E-05	0.0902	0.0111	0.8524	3.22E-08
$\sum b_i = 1.064$			$R^2 = 0.5956$			

Significant at 5 per cent level

The sum of the regression coefficients of variables was more than one i.e. $\sum b_i = 1.064$ which meant that there was increasing returns to scale. Also, the inputs were not used optimally. If the inputs which were positive and significant like seed and manure were used increasingly and optimally, production will also increase. Human labour was used in abundance which lead to its overuse. So, farmers need to reduce the use of human labour to make them more productive.

Conclusion

Cost concept analysis showed that the pearl millet production in Jaipur was profitable even under solar irrigation system. Net return of the farmer was □ 4,347.89 per ha. Regression analyses shows that there is a scope of increase in the pearl millet production by the optimal utilisation of several underutilised and overutilized inputs.

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