

Short Communication

A comparative economics of mustard crop in sprinkler and canal irrigation systems in Bikaner district of Rajasthan

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(Received: 15 January 2024; Revised: 29 June 2024; Accepted: 30 June 2024)

Abstract

Mustard, one of the most important oilseed crops, holds economic importance, prompting an exploration of irrigation impact on economic viability. The mustard is major oil seed crops in Rajasthan. This study conducted a comprehensive analysis of mustard crop cultivation costs under sprinkler and canal irrigation systems. Sprinkler irrigation, known for enhancing efficiency, is examined for its potential in water saving. As global food demands rise and water scarcity becomes critical, identifying an irrigation system balancing economic feasibility and environmental sustainability is imperative. The study dissects cost structures, yield variations, and overall economic viability associated with mustard cultivation under sprinkler and canal irrigation. Primary data collected through personal interview schedule method from 100 farmers for each irrigation system in Bikaner district of Rajasthan, considering diverse cost concepts. The results indicate that while the total cost of cultivation on sprinkler irrigated farms marginally exceeds that on canal irrigated farms, the detailed breakdown highlights advantages in key cost components for sprinkler systems. The study further reveals higher productivity and net income in sprinkler irrigated farms, corroborated by higher benefit-cost ratios. These findings collectively advocate for the adoption of sprinkler systems, not only for their economic advantages but also for sustainable agricultural practices including water saving. The nuanced understanding presented in this study serves as a valuable guide for stakeholders in making informed decisions for a resilient and resource-efficient agricultural landscape.

Keywords: Cost analysis, farm income, mustard cultivation, sprinkler irrigation system

Introduction

In India, groundnut, soybean and rapeseed-mustard are the major oilseeds and contribute approximately 80% (Chand *et al.*, 2020; Malva *et al.*, 2024) of oilseeds production. Rapeseed-mustard crops in India are grown in diverse agro-climatic conditions ranging from north-eastern to north western hills and down south under irrigated/rainfed, timely/late sown, saline soils and mixed cropping (Dhaka, 2007; Gawaria *et al.*, 2011; Jain *et al.*, 2020). Indian mustard accounts for about 80% of total hectares under these crops in the country. The average contribution of rapeseed-mustard to the total oilseed production in India was 24%, with its average productivity 1497 (kg/ha) during 2021-22. Though, rapeseed-mustard is placed 2nd in terms of production, after soybean, it ranks 1st in terms of oil yield among all oilseed crops. Mustard, being a vital oilseed crop, holds significant economic importance for farmers (Kumari *et al.*, 2023; Yogi *et al.*, 2024). In the realm of modern agricultural practices, optimizing irrigation systems is paramount for ensuring efficient resource utilization and sustainable crop production. This study delves into a comparative analysis of mustard's cost of cultivation

under two prominent irrigation methods—sprinkler and canal irrigations. The choice of irrigation system profoundly influences not only the economic viability of cultivation but also the overall sustainability of agricultural practices. Sprinkler irrigation holds immense potential in enhancing irrigation efficiency, which is crucial for sustainable agricultural development. Alongside adopting optimal crop plans, the strategic implementation of sprinkler irrigation can play a pivotal role in conserving water resources and bolstering food security at the national level (Lashari *et al.*, 2004; Namara *et al.*, 2007). It is essential to strike a balance in virtual water trade, ensuring that it aligns with the nation's food security goals rather than solely focusing on exports (Kakhandaki *et al.*, 201; Kumar *et al.*, 2018). Given the diverse regional and individual farmer contexts, the economics of sprinkler irrigation varies significantly, presenting a complex landscape of potential benefits and challenges.

The escalating demands on global food production necessitate a critical examination of irrigation practices to enhance crop yields while minimizing resource inputs. As water scarcity becomes an increasingly

pressing concern, identifying the irrigation system that strikes a balance between economic feasibility and environmental sustainability is imperative (Walia *et al.*, 2023). This study aims to contribute to this discourse by dissecting the cost structures, yield differentials, and overall economic viability associated with mustard crop cultivation under two distinct irrigation paradigms—sprinkler and canal. By elucidating the intricate relationships between costs, productivity, and returns, the research endeavors to guide strategic decision-making for farmers and policymakers, fostering a more resilient and resource-efficient agricultural landscape.

Materials and Methods

The present study is based on primary data analysis, the data were collected from 100 sprinkler irrigated farms and 100 canal irrigated farms in the Bikaner district of Rajasthan. The data collected from the respondents were used to do the B:C ratio calculations using MS Excel. This study aims to investigate the impact of the sprinkler irrigation system on farm income in the Bikaner district of Rajasthan based on the following cost concepts. Cost A₁: It includes, value of hired human labour; value of owned and hired animal labour; value of owned and hired machine labour; value of seeds (both from produced and purchased); value of manures, fertilizers

insecticides and pesticides; irrigation charges; depreciation; land revenue; interest on working capital and miscellaneous expenses.

Cost A₂: Cost A₁+ rent paid for leased in land

Cost B₁: Cost A₁+ interest on fixed capital assets (excluding land)

Cost B₂: Cost B₁+ rental value of owned land +rent paid for leased in land

Cost C₁: Cost B₁+ imputed value of family labour

Cost C₂: Cost B₂+ imputed value of family labour

Cost C₃: Cost C₂+ 10 % of cost C₂ as management cost

Income measures

Following income measures was used to check farm income from sprinkler and canal irrigation system.

Farm gross receipts (FGR)=Q_m×P_m+Q_b×P_b

Where, Q_m = Quantity of main product, P_m = Price of main product, Q_b = Quantity of by- product, and P_b = Price of by- product

Farm business income (FBI) = Gross income – Cost A₁ (cost A₂ in case of tenant operated land)

Family labour income (FLI) (returns to family labour and management) = Gross income – Cost B₂

Farm net income = Farm gross receipts – Cost C₂

Economic feasibility measures: B:C ratio

$$B:C \text{ ratio} = \frac{\text{Gross income/ha}}{\text{Total cost/ha}}$$

Table 1: Breakup of cost cultivation of mustard under sprinkler and canal irrigated farms (Rs./ha)

Particulars	Sprinkler irrigation	Canal irrigation
A. Variable cost		
Machinery power	18242 (21.89)	20272 (25.37)
Imputed family labour	7370 (8.84)	2007 (2.51)
Casual hired labour	2957 (3.55)	6065 (7.59)
Total fertilizer	6451 (7.74)	8291(10.38)
FYM	9441 (11.33)	3479 (4.35)
PPC	4689 (5.63)	5988 (7.49)
Irrigation charges	2235 (2.68)	446 (0.56)
cost of seed	5367(6.44)	2786 (3.49)
Interest on working capital @ 7%	3972(4.77)	3453 (4.32)
Total Variable Cost (TVC)	60726 (72.87)	52790 (66.06)
B. Fixed cost		
Depreciation	2467 (2.96)	2745 (3.44)
Rental value of owned land	9000 (10.80)	11000 (13.77)
Rent paid for leased in land	10000 (12.00)	12000 (15.02)
Interest on fixed capital @10%	1146 (1.37)	1374 (1.72)
Total fixed cost (TFC)	22614 (27.13)	27119 (33.94)
Total cost (TC)	83341 (100)	79910 (100)

Figures in parentheses are the percentages to the respective total cost (cost C₂)

Results and Discussion

Analyzing cost breakdowns, yield differentials, and benefit-cost ratios, the findings provide a comprehensive understanding of the advantages associated with sprinkler irrigation in enhancing both financial viability

and agricultural sustainability. Operation wise cost of cultivation of mustard under sprinkler and canal irrigated farms are presented in Table 1. The total cost of cultivation of mustard was estimated at Rs. 83341 and Rs. 79910/ha on sprinkler and canal irrigated farms. Thus, on an average, the total cost of cultivation of

mustard on sprinkler irrigated farms was marginally higher as compared to canal irrigated farms due to higher total variable cost. In total variable cost machinery labour, Imputed family labour, total fertilizer, farm yard manure, plant protection chemicals, irrigation charges and cost of seed were the major items of the total cost components to differentiate the cost structure between the sprinkler irrigated farms and canal irrigated farms. Among the total fixed cost depreciation, rental value of owned land and rent paid for leased in land of the total cost components to differentiate the cost structure between sprinkler irrigated farms and canal irrigated farms.

Expenditure on machine power, seed, manure, total fertilizers and plant protection chemicals, which accounted for 21.9, 6.4, 11.3, 7.7, and 5.6 % of total cost

Table 2: Yield and economics of mustard under sprinkler and canal irrigated farms (Rs./ha)

Particulars	Seed yield (q/ha)	Stover yield (q/ha)	Gross income (Rs./ha)	Farm business income	Family labour (Rs./ha)	Net income (Rs./ha)
Sprinkler irrigation	20.66	23.15	98270	42447	22300	14929
Canal irrigation	12.18	15.21	84668	31141	6766	4758

Table 2 reveals that, yield of mustard with sprinkler irrigation was 20.66 q/ha while on canal irrigated farms it was 12.18 q/ha. Thus, the productivity of sprinkler irrigated farms was higher than on canal irrigated farms. The gross income was recorded higher under sprinkler irrigation than the canal irrigated farms. It is also evident from the Table 2 that farm business income represents return over variable cost on sprinkler and canal irrigated farms, it was Rs. 42447 and Rs. 31141/ha. Thus, farm business income was quite higher in sprinkler system than in canal irrigated farms. The family labour income on sprinkler irrigated farms was Rs. 22300 and Rs. 6766/ha on canal irrigated farms. Thus, the family labour income on sprinkler irrigated farms was also found higher than on canal irrigated farms. Net income implies profit per hectare after deducting cost C2 from gross income. The net income for mustard cultivation on sprinkler irrigated farms was Rs.14929/ha and Rs.4758/ha on canal irrigated farms. Thus, the net income was higher on sprinkler irrigated farms than on canal irrigated farms. The comparative estimates of different costs incurred in mustard cultivation on sample farms using sprinkler and canal irrigation are given in Table 3.

Data reveals that the difference between Cost A1 on sprinkler and canal irrigated farms was mainly due to machinery labour, family labour, casual hired labour, manure, cost of seed, total fertilizer, and plant protection chemicals. Cost B1 and B2 on sprinkler irrigated farms were worked out to be Rs.56971 and Rs.75971/ha, respectively while on canal irrigated farms cost B1 and

on sprinkler irrigated farms while, in case of canal irrigated farms, the share of machine labour, seed, manure, fertilizer and chemicals of total cost were 25.4, 3.5, 4.4, 10.9 and 7.5 % respectively. Interest on working capital on sprinkler irrigated farms was 4.8 % and interest on fixed capital was 1.8 % and on canal irrigated farms it was 4.3 % and 1.7 % of total cost.

In brief, it could be concluded that the % share of imputed family labour, manures, irrigation charges, seed and interest on working capital in total cost were higher on sprinkler irrigated farms than on canal irrigated farms while, on canal irrigated farms the % share of charges of machine labour, casual hired labour, plant protection chemicals, fertilizers, depreciation of fixed assets, rental value of owned land and rent paid for leased in land in total cost were higher than on sprinkler irrigated farms.

B2 were worked out to be Rs. 54902 and Rs. 77902/ha, respectively. The Costs C1 and C2, on sprinkler irrigated farms Rs. 68067 and Rs.83341/ha while on canal irrigated farms Cost C1 and C2, were Rs. 56910 and Rs. 79910/ha respectively. Cost C3, which includes managerial cost, was worked out to be Rs. 91675 and Rs. 87901/ha, respectively.

Thus, on an average, the total cost (Cost C₂) of cultivation of mustard on sprinkler irrigated farms was higher as compared to canal irrigated farms. It is also evident from the Table 3 that on an average, the B:C ratio in mustard cultivation on sprinkler irrigated farms on Cost A1, A2, B1, B2, C1, C2 and C3 were 1.76, 1.49, 1.72, 1.29, 1.44, 1.18 and 1.07, respectively. On canal irrigated farms the B:C ratio, on overall basis, on Cost A1, A2 B1, B2, C1, C2 and C3 were 1.58, 1.29, 1.54, 1.09, 1.49 and 1.06, and 0.96 respectively. Thus, the overall B:C ratio in mustard production was higher in sprinkler farms than the canal irrigated farms.

Conclusion

In conclusion, the analysis of mustard crop cultivation costs and returns between sprinkler and canal irrigated farms highlights the economic advantages of sprinkler irrigation. While the total cultivation cost is slightly higher for sprinkler farms, the associated benefits far surpass those of canal irrigated farms. The breakdown of variable and fixed costs underscores the specific factors contributing to this difference, with machinery labor, family labor, and various inputs playing pivotal roles. The superior performance of sprinkler irrigation is

Table 3: Cost of cultivation of mustard on different cost concepts basis under sprinkler and canal irrigated farms (Rs./ha)

Costs	Sprinkler irrigation		Canal irrigation	
	Cost (Rs./ha)	B:C ratio	Cost (Rs./ha)	B:C ratio
CostA1	55824	1.76	53528	1.58
CostA2	65824	1.49	65528	1.29
CostB1	56971	1.72	54902	1.54
CostB2	75971	1.29	77902	1.09
CostC1	68067	1.44	56910	1.49
CostC2	83341	1.18	79910	1.06
CostC3	91675	1.07	87901	0.96

evident in higher yields, gross income, and net income, reflecting its efficiency in mustard production. The consistent favorability of the B:C ratio for sprinkler farms across different cost concepts reinforces the economic viability and profitability of adopting sprinkler irrigation. Despite the initial investment, mustard cultivation under sprinkler irrigation emerges as a financially sound choice, promising not only increased productivity but also superior overall returns on investment for farmers.

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