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Impact of drip irrigation method on bitter gourd crop in Malwa plateau agro-climatic region of Madhya Pradesh

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Abstract

The present study confined to Malwa Plateau Agro Climatic Region of Madhya Pradesh. The present study was conducted on bitter gourd in Dhar district of Madhya Pradesh. The total cost was found to be increased 4.75 percent of an average adopted farm (₹ 282614.90) as compared to an average non-adopted farm (₹ 269799.79) in cultivation of bitter gourd. The yield of bitter gourd was found to be increased 25.78 percent of an average adopted farm (181.02q/ha) as compared to non-adopted farm (143.92q/ha) in production of bitter gourd. The gross income was found to be increased 27.74 percent of an average adopted farm (₹ 662050.75/ha) as compared to an average non-adopted (₹ 518286.77/ha) farm. The return per rupee was also found to be increased 21.88 percent of an average adopted farm (₹ 2.34) as compared to an average non-adopted (₹ 1.92) farm in the study area. The cost of seed and human labour were found to be positive and significant in the adopted farm and the cost of chemical fertilizer, FYM, plant protection chemical, stacking and human labour were found to be positive and significant in the non-adopted farm.

Keywords: Drip irrigation method, cost of cultivation of bitter gourd, profitability and resource use efficiency of bitter gourd

1. Introduction

Irrigation can be broadly defined as the practice of applying additional water to the soil to enable or enhance plant growth and yield. There are several methods of irrigation in which the Surface method of irrigation is one of the most common methods for irrigation. This highlights the need to adopt a modern efficient irrigation method of drip which offers several advantages over furrow irrigation including higher water and fertilizer use competence and high yield. (Camp, C.R. 2001) [8] Micro irrigation method is a modern method used for water-saving and increasing water use efficiency. (Ram Kumar *et al*, 2016) [9]. Adoption of drip irrigation is one of the most efficient methods of scheduling of irrigation having more than 90 percent irrigation efficiency. (Tasal and Pawar 2013). Drip irrigation is most suitable for row crops (vegetables, soft fruit), tree and vine crops where one or more emitters can be provided for each plant. Drip irrigation is adaptable to any farmable slope and most soils (Verma and Sharma, 2017) [10]. Vegetables are one of the cornerstones of human nutrition, vital for a healthy and balanced diet. Thus, harvested global amounts of vegetables are huge – more than one billion metric tons per year. Over 834 million tons of fresh vegetables are produced in Asia. (Statista Research Department, 2020). In India, total vegetable growing area is 10.26 million hectare and production is 184.39 million tonnes while the productivity is 17973 kilogram per hectare respectively. In Madhya Pradesh total vegetables growing area is 0.89 million hectare and production is 17.55 million tonnes while the productivity is 19720 kilogram per hectare. The yield of vegetables in Madhya Pradesh is higher than the average yield rate of India.

2. Methodology

The present study confined to Malwa Plateau Agro Climatic Region of Madhya Pradesh. There are nine districts under Malwa Plateau *e.i.* Indore, Ujjain, Ratlam, Mandsour, Neemach, Dhar (Dhar, Badnawar and Sardarpur), Dewas, Shajapur and Agar-Malwa. Out of nine districts Dhar districts has selected purposely which are friendlier to adopt drip irrigation system in vegetables production. Respondents was selected based on adoption and non-adoption of drip irrigation system across different sizes group of holding. 120 adopters and 60

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non-adopters constituting total sample size of 180 respondents were selected for the study.

2.1 Statistical Tools

2.1.1 Relative change was calculated through following formula

$$\text{Relative change (\%)} = \frac{\text{Value of the Adopter} - \text{Value of the non adopter}}{\text{Value of the non adopter}} \times 100$$

2.1.2 Cost of cultivation

Variable cost: Sum of the Operational cost, material cost and other cost

Fixed cost: Sum of the interest of fixed capital, rental value of own land and managerial cost

Total cost: Sum of the variable cost and fixed cost

2.1.3 Profitability measurement

For the estimation of profitability of bitter gourd, the following income measures were used in this study.

a) Gross income	= Market price per quintal X Total Production
b) Net farm income (NFI)	= Gross income - total cost
c) Farm investment income	= Farm business income-imputed value of family labour
d) Family labour income (FLI)	= Gross income - cost B2
e) Farm business income (FBI)	= Gross income - cost A1
f) Cost of production	= Total cost/ Total production
g) Return per rupee	= Gross income/total cost

2.1.4 Resource use efficiency: Cobb – Douglas production function finally was fitted as it gives the best fit to data

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6}$$

3. Result and Discussion

3.1 Mean Difference of Socio-Economic Characteristics of Non-Adopter and Adopter farmers

The difference between adopted and non-adopted farmers in average age, agricultural experience, education level, family size, annual income and land holding is presented in table 4.21. The difference in average age between adopted farmers (48.04 years old) and non-adopted farmers (46.41 years old) were found to be 1.63 years. The difference in average farming experience between adopted farmers (27.65 years) and non-adopted farmers (27.15 years) was found to be 0.50 years. The difference in average education level between adopted farmers (9.34 class) and non-adopted farmers (8.64 classes) was found to be 0.70 classes. The difference in average size of family between adopted farmers (6.04) and non-adopted farmers (5.98) was found to be 0.06. The difference in average annual income between adopted farmers (₹ 248786.03) and non-adopted farmers (₹ 242632.20) was found to be ₹ 6153.83. The difference in average land holding

between adopted farmers (2.93 ha) and non-adopted farmers (2.96 ha) was found to be 0.03 ha in the study area.

The difference between adopted and non-adopted farmers in average age, agricultural experience, education level, family size, annual income and land holding were found to be not-significant difference in the study area. Hence, null hypothesis is accepted, and alternate hypothesis is rejected in the study area.

Table 1: Results of two-tailed t-test for continuous socioeconomic characteristics of adopters and non- adopters

Particulars	Non-adopter	Adopter	Mean difference	“t”
Age of respondent	46.41 (12.23)	48.04 (12.36)	1.63	0.89NS
Farming experience	27.15 (11.18)	27.65 (12.21)	0.50	0.29NS
Education level	8.64 (4.62)	9.34 (4.78)	0.70	1.00NS
Size of family	5.98 (1.89)	6.04 (1.99)	0.06	0.21NS
Average annual income	242632.20 (97691.67)	248786.03 (124254.15)	6153.83	0.39NS
Size of farm	2.96 (3.71)	2.93 (3.83)	0.03	0.11NS

Figure in the parenthesis shows standard deviation

*** Significant at 1% level of significant

** Significant at 5% level of significant

*Significant at 10% level of significant

3.2 Impact of Drip Irrigation on Bitter gourd

The change in between an average adopted and non-adopted farm in human labour days in cultivation, operational cost, material cost, other cost, variable cost, fixed cost, total cost, yield, return, return per rupee and cost of production in cultivation of vegetable such as bitter gourd.

3.2.1 Operational Cost

The operation cost was found to be decreased 12.59 percent in an average adopted farm (₹ 99310.67) as compared to an average non-adopted farm (₹ 112599.23) in cultivation of bitter gourd. The highest operational decrease in an average between adopted farm and an average non-adopted farm was found to be in hired human labour (16.76%) as compared to family human labour (12.31%) and machine power (10.81%) cost in cultivation of bitter gourd. This change in between an average adopted farm and an average non-adopted farm was found to similar across size of farm with minor variation. Although the change in an average machine power was found to more in small (12.59%) as compared to be medium (11.20%) and large (8.99%) size of farm in cultivation of bitter gourd.

Thus, an average operational cost across size of farm the maximum decrease was found to be in large (14.10%) as compared to medium (13.69%) and large (12.31%) size in an average adopted farm as compared to an average non-adopted farm in cultivation of bitter gourd.

Table 2: Operational cost across size of farms in cultivation of bitter gourd (₹/ha)

Particulars	Small		Medium		Large		Overall	
	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter
Hired human labour	20706.76	17874.67 (-13.68)	25306.67	21723.36 (-14.16)	34829.96	30067.11 (-13.67)	25524.69	21247.14 (-16.76)
Family human labour	40921.11	35802.97 (-12.51)	37960.51	32585.05 (-14.16)	29670.14	25146.82 (-15.25)	37387.99	33534.88 (-10.31)
Total human labour	61627.87	53677.64 (-12.90)	63267.18	54308.41 (-14.16)	64500.10	55213.93 (-14.40)	62912.68	54782.02 (-12.92)
Machine power	10926.36	9943.73 (-8.99)	12055.28	10704.77 (-11.2)	12775.72	11166.67 (-12.59)	11785.43	10511.31 (-10.81)
Operational cost	72554.23	63621.37 (-12.31)	75322.46	65013.18 (-13.69)	77275.82	66380.60 (-14.10)	74698.11	65293.33 (-12.59)

Figure in the parenthesis shows percent change in adopted over non-adopted farm

3.2.3 Material Cost

The material cost was found to be decreased 3.93 percent of an average adopted farm (₹ 74078.85) as compared to an average non-adopted farm (₹ 77110.18) in cultivation of bitter gourd. The highest decrease was found to be in stacking (3%) as compared to chemical fertilizer, FYM/organic manure & plant protection chemical (2%) and seed/plant & irrigation (1%) cost in between an average adopted farm and an average non-adopter farm, while cost of mulching was found to be 10 percent add in an average adoption of farm only. There change was found to similar across size of farm with minor variation.

Although the change in between an average adopted farm as compared to an average non-adopted farm in stacking

material cost were found to more in large (28.06%) size as compared to be medium (13.26%) and small (10.48%) size in an average adopted farm as compared to non-adopted farm, the change in chemical fertilizer cost was found to be more in small (12.61%) as compared to medium (10.81%) and large (3.18%) size in an average adopted farm as compared to an average non-adopted farm, the change in seed cost was found to be more in large (9.07%) as compared to medium (5.86%) and small (4.70%) size in cultivation of bitter gourd. (Table 4.) Thus, the material cost the maximum decrease was found to be in medium (4.49%) as compared to large (4.15%) and small (2.98%) size in an average adopted farm and an average non-adopted farm in cultivation of bitter gourd in the study area. (Table 3)

Table 3: Material cost across size of farms in cultivation of bitter gourd (₹/ha)

Particulars	Small		Medium		Large		Overall	
	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter
Seeds	16180.86	15419.63 (-4.70)	16671.22	15693.93 (-5.86)	17503.72	15916.67 (-9.07)	16657.92	15635.14 (-6.14)
Fertilizer	17489.82	15285.00 (-12.61)	17721.11	15806.24 (-10.81)	16809.14	16274.17 (-3.18)	17453.91	15703.21 (-10.03)
FYM / Organic manures	6327.27	4968.34 (-21.48)	7062.5	5464.69 (-22.62)	7911.21	6241.83 (-21.10)	6962.66	5431.05 (-22.00)
Plant protection Measurement	12584.09	10912.09 (-13.29)	13456.94	11120.56 (-17.36)	14387.5	11700.00 (-18.68)	13323.01	11155.63 (-16.27)
Irrigation	2476.82	1508.36 (-39.1)	2593.89	1527.10 (-41.13)	2850.58	1616.67 (-43.29)	2602.3	1537.54 (-40.92)
Mulching	0	6768.39 (∞)	0	7032.22 (∞)	0	10686.84 (∞)	0	7644.64 (∞)
Stacking	19222.73	17208.96 (-10.48)	19643.06	17039.25 (-13.26)	22750.28	16366.67 (-28.06)	20110.38	16971.64 (-15.61)
Total material cost	74281.59	72070.77 (-2.98)	77148.72	73683.99 (-4.49)	82212.43	78802.85 (-4.15)	77110.18	74078.85 (-3.93)

Figure in the parenthesis shows percent change in adopted over non-adopted farm

3.2.4 Other Cost

The other cost was found to be decreased 11.38 percent of an average adopted farm (₹ 5899.26) as compared to an average non-adopted farm (₹ 6656.69) in cultivation of bitter gourd. The highest decrease was found to be in interest on working capital (1%) as compared to miscellaneous (-1%) cost and there change in depreciation of farm assets was not found in between an average adopted farm and an average non-adopted farm. There change was found to similar across size of farm with minor variation. Although the change in between in an average adopted farm and to non-adopted farm in depreciation of farm assets were found to more in small (48.31%) as

compared to be medium (13.01%) and small (-22.20%) size, the change in miscellaneous was found to be more in large (19.74%) as compared to be medium (11.71%) and small (5.90%) size, the change in interest on working capital was found to be more in large (8.07%) as compared to medium (7.50%) and small (5.70%) size of farm in cultivation of bitter gourd in the study area.

Thus, the other cost across size of farm the maximum decrease was found to be in large (13.23%) as compared to medium (10.99%) and small (9.55%) size in an average adopted farm as compared to an average non-adopted farm in cultivation of bitter gourd.

Table 4: Other cost across size of farms in cultivation of bitter gourd

Particulars	Small		Medium		Large		Overall	
	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter
Miscellaneous	3977.45	3742.60 (-5.90)	4445.33	3924.62 (-11.71)	5912.67	4745.33 (-19.74)	4567.24	4016.45 (-12.06)
Interest on working capital	1282.08	1209.04 (-5.70)	1387.82	1283.76 (-7.50)	1583.53	1455.79 (-8.07)	1388.19	1281.63 (-7.68)
Depreciation	500.89	258.91 (-48.31)	798.80	694.85 (-13.01)	857.29	1047.62 (22.20)	701.26	601.18 (-14.27)
Total other variable cost	5760.42	5210.55 (-9.55)	6631.95	5903.23 (-10.99)	8353.49	7248.74 (-13.23)	6656.69	5899.26 (-11.38)

Figure in the parenthesis shows percent change in adopted over non-adopted farm

3.2.5 Variable Cost

The variable cost was found to be decreased 8.33 percent of an average adopted farm (₹ 145271.44) as compared to an average non-adopted farm (₹ 158464.98) in cultivation of bitter gourd. The highest cost decrease was found to be in operational (2%) as compared to material (-2%) and other cost was found no change in an average adopted farm and non-adopted farm in cultivation of bitter gourd.

This change was found to similar across size of farm with minor variation. Although the change in operational cost were found to more in large (14.10%) as compared to be medium (13.69%) and small (12.31%) size in an average adopted farm and an average non-adopted farm, the change in material cost

was found to be more in large (4.15%) as compared to be medium (4.49%) and small (2.98%) size in an average adopted farm and an average non-adopted farm, the change in other cost was found to be more in large (13.23%) as compared to medium (10.99%) and small (9.55%) size in an average adopted farm and an average non-adopted farm in cultivation of bitter gourd.

Thus, the variable cost across size of farm the maximum decrease was found to be in small (9.18%) as compared to medium (9.12%) and large (7.66%) in an average adopted farm and an average non-adopted farm in cultivation of bitter gourd. (Table5)

Table 5: Variable cost across size of farms in cultivation of bitter gourd (₹/ha)

Particulars	Small		Medium		Large		Overall	
	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter
Operational cost	72554.23	63621.37 (-12.31)	75322.46	65013.18 (-13.69)	77275.82	66380.60 (-14.10)	74698.11	65293.33 (-12.59)
Material cost	74281.59	72070.77 (-2.98)	77148.72	73683.99 (-4.49)	82212.43	78802.85 (-4.15)	77110.18	74078.85 (-3.93)
Other variable cost	5760.42	5210.55 (-9.55)	6631.95	5903.23 (-10.99)	8353.49	7248.74 (-13.23)	6656.69	5899.26 (-11.38)
Variable cost	152596.24	140902.69 (-7.66)	159103.13	144600.40 (-9.12)	167841.74	152432.19 (-9.18)	158464.98	145271.44 (-8.33)

Figure in the parenthesis shows percent change in adopted over non-adopted farm

3.2.6 Fixed Cost

The fixed cost was found to be increased 23.36 percent of an average adopted farm (₹ 137343.46) as compared to an average non-adopted farm (₹ 111334.81) in cultivation of bitter gourd. The highest cost increase was found to be in rental value of own land (2%) as compared to interest on fixed capital (1%) and managerial (-2%) cost in between an average adopted farm and an average non-adopted farm. This change was found to similar across size of farm with minor variation. Although the change in between an average adopted farm and an average non-adopted farm in interest on fixed capital cost were found to more in medium (242.22%) as

compared to be large (182.24%) and small (167.80%) size of farm, the change in rental value of own land was found to be more in small (29.94%) as compared to be medium (27.41%) and large (25.14%) size of farm and the change in managerial cost was found to be more in small (5.92%) as compared to medium (4.19%) and large (3.30%) size in cultivation of bitter gourd. (Table 6)

Thus, the fixed cost the maximum increase was found to be in small (25.45%) as compared to medium (23.06%) and large (20.84%) size in an average adopted farms compared to an average non-adopted farm in cultivation of bitter gourd. (Table 6)

Table 6: Fixed cost across size of farms in cultivation of bitter gourd (₹/ha)

Particulars	Small		Medium		Large		Overall	
	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter
Interest on fixed capital	644.69	1726.49 (167.80)	392.36	1342.73 (242.22)	362.88	1024.18 (182.24)	426.43	1309.41 (207.06)
Rental value of land	81917.08	106441.36 (29.94)	87138.15	111024.09 (27.41)	92925.00	116287.78 (25.14)	86381.13	110341.79 (27.74)
Managerial cost	23515.80	24907.05 (5.92)	24663.36	25696.72 (4.19)	26112.96	26974.42 (3.30)	24527.25	25692.26 (4.75)
Total fixed cost	106077.57	133074.90 (25.45)	112193.87	138063.54 (23.06)	119400.84	144286.38 (20.84)	111334.81	137343.46 (23.36)

Figure in the parenthesis shows percent change in adopted over non-adopted farm

3.2.7 Total Cost

The total cost was found to be increased 4.75 percent of an average adopted farm (₹ 282614.90) as compared to an average non-adopted farm (₹ 269799.79) in cultivation of bitter gourd. The fixed cost was found to be increased 207.06 percent in an average adopted farm as compared to an average non-adopted farm, while the variable cost was found to be

decreased 8.33 percent in an average adopted farm as compared to an average non-adopted farm.

The total cost maximum decrease was found to be more in small (5.92%) as compared to medium (4.19%) and large (3.30%) size in an average adopted farm as compared to an average non-adopted farm in cultivation of bitter gourd in the study area (Table 7.)

Table 7: Total cost across size of farms in cultivation of bitter gourd (₹/ha)

Particulars	Small		Medium		Large		Overall	
	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter
Variable cost	152596.24	140902.69 (-7.66)	159103.13	144600.40 (-9.12)	167841.74	152432.19 (-9.18)	158464.98	145271.44 (-8.33)
Fixed cost	106077.57	133074.90 (25.45)	112193.87	138063.54 (23.06)	119400.84	144286.38 (20.84)	111334.81	137343.46 (23.36)
Total cost of cultivation	258673.81	273977.59 (5.92)	271297.00	282663.94 (4.19)	287242.58	296718.57 (3.30)	269799.79	282614.90 (4.75)

Figure in the parenthesis shows percent change in adopted over non-adopted farm

3.2.8 Yield, Gross Income, Net Farm Income, Family Labour Income, Farm Business Income and Farm Investment Income, Return per Rupee and Cost of Production

The yield of bitter gourd was found to be increased 25.78 percent of an average adopted farm (181.02q/ha) as compared to non-adopted farm (143.92q/ha) in production of bitter gourd. The change in yield across size of farm maximum was found to be in small (27.55%) as compared to medium (25.37%) and large (23.87%) in an average adopted farm as compared to an average non-adopted farm in production of bitter gourd in the study area. The gross income was found to be increased 27.74 percent of an average adopted farm (₹ 662050.75/ha) as compared to an average non-adopted farm (₹ 518286.77/ha) in which across size of farm the maximum change was found to be in small (29.74%) as compared to medium (27.41%) and large (25.14%) in an average adopted farm as compared to an average non-adopted farm in production of bitter gourd. The net farm income was found to be increased 52.70 percent of an average adopted farm (₹ 379435.85/ha) as compared to an average non-adopted farm (₹ 248486.77/ha) in which across size of farm the maximum change was found to be in small (56.63%) as compared to medium (52.46%) and large (48.35%) in an average adopted farm as compared to an average non-adopted farm in production of bitter gourd.

The family labour income was found to be increased 41.32 percent of an average adopted farm (₹ 438662.99/ha) as compared to an average non-adopted farm (₹ 310402.22/ha) in which across size of farm the maximum change was found to be in small (43.10%) as compared to medium (40.62%) and large (38.96%) in an average adopted farm as compared to an average non-adopted farm in production of bitter gourd.

The farm business income was found to be increased 38.54 percent of an average adopted farm (₹ 550314.19/ha) as compared to an average non-adopted farm (₹ 397209.78/ha) in which across size of farm the maximum change was found to be in small (40.47%) as compared to medium (37.95%) and large (36.02%) in an average adopted farm as compared to an average non-adopted farm in production of bitter gourd.

The farm investment income was found to be increased 43.62 percent in an average adopted farm (₹ 516779.31/ha) as compared to an average non-adopted farm (₹ 359821.79/ha) in which across size of farm the maximum change was found to be in small (46.87%) as compared to medium (43.39%) and large (39.92%) in an average adopted farm as compared to an average non-adopted farm in production of bitter gourd.

The family labour income, farm business income and farm investment income were found to be increased 41.32, 38.54 and 43.62 percent respectively, in an average adopted farm as compared to an average non-adopted farm in production of bitter gourd. This change was found to similar across size of farm with minor variation in the study area.

The return per rupee was also found to be increased 21.88 percent of an average adopted farm (₹ 2.34) as compared to an average non-adopted (₹ 1.92) farm in which maximum change was found to be in small (22.63%) as compared to medium (22.28%) and large (21.88%) size of farm in production of bitter gourd in the study area.

The cost of production was also found to be decreased 16.72 percent of an average adopted farm (₹ 1561.24) as compared to an average non-adopted (₹ 1874.65) farm in which maximum change was found to be in large (16.61%) as compared to medium (16.89%) and small (16.96%) size of farm in production of bitter gourd in the study area.

Table 8: Yield and return across size of farm in production of bitter gourd (₹/ha)

Particulars	Small		Medium		Large		Overall	
	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter	Adopter
Yield (q)	138.50	176.66 (27.55)	145.00	181.78 (25.37)	151.50	187.67 (23.87)	143.92	181.02 (25.78)
Gross income	491502.50	638648.18 (29.94)	522828.89	666144.54 (27.41)	557550.00	697726.67 (25.14)	518286.77	662050.75 (27.74)
Net farm income	232828.69	364670.59 (56.63)	251531.89	383480.60 (52.46)	270307.42	401008.10 (48.35)	248486.98	379435.85 (52.70)
Family labour income	297265.60	425380.61 (43.10)	314155.76	441762.37 (40.62)	326090.52	453129.34 (38.96)	310402.22	438662.99 (41.32)
Farm business	379827.37	533548.46	401686.27	554129.19	419378.40	570441.30	397209.78	550314.19

income		(40.47)		(37.95)		(36.02)		(38.54)
Farm investment income	338906.26	497745.49 (46.87)	363725.76	521544.14 (43.39)	389708.26	545294.48 (39.92)	359821.79	516779.31 (43.62)
Total cost	1.90	2.33 (22.63)	1.93	2.36 (22.28)	1.94	2.35 (21.13)	1.92	2.34 (21.88)
Total cost	1867.68	1550.88 (-16.96)	1871.01	1554.98 (-16.89)	1895.99	1581.07 (-16.61)	1874.65	1561.24 (-16.72)

Figure in the parenthesis shows percent change in adopted over non-adopted farm

3.3 Resource Use Efficiency

Resource use efficiency was estimated through Cobb - Douglas production function. The resource use efficiency of adopted and non adopted farm in cultivation of bitter gourd is analyzed and the results are presented in Table 9. The coefficient of multiple determination (R^2) value indicates the proportionate of total differentiation in gross income explained by the input variables. The coefficient of multiple determination (R^2) value of non-adopted farm and adopted farm was found to be 0.97 and 0.98 respectively in cultivation of bitter gourd. It indicated that about 97 and 98 percent are non-adopted and adopted farm respectively, differentiation in the gross income are explained by the input variables (seed, chemical fertilizer, FYM/organic manure, plant protection chemical, irrigation, stacking materials, machine power and human labour) of non-adopted and adopted in cultivation of bitter gourd respectively in the study area. The higher percentage value of R^2 shows a better representation of the relationship between gross income and input variables.

The cost of human labour in non-adopted farm and adopted farm was found to be positively moderate significant and positively highly significant, respectively. This means that a 1 percent increase in the cost of human labour would result in a 0.449 and 0.415 percent increase in gross income in the non-adopted farm and the adopted farm, respectively. In non-adopted farm, a 1 percent increase in the cost of human labour will result in a 0.034 percent increase in gross income compared to a adopted farm in cultivation of bitter gourd.

The seed cost was found to be positively highly significant in the non-adopted farm. This means that a 1 percent increase in seed cost would result in a 0.364 percent increase in the gross income of the non-adopted farm while in the adopted farm, there was no significant effect of seed cost on the gross income in bitter gourd cultivation.

The cost of chemical fertilizer was found to be positive and highly significant in the adopted farm. This means that a 1 percent increase in the cost of chemical fertilizer would result in a 0.094 percent increase in gross income for the adopted farm while in the non-adopted farm, there is no significant effect of chemical fertilizer cost on gross income in cultivation of bitter gourd.

The cost of FYM/organic manure was found to be positive and significant in the adopted farm. This means that a 1 percent increase in the cost of FYM/organic manure would result in a 0.027 percent increase in gross income for the adopted farm while in the non-adopted farm, there is no significant effect of FYM/organic manure cost on gross income in cultivation of bitter gourd.

The cost of plant protection chemical was found to be positive and moderate significant in the adopted farm. This means that a 1 percent increase in the cost of plant protection chemical would result in a 0.109 percent increase in gross income for the adopted farm while in the non-adopted farm, there is no significant effect of plant protection chemical cost on gross income in cultivation of bitter gourd.

The cost of stacking materials was found to be positive and significant in the adopted farm. This means that a 1 percent increase in the cost of stacking materials would result in a 0.154 percent increase in gross income for the adopted farm while in the non-adopted farm, there is no significant effect of stacking materials cost on gross income in cultivation of bitter gourd in the study area.

The cost of human labour and irrigation were found to be no significant effect on gross income in both adopted and non-adopted farm in cultivation of bitter gourd in the study area.

The scale of return (Σbi) in non-adopted and adopted farm was found to be 1.04 and 1.00 respectively. It means increase of various input would be increased gross income as increasing rate of return and constant rate of return in non-adopted farm and adopted farm respectively in cultivation of bitter gourd in the study area.

Table 9: Resource use efficiency/coefficient ('b') in adopted and non-adopted farm in cultivation of bitter gourd

Production Elasticity's Variables	Non-adopted farm 'b'	Adopted farm 'b'
Intercept	2.598	3.423
Seed	0.364***	0.021
Chemical fertilizer	-0.039	0.167***
FYM/organic manure	-0.010	0.036*
Plant protection chemical	0.150	0.109**
Irrigation charges	0.025	0.046
Stacking	0.039	0.154*
Machine power	0.057	0.050
Human labour	0.449**	0.415***
R^2	0.97	0.98
Σbi	1.04	1.00

*** Significant at 1% level of significant

** Significant at 5% level of significant

*Significant at 10% level of significant

3.4 Conclusion

This study confined on bitter gourd crop those irrigated through drip irrigation system. The primary data was collected from Dhar district of Madhya Pradesh and 120 adopted and 60 non-adopted farmers were selected for the study. The variable cost was found to be decreased 8.33 percent of an average adopted farm (₹ 145271.44) as compared to an average non-adopted (₹ 158464.98) farm. The fixed cost was found to be increased 23.36 percent of an average adopted farm (₹ 137343.46) as compared to an average non-adopted (₹ 111334.81) farm. Thus, the total cost was found to be increased 4.75 percent of an average adopted farm (₹ 282614.90) as compared to an average non-adopted farm (₹ 269799.79) in cultivation of bitter gourd. The yield of bitter gourd was found to be increased 25.78 percent of an average adopted farm (181.02q/ha) as compared to non-adopted (143.92q/ha) farm. The gross income was found to be increased 27.74 percent of an average adopted farm (₹ 662050.75/ha) as compared to an average non-adopted (₹ 518286.77/ha) farm. The net farm income was found to be increased 52.70 percent of an average adopted farm (₹

379435.85/ha) as compared to an average non-adopted (₹ 248486.77/ha) farm. The return per rupee was also found to be increased 21.88 percent of an average adopted farm (₹ 2.34) as compared to an average non-adopted (₹ 1.92) farm in cultivation of bitter gourd in the study area. The cost of seed and human labour were found to be positive and significant in the adopted farm and the cost of chemical fertilizer, FYM, plant protection chemical, stacking and human labour were found to be positive and significant in the non-adopted farm.

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