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An Economic Analysis of High Efficiency Irrigation System for the Farmers of Pakistan

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Abstract:

Water is the most precious resource, vitally important for sustainable agriculture. Pakistan is among the utmost vulnerable states to water scarcity. Scarce resource the water is depleting due to inefficient irrigation methods. This challenging situation demands to conserve precious water and ensure its efficient use. Therefore, Pakistan is immediately required to improve its irrigation efficiency and water productivity by introducing modern sustainable irrigation technology .This study examine theeconomic analysis of high-efficiency irrigation system (HEIS) and water productivity in southern Punjab, Pakistan.Multi-stage sampling is used to select the sample of 400 farmers (200 HEIS adopters & 200 non-adopters) from major districts of south Punjab.Benefit cost ratio (BCR) values for wheat, guava and citrus using SI and DI are found to be larger than 1.The SI system's net present value (NPV) values for the wheat crop ranged from Rs. 248034 to Rs.[1] 463191. Similarly, the results are consistent for DI for guava and citrus orchards . (BCR>1 and NPV positive values demonstrate that HEIS project is more economically feasible and viable than TI). Moreover, the benefit-cost ratio demonstrated that, when compared to conventional irrigated farms, the yield of citrus, wheat, and guava due to HEIS improved significantly to 48.48%, 70% and 44.83% respectively. Water productivity of HEIS-irrigated wheat, guava and citrus were calculated as 1.2 kg/m^3, 2.6 kg/m^3 and 2.5 kg/m^3 respectively which increased highly significantly than TI. The findings suggested that government initiatives should focus to enhance adoption rate of HEIS to increase water productivity aimed poor farmers prosperity. This could be accomplished by providing modest subsidized HEIS, improving education, engaging young ones in farming and imparting awareness to farmers about the socioeconomic benefits of HEIS.

Keywords: *Cost-benefit Ratio; Scarcity, HEIS, NPV, water productivity, Socio-Economic.*

Introduction

Globally water isregarded as the main resource for agricultural production. It is not only necessary for agriculture, industry, and economic development,it is also a vital component for the environmental preservation and a basic requirement for human life(Henneberger et al.,

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2015).Current challenges on the quantity and quality of the natural system are population growth, irrigation agriculture expansion, industry development, and climatic change (Chartzoulakis and Bertaki2015).Concerns about freshwater resource scarcity and its excessive consumption have risen global economic decline andthe need of food (Gheewala et al., 2017).Freshwater which we use for bathing, irrigating our farms, and drinking, is exceedingly scarce. Only 3% of the water on Earth is freshwater, and two-thirds of that is hidden in icebergs or otherwise inaccessible to humans.Consequently, it becomes challenging to guarantee the availability of water that is crucial for sustainabledevelopment (Hossain et al., 2017).Globally, irrigated land has increased by more than six times in the past century(Charizoulakis et al., 2015). However, 8-15 percent of freshwater supplies would be diverted from agriculture to fulfill incrasing residential and industrial demand. Further irrigation efficiency is low, just 55 percent of the water being utilized by crops, rest of the water includeinwastage through poor irrigation system.The demand for the services (population, agriculture, industrial and climate change) provided by these resources is predicted to rise in tandem with the depletion and degradation of ecosystems and supplies of water.Water is mainly used in agriculture sector, irrigation in agriculture consuming over 70% of the world's available water resources (Galan-Martin et al., 2017). Agriculture provides feed, food, and fiber to the nation to as sure their nutrition and health, as well as meeting agricultural requirements in terms of labor, resources and revenue (Dangour et al., 2012). However, owing to rapid expansion for non-agricultural water demand, such as industrial, household, ecological, and environmental applications, agricultural water shortages are becoming more acute (Levidow et al., 2014; Jiang et al., 2016). These facts highlight the need for effective agricultural irrigation water management, particularly in developing nations like Pakistan where agriculture is critical to socio-economic growth.

Pakistan being predominantly an agrarian economy mainly depends upon the surface and sub-surface water resources to irrigate agricultural farms. In Pakistan irrigation demands increases owing to the arid and semi-arid climate of the state. The average water productivity of Agriculture in Pakistan is 0.13 kg per cubic meter which is one-third and one-sixth of India and China respectively (GOP, 2014). The global water productivity of wheat is 1 kg per cubic meter while in Pakistan it is 0.76 kg per cubic meter which is 24 % less than the globe. In Asia average productivity of rice is 1 kg per cubic meter while in Pakistan, it is 0.45 kg per cubic meter i.e. 55 % less than average in Asia (Watcharaanaantapong et al., 2014). In the world, the consideration about one of the most water-stressed river basins is the Indus River Basin of Pakistan concomitant with extensive surface water use and groundwater withdrawals (Janjua et al., 2021). Therefore, Pakistan is immediately required to improve its irrigation efficiency by introducing sustainable irrigation water use techniques and technologies. To boost water productivity on the farm in south Punjab, many highly efficient irrigation techniques can be applied. It is believed that high-efficiency irrigation systems (HEIS) have great potential for wisely utilization of irrigation water and improving agricultural production (Alghobari and Dewidar 2018). Modern irrigation techniques are capable of supplying irrigation water equally across the entire field, ensuring that each plant receives the exact amount of water it requires (Wang et al., 2020). Both SI and DI systems are regarded as high-efficiency irrigation techniques. Trickle or drip irrigation system has proved highly efficient irrigation practices for irrigating specific areas and plants such as orchards (Albaji et al., 2015). These microsystem for irrigation is the best and the most efficient irrigation system, with a 98% improvement in water application efficiency, a 100% increase in crop yields, and a 25% reduction in fertilizer use (Anjum et al., 2014; Fan et al., 2020).

The definite objectives of the study are as follow:

- To evaluate the economic analysis of high-efficiency irrigation systems in South Punjab.
- To evaluate water productivity.

Methodology

Study Area:

Multi-stage sampling technique was used to select the sample of 400 farmers (200 HEIS adopters & 200 non-adopters) from major districts (Multan, Layyah, Bahawalpur, and Bahawalnagar) of south Punjab. The selected region is widely known for its cultivation of wheat, cotton, sugarcane, maize, rice, oil seed crops, gram, mango, citrus, guava, grapes, and vegetables. The quality of the groundwater is low and there are limited canal water resources in many areas of south Punjab.

The offices of the deputy directors, Pakistan council of research in water resources (PCRWR) Islamabad, Jaffer Brothers, Dadex, Royal Construction Company, Haji sons and other services and supplier companies were specifically approached to request a list of the HEIS irrigated growers of wheat, citrus, and guava orchard. In the second stage, 25 drip-irrigated and 25 conventionally irrigated citrus orchard growers were purposefully chosen from each district, yielding a total sample of 100 drip-irrigated and 100 conventionally irrigated citrus orchard growers.In the third stage, 15 traditional and 15 drip irrigated guava growers selected from each district, bringing the total sample size to 60 traditional and 60 drip-irrigated growers. Similarly, in the fourth stage, ten sprinkler and ten traditional irrigated wheat growers were purposively chosen from each district, resulting in a sample size of forty growers of sprinkler and forty growers of traditional irrigated.All the traditional irrigated growers were selected from the same village where from HEIS irrigated growers were selected. A well-designed questionnaire was developed to collect information. To obtain comprehensive results, the questionnaire was pre-tested by interviewing 30 respondents. The questionnaire included the following information: demographic data on farmers; farm characteristics, production details, discharge and different variables regarding socio-econopmic features to compute weighted score.

a) Weighted Score

The weighted score can be calculated by the formula

Weighted Score = $n_1x_1 + n_2x_2 + n_3x_3 + n_4x_4 + n_5x_5 \ldots\ldots\ldots n_i x_j$.

Where;

n_1 = Number of observation 1

x_1 = Number of variable 1

n_2 = Number of observation 2

x_2 = Number of variable 2

n_3=Number of observation3

x3=no. of variable 3 and so on

In case of HEIS water discharge was measured by taking reading from flow meter installed on head unit. However, the lists of sanctioned discharge (Q) in cusecs of water channels(TI)were obtained from offices of On Farm Water Management and irrigation

Departments . Then total volume of water used/ applied for both HEIS and TI was measured as

Total volume of water used (HEIS) = Flow meter reading x total no. of irrigationx time for irrigation (h)

Since, a few farmers were also irrigating their fields using tube well water, the discharge of tube-well was measured at site personally using theformula (full flow).

$Q = 0.0174 \times D^2 \times X / \sqrt{Y}$ (Dkasqureaurypejazarlen)

Q = Discharge of tub-well

D = inside diameter of delivery pipe average value (12.7 cm)

X = horizontal coordinate average value (52 cm)

Y = vertical coordinate average value (25 cm)

0.0174 = constant factor

Economic Analysis

The economic analysis evaluates the financial and other costs and benefits of running a program or project. The net benefits calculated using net present value (NPV) or using the benefit-cost ratio (BCR) (Muehlemann and Wolter 2014). The BCR is an indicator that shows a relation between the benefit and cost of a project expressed in monetary or qualitative terms (Satyasai, 2009). The BCR is defined as the ratio of the present value of benefits to the present value of costs or the present value of estimated benefits divided by the estimated cost. The present value of benefit and cost may be estimated with the help of a suitable discount rate. Here in the present study we supposed three different discount rates (DR) 10 %, 15 % and 20% were used to analyze the sensitivity of the HEISprojectbycalculating BCR and NPV (Narayanamoorthy 2008).

$$\mathrm{BCR} = \sum \frac{B_t}{(1+r)^t} / \sum \frac{C_t}{(1+r)^t},$$

WhereB_t = benefit for each year, C_t = cost for each year, r = discount rate and t = number of years (1, 2, 3 …n). When the value of BCR is greater than 1, the proposed project is considered an economically feasible and viable option. The net present value (NPV) is the difference between the present value of benefits and the present value of costs, and it represents a project's net worth.

Both the benefits and costs are discounted using a discount rate for ensuring fair comparisons. Mathematically it can be expressed as follows (Narayanamoortrhy, 2008).

$$\mathrm{NPV} = \sum \frac{(B_t - C_t)}{(1+r)^t},$$

WhereB_t = benefit for each year, C_t = cost for each year, r = discount rate and t = number of years (1, 2, 3 …n). If NPV is positive, the project is economically feasible/justifiable. If there are different policies or projects, select the one with the highest NPV. NPV was measured using different discount rates of 10%, 15% and 20% to assess the feasibility, validity, and viability of sprinkler and drip projects. The total initial investmenof the projects (sprinkler and drip systems) has incurred in the first year and taken as cash outflow. According to

Narayanamoortrhy (2018) a few considerations based on reality are needed to disclose the actual cash flows for the entire life period of sprinkler and drip irrigation systems. So, it is supposed that the whole life of HEIS i.e. drip and sprinkler systems will be twenty (20) years. Based onthelife period of HEIS BCR and NPV values are estimated. We estimated the BCR and NPV values by using discount rates of 10%, 15% and 20%. It was also assumed that during the 20 years of the life of HEIS the cost of production and income of HEIS irrigated growers remained the same. Further, it is assumed that the production of citrus, guava and wheat remained constant during the whole life of the project i.e. HEIS.

Results and discussion:

The results and discussion is illustrated in this section.The descriptive results regarding demographic and farm features are presented in table 1.

Table 1: Descriptive summary of respondent's demographic and farm features.

Variable	Category	Adopter(%)	Non-Adopter(%)
Age	18-30	54.5	20.5
	31-45	33	19.5
	46 &Above	12.5	60
Education	Illiterate	4.5	33.5
	Literate	11	39.5
	Matric	8.5	15
	Intermediate	10	9
	Graduation	25	1
	Masters	41	2
Landing Holding	Less than 10	1.5	57.5
	11-20	15	36
	21-30	35	5
	More than 30	48.5	1.5

Demographic and farm featuresdemonstratedthatmore than half (54.5%) of the respondents who adopted HEISs fell into the 18 to 30 age range. Respondents with higher levels of education (41%), and land holdings of more than 30 acres (48.5%), all practiced HEIS. Drip irrigation (DI) is the most preferred and commonly adopted irrigation approach by the respondents [(156(78%)] followed by sprinkler irrigation(SI) [40(20%)] and bubbler irrigation (BI) [4(2%)].The main reason behind that the majority of farmers in the study area practiced guava and citrus plantation.Similarly, this irrigation technique has been used in many countries to grow orchards and crops in areas where water is scarce or groundwater is of poor quality (Van der Kooij et al., 2013). Furthermore, DI was widely adopted because it has reduced evaporation losses as compared to other irrigation methods (Wang et al., 2020).

Table 2: The COP of SI and TI of wheat growers (per acre).

Variables	SI	TI
Land Preparation	5,279.90	7,081.40
Seed	1,123.40	1,247.00
Fertilizers	9,448.90	11,820.00
Chemicals	1,457.80	1,898.90
Labor	974.3	1,625.90
H harvesting/Tractor Used	7,265.70	11,301.60

Watering / Working / Operation cost	13,964.50	2,638.10
Transportation	52.9	51.9
Repair & Maintenance	3,537.30	997.4
Total Cost	43,104.70	38,662.21
Installation Cost @ 40%	39,490.30	-
Gross Cash Expenses	82,594.99	38,662.21

SI= sprinkler irrigation TI= traditional irrigation

Table 2 presents the COP of wheat under the SI and TI. The findings demonstrate that, as compared to CI, the productivity of inputs used for soil preparation, seeds, fertilizer, chemicals, and labor improved to 34%, 11%, 25%, 30.2%, and 66.9%, respectively. These outcomes are in line with (Luhach et al., 2004) assertion that HEIS has demonstrated the ability to reduce labor costs while also saving a sizable amount of water. The watering and maintenance cost for SI has increased to 429.34 % and 2.54.66 % respectively.

The findings indicate that, in comparison to TI, the cost of irrigation and repairs has heightened for SI. Furthermore, the gross cost of SI is higher due to installation costs.Farmers paid 40% of the installation costs, and the government of Punjab, Pakistan, provided a subsidized system for the remaining 60%. In comparison to TI, the SI COP for wheat farmers has grown to 11.49% per acre. The findings indicate that the main cause of the increase in COP for HEIS irrigated wheat growers was the system's operating and maintenance costs. However, compared to TI, SI's other input costs have substantially reduced as inputs could be applied more efficiently and at the time of need only in optimum required quantity by HEIS.

Table 3: Yield and revenue of SI and TI of wheat growers (per acre).

Variables	Wheat	
	SI	CI
Yield Wheat Grain	49	33
Sale Price	1,850	1,830
Income Wheat Grain	90,650	60,390
Yield Wheat straw	46	30
Sale Price Wheat straw	250	250
Income Wheat Straw	11,500	7,500
Total Income	102,150	67,890
Net Income	59,045	29,228

SI= sprinkler irrigation TI= traditional irrigation

The average yield and netbenefit/cash-inflow of the SI and TI of wheat growers are presented in Table 3. The yield and net benefit of SI were enhanced to 48.48 % and 102.02 % respectively against TI. The wheat yield might be increased due to easily and precisely availability of irrigation water at the critical stages like crowning, tillering, dough and grain filling stages. These results indicated that benefits of sprinkler irrigated wheat have increased due to significant increase in yield than TI. These results also confirmed the findings of the study conducted by (Razzaq et al., 2018; Hanjra and qureshi 2010).

Table 4: The COP of CI and HEIS of orchards growers (per acre).

	Guava		Citrus		Citrus	
Variables	DI	TI	DI	TI	SCDI	TI
Land Preparation	10,422	13,44	8,539	12,47	8,539	12,47

		4		9		9
Fertilizers	27,777	31,975	24,962	31,818	24,962	31,818
Chemicals	4,514	6,454	3,615	5,267	3,615	5,267
Labor	20,289	23,941	18,668	22,198	18,668	22,198
Picking / Harvesting	8,210	9,022	6,966	8,302	6,966	8,302
Watering / Working / Operation cost	33,730	8,432	29,496	3,337	0	3,337
Repair & Maintenance	6,504	1,756	5,826	1,336	5,826	1,336
Total Cost	104,940	95,025	98,072	84,736	68576	84,736
Installation Cost @ 40%	52,482	N/A	45,850	N/A	75,346	N/A
Gross Cash Expenses	157,422	95,025	143,922	84,736	143,922	84,736

SI= sprinkler irrigation TI= traditional irrigation

Table 4 presents the COP of orchard growers under the DI and TI. In comparison to TI, the DI COP of orchard farmers (guava and citrus) has grown to 10.43% and 15.74% per acre respectively. Whereas for solar-cum-drip irrigation (SCDI) citrus growers, the COP reduced to -19.07%, it is due to free solar energy for watering or operating HEIS system with out consuming electric or any other energy source.

The findings demonstrate that, as compared to TI, the productivity of inputs used for land preparation, fertilizer, chemicals, labor and picking improved to 28.9%, 15.1%, 42.9%, 17.9%, and 9.9%, respectively. However, compared to TI, DI's other input costs have substantially reduced as inputs might be applied more efficiently at the time of need only by HEIS.

Table 5: Yield and revenue of TI and DI of orchards (per acre).

Variables	Guava		Citrus	
	DI	CI	DI	CI
Yield	280	165	210	145
Sale Price	1,230	1,100	1,850	1,550
Total Income	344,365	181,078	388,500	224,750
Net Income	239,425	86,054	290,428	140,014

SI= sprinkler irrigation TI= traditional irrigation

Table 5showsthatthe yield of DI for guavaand citrus orchards growers are enhanced to70% and 44.83% respectively against TI. Similarly, net benefit increased to 178.23% and 107.43% respectively against TI. The yield of drip irrigated guava and citrus farms might be increased as water and other inputs were precisely applied near the root zone in the form of drop that might prove helpful to control canopy and extra vegetative growth and resulted in the efficient utilization of water and fertilizers, weeds reduction, and more yield . The finding of this study indicated that gross margin or net benefit of guava increased due to an increase in yield compared to traditional irrigated guava.

Table 6: Economic analysis of high-efficiency irrigation systems.

Variable	IMs	Benefit	Cost	GM
Wheat	SI	102150	43104.7	59045

	TI	67890	38662.2	29227.8
Gauva	DI	344365	104940	239425
	TI	181078	95025	86054
Citrus	DI	388500	98072	290428
	TI	224750	84736	140014
Citrus	SCDI	388500	68576	319924
	TI	224750	84736	140014

SI= sprinkler irrigation TI= traditional irrigation, drip irrigation, GM= gross margin

The GM of wheat, guava and citrus of both HEIS and TI are presented in Table 6. Based on an economic analysis of the data, it was determined that SI wheat growers had an average cost of Rs. 43104.7 per acre and a net benefit of Rs. 59045 per acre. In comparison to CI wheat growers, the GM of SI wheat growers has risen to 102%. The outcomes are also consistent for orchard growers using HEIS.

Benefit cost ratio and net present value of high efficiency irrigation system

The BCR and NPV values were calculated using discount rates of 10%, 15%, and 20%.

Table 7: The BCR and NPV values for SI and DI systems.

Water productivity	**Discount rate**	SI **(Wheat)**	DI **(Guava)**	DI **(Citrus)**
BCR (Ratio)	10%	1.4	2.8	3.3
	15%	2	3.4	3
	20%	2.3	3	4
NPV (Rs.)	10%	463193	1985877	2357201
	15%	330091	1430631.9	1772035
	20%	248034	1158172	1379321

BCR = benefit cost ratio, NPV= net present value, SI= sprinkler irrigation,TI= traditional irrigation

Table 7 presents the results for BCR and NPV and shows that for all three discont rates, BCR values for wheat, guava and citrus using SI and DI are found to be larger than 1 (BCR>1 demonstrates that HEIS project is more economically than TI). These findings conclusively demonstrated that the HEIS for wheat, guava, and citrus is a socially and economically viable solution. Positive results are found for the NPVunder different discount rates utilized in the investigation. The SI system's NPV values for the wheat crop ranged from Rs. 248034 to Rs. 463193. The outcomes of NPV further demonstrated the high profitability and economic viability of the SI method for wheat crops. Similarly, the results are consistent for DI for guava and citrus orchards. These results also supported the findings of a study by (Razzaq et al., 2018), which found that, compared to TI, SI and DI had higher GM for wheat and mango orchard growers. Among different projects the best is that one having higher BCR value. So, DI is the best suited project compared to SI due to higher BCR value.

Water Productivity Measurements

Water productivity is a crucial indicator of how much water HEIS may save as compared to the TI method. However water productivity calculated applying the equation.

Water Productivity = [output (kg/acre)] / irrigation water used (m^3/acre)]

WP =Yield (kg)/ irrigation water used(m^3) = kg/m^3

Table 8: Total volume of water used for HEIS against CI growers.

	Wheat		Guava		Citrus	
Variables	SI	TI	DI	TI	DI	TI
Discharge (Cusec/s)	0.634	2.1	0.1173	1.95	0.112	1.9
Total No. of Irrigation	28	4.5	240	16.5	210	15.5
Time Per Irrigation (Hours)	0.9	2.5	1.5	2.4	1.4	2.1
Total volume of Water Used $Cf^{3/Acre}$	57516.5	85050	152020.8	277992	118540.8	222642

$Cf^{3/Acre}$ = Cubic feet per acre SI= sprinkler irrigation TI= traditional irrigation, drip irrigation

Table 8 presents the water productivity analysis of wheat, guava, and citrus crops The general finding of the analysis revealed that the average discharge cusec per second, number of irrigations, time per irrigation, and total volume of water used in cubic feet of SIand DI are the least against the TI method.

Table 9: Water Productivity for HEIS against TI growers

	Wheat		Guava		Citrus	
IMs	SI	TI	DI	TI	DI	TI
Yield (Kg/acre)	1960	1320	11200	6600	8400	5800
Water Productivity (Kg/m^3)	1.2	0.55	2.6	0.84	2.5	0.92

IMs= irrigation methods, SI= sprinkler irrigation,TI= traditional irrigation, DI= drip irrigation

Table 9 compares the WP of two irrigation methods: TI and HEIS (SI and DI). When compared to the traditional wheat producers' 0.55 kg/m^3 WP, the SI wheat growers' 1.2 kg/m^3 WP was noticeably higher. The WP based on DI for guava (2.6 kg/m^3) and citrus (2.5 kg/m^3) orchards is greater than TI (0.84 kg/m^3, 0.92 kg/m^3), respectively. The water productivity of HEIS farms might increased as water was precisely applied near the root zone in the form of drop and rain that might prove helpful to control canopy and extra vegetative growth and resulted in the efficient utilization of water and more yield. Additionally based on WP, when HEIS producers were compared to TI growers, HEIS significantltyincreased the output of wheat, guava, and citrus to 48.48%, 69.70%, and 44.83%, respectively.WaterProductivity might be increased due to even and precisely application of water near root zone that minimized the application losses.Our findings have shown that HEIS has a tremendous possibility to increase water productivity in south Punjab. The results support the study's conclusion that using HEIS was an efficient way to conserve water and increase production (Abdulai et al., 2011).

Conclusion:

Water shortage is influenced not just by hydroclimate conditions, which affect freshwater supply, but also by human water consumption, socioeconomic variables, and government policy (Motoshita et al., 2014). Since water demand has approached or exceeded the total renewable freshwater supplies so water shortage has also become one of the biggest concerns to sustainable development in many areas of the world (Kumma et al., 2016). Indus River Basin of Pakistan is the most water stressed river and Pakistan is among the most vulnerable states to water scarcity. These facts highlight the need of efficient agricultural irrigation water management, particularly in developing nations where agriculture is critical to socioeconomic growth. However, HEIS has the potential to improve the lives of farmers of the farmers of Pakistan by maximizing yield, water productivity and generating higher revenue and premium for prosperity. Increasing trends in yield, water productivity, growing high-value crops, gross margin or net profit, education, social status, health, living standard, BCR and NPV values all are positive indicators towards sustainable agriculture and socio-economic development of HEIS irrigated growers (HEIS adopters) than traditional irrigated growers (non-adopters) in the study area. Likewise, solar-cum-drip irrigation system is very useful as it uses free solar energy for watering the plants i.e. zero operational cost. Since, low education level, age factor, land holding, capital and unawareness about economic benefits of HEIS might also be hindrenace in practicing HEIS.

Recommendations

Therefore, the following recommendations are made based on research findings to cope with water scarcity leading to socio-economic development and sustainable agriculture for food security. Young and big farmers with access to education and the absence of financial issues may increase the likelihood of adopting HEIS. The government should provide the maximum HEIS subsidy with especial focus on solar operated HEIS to minimize initial installation costs for efficient utilization of scarecer irrigation water, increasing water productivity and minimizing energy crisis by practicing HEIS especially solar energy operated HEIS.Inaddition, the young, educated farmers should be targetd to create awareness regarding the economic benefits of HEIS.The economic analysis of both sprinkler and drip irrigation methods via NPV and BCR vet the economic feasibility and viability of HEIS technologies. Since, NPV of drip project is higher than sprinkler , drip project is more economic, feasible and viable option compared to sprinkler project. However, The policy makers should also use the findings of this study to increase education level of farmers, approaching and motivating young and smsll land holders about the benefits and potential of HEIS to save scarce resource the water, energy and increasing water productivity. So that farming community in Pakistan might be able to understand the importance of HEIS especially solar-cum HEIS for efficient irrigation water utilization,energy saving, prosperity and premium leading to socio-economic development.

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