International Journal of Food Science and Agriculture, 2022, 6(1), 107-119
https://www.hillpublisher.com/journals/jsfa/
ISSN Online: 2578-3475
ISSN Print: 2578-3467

Assessment of Socio-Economic Improvement amongst Vegetable Grower by Adoption of High Efficiency Irrigation Systems in District Rawalpindi, Punjab, Pakistan

Syed M. Zakria*, Muhammad Bilal, Syed Ahmad Zakria

Institute of Agricultural Sciences, University of the Punjab, Lahore, Pakistan.

How to cite this paper: Syed M. Zakria, Muhammad Bilal, Syed Ahmad Zakria. (2022) Assessment of Socio-Economic Improvement amongst Vegetable Grower by Adoption of High Efficiency Irrigation Systems in District Rawalpindi, Punjab, Pakistan. *International Journal of Food Science and Agriculture*, 6(1), 107-119.
DOI: 10.26855/ijfsa.2022.03.013

Received: February 5, 2022
Accepted: March 2, 2022
Published: April 7, 2022

***Corresponding author:** Syed M. Zakria, Institute of Agricultural Sciences, University of the Punjab, Lahore, Pakistan.
Email: smzakria1@yahoo.com

Abstract

Pakistan is facing challenges at the intersection water scarcity, depleting water resources, low productivity, climate change implications on top of it, which needs to be addressed urgently. Major impediments of Pakistan agriculture are obsolete, abandoned and inefficient irrigation and agri. practices to overcome interconnected issues and imminent threats to economy at large. The only solution out there is the more efficient management of diminishing resources by adoption of irrigation water saving interventions, and one of the most efficient initiatives is Drip Irrigation System (DIS) which enables timely and judiciously application of water and other inputs as per plant requirement at various stages of growth to the effective rootzone. The research is carried out, with one of the objectives, the socio-economic improvement assessment of vegetable growers by adoption of High Efficiency Irrigation Systems (HEISs) in district Rawalpindi Punjab, Pakistan. In total 27 sites vegetables grown under DIS data of 135 acres, 108 acres 4 from each scheme site under DIS and 27 acres, 1 acre adjacent to site as control under conventional irrigation. Triangulation approach is used to figure out socio-economic impacts. Quantitative data were analyzed by using Statistical Package for Social Sciences (SPSS), Student's t-Test also used to observe association between variables. It is estimated that quantity of water applied both DIS and conventional 2,671.52 m^3, 3,895.46 m^3 respectively is reflecting significantly higher saving results, similarly time saving again highly significant too in DIS 53.79 and conventional irrigation took 97.59 minutes to irrigate 1 acre. Comprehensive estimation of yield, price, total income, expenditure, and net income figured out revealed yield with DIS 54,778 kg in comparison with conventional 22,689 kg highly significant achievement. Finally, the ultimate decisive factor, net income calculated is high significantly in DIS Rs. 450,726 compared with conventional Rs. 222,437 per acre with difference of means Rs. 228,289 more than double. Salient features of socio-economic improvement are summarized as under also, 90% expressed increased cell phone usage, 74% observed income increase, 72% found better lifestyle, 64% revamped machinery pool, 64% also for improved transportation, 57% increased domestic livestock, 56% for better food availability, 54% availed better children education, 52% noticed increased social and 22% political activities, 31% termed better health access. It is concluded that DIS is the most efficient irrigation water saving intervention alongside other benefits for up scaling socio economic profile for the farming community.

Keywords

Water Scarcity, Productivity, Drip Irrigation System, Socio Economic Improvement, Pakistan

1. Introduction

Pakistan is known agricultural dominant economy having population 207.77 million at an alarming growth rate 2.4% with 63.62% population living in rural areas. Pakistan, the country comprises cropped area of 22.75 million hectares out of the total geographical area 79.71 million hectares. Agriculture is holding leading position in economy by contributing 24% more than 6,051 billion in GNP [1]. Agriculture occupies major water user status by withdrawing 70% of fresh water, 81% cropped area irrigated, and 90% produce are from irrigated lands. Analysis of water availability in the country reveals, as per report of IMF, endorsed by the UNDP and PCRWR, Pakistan ranks 3rd in the world among countries facing severe water shortage and warned that by 2025 country will reach at absolute water scarcity. In 2016, PCRWR reported that country touched the "Water Stress Line" in 1990 and have crossed the "Water Scarcity Line" in 2005. It is also added back in 2009 per capita annual availability was 1,500 m^3, which drastically decreased to 1,017 m^3, and is closed to scarcity threshold 1,000 m^3 perilously [2]. In the current scenario focusing on Punjab Province, agri. cropped area is 17.03 million hectares, contributing 80% of country food requirement and providing 42.3% labor force too [3]. As per PWA 1991 water allocation for Punjab is 55.94 MAF, receiving 50 MAF, 33MAF is augmented by mining ground water resources to meet crop water requirement leaving behind short fall of 12MAF. Due to water shortage 30-40% canal with drawl remained -19% during the year 2017-18. And on the other hand, ground water exploitation has been risen exorbitantly 50-60% of the farm gate supplies throughout Punjab Province. It is pertinent to mention that northern part of the province and Rawalpindi District in specific have to rely mostly on ground water suction. At present in Punjab 1.04 million tube wells have been installed [3].

In spite of occupying crucial significance as per FAO 2013 Feeding The World Report cereal productivity in 1000hg/ha of USA is 70, China 55, India 27, Turkey 27 and Pakistan 26 whereas overall South Asia carries 28. And further productivity in wheat yield of China is 47, USA 31, India 28, Pakistan 26, Turkey 24, and overall South Asia stands at 26 too. Similarly, vegetable productivity of USA is 318, Turkey 238, China 230, India 138, Pakistan 126 and overall South Asia 143 [4].

It is evident from the comparison that productivity is much lower than the potential which needs to be enhanced by 60% to cope with the country's burgeoning population. Therefore, in brief right now Pakistan is facing challenges of water scarcity, agriculture productivity, consequently compromising food security, ground water depletion, loss of biodiversity and environmental degradation. The major impediments are obsolete and inefficient irrigation and agriculture practices. To overcome the impending crisis one of the most appropriate solutions is adoption of innovative irrigation water saving interventions such as HEISs introduced by the Government of Pakistan with assistance of World Bank during the year 2012 initially for 4 years and then extended for another 5 years from 2016 till 2020-21 with total cost of Rs. 67,459 million, on cost sharing arrangement (HEISs as a component) with title "Punjab Irrigated-Agriculture Productivity Improvement Project" (PIPIP) [5]. The project aiming to resolve imminent threat to diminishing water resources, agriculture productivity, environment at large, socio economic up scaling of farming community in specific through adoption of Drip and Sprinkler irrigation initiatives commonly known as HEISs. These are proven irrigation water saving interventions. The DIS enables timely and judiciously application of water and other inputs as per plant requirement at various stages of growth to the effective root zone through emitters on plastic pipes laid down above or beneath the surface to enhance water productivity. The system is inclusive of pumping unit, fertilizer tank, connecting fittings, filters, field hydrants, laterals, and emitters etc. The DIS carries multiple advantages over various other water saving interventions from efficient use to socio economic status improvement till self-sufficiency [6]. The present case study is conducted during the year ending December 2018 with one of the objective socio-economic impact assessment of vegetable growers by adoption of HEISs in District Rawalpindi, Punjab, Pakistan.

2. Methodology

The city of Rawalpindi is situated as District and Divisional Hqs. adjacent to Country Capital Islamabad in north of Punjab Province at an elevation 508 meter above sea level as 4th largest city with population 5.46 million as per Population Census held in 2017-18. The district contributes the share of requirement in fruits and vegetables 74.5% and 25.5% respectively remaining need is met from adjoining districts. Mainly district grows vegetables such as Cucumber, Tomato, Potato, Cabbage, Onion and Cauliflower. Rawalpindi district comprises of 7 Tehsils/Sub-Divisions namely Mur-

ree, Kotli Sattian, Kahuta, Kallar Syedan, Gujar Khan, Taxila and Rawalpindi itself. The entire district is covered leaving behind Murree and Kotli Sattian tehsils devoid of HEISs vegetable sites under project. There are 27 sites in total adopted DIS for vegetables cultivation. Data of 135 acres is collected, 108 acres 4 acres from each site/scheme under HEISs and 27 acres 1 acre adjacent to scheme as control irrigated conventionally. Complete list of scheme sites with particulars was obtained from OFWM district office and data was collected in collaboration with field staff. The data regarding vegetables pertains to the year ending December 2018, recorded through pretested, validated, questionnaire in person at the convenience of beneficiaries. Triangulation approach is used, objectives of the research are taken as dependent variables and variables such as educational qualification, land holding size, yield estimation, income and other questions to ascertain socio economic improvement were taken as independent variables to ensure meaningful conclusion. Quantitative data were analyzed using Statistical Package for Social Sciences (SPSS). And descriptive statistics including frequencies, percentages, means, standard deviations were used to summarize different variables by applying Student's t-Test for interpretations, observing associations between dependent and independent variables and for conclusion inference.

3. Result and Discussions

From socio economic prospective characters such as education, land holding size play pivotal role in innovation adoption. Various studies have been carried out, concluding diversified opinions are discussed below briefly.

3.1 Education

Education is considered proven source for increasing knowledge, enhancing awareness and wisdom. Hoodbhoy [7] considered education provides exposure to increase knowledge and wisdom. Farid et al. [8] education had significant effect on adoption of innovative farm practices. Mirza [9] and Khan [10] concluded education has significant positive impact in adoption of improved farm technologies.

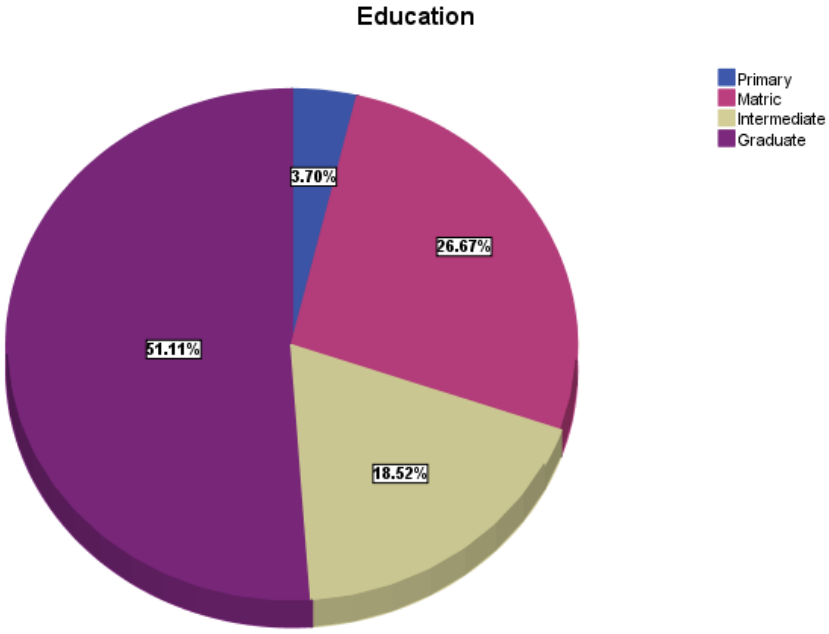

Figure 1. Respondents' percentages, their education level.

The data collected during study depicted as Figure 1 leads us to conclude that lowest percentage in adoption of DIS as HEISs is of respondents having primary level education, the next is intermediate then matric and highest percentage have graduate level qualification. Percentages are 3.7%, 18.5% 26.7% and 51.11% respectively. Hassan et al. [11] found significant impact of education, in adoption of improved production technologies. Latif et al. [12], Mahmood et al. [13] concluded the same. It is determined that higher education has significant positive impact on adoption of water saving initiatives.

3.2 Farm Size

M & E Consultant [14] estimated that HEISs adopters belong to relatively wealthy group of farmers and possess an

average farm size 2.10 acres overall in Punjab Province. In Rawalpindi district during the research, it is determined 5.48 acres. Similarly, 100% of respondents availed tunnel farming technique, some of them 7.4% availed solar powered system, facility extended by OFWM Wing, Punjab Agriculture Department. Data collected is presented in Table 1 and Table 2.

Table 1. Responses distribution regarding tunnel farming

		Count	Column N %
Q5a Use tunnel farming	Yes	135	100.0%
	No	0	0.0%
Q5b Tunnel type	Yes Seasonal	135	100.0%
	No Off Season	0	0.0%
Q5c Kind of tunnel type	Low Tunnel	0	0.0%
	Walk in Tunnel	111	82.2%
	High Tunnel	24	17.8%

Table 2. Responses distribution regarding water source, energy source and cultivation type

		Count	Column N %
Q9 Source of water	Mini dam	49	36.3%
	River	18	13.3%
	Tube well	58	43.0%
	Water stream/Springs	10	7.4%
Q10 Source for Tube well	Electricity	10	7.4%
	Diesel	115	85.2%
	Solar/Others	10	7.4%
Q12 Current type of irrigation/cultivation	Furrow	0	0.0%
	Bed and Furrow	131	97.0%
	Bed & Furrow/Flooding	4	3.0%
	Other	0	0.0%

The information pertaining to source of water, source of energy and type of cultivation is shared in Table 2. It leads to conclude that HEISs owners/adopters have higher education level, are wealthy group, possess higher awareness level. They are 100% growing vegetables under tunnel technique, as a source of energy for tube well 7.4% availed solar powered generation, 97% cultivating vegetables on bed and furrows as mentioned above in the table. These results are similar to Ibrahim [15], Mahmood et al. [13] and Madhava et al. [16] who estimated positive impact of education, farm size in adoption of water saving interventions for productivity enhancement. Khurshid et al. [17] also estimated yield increase with bed and furrow cultivation while comparing with flood irrigation system.

3.3 Preferred Adoption of Drip Irrigation Systems

The result of data collected indicated that 100% respondents (vegetable growers under HEISs only) in the district opted for adoption of DIS only none else HEISs type due to multiple advantages and considering DIS the most efficient irrigation system. Similar estimation has been expressed by Arin [18], FAO [19], Khalid et al. [20], Barta et al. [21] who ranked high the DIS, the most efficient water saving intervention introduced so far.

3.4 Distribution of Vegetables Sown Under DIS

The figure 2 depicts the detail of vegetables sown on an area of 135 acres under study with HEISs/DIS and with conventional irrigation methods. The percentage distribution is 52.59% cucumber, 31.11% tomato, 11.85% bitter gourd and at the lowest 4.44% onion. It is also reflecting shifting trend of cropping pattern from traditional to more profitable crops.

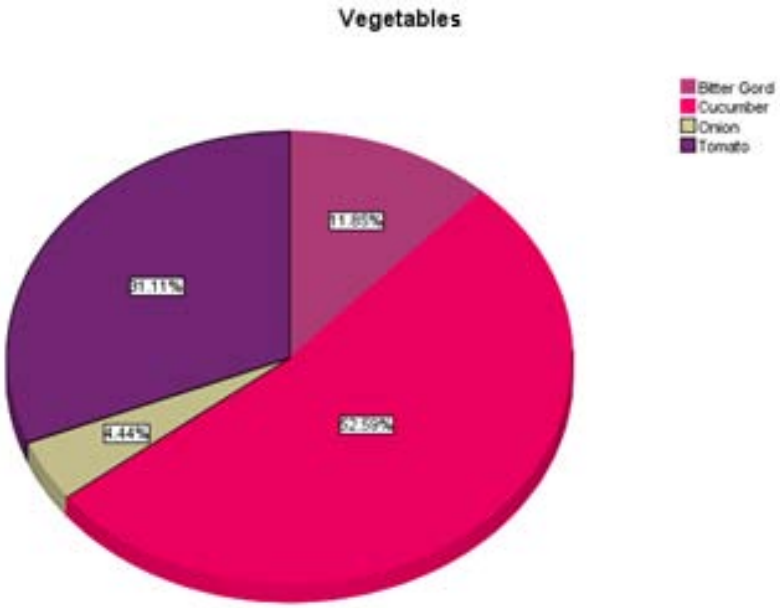

Figure 2. Detail of vegetables sown with DIS under study.

Table 3. Comparison between HEISs method and Conventional method regarding water irrigation frequency, average depth, water quantity, time for irrigation/acre

Statement	Descriptive statistics				Relationship		Difference			t	P
	Mean	N	SD	SE	r	P-value	Mean	SD	SE	Value	Value
Q16ia Water irrigation frequency – HEISs (Nos.)	133.70	135	20.96	1.80	-0.284	0.001	98.50	26.54	2.28	43.12**	0.000
Q16ib Water irrigation frequency – Conv. (Nos.)	35.21	135	11.38	0.98							
Q16iia Average depth – HEISs (Inches)	4.87	135	0.59	0.05	0.929	0.000	-0.13	0.38	0.03	-4.00**	0.000
Q16iib Average depth – Conv. (Inches)	5.00	135	0.86	0.07							
Q16iiia Water quantity – HEISs (volume m^3)	2,671.52	135	786.49	67.69	0.963	0.000	-1223.93	370.33	31.87	-38.40**	0.000
Q16iiib Water quantity – Conv. (volume m^3)	3,895.46	135	1,061.66	91.37							
Q16iva Time for irrigation/acre – HEISs (minutes)	53.79	135	30.41	2.62	0.829	0.000	-43.80	23.18	2.00	-21.95**	0.000
Q16ivb Time for irrigation/acre – Conv. (minutes)	97.59	135	40.93	3.52							

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)
r = Pearson's correlation
SD = Standard deviation
SE = Standard error

3.5 Comparison of DIS Vs Conventional Irrigation

To mitigate the challenges of productivity enhancement and sustainable agriculture in rain fed and irrigated areas both P Ashoka et al. [22], B. K Jah et al. [23] considered DIS the most efficient water saving initiative and also to get the higher return from vegetable crops in specific. CGIAR [24] termed the DIS the most feasible solution for water saving up to 45%.

Detailed comparison between DIS and Conventional Irrigation Systems/methods pertaining to irrigation frequency, depth of water applied, quantity applied, and time taken to irrigate 1 acre based on perception/experience of beneficiaries is analyzed in Table 3.

3.6 Frequency of Water Applied

It is estimated the irrigation water frequency in Nos. (How Many Times) of DIS in comparison with conventional is significantly higher (t-value 43.12, p-value <0.000) the figure in case of DIS method 133.70 times while in conventional is 35.21 times. Similar conclusion has been drawn by M & E Consultants [14] stating system is designed for DIS 10 hrs.

to meet peak crop water requirement and maximum interval for 4 days in case of conventional method.

3.7 Depth of Water Applied

An average means of irrigation water depth in inches (How Much Depth) is determined in case of DIS method remained 4.87 inches and 5.00 inches in case of conventional, negligible difference is means of both -0.13 inches.

3.8 Quantity of Water Applied

And similarly, quantity of irrigation water applied in m^3 (How Much Quantity) for 1 acre vegetable sown an average means calculated for DIS is 2,671.52 m^3 in case of control means 3,895.46 m^3 which is significantly higher side proving the DIS is the most water use efficient system. IFC (World Bank Group) [25] endorsed that 30-60% water use efficiency is increased. Mahajan et al. [26] assessed the saving 48.1% and Naraynamoorthi [27] determined the irrigation water saving up to 44%.

3.9 Time of Water Applied

Time saving is also assessed to irrigate in minutes (How Much Time) 1 acre vegetable sown in both systems Drip irrigations means are 53.79 minutes while with control 97.59 minutes almost double than DIS which is again highly significant difference indicating time saving.

Various studies lead to conclude that saving of irrigation water and time have multiple positive impacts such as labor and energy cost saving, yield and area under cultivation increase also. Kumar et al. [28] assessed that water use efficiency through DI method would lead to reduce over exploitation of ground water also. T. A. Howell [29] concluded that despite of various constraints maximum water use efficiency is attainable through micro irrigation system (MIS) which could lead to accomplish ultimate objective of sustainable agriculture and environment.

Table 4. Comparison between HEISs method and Conventional method regarding production, price, total income, expenditure, and net income from vegetables

Statement	Descriptive statistics				Relationship		Difference			t	P
	Mean	N	SD	SE	r	P-value	Mean	SD	SE	Value	Value
Q20a HEISs – Production kg	54,778	135	15,323	1,319	0.910	0.000	32,089	9,349	805	39.88**	0.000
Q20a2 Conv – Production kg	22,689	135	7,087	610							
Q20b HEISs - Price Rs./kg	21.95	135	4.234	0.364	0.871	0.000	-0.104	2.680	0.231	-0.45^{NS}	0.654
Q20b2 Conv - Price Rs./kg	22.05	135	5.375	0.463							
Q20c HEISs - Total income Rs.	1,132,733	135	306,416	26,372	0.833	0.000	659,511	210,636	18,129	36.38**	0.000
Q20c2 Conv - Total income Rs.	473,222	135	130,128	11,200							
Q20d HEISs – Expenditure Rs.	682,007	135	229,469	19,750	0.689	0.000	431,222	177,027	15,236	28.30**	0.000
Q20d2 Conv – Expenditure Rs.	250,785	135	97,579	8,398							
Q20e HEISs - Net Income Rs.	450,726	135	125,692	10,818	0.581	0.000	228,289	102,291	8,804	25.93**	0.000
Q20e2 Conv - Net Income Rs.	222,437	135	71,531	6,156							

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01)
r = Pearson's correlation
SD = Standard deviation
SE = Standard error

Prior to socio economic improvement assessment let us 1st focus and determine comparison of 1 acre vegetables grown with both DIS and conventional irrigation methods. And to have comprehensive analysis of yield, price, total income, expenditure incurred and net income for conclusion from the data figured out in Table 4.

3.10 Comparison of Yield

During the course of study, it was analyzed that mean yield of vegetable grown under DIS is 54,778 kg in comparison with control irrigated conventionally which remained up to 22,689 kg. The results are highly significant (with t-Value 39.88 and p-Value 0.000) leading to conclude yield increase with DIS.

3.11 Comparison of Price

It is interesting that price of produce per kg calculated for conventional method a little bit higher than DIS price per kg, for DIS estimated as Rs. 21.95 for conventional method as Rs. 22.05 difference of means is -0.104. The difference could be due to better management in disposal and market facilities available to them.

3.12 Comparison of Income

As regards total income that is estimated and found highly significant with t-Value 36.38 and p-Value 0.000 almost more than double with DIS as compared to control. Total income of vegetable means with DIS is Rs. 1,132,733 and for control Rs. 473,222.

3.13 Comparison of Expenditure

It is determined that on 1 acre vegetable grown under drip expenditure incurred are Rs. 682,007 and in case of conventional remained Rs. 250,785 reflecting that farmers raising vegetable with HEISs invested more than the controlled acreages, which could not help them raising yield, income due to inefficient irrigation, agricultural practices. Resultantly, low yield lead to poor net income estimated as under.

3.14 Comparison of Net Income

And the end result net income figured out with DIS increased and is highly significant with figures t-Value 25.93 and p-Value 0.000, in Rupees term net income per acre with innovative intervention is Rs. 450,726 compared with controlled Rs. 222,437 almost double resulted in net income increase than conventional irrigation technique.

Numerous studies conducted, concluded the similar results such as Mahmood et al. [13] and Ali [30] estimated with adoption of water saving initiative yield is increased by 20% and 115% respectively. IFC (World Bank Group) [25] resulted in 40-110% yield increase, with water use efficiency leading to income increase 30-100% also. Rizwan et al. [31] arrived at conclusion that in addition to water and fertilizer saving increased crop yield by 30-40%. It is further added wheat yield increase 23%, Potato 34% yield enhanced reported by Technical Expert Group (TEG) Punjab Agriculture Department. Nuclear Institute for Agriculture and Biology (NIAB) concluded 52% yield increase DGA (WM) [5]. M & E Consultant [14] estimated 100% crop yield increase. Gunaratne et al. [32] estimated 50% yield increase Shaik et al. [33] reported 26-50% increase in crop yield as in impact of DIS. Boyd et al. [34] recommended adoption of DIS method as irrigation management tool will not only increase WUE but will help increasing quantity and quality of the crops also. M & E Consultant [14] further added in addition to yield increase net income increase per acre Rs. 58,000 along with crop diversification and early maturity benefits. Shaik et al. [33] reached at the conclusion that overall majority of DIS owner had medium level socio economic impacts.

Table 5. Respondents' responses regarding improvement particulars/type and extent

	Yes		No	
	Count	Row N %	Count	Row N %
Q43i Increase in income	100	74.1%	35	25.9%
Q43ii Usual increase source of income	86	63.7%	49	36.3%
Q43iii Better lifestyle	97	71.9%	38	28.1%
Q43iv Better food access	75	55.6%	60	44.4%
Q43v Better use of clothes	39	28.9%	96	71.1%
Q43vi Improvement in Child Education	73	54.1%	62	45.9%
Q43vii Improvement in Medication/Health	42	31.1%	93	68.9%
Q43viii Hajj/Umrah performance	25	18.5%	110	81.5%
Q43ix Marriage ceremonies	21	15.6%	114	84.4%
Q43x Increase in Domestic Animals	77	57.0%	58	43.0%
Q43xi Increase in Agric. Machinery	87	64.4%	48	35.6%
Q43xii Hand/Electric pump	57	42.2%	78	57.8%
Q43xiii Participation in Social Activities	70	51.9%	65	48.1%
Q43xiv Home Kacha/Pacca	32	23.7%	103	76.3%
Q43xv Use of gas at home	18	13.3%	117	86.7%

Q43xvi Participation in Political activities	30	22.2%	105	77.8%
Q43xvii Improvement in use of mobile phone	122	90.4%	13	9.6%
Q43xviii Improved Transportation	86	63.7%	49	36.3%
Q43xix Satellite dish usage	70	51.9%	65	48.1%
Q43xx Generator/UPS usage	66	48.9%	69	51.1%
Q43xxi Others	10	7.4%	125	92.6%

3.15 Socio Economic Improvement

And now let us step into quantification of socio-economic impacts or changes if any after adoption/installation of DIS as irrigation water saving technology. It is worth mentioning that beneficiaries were asked to reply simply in Yes or No whether adoption could bring change 100% replied in Yes as they were convinced that innovation brought positive change in their socio-economic status.

3.16 Socio Economic Profile & Improvement

The Table 5 & Figure 3 described in detail the sequential improvement with nature, extent and percentages of positive changes brought the DIS. An overwhelming majority of 90% expressed improvement in terms of increased connectivity by cell phone usage, second 74% due to obvious reasons, increase in income, 3rd 72% attained better lifestyle which is again one of the prime objectives of every development project. Next 64% responses depict the wisdom of farming community, enhanced machinery pool to cope with future requirements in farm mechanization. Similarly, 64% found improved mobility in transportation context, 57% observed increase in domestic livestock, 56% noticed better food availability, 54% could avail better education of their children. According to 52% participation in social activities has been increased also. Positive changes in domestic energy and water requirements have noticed too. And further 31% expressed access to better health care facilities, political activities/participation has increased as per 22%, so on for other utilities status have been recorded increased proving the visible positive socio-economic impacts amongst vegetable growers with adoption of irrigation water saving initiative DIS.

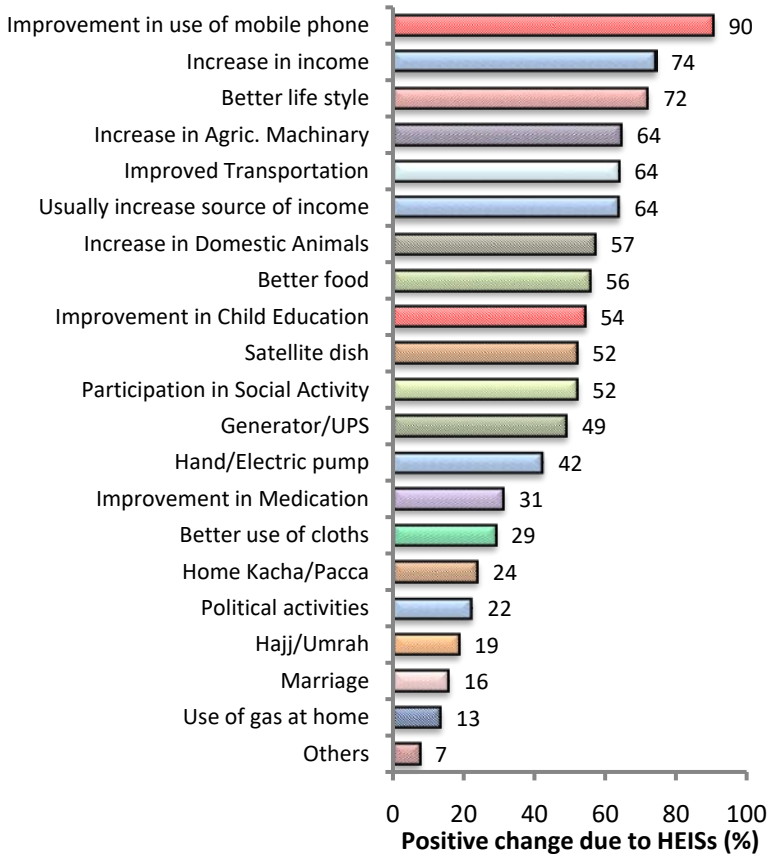

Figure 3. Detailed improvement type, extent, and percentages wise.

Similar results have been estimated by Mahmood et al. [13] and Khan [35] while expressing changes 100% of respondents were of the view income resources increase, better living standards, better children education, increased participation in social activities. These improvements are positive indicators towards achieving ultimate goal, socio economic upscaling of farming economy. IFC (World Bank Group) [25] determined that adoption of water saving intervention impacts lead to higher income 30-100%, TEG DGA (WM) [5] estimated positive impact on socio-economic status of community. CGIAR [6] conceived higher income. Shaik et al. [33] have views like self-sufficiency and upscaling living profile, and further expressed at the conclusion that with adoption of DIS overall majority had medium level socio-economic impacts. Suresh et al. [36] concluded significant contribution with DIS in improving socio economic conditions. Zaccaria D. et al [37] described environmental benefits with economic advantages for farming community. UNEP [38] is convinced, irrigation efficiency improvement culminates at achieving various socio economic and sustainable benefits.

3.17 Suggestions by the Respondents

During the research carried out vegetable growers installed DIS in the district Rawalpindi were asked to share their experiences and to put forward the suggestions as future guidelines for modification in ongoing Punjab Agriculture Department, OFWM lead PIPIP. The major chunk 89.63% desired to have changes and only 10.37% very thin percentage is satisfied with the present implementation arrangement. Results reflected in Figure 4

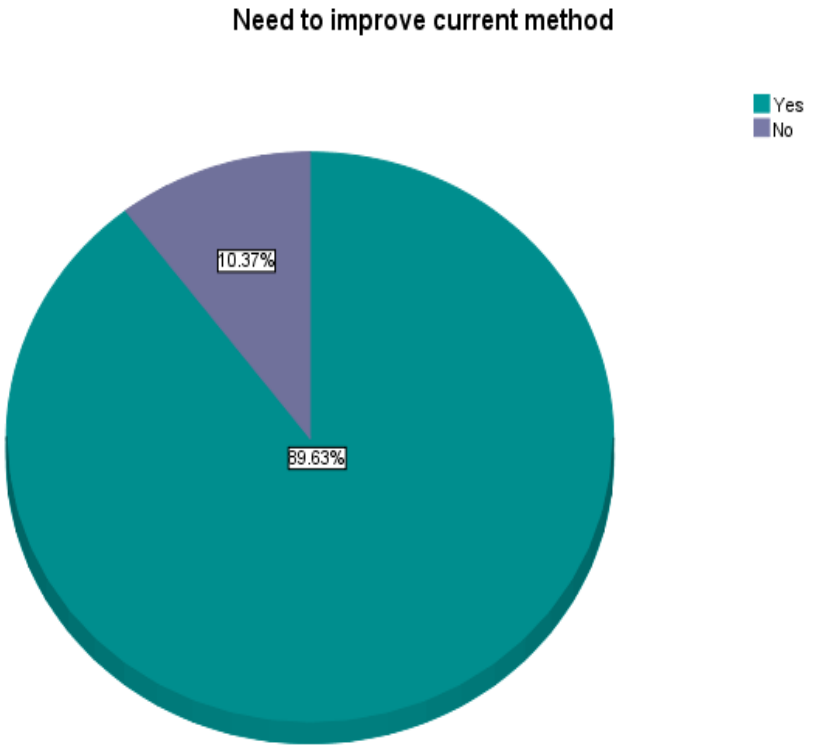

Figure 4. Respondents distribution regarding change in the system.

Proposals floated are pertaining to capacity building, training duration, training site, production plan provision, backup services etc. The crucial change from their point of view (HEISs specific) and this paper context is increase in subsidy ratio. They suggested to enhance subsidy ratio from existing 40-60% to 50-50%, 20-80% and 10-90% with percentages as 4%, 41% and 55% respectively as estimated in Figure 5. Ratio refers to cost sharing arrangement in vogue 40% of the system cost is contributed by the farmers and 60% is borne by the Government as subsidy. The suggestions/proposals are similar to the findings such as proper identification of farmers and subsidy programmes are prerequisite of successful adoption. Gunaratne et al. [32]. M & E Consultants [14] expressed concern also that subsidy ratio should be at par with other components of Punjab Agriculture Department, OFWM facilities. Madhava et al. [16] have

taken the high initial cost and in adequate subsidy as constraint. Brain H. [39] concluded for adoption of DIS farmers should be offered incentives to be more efficient users.

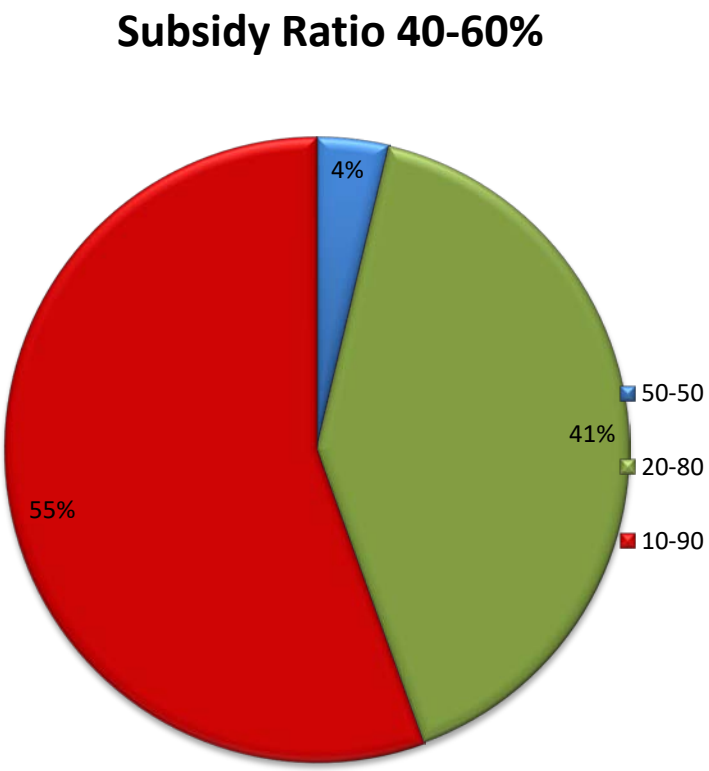

Figure 5. Responses regarding subsidy ratio.

4. Additional Suggestions

The beneficiaries were asked to put forward additional suggestions/proposals other than narrated above to make the existing procedure farmer friendly by addressing the obstacles. In total 6 suggestions were floated based on their perception those are presented in Figure 6 and described as follows: i) HEISs uplifting by 8% with computerized one. There is always room for improvement Murugan et al. [40] emphasized in research and development to utilize potential at its best. For competition impact evaluation, feedback is essential feature to fill the gaps for improvement. Pooja et al. [41] concluded that challenges of researchers are there to make DIS automated; ii) Hiring of crop experts demanded 30% respondents, by Services and Supply Companies (SSCs). It carries vital importance at initial stages precise technical information be provided for the crop designed and other crops for crop diversification alongside capacity building of all stake holders. Crop experts by the SSCs must be hired for the purpose; iii) High tunnel provision facilities demanded by 11% beneficiaries to meet the objective of crop diversification because at the present only walk in tunnels are being subsidised by the OFWM under this project; iv) Marketing infrastructure improvement was also suggested by 7%, which is quite genuine demand until and unless the produce is disposed off timely and properly the socio-economic status will remain uncertain. The PRISM approach [42] has taken it as integral part of viable agriculture; v) In case of emergency replacement of electric motors by the SSCs was demanded by 7% for 5 years as the existing warranty period covers 2 years only; vi) Similarly, 15% respondents demanded electricity provision for tube well operations with diesel replacement to cut down the cost and carbon footprints both; vii) 22% respondents had nothing to propose perhaps they were satisfied with the implementation procedure in vogue.

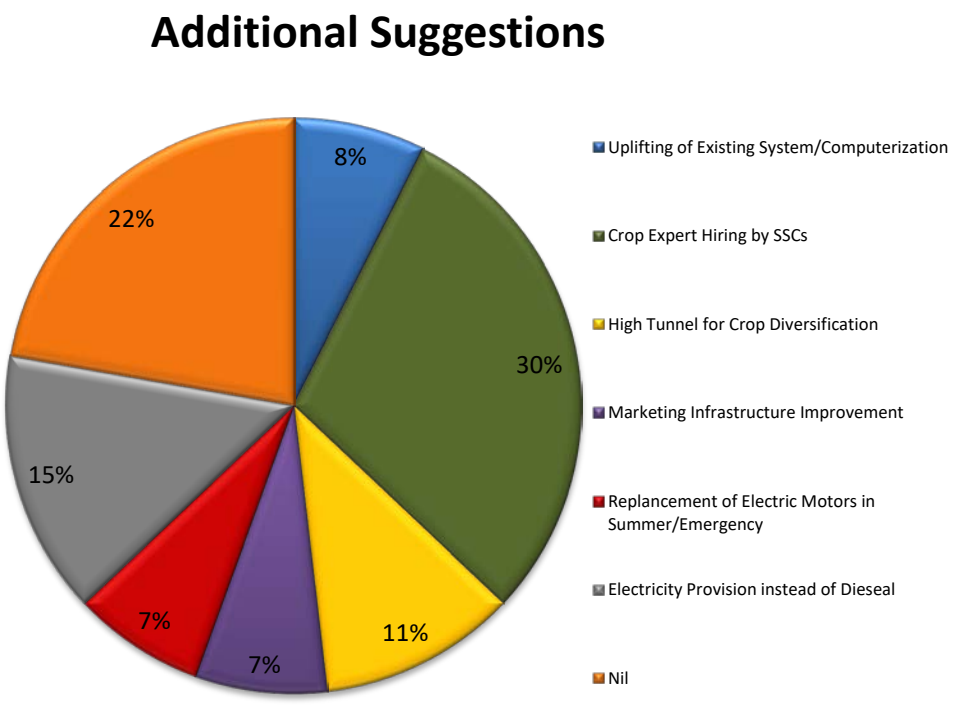

Figure 6. Respondents' additional suggestions.

5. Conclusion

From socio-economic improvement perspective considering 1 acre unit comprehensive estimates of yield, price, total income, expenditure incurred and net income are figured out. The mean yield of vegetables with DIS is 54,778 kg in comparison with conventional 22,689 kg, highly significant increase by adoption of DIS, total income per acre in case of DIS is Rs. 1,132,733 and in conventional Rs. 473,222 is high significantly. In case of expenditure incurred due to obvious reasons DIS is Rs. 682,007 and in conventional Rs. 250,785 per acre with DIS is on higher side. Finally, the ultimate decisive factor net income with intervention adoption is Rs. 450,726 per acre compared with conventional Rs. 222,437 per acre almost double income is highly significant improvement too, which is prime objective, socio-economic improvement of the farming community. The nature and extent of impacts are estimated as follows, 100% was in favor that DIS adoption brought positive changes. The salient features are summarized as 90% expressed increased cell phone usage, 74% observed increase in income, 72% found upscaling lifestyle, 64% revamped machinery pool, 64% also for improved transportation, 57% increased domestic livestock, 56% for better food availability, 54% availed better children education, 52% noticed social and 22% political activities increase. And 31% termed better healthcare access. And at the end vegetable growers upon asking to float proposal for future strategies 89.63% desired to have modification for the procedure in vogue. The vital and crucial suggestions from the paper context (HEISs specific) are increase in subsidy ratio 55% suggested to enhance ratio from 40-60% to 20-80%. The ratio refers to existing cost sharing arrangement, 40% of the system cost is being contributed by the farmers and 60% is borne by the government as subsidy.

It is concluded that DIS is the most efficient irrigation water saving intervention to enhance agri. Productivity, food security, mitigation of environment degradation, ensuring conservation of diminishing water resources in general and in specific upscaling socio economic profile of the farming community.

6. Acknowledgment

Authors are thankful to farmers participated in perception-based research and for provision of requisite comprehensive information. Thanks also to Mr. Muhammad Saqib Sohail for composing manuscript with zeal.

References

[1] Pakistan Development Statistics. (2017-18). Bureau of Statistics Islamabad, Pakistan.

[2] Meer Shah Baloch. (2018). D W. Water Circus. Why is Pakistan Running Dry D W.

[3] Punjab Development Statistics. (2017-18). P & D department, Government of Punjab, Lahore.

[4] Food and Agricultural Organization (FAO). (2013). Feeding The World Report. Statistical Yearbook.

[5] Directorate General Agriculture (Water Management) Punjab. (2017). Lahore PC-I, Punjab Irrigated-Agriculture Productivity Improvement Project (PIPIP), 2012-13 to 2020-21.

[6] Kakumanu, K. R., K. Palanisami, and G. Adinarayana. (2015). CGIAR, Research program on dry land systems. Report on capacity building on drip irrigation systems in dry land systems.

[7] Hoodbhoy, P. (2009). Pakistan's Higher Education System: what went wrong and how to fix it. Pak. Develop. Rev., 48(4): 581-594.

[8] Farid, K. S., N. Z. Tanny, and P. K. Sarma. (2015). Factors affecting adoption of improved farm practices by the farmers of Northern Bangladesh. J. Bangl. Agri. Univ., 13(2): 291-298.

[9] Mirza, A. H. (1994). Diffusion and adoption of innovations. In: Memon, R.A. & E. Bashir (eds.), Extension methods. National book foundation. Islamabad, Pakistan. 97-120.

[10] Khan, C. Z. A. (1994). Prospects for effective institutional and functional linkages between agricultural research, extension, and farming communities in Balochistan. National workshop on Linkages between Agricultural Research, Extension and farming communities. Deciduous Fruit Development centre, Sariab, Quetta.

[11] Hassan, M. Z. Y., B. N. Siddiqui, and M. N. Irshad. (2002). Effect of socio-economic aspects of mango growers on the adoption of recommended horticultural practices. Pak. J. Agri. Sci., 39(1): 20-21.

[12] Latif, M. S. S. H. and M. U. Rashid. (2016). Adoption of High Efficiency Irrigation System (HEISs) to overcome scarcity of irrigation water in Pakistan. Proceedings of Pakistan Academy of Sciences, Life sciences and Environmental Sciences.

[13] Mahmood, N., T. Ali, M. Ahmad, and A. A. Maan. (2012). Impact assessment of adoption of water saving irrigation interventions on the socio-economic development of small farmers in District Faisalabad. Journal of Agri. Research.

[14] Monitoring and Evaluation Consultants. (2017-18). Impact Assessment Report, Punjab Irrigated-Agriculture Productivity Improvement Project (PIPIP), Lahore MM Pakistan (Pvt Ltd.). PIPIP@mmpakistan.com.

[15] Ibrahim, M., Idrees, M. (1993). Agricultural credit role in the development of agriculture. Journal of Rural Development and Admn, 25(4): 67-74.

[16] Madhava Chandran, U. Surendran. (2016). Study on factors influencing the adoption of drip irrigation by farmers in humid tropical Kerala, India. International Journal of Plant Production, 10(3).

[17] Khurshid, A. M. and B. Chaudhry. (1990). Practical experiments on cotton and its results. Zaraat Nama, Department of Agriculture, Lahore.

[18] Arin, K. (2015). International Atomic Energy Agency, International Commission on Irrigation and Drainage, MIT, NG, Stockholm International Water Institute, World Changing. World News, July 20, 2015.

[19] Food and Agricultural Organization (FAO). (2003). World Agriculture: towards 2015/2030. Earthscan Publications Ltd. London, 432.

[20] Khalid, H., A. Majeed, K. Nawaz, S. Afghan, K. Ali, Feng Lin, Z. Zafar, and G. Raza. (2010). Comparative study of subsurface drip irrigation and flood irrigation systems for quality and yield of sugarcane. African General of Agri-Research.

[21] Barta, R., Broner I., and Schneekloth, J. (2004). Colorado High Plains Irrigation Practices Guide. Colorado Water Recourses Research Institute. Special Report no.14.

[22] P. Ashoka, Kadasiddappa, M. M., and Sanjey, M. T. (2015). Enhancing Water Productivity through Micro Irrigation Technologies in Indian Agriculture. Annals of Plant and Soil Research, 17: 601-605.

[23] B. K. Jha, S. S. Mali, S. K. Naik, and T. Sengupta. (2017). Yield, Water Productivity and Economics of Vegetable Production Under Drip and Furrow Irrigation in Eastern Plateau and Hill Region of India. International Journal of Agricultural Science and Research (IJASR). Vol#7.

[24] Roberts, M. (2008). Optimization Crop Production with Drip Irrigation. CGIAR Challenge Program on Water and Food 2013.

[25] International Finance Corporation (IFC) World Bank Group. (2014). Impact of efficient irrigation technology on small farmers, Dec 12.

[26] Mahajan, G., Singh, K. G. (2006). Response of Greenhouse tomato to irrigation and fertigation. Agricultural Water Management, 84: 202-206.

[27] Narayanamoorthy, A. (2004). Impact study of drip irrigation in India. The case study of Sugar Cane. Development Policy Review.

[28] Kumar, M. D., B. Sharma, and O. P. Singh. (2008). Water Saving and Yield Enhancing Micro Irrigation Technology. How far can they contribute to Water Productivity in Indian Agriculture?

[29] Terry A. Howell. (2015). USDA Bushland Texas, USA. Irrigation Efficiency. Research Gate.

[30] Ali, B. (1983). Optimal Watercourse Improvement in Pakistan. A mixed integer programming model. Proceedings of the international seminar on Water Resources Management, Lahore (Pakistan) Oct 22-27, 1983, 64-86.

[31] Rizwan, M., Allah Bakhsh, X., Li, L. Anjum, K. Jamal, and S. Hamid. (2018). Evaluation of the Impact of Water Management Technologies on Water Savings in the Lower Chenab Canal Command Area, Indus River Basin. MDPI.

[32] Gunaratne, L. H. P., Ekanayake, E. M. T., and E. R. N. Gunawardne. (2005). Technical and Socio-economic assessment of micro irrigation systems in the small-scale farming sector of Sri Lanka, Tropical Agricultural Research Vol.18.

[33] Shaik, M. S. R. and J. J. Mistry. (2018). Socio-economic impact of adoption of drip irrigation system on drip owners of Aravalli District. International Journal of Current Micro Biology and applied Sciences.

[34] Boyd, B., J. Cook, C. Rowley. (2019). Small Acreage Irrigation Guide. Water Rights and Irrigation Management. USDA Colorado State University USA.

[35] Khan, I. A. (1992). A sociological study of effects of water course improvement on farm production in tehsil Sheikhupura. M.Sc. Rural Sociology Thesis, Univ. of Agri., Faisalabad.

[36] Suresh, K., K. Palanisami. (2010). Impact of Drip Irrigation on Farming System. Evidence from Southern India, AgriEconomic Research Review Vol.23.

[37] Zaccaria, D., L. Levidow, R. Maia, E. Vivas, M. Todorovic, A. Scardigno. (2014). Improving Water Efficient Irrigation. Prospects and Difficulties of Innovative Practices. Agricultural Water Management, 146.

[38] UNEP. (2017). DHI Centre on Water and Environment. Climate Change Adaptation Technologies for Water. Guide to Adaptation technologies for Increase Water Sector Resilience.

[39] Handwerk Brian. (2018). Sustainable earth: Water. National Geographic News.

[40] Murugan, M. P., Semwal, A. D., Batra, H. V. (2015). Impact assessment of technologies developed and commercialized by defense food research laboratory: A case study. Indian Res J Ext Edu., 15(2): 24-31.

[41] Pokharkar Pooja, Dhobale P, Sayyad Asmabi, Nalwde Priyanka. (2017). Future of Drip Irrigation System A Proposed Approach. Multidisciplinary Journal of Research in Engineering and Technology, 4: 1055-1060.

[42] International Development Enterprises (IDE). (2003). Poverty Reduction through Irrigation and Smallholder Markets (PRISM) A Manual, draft Sep 5.