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IMPACT OF DRIP IRRIGATION SYSTEM (DIS) IN VIRUDHUNAGAR DISTRICT OF TAMILNADU

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ABSTRACT :

Irrigation researchers are applying various strategies to fulfil the irrigation requirements. One of the strategies is operating Drip Irrigation System(DIS). Main aim of this system is utilising minimal level water resources and to meet the agricultural requirements. This study explains about impact of DIS Virudhunagar district in Tamilnadu.The objective of the study explains about effects of DIS in Virudhunagar district.This study is based on primary data. Purposive Sampling Technique is selected for sample survey. In this district, there are two blocks are taken (Tiruchuli and Kariapatti). 50 samples are selected in each block.From the findings it may be concluded that majority of the respondents are, school level completed respondents. They are medium level of income earners, land holdings and have fully implemented DIS for their lands. Income and land size is main criteria to implement this system. After implementation of this scheme, they are acknowledged that production and productivity is improved and water consumption level is drastically decreased.

KEYWORDS : *Drip Irrigation System, Purposive Sampling Technique, water consumption, production and productivity, agricultural requirements.*

1. INTRODUCTION:

Water resource occupies nearly three-fourths of the world and remaining parts are land. Out of 100 percentage of water, nearly 97 per cent of this resource is available in ocean and remaining percentage (3 per cent) is in form of fresh water. More than two - third percentage of water exists in Arctic and Antarctica continent and it is frozen ice. The rest of this resource is obtainablefrom land(Peter H. Gleick, 1996). This resource is acquiring from rainfall, water springs and frozen ice melting (Hendrik Wulfa, 2016**)**. It is one of the renewable sources. But, it is not properly stored and managed by public and governments. This natural resource is wastedrecklessly in many ways.Most of the earthpartsare affected by scarcity of water. It causes many unpleasant consequences. Particularly, it affects the living things like human, birds and animals' water consumption level, agricultural production, sustainable development and entire ecological system.

In India, about 66 per cent of cultivatable lands depend on monsoon(Raja Sekar M, 2011).Generally,this season is irregular or doubtful and it is either heavy or less rainin this country. It leads to drought or flood. In this reason, it is called as '*gambling of monsoon*'. Water harvesting is only way to preserve water resources. But, there is no proper water management and storage system in India. This source is unnecessarily wasted and it mixes with sea water. Due to this impact, most of the land has not availed irrigation facility. Hence,this facility has not been properly utilised for cultivation(Dhruv Saxena,2017). Farmers cannot provide expected level of agricultural production. It leads to improper and unbalanced cropping pattern.

In this reason, government implemented various irrigation developmental activities and strategies to conserve the water resources. It enhances the sustainable development in agriculture sector. It will helpful for future generation and cultivation(Katar Singh, 2007). It is stored by two methods: natural storage method and man-made or artificial method. Natural storage methods are groundwater aquifers, soil water and natural wetlands. Artificial storage methods are small artificial ponds, tanks, reservoirs and dams (Albert Tuinhof &Jan Piet Heederik, 2002).

2. MICRO IRRIGATION:

Several categories of irrigation methods are available in this world and they are as follows: surface irrigation, localised irrigation, drip irrigation, sprinkler irrigation (micro irrigation), central pivot irrigation, lateral move irrigation, sub-irrigation and manual irrigation methods (Bjorneberg, D.L, 2013). In these methods, DIS method is one of the most cost-effective and eco-friendly techniques. It is called as '*micro-irrigation*' or '*trickle irrigation*' *system*(Report of Task Force on Micro Irrigation 2004). This method was one of the oldest techniques. Ancient micro irrigation method had been first used by China and it was utilised from approximately first century BC(Girma Megersa &Jemal Abdulahi, 2015).Various experimental activities related to micro irrigation methods were conducted by German researchers in 1860(Vaibhav Bhamoriya & Susan Mathew, 2014). They analysed several strategies for micro irrigation methods. By this effort, they invented inner structure or subsurface system for micro irrigation. For this purpose, they utilised clay pipe to create combination irrigation and drainage systems.

In the year 1866, irrigation researchers applied micro irrigation method in some of Afghanistan areas and they utilised clay pipe to both irrigate and drain planting areas. After Second World War, usage of plastic was high. An Australian scientist Hannis Thill designed special plastic pipe with long tube to equal distribution of water to crops(Anurag Mehta 2015). For this irrigation system, various strategies and ideas were implemented by different researchers. New and innovative concept of this irrigation was emitter concept. It was developed several years before by Simcha and his son Yeshayahu in Israel. In 1959, Simcha Blass and Kibbutz Hatzerim developed and patented the first practical surface micro irrigation emitter(Sharrif Moghaddasi Mohammad, 2011).

Generally, this system of irrigation facilitates to save water or using minimal quantity of water for maximum required lands and it helps to get highest level of agricultural yields. This method helps to sustain and preserve the soil nutrients and permitting wet to trickle gradually to the roots of plants. This system may be above from the soil surface or buried below the surface. It helps to minimise the water evaporation.

3. OBJECTIVE AND HYPOTHESIS OF THE STUDY:

This part of the study explains about effects of DIS in Virudhunagar district. This district is one of the lowest rainfall regions in Tamilnadu.In this cause, most of this region did not getadequate level of water facilities. Focal point of this research is (a) to explore the socio-economic of conditions of respondent (b) to identify the advantages of DIS in this district and (c) to find out the difficulties in this irrigation system in this district. This study is hypothesised that (a) Implementation of DIS is correlated with system economic factor and land size

4. METHODOLOGY OF THE STUDY:

This study is based on primary data. Purposive Sampling Technique is selected for sample survey.Virudhunagar district is taken for this research. In this district, Tiruchuli and Kariapatti blocks werechosen for this research. This district is located in southern part of Tamilnadu. 100 samples were taken for sample survey. These samples were collected from 5 villages in each block respectively and 10 respondents from each village. These respondents have possession of own land cultivators and they are implementing DIS in their lands. For this research, Correlation and Cluster analysis are used to analyse the primary data.

Figure No. 1
District-Wise Tamil Nadu Map

Figure No. 2
Virudhunagar District Block-Wise Map

- Virudhunagar District **- Tiruchuli** **- Kariapatti**

Source: https://virudhunagar.nic.in/

5. ANALYSIS

5.1. Socio-Economic Conditions:

Socio-economicconditions refer a person's class in society based on how much money he / his family members make. It provides demographic details of respondents and presents actual situation of the study area (Pawan Bhola, 2014). This researchincludes the following variables: (1) sociological factors are sex, age, community, religion and educational qualification (2) economic factors are respondents' income and his/her family income. These factors are related and it will influence one another.The following table No.1 explains about socio-economic conditions of respondents in these blocks.

Table No.1
Socio-Economic Conditions of Respondents

Sl. No.	Particulars		BLOCKS				Total	
			Tiruchuli		Kariapatti			
			Freq.	%	Freq.	%	Freq.	%
1.	Sex	Male	42	*84*	40	*80*	82	*82*
		Female	8	*16*	10	*20*	18	*18*
2.	Age	>25 Years (Young)	9	*18*	11	*22*	20	*20*
		25 – 50 Years (Middle)	14	*28*	10	*20*	24	*24*
		Above 50 Years (Elder)	27	*54*	29	*58*	56	*56*
3.	Community	BC	19	*38*	23	*46*	42	*42*
		MBC	24	*48*	21	*42*	45	*45*
		SC/ST	7	*14*	6	*12*	13	*13*

4.	**Religion**	Hindu	44	*88*	43	*86*	87	*87*
		Christian	5	*10*	7	*14*	12	*12*
		Muslim	1	*2*	0	*0*	1	*1*
5.	**Educational Qualification**	Up to Elementary Level	8	*16*	11	*11*	19	*19*
		Up to Secondary Level	11	*22*	4	*8*	15	*15*
		Up to Higher Secondary Level	21	*42*	24	*48*	45	*45*
		Diploma	4	*8*	6	*12*	10	*10*
		Degree	6	*12*	5	*10*	11	*11*
6.	**Respondents' Income (Per Year)**	Below □1,00,000	9	*18*	17	*34*	26	*26*
		□1,00,000 - □2,00,000	36	*72*	31	*62*	67	*67*
		Above □2,00,000	5	*10*	2	*4*	7	*7*
7.	**Total family Income (Per Year)**	Below □1,00,000	5	*10*	10	*20*	15	*15*
		□1,00,000 - □2,00,000	37	*74*	34	*68*	71	*71*
		Above □2,00,000	8	*16*	6	*12*	14	*14*

Source: Primary Data. **(Freq. –** Frequency: **% -** Percentage)

Above table no.1 describes about socio-economic conditions of respondents in Virudhunagar district.

5.1.1. Sex: More than 80 per cent of the respondents are male. This analyse shows that most of the male respondents are landowners.

5.1.2. Age: In this study area, majority of the farmers are comes under elder group. Hence, this investigation concluded that young age group did not have any interest to do the agricultural activities.

5.1.3. Community: About76 to 88 per cent of the respondents are belongs to Backward Class and Most Backward Class in this district. This analyse shows that very meagre per cent of the Schedule Caste / Schedule Tribe Classes are implemented DIS.

5.1.4. Religion: Most of the respondents are based on Hinduism.

5.1.5. Educational Qualification: Nearly 50 per cent of the respondents are qualified in higher secondary level of school education.

5.1.6. Income of the respondents: About two – third of the respondents are earnings up to □ 2 lakhs per annum.

5.1.7. Total Family Income: About80 – 90 per cent of the respondents' family income is more than □ 1 lakh per annum.

5.2. Land and DIS Details:

Table No. 2 explains about respondents' land particulars in this district. It includes the following information and they are follows: land size and area of DIS implemented.

Table No. 2

Respondents' Land Size & DIS Implementation

Sl. No.	Particulars		BLOCKS				Total	
			Tiruchuli		Kariapatti			
			Freq.	%	Freq.	%	Freq.	%
1.	**Land Size**	1 – 2 Acres	9	*18*	11	*22*	20	*20*
		2 – 5 Acres	23	*46*	24	*48*	47	*47*
		5 – 10 Acres	12	*24*	8	*16*	20	*20*
		Above 10 Acres	6	*12*	7	*14*	13	*13*
2.	**DIS Implementation**	Partially	17	*34*	18	*36*	35	*35*
		Fully	33	*66*	32	*64*	65	*65*

Source: Primary Data

5.2.1. Land Size: Nearly 50 per cent of the respondents (46 to 48 per cent) have two – five acres of land in their area. About 12 – 14 per cent of the respondents are retains more than ten acres of land.

5.2.2. DIS Implementation: Almost two – third of respondents are fully implemented DIS in their lands.

5.3. Relationship between implementation of DIS and economic factor and land size

5.3.1.Hypothesis: Implementation of DIS is correlated with economic factor and land size.

The following part of the study makes clear about connection between operation of DIS with family income and land size in this district. Correlation analysis is tested this hypothesis.

Table No. 3

Relationship between DIS implementation with economical factor and land size

Particulars		Blocks												r (Sig)
		Tiruchuli						Kariapatti						
		Implementation of DIS						Implementation of DIS						
		Partial		Fully		Total		Partial		Full		Total		
		F	%	F	%	F	%	F	%	F	%	F	%	
Family Income	Below □.1 Lakh	5	10	-	-	5	10	10	20	-	-	10	20	<0.05
	□1 Lakh - □2.5 Lakh	12	24	25	50	37	74	8	16	26	52	34	68	
	Above □2.5 Lakh	-	-	8	16	8	16	-	-	6	12	6	12	
Land Size	1 – 2 Acres	9	18	-	-	9	18	11	22	-	-	11	22	<0.05
	2 – 5 Acres	8	16	15	30	23	46	7	14	17	34	24	48	
	5 – 10 Acres	-	-	12	24	12	24	-	-	8	16	8	16	
	Above 10 Acres	-	-	6	12	6	12	-	-	7	14	7	14	

Source: Primary Data. F – Frequency; **% -** Percentage&**r –** Karl Pearson CorrelationAnalysis

Sig - Significance Level

This part of the study illustrates about relationship between the economical factor (Respondents' family income includes respondents' individual income and total family members' income, and land size) and implementation of DIS in the research area. It is classified into two parts and they are as follows:

First part of the investigation measures the association between implementation of DIS and family income of respondents. Income is most important and influential component for purchase of DIS. The entire lower income respondents (Less than □ 1, 00,000) have partially applied this instrument. All higher income respondents (More than □ 2, 50,000) have availed thismechanism. This analysis proved that above mentioned hypothesis is accepted. These variables are positively correlated and significance level is less than 5% of confidence.

Second part of this study elucidates the connection between the effectuation of DIS and land size. Nearly 2/3 of respondents are applied this facility for entire land. Above revealed hypothesis is accepted by correlation analysis. These variables are optimistically correlated.

5.4. Impact of DIS:

5.4.1. Advantages inDIS:

An attempt has been made to find out the group of respondents' assessment on advantages inDIS in the two blocks and cluster analytic method has applied. This analysis is used to classify objects into groups. This study is considered within group linkage method and measures the interval through Pearson correlation analysis. It helps to test the hypothesis.The dendogram are given in figure no. 3 & 4 and it is summary of statistics are given in table no.5 &6.

Figure No. 3
Advantage inDIS in Tiruchuli Block

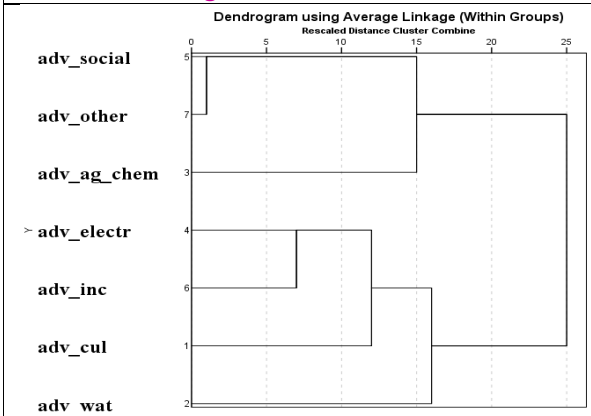

Figure No.4
Advantage inDIS in Kariapatti Block

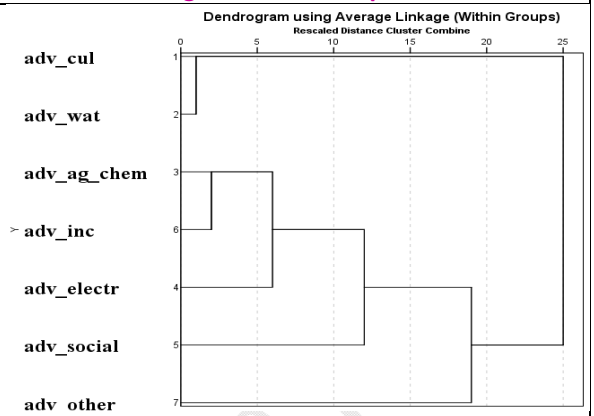

Table No. 4.
Cluster code & Advantages in DIS

Code	Variables
adv_inc	Income increased
adv_social	Social Status improved
adv_cul	Cultivation Increased
adv_wat	Low level of water consumption
adv_ag_chem	Low level of Agro-chemical usage
adv_electr	Low level of Electricity usage
adv_other	Other improvements

Table No. 5.
Cluster Analysis and Advantages inDIS

Block	Cluster	Variables	Yes Range (%)	NO Range (%)
Tiruchuli	1.	Social status improved, low level of agro-chemical usage and Other improvements	16 – 40	60 – 84
	2.	Low level of electricity usage, income increased & cultivation increased	54 – 70	30 – 46
	3.	Low level of water consumption	90	10
Kariapatti	1.	Cultivation increased & low level of water consumption	80- 84	16 – 20
	2.	Low level of agro-chemical usage, income increased & Low level of electricity usage	46 – 70	30 – 54
	3.	Social status improved	26	74
	4.	Other improvements	16	84

Table No. 6
Advantages in DIS

Sl. No.	Particulars		BLOCKS				Total	
			Tiruchuli		Kariapatti			
			Freq.	%	Freq.	%	Freq.	%
1.	Income increased	Yes	30	60	35	70	65	65
		No	20	40	15	30	35	35
2.	Social Status improved	Yes	9	18	13	26	22	22
		No	41	82	37	74	78	78
3.	Cultivation Increased	Yes	35	70	40	80	75	75
		No	15	30	10	20	25	25
4.	Low level of water consumption	Yes	45	90	42	84	87	87
		No	5	10	8	16	13	13
5.	Low level of Agro-chemical usage	Yes	20	40	23	46	43	43
		No	30	60	27	54	57	57
6.	Low level of Electricity usage	Yes	27	54	29	58	56	56
		No	23	46	21	42	44	44
7.	Other improvements	Yes	8	16	6	12	14	14
		No	42	84	44	88	86	86

Source: Primary Data: Freq. – Frequency &**%** - Per cent

Above portion provides information about advantages inDIS in this research region. It is analysed by clustering techniques. This study is categorised on the basis of blocks and they are follows:

Tiruchuli Block:

There are three clusters are framed by this analysis. First group of variables like social status, low level of agro-chemical usage and other improvements are getting low level benefits. In cluster number two explains that after implementation of DIS, respondents have been availed following gains (a) low level of electricity usage, (b) income increased and (c) cultivation increased. And finally, about 90 per cent of the respondents are approved that water usage is minimal because of this system (cluster – III)

Kariapatti Block:

A close examination of the dendogram and the table yields different picture in this block. This investigation eliminates above mentioned hypothesis and it formed four clusters. About 80 - 84 per cent of the respondents' opined that cultivation increased and low level of water consumption (Cluster – I). There are 46 – 70 per cent of respondents who havebelieved that execution of DIS is providing betterment in low level of agro-chemical usage, income increased and low level of electricity usages (Cluster – II). Third cluster portrays that social status. About 26 per cent of respondents felt that this status is obtained through DIS. Out of 50 respondents, only 8 respondents are availed other types of benefits from this system. Hence, it is concluded that higher percentage of respondents are agreed that low level of irrigation utilisation and cultivators' productivity improved and it is happened by DIS. About two – third of the DIS users are accepted that income level isbetter. This variable helps to increase the purchasing power (Jewel, land, and luxury goods) and savings level.

5.4. Problems in DIS:

It is of interest to understand the view about Problems in the two blocks. The answers collected from the DIS users have been subjected to clustering techniquesand their responses have been explained in

the form of dendogram for the study area (Figure No. 5 & 6). Number of respondents who said "Yes" or "No" to a query and their responses have been summed up in table No. 8 & 9.

Figure No. 5
Problems inDIS in Tiruchuli Block

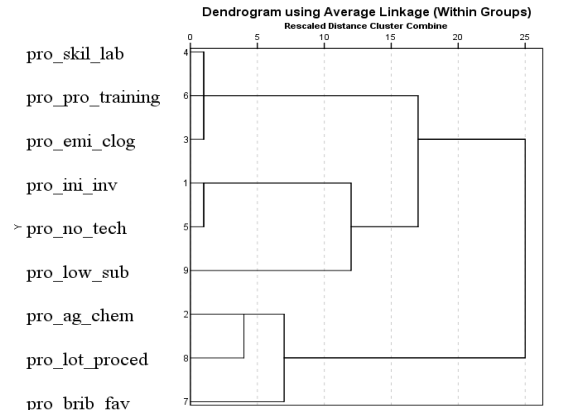

Figure No.6
Problems inDIS in Kariapatti Block

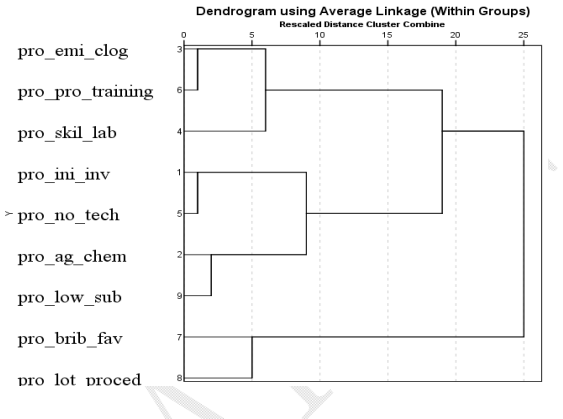

Table No. 7.
Cluster code &Problems in DIS

Code	Variables
pro_ini_inv	Initial investment high
pro_ag_chem	Liquid agro-chemical cost high
pro_emi_clog	Emitter Blockage
pro_skil_lab	Lack of skilled labour
pro_no_tech	No technical support after sales
pro_pro_training	Insufficient training programme
pro_brib_fav	Bribes & Favouritism
pro_low_sub	Insufficient subsidy
pro_lot_proced	Lot of procedure to avail DIS loan

Table No. 8.
Cluster Analysis and Problems in DIS

Block	Cluster	Variables	Yes Range (%)	NO Range (%)
Tiruchuli	1.	Lack of skilled labour, Insufficient training & awareness programme & Emitter blockage	50 – 58	42 – 50
	2.	Initial investment high, No technical support after sale and Insufficient subsidy	66 – 76	24 – 34
	3.	Liquid agro- chemical cost high, Lot of procedure to avail DIS loan and Bribe & favouritism	84 – 88	12 – 16
Kariapatti	1.	Emitter Blockage, insufficient training & awareness and lack skilled labour	46 – 58	42 – 54
	2.	Initial investment high & No technical support after sale	68 – 70	30 – 32
	3.	Liquid agro-chemical cost high & low subsidy	76 – 78	22 – 24
	4.	Bribe and favouritism & lot of procedure	86 – 88	12 – 14

Table No. 9
Problems in DIS

Sl. No.	Particulars		BLOCKS				Total	
			Tiruchuli		Kariapatti			
			Freq.	%	Freq.	%	Freq.	%
1.	Initial investment high	Yes	33	66	35	70	68	68
		No	17	34	15	30	32	32
2.	Liquid agro- chemical cost high	Yes	44	88	39	78	83	83
		No	6	12	11	22	17	17
3.	Emitter Blockage	Yes	23	46	28	56	51	51
		No	27	54	22	44	49	49
4.	Lack of skilled labour	Yes	25	50	25	50	50	50
		No	25	50	25	50	50	50
5.	No technical support after sales	Yes	34	68	34	68	68	68
		No	16	32	16	32	32	32
6.	Insufficient training programme	Yes	24	48	29	58	53	53
		No	26	52	21	42	47	47
7.	Bribes & Favouritism	Yes	46	92	43	86	89	89
		No	4	8	7	14	11	11
8.	Insufficient subsidy	Yes	38	76	37	74	75	75
		No	12	24	13	26	25	25
9.	Lot of procedure to avail DIS loan	Yes	40	80	44	88	84	84
		No	10	20	6	12	16	16

Source: Primary Data: Freq. – Frequency &**% -** Per cent

This analysis clearly indicates that there are three groups in Tiruchuli blocks and four groups in Kariapatti block. A close examination of the summary statistics indicates the following:

Tiruchuli Block:

Cluster No.1. Lack of skilled labour, insufficient training and Emitter blockage are minimum level of problems faced by respondents.

Cluster No.2. Moderate obstacles are Initial investment high, No technical support after sale and Insufficient subsidy.

Cluster No.3. Respondentsmeet the highest level of problems in following variables: liquid agro - chemical cost high, lot of procedure to avail DIS loan and bribe & favouritism are highest problems.

Kariapatti Block:

Cluster No.1. Minimal level Problems:Emitter Blockage, insufficient training & awareness and lack skilled labour

Cluster No.2. Almost 70 per cent of respondents felt that they are struggling by following problems: Initial investment high & No technical support after sale.

Cluster No.3. More than three fourth of respondents are expressed their opinion on related to problem of implementing DIS is liquid agro - chemical cost high and low subsidy.

Cluster No. 4. Nearly 90 per cent of the respondents are acknowledged that officials, politicians and intermediaries are asking Bribes. They are doing favouritism for friends, relatives and political party members. Implementation of DIS is not a easy task. Lot of modus operandi are followed by implementing agencies.

6. CONCLUSION & SUGGESTIONS:

From the above findings it may be concluded that majority of the respondents are male, elder group (Above 50 years old), school level completed respondents. They have medium level of income earners, land holdings and fully implemented DIS for their lands. Income and land size is main criteria to implement this system. After implementation of this scheme, they are acknowledged that production and productivity is improved and water consumption level is drastically decreased. They are mainly afraid of bribery and lengthy procedure to avail the DIS. Government and implementing agencies should take necessary steps to improve this system.

SOME SUGGESTIONS ARE RELATED TO IMPROVE THE DIS:

Central and State government should take necessary stepsto minimise liquid agro-chemical and initial implementation cost.They should start the DIS manufacturing industries and provide necessary spare parts to farmers.Cultivatorsshould encouragedby institutional support. They should provide necessary financial assistance, guidelinesand subsidy for farmers.But, they have lot of modus operandi to avail the DIS and it must be reduced. Authorities should recommend the appropriate and suitable DIS techniques.They should establish various DIS service centres, effective workshop,training and awareness programmes.It must be related to optimum water utilisation or it focuses on "**Minimum Water and Maximum Production**". Executing agencies should monitor each and every DIS users and it helps to solve DIS users' problems. Finally, Government and Private sector should invest more funds for DIS research and developmental activities.

REFERENCE:

Peter H. Gleick (**1996**), "Basic Water Requirements for Human Activities: Meeting Basic Needs", Water International, Volume. 21, No. 2, pp. 83 – 92.

Albert Tuinhof & Jan Piet Heederik, (**2002**), "Seminar on Management of AquiferRecharge and SubsurfaceStorageMaking Better Use of Our Largest Reservoir", Organised by the Netherlands National Committee for the IAH, Wageningen18 - 19 December, pp.7

Report of Task Force on Micro Irrigation (**2004**), Ministry of Agriculture, Department of Agriculture and Cooperative, January , New Delhi.

Katar Singh, (**2007**), "Rational pricing of water as an instrument of improving water use efficiency in the agriculture sector. A case study in Gujarat, India", International journal of water resource development, , Volume..23 No.4, pp.679-690

Raja Sekar M., (**2011**), "How to solve the problems of India's rain-dependent agricultural land", The Economic Times, July14.

Sharrif Moghaddasi Mohammad(**2011**), "Drip Irrigation Benefits And Saving Water", Research Journal of Fisheries and Hydrobiology, Volume 6 No. 2, pp 88-91,

Bjorneberg, D.L (**2013**), "Irrigation Methods, USDA Agricultural Research Service", Kimberly, ID, USA, Elsevier Inc.

Pawan Bhola, (**2014**), "Importance of Socio Economic Survey", International Journal for Research Publication & Seminar, Volume 5, No.2, March –July.

Vaibhav Bhamoriya & Susan Mathew (**2014**), "**An Analysis of Resource Conservation Technology: A Case of Micro-Irrigation System (Drip Irrigation)**", Centre for Management in Agriculture Indian Institute of Management, Ahmadabad, August, pp 10

Anurag Mehta (**2015**), "Automatic Drip Irrigation System using Wind energy", International Journal of Geology, Agriculture and Environmental Sciences Volume 3 No. 2, April pp 38 – 41.

Girma Megersa and Jemal Abdulahi (**2015**), "Irrigation system in Israel: A review", International Journal of Water Resources and Environmental Engineering, Volume 7 No. 3, pp.29-37, March.

Hendrik Wulfa,(et.al) (**2016**), "Differentiating between rain, snow, and glacier contributions to river discharge in the western Himalaya using remote-sensing data and distributed hydrological modeling", Advantages in Water Resources, Volume No. 88, pp.152 – 169.

Dhruv Saxena(**2017**), "Water Conservation: Traditional Rain Water Harvesting Systems in Rajasthan", International Journal of Engineering Trends and Technology, Volume No. 52(2), pp.91 – 98.

https://en.wikipedia.org/wiki/Water_storage