RESEARCH RECOMMENDATIONS

Soil and Water Conservation Engineering Department

College of Agricultural Engineering and Technology

Junagadh Agricultural University, Junagadh-362001

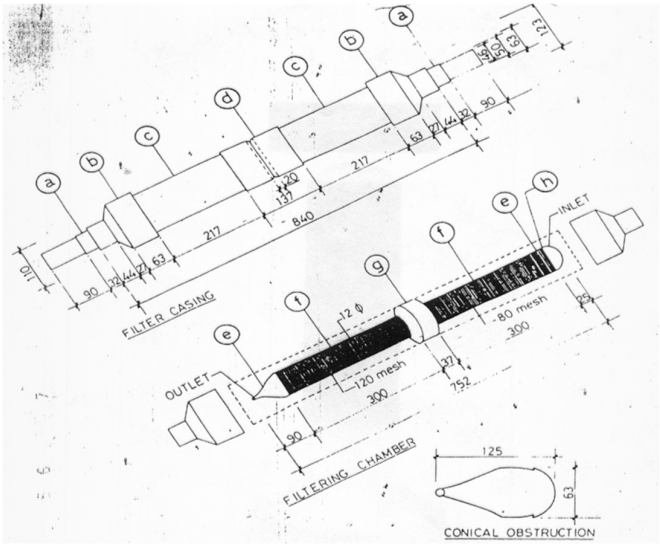
RECOMMENDATION No. : 1
Year: 1994
Name of the Scientists: Prof. R.B. Maravia&Er. P.B. Vekaria
End Users: Scientists and farmers

In the South Saurashtra Agro-climatic zone adopting drip irrigation in sugarcane crop can keep the 2 lph dripper, spacing of 50 cm and / or 45 cm respectively; for wetting 30 cm and / or 40 cm surface layer of soil for 2 lph drippers so as to obtain uniform application of water.

RECOMMENDATION No. : 2
Year: 1998
Name of the Scientist: Prof. N. K. Gontia
End Users: Farmers and drip manufacturers

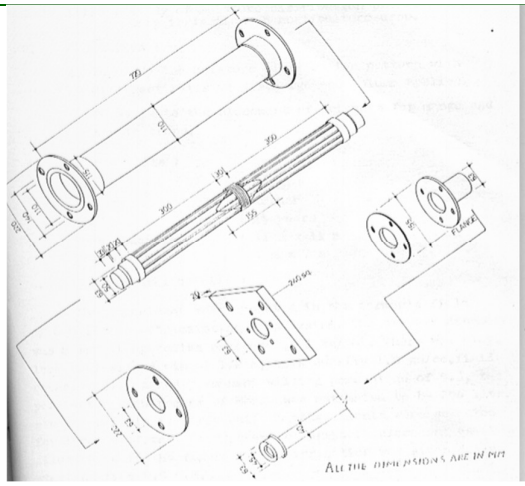
The drip manufacturing companies and farmers are advised to adopt the double screen filter where suspended particles in water is high and single screen filter for low turbidity water of design developed by Gujarat Agricultural University, Junagadh and shown in figure with the following information.

1) To clean the filters frequently when used in high turbidity water
2) To clean the filter every day or after 8 hours of run with low turbidity of water
3) The capacity of the filter is 20 cum/hr (5.55 lps)
4) The unit manufacturing cost of the filter is Rs. 500/-.



Legend:
a – PVC pipe, b – Reducer, c – PVC casing, d – PVC coupler,
e –Conical obstruction, f – Brass screen, g – Wooden ring, h – PVE perforated pipe.

Fig. Filter assembly for double screen filter.



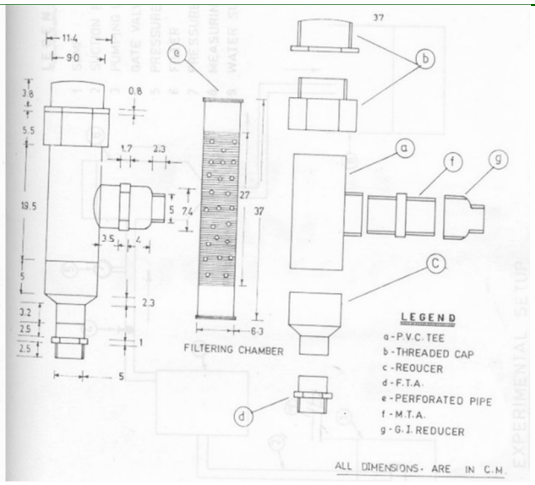


Fig. Double screen filterFig. Filter assembly of single screen filter.

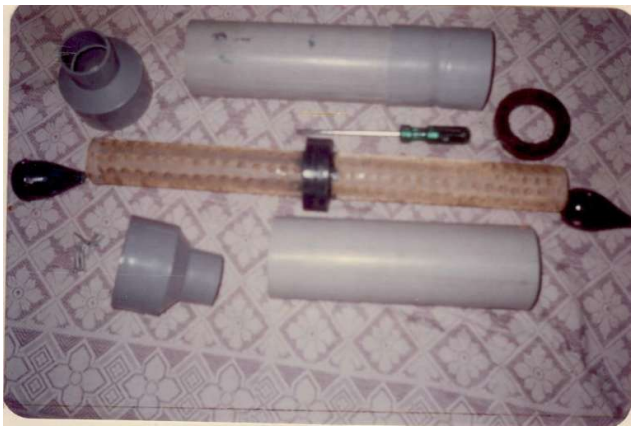


Fig. Different parts of filter

Fig. Experimental setup

RECOMMENDATION No. : 3
Year: 1999
Name of the Scientists: Prof.N. K. Gontia
End Users: Farmers

Farmers of Saurashtra region of Gujart are recommended to irrigate the close growing crops like wheat, groundnut, gram, bajra, etc. by using segmented border method for 20% saving of water. The border of length 90 m will be irrigated in two equal segments by irrigating last

segement first and than whole border with inflow of 1.75 lps/m width in first stage reduced half rate 0.87 lps/ widths in second stage of irrigation. PVC pipes are required to supply desired rate of inflow with an inlet head of 1.0 m. The additional cost involved in pipe and fittings is Rs. 9000=00 per system compensated by saving of pumping cost.

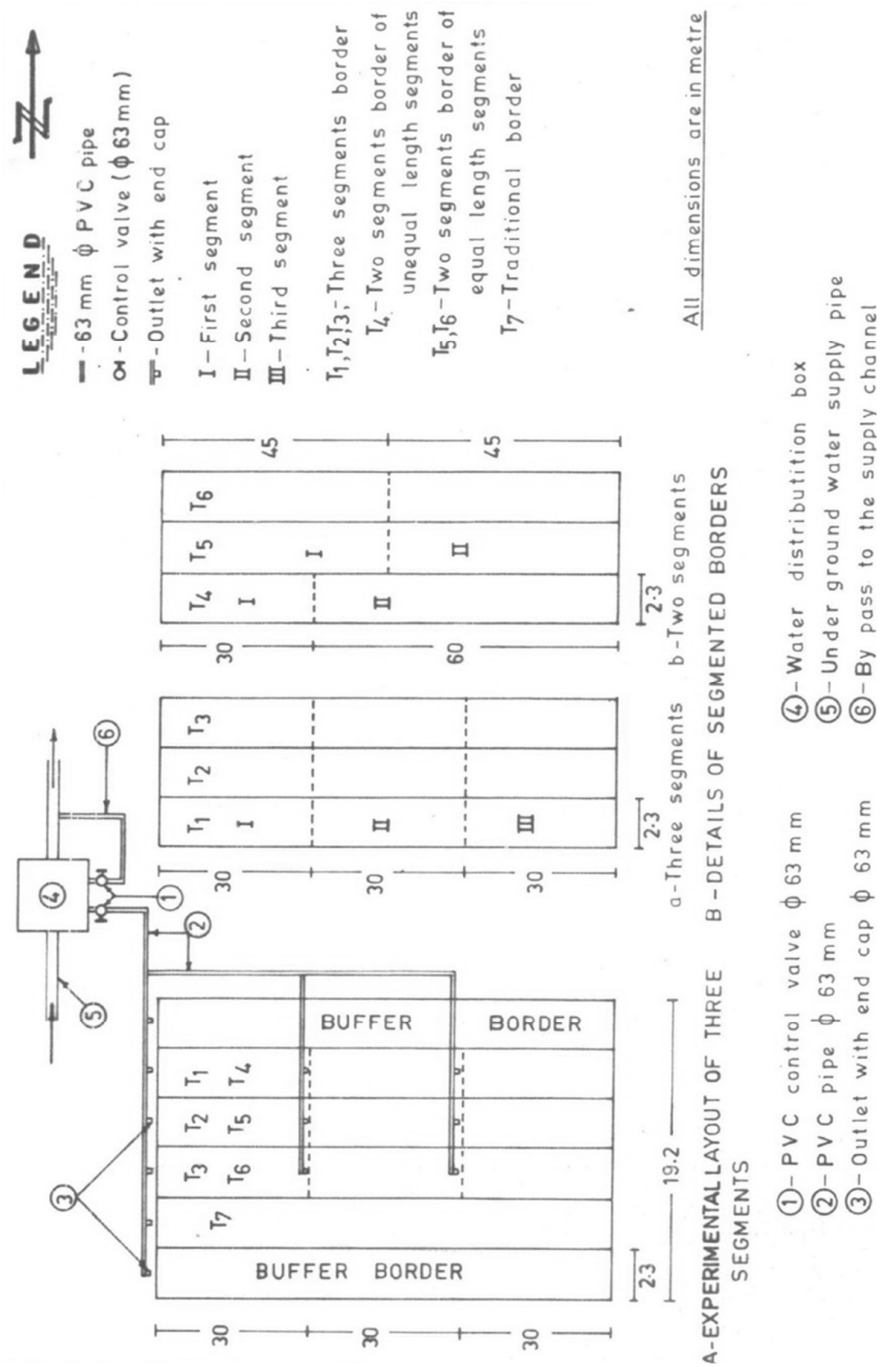


Fig. Layout of various experiments of border irrigation with wheat crop

(a) Three Segments

(b) Two Segments

Fig. PVC pipe layout for water supply in segmented borders

Fig The water supply at inlet and observations of advance and recession (Two segment border T4)

RECOMMENDATION No. : 4
Year: 2000
Name of the Scientists: Dr.R. Subbaiah
End Users: Scientists and Farmers

For the South Saurashtra agro climatic zone, Gujarat state with black soil it is recommended to irrigate the wheat cultivar whenever the moisture content of the soil attains 80 per cent of the field capacity up to first physiological stage that is crown root initiation, at 74 per cent of field capacity from first to second stage (Late tilleirng) at 80 per cent of field capacity from second to forth stage that is flowering and milk ripe stages and at 74 per cent of field capacity from milk ripe to harvesting stage. These schedules of irrigation give optimum yield of 4015 kg/ha with eleven irrigations amounting to 42 cm of water.

The crop coefficient (Kc) for wheat cultivar of South Saurashtra agro climatic zone can be recommended as;

$Kc = 0.4239 + 0.00935\ D + 0.000132\ D^2 - 0.000005\ D^3$

Where D is the days from the date of sowing.

The stress sensitivity factors of Dated Water Production function for wheat cultivar for South Saurashtra agro climatic zone can be recommended as 0.15, 0.18, 0.21, 1.27, and 0.61 respectively for crown root initiation stage (0 to 25 days), later tillering stage (25 to 40 days), flowering stage (40 to 60 days) Milk ripe stage (60 to 80 days) and Dough ripe stage (80 to harvesting).

RECOMMENDATION No. : 5
Year: 2001
Name of the Scientists: Dr.R. Subbaiah and Er. V K Sardhara
End Users: Scientists

For the scientist of south Saurashtra agro climatic zone, Gujarat state, it is recommended to irrigate the groundnut cultivar whenever the moisture content of the soil reaches 61 percent of the field capacity up to vegetative stage, at 74 per cent of the field capacity up to flowering stage, 87 per cent of the field capacity up to pegging and pod formation stage, 74 per cent of the field capacity up to pod addition and development stage and 61 per cent of the field capacity during maturity stage for attaining optimum crop yield.

To adopt the following sigmoidal equation to predict the temporal variation of groundnut roots.

$RD_t = 5 + (90)\ Sin(t / RTCM)^{0.79}$

RTCM = remaining days to crop maturity

to adopt the following equation to predict the crop coefficient (K_c)
$K_c = \sum A_i\ D^{i-i} R^2 = 0.962$, SE = 0.13

where, $A_1 = 0.451$; $A_2 = 0.0419$; $A_3 = 0.315$;
$A_4 = 0.765 \times 10^{-4}$; $A_5 = 0.118 \times 10^{-5}$; $A_6 = 3.841 \times 10^{-6}$; $A_7 = 0.226 \times 10^{-10}$

D = days from the date of sowing
The stress sensitivity factors of dated water production function for groundnut cultivar is recommended as 0.25 for vegetative stage, 0.75 for flowering stage, 1.15 for pegging and pod formation stage, 0.95 for pod addition and development and 0.60 for maturity stage respectively.

RECOMMENDATION No. : 6
Year: 2001
Name of the Scientists: Prof.H. D. Rank
End Users: Farmers

The farmers of this region are recommended to follow the irrigation schedules based on the pan evaporation fraction of 0.9 to grow the summer groundnut (GG-2) crop under border irrigation (having border length of 20m and width of 1.8 m). The crop should be given irrigations having depth of 4 cm at sowing, 2 cm at 7, 18 and 28 DAS, 4 cm at 34, 40, 46 and 52 DAS, 5 cm at 58, 63, 68, 73, 78, 83, 88, 94, 100 and 107 DAS respectively.

Fig. Groundnut Crop Under Border Irrigation(IW/CPE of 0.8 and 0.9)

RECOMMENDATION No. : 7
Year: 2001
Name of the Scientists: Prof. H. D. Rank
End Users: Farmers

The farmers of this region are advised to adopt micro sprinkler irrigation system for summer groundnut (GG-2) following the irrigation schedules based on pan evaporation fraction of 0.8. In the system, the 16mm laterals of 16m lengths should be fitted at 4.05 m apart. The micro sprinkler of 160 1ph should be connected with lateral at 4m distances. The system should be operated at 2.0 kgf./cm^2 for 4 hours after sowing, 3 hours at 8 and 18 DAS, 4 hours at 28, 34, 40. 46. 52. 58. 63. 68. 73. 78. 83. 88. 94. 100 and 107 DAS. It gives about 20 % more yield with 10 % less water as compared to border irrigation.

Fig. Groundnut Crop under Microsprinkler Irrigation(IW/CPE of 0.8)

RECOMMENDATION No. : 8
Year: 2001
Name of the Scientists: Prof. H. D. Rank
End Users: Farmers

The farmers of this region are recommended to adopt drip irrigation system following the irrigation scheduling based on pan evaporation fraction of 0.8. The farmers should irrigate the crop at 3 days interval having irrigation depth of 1.2 cm, 2.0cm, 2.3cm and 2.3 cm during the month of February, March, April and May (2 to 3 weeks of May), respectively.

It gives about 41 % more yield with 14.3 per cent less water as compared to border irrigations.

Fig. Groundnut Crop under Drip Irrigation (IW/CPE OF 0.8)

RECOMMENDATION No. : 9
Year: 2004
Name of the Scientists: Dr. N. K. Gontia and Er. K. C. Patel
End Users: Scientists

For the Scientists of South Saurashtra Agro climatic Zone, Gujarat State it is recommended : To adopt the following approach based on average infiltration rate for determining the ponded radius (r_w) and wetted radius (R_w) in drip irrigation hydraulics in loamy clay soil.

$R_w^2 = q/(\pi\, C_d\, l_t)$

Where.

$C_d = \{(l_i/l_t) + 2\}/3$,

l_i = initial infiltration rate,

l_t = infiltration rate at time 't',

q = volume of water emitted in time 't',

$R_w = [\pi/2] \times [r_w/r_{wd})^2]$,

R_{wo}= radius 'r_w' after very long time, say 24 hours.

To adopt the following equations for determining time of irrigation (t) with the help of wetted diameter ($D_w = 2 \times R_w$) in drop irrigation hydraulics in loamy clay soil.

Sr. No.	Emitter Discharge	For loamy clay soil	R^2 value
1	4 lph	$D_w = 6.70\ t^{0.4174}$	0.9750
2.	8 lph	$D_w = 10.45\ t^{0.4088}$	0.9938
3	16 lph	$D_w = 18.93\ t^{0.3802}$	0.9745
4	48 lph	$D_w = 20.37\ t^{0.4271}$	0.9989

RECOMMENDATION No. : 10
Year: 2004
Name of the Scientists: Dr. N. K. Gontia
End Users: Farmers

The farmers of South Saurashtra Agro climatic Zone are recommended to use high discharge drip irrigation system of emitters 16 liters per hour for close growing groundnut crop covering the entire field in loamy clay soil to minimize the initial high cost of installation and labour cost.

Fig. High discharge drip irrigation system an over view for Groundnut crop

RECOMMENDATION No. : 11

Year: 2006

Name of the Scientists: Er.P B Vekariya and Dr R Subbaiah

End Users: Scientists, Entrepreneurs and Industrialists

The technology is recommended to scientists, entrepreneurs and industrialists to adopt the following dimensionally homogeneous equation for micro tube emitters while designing drip system.

$Q = [(20 \times g \times D^5 \times H)/L]^{1/2}$

where, Q = Emitter rate (cm^3/sec)

g = gravity constant (cm/sec^2)

D = micro tube diameter (cm)

L = Length (cm)

H =operating pressure (cm of water column)

The dimensionally homogeneous equation holds good for all flow regimes. Further they may adopt/ manufactures less than 1.5 mm diameter of tube as micro tubing emitters because greater than 1.5 mm tube behave as like conveyance pipe instead of pressure dissipation element.

RECOMMENDATION No. : 12

Year: 2007

Name of the Scientists: Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: NGO/ Gov. Agencies

The mathematical model and nomograph of rainfall intensity-duration-frequency relationships for Junagadh region developed by Soil and Water Engineering Department of College of AgrilEngg. and Technology, Junagadh Agricultural University, Junagadh are recommended to the designers, planners, NGOs and Govt. agencies involved in watershed developments projects for the design of structures

$$I = \frac{68.86T^{0.265}}{(t+0.86)^{1.022}}$$

Where, I=rainfall intensity(mm/hr); T=return, period (years); t=duration(hours);

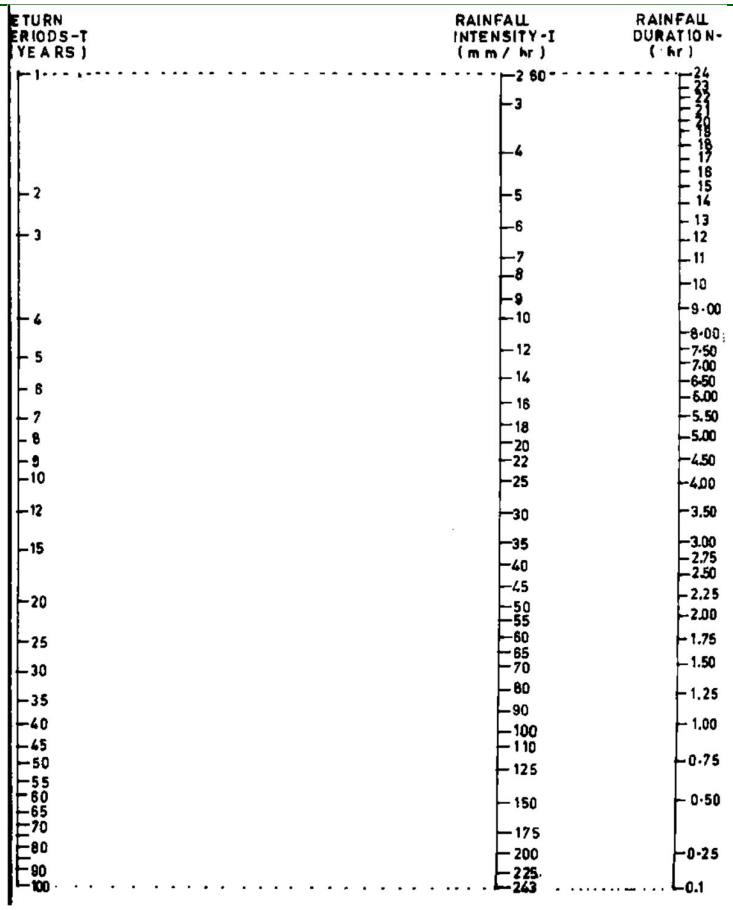


Fig.: Nomograph for Rainfall Intensity (I)-Duration (t)-Return Period (T) relationships for Junagadh

RECOMMENDATION No. : 13

Year: 2007

Name of the Scientists: Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: NGO/ Gov. Agencies

The mathematical model and nomograph of rainfall intensity-duration frequency relationships for Mahi basin developed by Soil And Water Engineering department of College of Agril. Engg. and Technology, Junagadh Agricultural University, Junagadh are recommended to the designers, planners, NGOs and Govt. agencies involved in watershed developments projects for the design of structures.

$I = 113.3211T^{0.2156} / (t + 1.4275)^{1.0132}$; Where, I=rainfall intensity(mm/hr); T=return period(years); duration(hours);

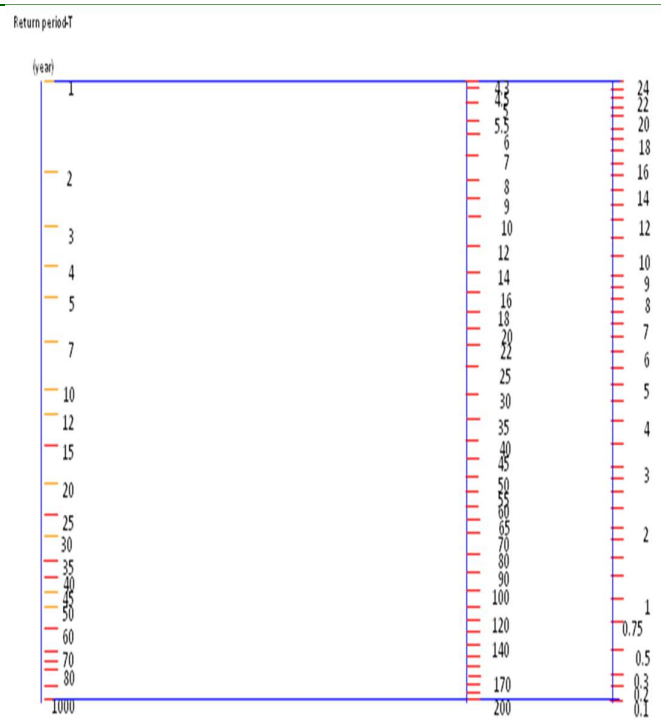


Fig.: Nomograph showing the rainfall intensity-duration-frequency relationships for Central Gujarat.

RECOMMENDATION No. : 14

Year: 2010

Name of the Scientists: Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Scientific community/ Gov./ NGO

The aquifer properties viz. transmissibility and storage coefficient for different talukas of the Junagadh district are recommended for the Scientific community / Government/NonGovernment Organizations for crop planning and simulating groundwater behaviorfor adopted cropping pattern are as below.

Table : Aquifer Properties of different talukas of Junagadh District

S. N.	Taluka	Tested site	Aquifer properties	
			Transmissibility (m^2 /h)	Storage coefficient
1	Vanthali	Vanthali	0.55	0.1919
2	Manavadar	Manavadar	1.187	0.0000358
3	Vishavadar	Vishavadar	0.7065	0.0002272
4	Mangrol	Mekhadi	6.439	0.1655
6	Junagadh	Junagadh, Bamangam	4.36057	0.0047
7				
8	Una	Keshariya	3.3697	0.00011264S
9	Kodinar	Vadanagar	1.141	0.0001614
10	Sutrapada	Amrapur	9.65	0.108223
11	Mendarada	Amargadh	9.072	0.0013881
12	Talala	Chitrod	33.8846	0.061592
13	Veraval	Supasi	44.553	0.1267303
14	Keshod	Pipari	13.30	0.0000982164
15	Bhesan	Sukhpur	14.2165	0.0252
16		Khambhaliya		

17		Bamangadh		
18		Samatpara		
18	Malia	Vadia	19.3192	0.033766
19		Panakava		
20		Itali		
21		Babara		
22		Dudhala		

RECOMMENDATION No. : 15

Year: 2011-12

Name of the Scientists: Dr. N. K. Gontia and Prof. P. B. Vekariya

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Scientific Community/ Gov./ NGO

The efficient utilization of available water in Meghal river basin is recommended using surface as well as micro irrigation systems. The total groundwater recharge through rainfall and water harvesting structures in the study area is 12,592 ha m. The possible options for efficient utilization of groundwater using different irrigation systems are as below:

Option 1: Using surface irrigation methods

In Meghal river basin, if surface irrigation system is adopted at 60 per cent application efficiency, about 9084 ha of wheat crop (irrigation water requirement 457 mm) can be irrigated using 5187 ha m of water. The remaining amount of water can be used for irrigating horticultural crops viz. coconut, mango and sapota (gross irrigation requirement 1097, 453 and 768 mm) of about 3669, 1005 and 596 ha area, which covers about 2/3rd area of horticultural crops.

Option 2: Allocating all crops under micro irrigation system

In Meghal river basin, if drip irrigation system is adopted (90 per cent application efficiency) for existing horticultural crops of coconut, mango and sapota in 5595, 1602 and 796 ha area water required is 6137, 725 and 611 ha m respectively. The remaining water can be utilized through sprinkler irrigation (80 per cent application efficiency) for irrigating wheat crop will cover about 11,950 ha area. This can bring under irrigation all horticultural crops and an additional area of 2866 ha (76%) of wheat crop.

RECOMMENDATION No. : 16

Year: 2012-13

Name of the Scientists: Prof. P. B. Vekariya and Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers, Planners, NGOs and Line Departments

Groundwater utilization and management policy guidelines are recommended for the South West Saurashtra region to Farmers as well as concerned Planners, NGOs and line departments.

- In normal years, the groundwater potential of South West Saurashtra region is estimated at 4060.66 MCM which is just sufficient to meet requirement of exiting cropping pattern. The water table in the North East area (Talukas: Bhesan, Dhari, Part of Visavadar, part of Junagadh) usually goes down up to 20m during pre monsoon. Therefore, water harvesting activities and low water requirements, crops should be encouraged to improve the groundwater conditions.
- Around Veraval and Talala, the transmissibility of aquifer is observed around 32 sq.m /hr. Veraval is near sea cost having low altitude, where asTalala having higher altitude. Talala, Mendarada and Visavadar and Maliatalukas should be encouraged for surface water harvesting and well recharging (aquifer recharging) as this part has higher transmissibility

and upland which creates groundwater flow seaward after recharge which helps to improve ground water quality at coastal belt as well enhance groundwater potential.

- Conjunctive use planning is recommended in good quality groundwater area also to reduce groundwater draft and save power costs.
- Around 2130 sq.km (23%) area of region is under degraded groundwater class during pre-monsoon mostly found along coastal line. The area must be improved by bandharas construction along costal areas, water harvesting structures and conjunctive water use planning. Also salt tolerance and low water requirement crops should be introduced.
- The absolute head continuously falling from North-East upland to sea cost. Just near coastal line 20 m of head remains in pre monsoon. Under such head condition, water harvesting and conjunctive water use planning should be encouraged. The streams must be checked before 2 km from sea coast by Bandhara system which will reduce sea water intrusion as well as not affects the river livelihood up to the end of river.
- In the area of good class of groundwater, high value crops which can grow under local climatic conditions may be encouraged beside existing cropping pattern as good groundwater quality supply is possible to meet.

RECOMMENDATION No. : 17
Year: 2012-13
Name of the Scientists: Prof. P. B. Vekariya and Dr. H. D. Rank
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farmers, Planners and NGOs

It is recommended to farmers, Planners and NGOs that conjunctive use of surface water from nearby water harvesting structures with groundwater for irrigating wheat crop in Junagadh region is benefited. Also highly recommended to Irrigation department of Government of Gujarat to allow using check dam water to nearby farmers freely instead of keeping it for recharge only after monsoon. As under conjunctive use 533.94 cum (7.72%) of groundwater draft per ha. can be reduced and 123.8 units power per ha. (4.9%) can be saved per irrigation given from check dam. It is economical when at least two irrigations given from surface sources and from second irrigation B/C can rise by 0.038 per irrigation given from check dam as compare to without Conjunctive water use. The conjunctive use can control up to 101 mm of evaporation loss from surface water sources. Good scopes are lying to avoid deep pumping, reduce groundwater draft and achieve higher economy by utilizing spill over water before it escapes from water harvesting structures.

RECOMMENDATION No. : 18
Year: 2012-13
Name of the Scientists: Dr. H. D. Rank
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farngomers, Planners and NGOs

The farmers of the South Saurashtra region sowing summer sesame (Guj. Til - 3) crop are advised to adopt any one of the following two irrigation scheduling options through high discharge drip irrigation system (20lph drippers at 1 m dripper spacing and 2m lateral spacing) with mulch application (5 tone/ha wheat straw) for getting the maximum return.

Option - I: When water availability is not limiting factor.
The irrigation should be scheduled at IW/ETc of 1.0. For that, the above said high discharge drip system should be run for 4 hr& 25 min(40 mm irrigation) immediately after sowing and

3 hr& 15 min (29.5 mm irrigation) at 8, 18, 28, 36,43, 49, 54, 59, 64, 69 and 74 days after sowing.

Option - II: When Water availability is limiting factor.
The deficit irrigation should be scheduled at IW/ETc of 0.6. The saved water should be used to bring additional area under sesame crop cultivation at same deficit irrigation scheduling level. For that the above said high discharge drip system should be run for 4 hr& 25 min (40 mm irrigation) immediately after sowing , 3 hr& 15 min (29.5 mm irrigation) at 10 days after sowing and 3 hr& 40 min (33.3 mm irrigation) at 23, 36, 47, 58 and 70 days after sowing.

RECOMMENDATION No. : 19
Year: 2014-15
Name of the Scientists: Dr. H. D. Rank, Prof. P. G. Vadher, Prof. P. B. Vekariya, Dr. R. Subbaiah and Dr. N. K. Gontia
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Scientific Community

The Impact of Seawater Intrusion on the Qualitative Parameter of Ground Water

The following scientific information as models developed for rainfall and groundwater EC are released for the scientific communities/Line Departments of State/Central Governments/NGOs working in the coastal belts of the Saurashtra region.

SN	Costal belt region	Best fit model	R^2
1	0-5 km	$EC_{PM} = 0.6364(EC_{bm}) - 0.00166(RF) + 2.9495$	0.8265
2	5-10km	$EC_{PM} = 0.6965(EC_{bm}) - 0.000359(RF) + 1.2837$	0.6429
3	10-15km	$EC_{PM} = 0.4171(EC_{bm}) - 0.000267(RF) + 1.5592$	0.6368
4	15-20km	$EC_{PM} = -0.3577(EC_{bm}) - 0.0000683(RF) + 1.8636$	0.8159
EC_{BM} and EC_{PM} are the groundwater EC(dS/m) during pre and post monsoon, RF=monsoon rainfall(mm)			

RECOMMENDATION No. : 20
Year: 2014-15
Name of the Scientists: Dr. H. D. Rank, Prof. P. G. Vadher and Prof. P. B. Vekariya
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Scientific Community

An assessment of suitability of groundwater for drip irrigation in Saurashtra region

The following scientific information is released for the scientific community.

- The pH of the groundwater was observed higher (more than 7) in all districts of the Saurashtra region. The maximum ground water samples (99.14 %) were found in category scale forming but non corrosive class.
- Based on the EC, SAR and RSC of the groundwater, 56.24, 18.4, 6.64 and 18.68 per cent samples were found under categories of good water, saline water, high SAR saline water and alkali water class, respectively.

- The hardness of the groundwater in Jamnagar, Rajkot, Surendranagar, Junagadh and Porbandar districts were varying from 9 to 177, 12 to 206, 12 to 292, 10 to 221 and 12-176, respectively.

RECOMMENDATION No. : 21
Year: 2016-17
Name of the Scientists: Prof. P. B. Vekariya and Dr. H. D. Rank
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farmers, NGO's and Line Department

Aquifer Mapping of Uben River Basin

The farmers, NGO's and line department people are advised to construct ground water recharge structures and shaft recharging technique for augmenting surface water resources around the area starting from Sakkarbaugh, Vadal, Choki, Makhiyala up to Fareni. Keeping and view the higher horizontal, vertical hydraulic conductivity and transmissibility of unconfined/confined aquifer. The surface water harvesting structures should be encouraged for augmenting the surface water resources in rest parts of the Ubenbeasin.

RECOMMENDATION No. : 22
Year: 2017-18
Name of the Scientists: Er. P. B. Vekariya, Dr. H. D. Rank and Dr. R. J. Patel
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farmers; NGOs and line Department of Government

Evaluation of on stream check dam groundwater recharge technique for Junagadh region

IT is recommended to farmers, NGOs and line departments of Government on-stream check dam groundwater recharge technique is a cost effective groundwater recharge technique. In Junagadh region, it results 0.15 cum groundwater recharge per square meter of catchment area at the cost of Rs. 1.02 per cum as per prevailing cost.

RECOMMENDATION No. : 23
Year: 2017-18
Name of the Scientists: Er. P. B. Vekariya, Dr. H. D. Rank and Dr. R. J. Patel
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farmers; NGOs and Line Department of Government

Evaluation of groundwater recharge basin technique for Junagadh region

IT is recommended to farmers, NGOs and line departments of Government that recharge basin is a cost effective recharge technique. In Junagadh region it results in recharge about 0.13 cum. Groundwater per square meter of catchment area at the cost of Rs. 0.27 per cum

RECOMMENDATION No. : 24

Year: 2017-18

Name of the Scientists: Er. P. B. Vekariya,Dr. H. D. Rank and Dr. R. J. Patel

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers; NGOs and Line Department of Government

Evaluation of roof water harvesting recharge technique for Junagadh region

IT is recommended to citizens, farmers, NGOs and line departments of Government that roof water harvesting is an effective groundwater recharge technique. In Junagadh region, it results in groundwater recharge of 0.22 cum out of potential runoff of 0.73 cum per sq. m of roof area, which may be done through tube well recharge and remaining 0.51 cum may be stored in a sump with a cost of Rs. 34 per cum at prevailing cost. The annual runoff coefficient of 0.71 for roof top is recommended for designing the roof water harvesting system.

RECOMMENDATION No. : 25

Year: 2017-18

Name of the Scientists: Dr. H D Rank, Er. P B Vekariya, Dr. H R Vadar, Er. H H Mashru, Dr. R J Patel and Dr. H V Parmar

Name of Scheme: National Initiatives on Climate Resilient Agriculture(NICRA) running under AICRP on Irrigation Water Management

End Users: Scientists Policy Makers

Ambient temperature trend analysis for the south Saurashtra region in view of climate change

The Scientists Policy makers in the field of breeding/climate change adaption are advised to use the following mathematical models to predict the day maximum and day minimum temperature for future period in Junagadh region.

Season	Day Maximum Temperature (°C)		Day Minimum Temperature (°C)	
	Model	R^2	Model	R^2
Winter	T_{max}= 0.0209*Year – 8.8495	0.75	T_{max}= 0.0318*Year – 49.781	0.78
Summer	T_{max}= 0.0191*Year – 0.1754	0.84	T_{max}= 0.0321*Year – 42.693	0.84
Monsoon	T_{max}= 0.0211*Year – 8.0849	0.71	T_{max}= 0.0532*Year – 81.855	0.94

RECOMMENDATION No. : 26

Year: 2018-19

Name of the Scientists: Dr. H. R. Vadar, Dr. J. M. Modhvadia and Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers

Coriander crop response to deficit soil moisture in various growth stages under drip irrigation system

The farmers of South Saurastra Agro-climatic zone growing coriander crop (variety: GC-2) are advised to irrigate the crop using drip irrigation having following system details and time of operation to get maximum net return and

water saving upto 17.6%. They are also advised to consider flowering stage as most sensitive to deficit irrigation followed by vegetative stage and seed development/setting.

Drip system details	Stage (DurationSAD,)	Irrigation time	Irrigation interval
Lateral size : 16 mm Lateral spacing : 0.9m Dripper spacing : 0.5 m Dripper discharge : 41ph	Vegetative stage (0 to 55)	55 min	Alternate day
	Flowering stage (56 to 80)	63 min	
	Seed development/ setting stage (81 to 100)	77 min	

RECOMMENDATION No. : 27

Year: 2018-19

Name of the Scientists: Er. P. B. Vekariya and Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers, Govt. Departments and NGOs

Evaluation of well recharge techniques for Junagadh region

It is recommended to the farmers, Govt. departments and NGOs that the open well technique is effective for recharging shallow aquifer in Junagadh region which may recharge 103cu.m groundwater per sq.m of bottom area of open well with recharge cost of Rs. 1.94 per cum.

The tube well is effective for deep aquifer recharge, which may recharge 44473 cu.m groundwater per year with recharge cost Rs. 0.45 & 0.28 per cum including and excluding tube well cost respectively.

RECOMMENDATION No. : 28

Year: 2018-19

Name of the Scientists: Dr. H D Rank, Er. P B Vekariya, Dr. R. J Patel, Er. H H Mashru and Dr. H V Parmar

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Scientific Community/ Policy Makers

Assessment of potential water resources of Aji river basin using SWAT Model

The scientific Community/Policy makers working for Aji River Basin are informed as below.

1. Warming trend

- The day maximum temperature may increase by 3.31 °C, 3.31 °C, 1.46 °C and 23.52 °C, up to end of 2070 over the present 34.51 °C, 38.65 °C, and minimum temperature by 3.35 °C, 5.80 °C, and 3.07 °C, up to end of 2070 over the present 14.83 °C, 26.83 °C, and 22.37 °C in winter summer and monsoon season respectively.
- The adoptions of heat resistant crop varieties with frequent irrigation of smaller depth through MIS particularly during summer season should be promoted to lessen the adverse effects of higher temperature.
- The following mathematical models may be used to predict the day maximum and day minimum temperature for the period up to 2070.

Period/ Season	Day Maximum Temperature (°C)		Day Minimum Temperature (°C)	
	Model	R^2	Model	R^2
Annual	T_{max}= 0.0462 ×Year – 56.927	0.90	T_{max}= 0.081 ×Year –141.62	0.98
Winter	T_{max}= 0.0625 ×Year – 91.552	0.86	T_{max}= 0.0632 ×Year – 112.64	0.98
Summer	T_{max}= 0.0276 ×Year – 17.023	0.90	T_{max}= 0.1094 ×Year – 194.28	0.98
Monsoon	T_{max}= 0.0476 ×Year – 59.997	0.87	T_{max}= 0.0579 ×Year – 94.417	0.88

2. Surface water

- The crop water requirements during winter, summer and monsoon season may change by the tune of 6.4%, - 0.3% and 1.5% respectively in future up to 2070 as compared to the past, due to global warming. On an average, the water balance components like rain fall and runoff may be decreased by 26%, and 29% in future up to 2070 as compared to post. The monsoon seasonal rainfall and runoff will be decreased up to 2070 but the extreme event (100 years return period) will be increased by tune of 39% and 87.5% respectively due to climate change impacts. Therefore, the following empirical probability distributions should be used for the rainwater management planning.

Hydrological Parameter	Probability distribution	Empirical cumulative probability function
Monsoon Rainfall(mm)	Frechet type (Fisher-Tippett 2)	$P(x \geq X) = 1 - e^{-[\frac{(x-(-53))}{-10.5627}]^{-1.88227}}{}_{e^{-1.88227}}$
Monsoon runoff (mm)	Log-logistic	$P(x \geq X) = 1 - \frac{1}{1 + e^{(-1.20156 \ln(x) + 5.00776)}}$

3. Ground water

- The groundwater recharge may be decreased by 51% up to 2070 compared to past due to the climate change impacts. Therefore, the water harvesting-cum-groundwater recharge structures as well as artificial groundwater recharge through open/tube well should be planned for the groundwater sustainability.

RECOMMENDATION No. : 29

Year: 2019-20

Name of the Scientists: Dr. H R Vadar, Dr. H D Rank, Er. P B Vekariya, Dr. J M Modhvadia and Er. H H Mashru

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Scientific Community/Policy Makers

Evaluation of hydraulic performance of oozing pipe irrigation

The irrigation applications through porous pipe system gives very poor uniformity coefficient of 6.65% in case of 60m lateral length at 100cm input head to 47% in case of 30m lateral length at

200cm input head, which should be more than 90%. The uniformity in the wetting bulb size along the length of lateral also varies greatly.

RECOMMENDATION No. : 30
Year: 2020-21
Name of the Scientists: Er. P B Vekariya and Dr. H D Rank
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farmers/ NGO/ Government department

Online Screen –Gravel Filter for Groundwater Recharge

The farmers, NGOs, line department of Government of Gujarat are recommended to adopt online screen cum sand groundwater recharge filter developed by the Junagadh Agricultural University. The developed filter consists of sand filtration layer placed in between two composite screens viz. macro screen and micro screen. It avoids excavation and construction work. It is portable, easy to clean and auto flushing; requiring to wash or change a sand layer in every year. It has a filtration efficiency of more than 80%

Filter Specifications:

- Bottom composite screen: Macro screen is underlain micro screen
- Thickness sand filtration bed 15 cm and size of sand 1mm
- Top composite screen: Micro screen is underlain macro screen
- Macro screen: 18 gauge GI having 40% perforation of 12 mm circular holes
- Micro screen: S.S. 304 grade having 0.75 mm screen size.

RECOMMENDATION No. : 31
Year: 2021-22
Name of the Scientists: Er. P B Vekariya and Dr. H D Rank
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farmers/ NGO/ Government department

Assessment and management planning of groundwater resources of Uben river basin

It is recommended to the farmers, NGOs and Government line departments that 50 % of rainfall as groundwater recharge including natural recharge is required for sustaining water resources in the Uben basin. The optimum groundwater recharge planning of Uben basin should be done by recharging through 2372 check dams, 15751 farm ponds, 5558 open wells and 1390 tube wells.

RECOMMENDATION No. : 32
Year: 2021-22
Name of the Scientists: Er. P B Vekariya and Dr. H D Rank
Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)
End Users: Farmers/ NGO/ Government department

Calibrated hydraulic conductivity of Uben basin

It is recommended to the Scientific community that the calibrated hydraulic conductivities for confined and unconfined aquifers of Uben river basin determined by electrical resistivity method are as:

Hydraulic conductivity of Calibrated Uben basin			
SN	Location	Unconfined K (m/s)	Confined K (m/s)
1	Sakkarbaugh	0.006482947	0.00387976
2	Sukhpur	0.004538363	0.00363189
3	Ranpur	0.002018549	0.004539113
4	Parabdham	0.0030266	0.0034919
5	Evenagar	1.00E-04	0.0051875

6	Patala	1.50E-04	3.00E-04
7	Choki	0.0060522	0.001398
8	Vadal	0.0064829	3.00E-04
9	Makhiyala	1.50E-04	0.0090752
10	Chobari	0.0030246	0.0052944
11	Satalpur	0.0013	0.0014
12	Goladhar	0.00303	0.00248
13	Ravani-Rupavati	2.63E-04	0.0009102
14	Fareni	0.0060486	0.0090752
15	Bava-Pipaliya	0.0018163	0.0060512

RECOMMENDATION No. : 33

Year: 2022-23

Name of the Scientists: Prof. P. B. Vekariya Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers/ NGO/ Government department

Identification of potential groundwater recharge zones in Ozat river basin

It is recommended to the Farmers, NGOs and Government line departments that the Ozat river basin is divided in to five groundwater potential recharge zones namely excellent, good, moderate, poor and very poor having an area of 220.14 km^2 (6.93%), 2094.81 km^2 (65.95%), 430.05 km^2 (13.54%), 430.87 km^2 (13.57%) and 0.36 km^2 (0.01%) respectively.

RECOMMENDATION No. : 34

Year: 2022-23

Name of the Scientists: Prof. P. B. Vekariya Dr. H. D. Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers/ NGO/ Government department

Identification of potential groundwater recharge zones in Ozat river basin

The scientific communities are infromed that the planning for recharging of 610.18 MCM runoff (75% dependability) of Ozat basin may be done by recharging through 4520 check dams, 51113 farm ponds, 22599 open wells, 5650 tube wells in excellent and good groundwater recharge potential zones, while 10496Gabion/loose rock dams in moderate groundwater potential zones.

RECOMMENDATION No. : 35

Year: 2022-23

Name of the Scientists: Dr. J. M. Modhvadia, Dr. H. D. Rank, Dr. H R Vadar, Dr. R. J. Patel

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers

Cotton Crop Response to Drip Fertigation

The farmers of South Saurashtra Agro-Climatic zone growing Bt. cotton crop are recommended to apply 25 % of RDF(240 N:50 P_2O_5:150 K_2O kg/ha) as basal doze and remaining NPK through drip fertigation in 12 equal splits after 30-45 days of sowing at 9 days interval using following drip irrigation system to get higher yield, net return, and water productivity as compared to conventional fertilizer applications adopted by farmers.

Specifications of drip irrigation system and its operating time

Drip irrigation system details	Drip irrigation system operating time at ever days

SN	System components	Specification	SN	Month	Operating time (minute.)
1	Lateral size	16mm(OD)	1	September	60
2	Dripper rate	4lph	2	October	90 to 125
3	Lateral type	InlineDrip	3	November	90 to 120
4	Dripper spacing	0.5m	4	December	70 to 90
5	Lateral spacing	1.2 m	5	January	70 to 90
6	Nos of rows /drip line	1 no.			

RECOMMENDATION No. : 36

Year: 2023-24

Name of the Scientists: Dr. J. M. Modhvadia, Dr. P. H. Rank, Dr. R J Patel, Dr. L. C. Vekariya, Prof. P. B. Vekariya, Dr. H D Rank

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers

Yield response of drip fertigation for wheat-green gram crop sequence

The farmers of South Saurashtra Agro-Climatic zone growing wheat are recommended to apply 75 % of NPK of RDF (120 N:60 P_2O_5:60 K_2O kg/ha) through drip fertigation only (with no basal doze) adopting the following drip system and irrigation schedules to wheat crop in 8 equal splits at 6 days interval after 12 days of sowing to get higher grain yield and net return.

Specifications of drip irrigation system and its operating timefor wheat crop				
Drip irrigation system details	Nos and depth of irrigation and drip irrigation system operating time for wheat crop during winter season			
	DAS	No. of irrigations	Irrigation depth (mm)	Operating time/ irrigation
Lateral type = Inline Inline drip size = 16 mm (OD) Dripper rate = 4 lph Dripper spacing = 0.5 m Lateral spacing = 0.675 m Nos of crop rows per drip line = 3	0	1	40	3 h & 23 Minutes
	0-10	1	30	2 h & 32 Minutes
	10-40	5	20	1 h & 41 Minutes
	41-70	5	22	1 h & 51 Minutes
	71-90	3	24	2 h
	> 90	2	26	2 h & 12 Minutes

It is also recommended to sow green gram crop in paired row (0.3 m x 0.375 m) after harvesting of wheat crop without any cultivation operation and to apply 75 % P of RDF (20 N:40 P_2O_5:00 K_2O kg/ha) as basal doze and 75 % N of RDF through drip fertigation adopting the following drip system and irrigation schedules in 5 equal splits at 6 days interval after 12 days of sowing to get higher seed yield and net return.

Specifications of drip irrigation system and its operating timefor green gram crop				
Drip irrigation system details	Nos and depth of irrigation and drip irrigation system operating time for green gramcrop during summer season			
	DAS	No. of irrigations	Irrigation depth (mm)	Operating time/ irrigation
Lateral type = Inline	0	1	20	1 h & 41 Minutes

Inline drip size = 16 mm (OD) Dripper rate = 4 lph Dripper spacing = 0.5 m Lateral spacing = 0.675 m Nos of crop rows per drip line = 2	0-10	1	15	1 h & 16 Minutes
	11-30	5	21	1 h & 46 Minutes
	31-70	6	23	1 h & 56 Minutes
	>70	1	22	1 h & 51 Minutes

RECOMMENDATION No. : 37

Year: 2024-25

Name of the Scientists: Prof. P. B. Vekariya, Dr. H. D. Rank, Dr. D. J. Patel, Er. P. J. Bagada

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers

Development of semi-automatic channel for border irrigation.

The farmers and industrialist are recommended to use JAU developed Metallic or PVC border irrigation channel instead of kachha channel, so seepage loss may be reduced by 87 % as compared to kachha channel. With the adoption of border irrigation channel additional 200 Sq.m crop area may be increased per hectare. With 5 years life of system yearly cost was found Rs. 1029 and Rs. 440 per meter length of channel in case of metallic and PVC channel respectively, while yearly cost with automation was found Rs. 1232 per gate and Rs. 643 per meter length of channel in case of metallic and PVC channel respectively. Costing is as per prevailing market rates.

RECOMMENDATION No. : 38

Year: 2025-26

Name of the Scientists: Name of the Scientists: Dr. R. J. Patel, Dr. J. M. Khaniya, Dr. P. H. Rank, Prof. P. B. Vekariya, Dr. G. V. Prajapti

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers

Simulating the Climate Change Impacts on Water Productivity of Chickpea using AquaCrop model

Recommendation for Farmers

The farmers of the South Saurashtra Agro-Climatic zone growing chickpea crop (Gujarat Gram- 5) are recommended to apply the irrigations using drip systems as per the following details and schedules to get higher seed yield and net return as well as to make it more climate resilient as compared to conventional irrigations by border method adopted by farmers. Specifications of drip irrigation system and its operating time for chickpea crop

Drip irrigation system details	Nos and depth of irrigation and drip irrigation system operating time for chickpea crop during winter season		
DAS	No of irrigations	Irrigation depth (mm)	Drip system Operating time
Lateral type=Inline Inline drip size=16mm (OD) Dripper rate=4lph Dripper spacing=0.4m Lateral spacing=0.9m Nos of pair of crop rows per drip line=1 Parried row: 0.3mx0.6mx0.1m	0	1 20	1 h & 48 Minutes
0-7	1	10	54 Minutes

21-50	3	17	1 h & 32 Minutes
51-75	4	20	1 h & 48 Minutes
75-100	3	20	1 h & 48 Minutes
Total	12	221	19 h & 54 Minutes

RECOMMENDATION No. : 39

Year: 2025-26

Name of the Scientists: Dr. R. J. Patel, Dr. J. M. Khaniya, Dr. P. H. Rank, Prof. P. B. Vekariya, Dr. G. V. Prajapti

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Scientific Community

Simulating the Climate Change Impacts on Water Productivity of Chickpea using AquaCrop model

The scientific communities working on simulation of chickpea response to irrigation water management strategies using AquaCrop model are informed to use the following information to calibrate the model for chickpea crop under border or drip irrigation.

Aqua crop model calibration parameters

SN	Parameter		Unit	Parameter value for
Border irrigation				**Drip irrigation**
1	Threshold base temperature for crop development	oC	5	5
2	Threshold upper temperature for crop development	oC	30	30
3	Initial canopy cover (CCo)	%	1.11	1.11
4	Canopy development rate (CGC)	% / day	11.1	12.1
5	Non-stressed crop transpiration (K_{ctr})	Fraction	0.85	0.9
6	Crop water productivity-normalized for climate and CO_2	gm/sq.m	25	14.7
7	Canopy decline rate (CDC)	% / day	13.1	11.8
8	Maturity	days	103	100
9	Harvest Index(HI)	%	26	25

RECOMMENDATION No. : 40

Year: 2025-26

Name of the Scientists: Name of the Scientists: Dr. R. J. Patel, Dr. J. M. Khaniya, Dr. P. H. Rank, Prof. P. B. Vekariya, Dr. G. V. Prajapti

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Scientific Community

Simulating the Climate Change Impacts on Water Productivity of Chickpea using AquaCrop model

The scientific communities working on irrigation water management strategies are informed that the impact of climate change on the chickpea crop can be as below.

Outcome Parameters at present climate (Last 10 Years average)		Percent Increase(+)/Decrease(-) of outcome parameter over present if warming by			
0.5 oC		1.0 oC	1.5 oC	2.0 oC	
GDD (days-oC)	1840 days-oC	2.80	5.60	8.40	11.31
ETo (mm)	329 mm	1.20	2.41	3.63	5.06
ETc (mm)	226mm	1.23	2.46	3.66	5.11
Irrigation water under Surface irrigation	305mm	1.21	2.62	3.64	4.92
Irrigation water under Drip irrigation	224 mm	1.21	2.41	3.62	5.36
Biomass Yield under Surface irrigation	8109 kg/ha	-1.60	-3.11	-4.14	-6.14
Biomass Yield under Drip irrigation	8530kg/ha	-0.33	-0.18	-0.26	-0.68

Seed yield under Surface irrigation	2334 kg/ha	-1.59	-3.08	-4.58	-6.13
Seed yield under Drip irrigation	2407 kg/ha	-0.33	-0.17	-0.25	-0.66
Water Productivity under Surface irrigation	7.65 kg/ha-mm	-2.76	-5.56	-7.93	-10.53
Water Productivity under Drip irrigation	10.75 kg/ha-mm	-1.52	-2.52	-3.73	-5.72

RECOMMENDATION No. : 56

Year: 2025-26

Name of the Scientists:

Prof. P. B. Vekariya, Dr. R. J. Patel, Dr. H. D. Rank, Dr. H. V. Parmar,

Name of Scheme: All India Coordinated Research Project on Irrigation Water Management (ICAR)

End Users: Farmers

Identification of potential groundwater recharge zones in major river basins of Saurashtra.

Farmers, farmer self-help groups, government line departments, and non-government organizations are recommended to use the maps developed by Junagadh Agricultural University for groundwater recharge and harvesting activities in the Ozat, Bhadar, Aji, Bhogavo, Machhu, Meghal, and Shingoda river basins. These maps delineate good potential groundwater recharge zones covering an area of 7677 square kilometers and identify 43,009 suitable locations for groundwater recharge structures such as check dams, ponds, and percolation tanks. The use of these maps will help for avoiding areas with moderate to very poor groundwater recharge potential and sites unsuitable for the construction of recharge structures within these river basins. For the state of Gujarat, maps have been prepared identifying 95536 square kilometers of good potential groundwater recharge areas and 239885 suitable locations for groundwater recharge structures. The use of these maps is recommended to avoid unsuitable groundwater recharge areas and sites across Gujarat and to enhance the effectiveness of groundwater recharge interventions.