JUNAGADH AGRICULTURAL UNIVERSITY, JUNAGADH

RESEARCH RECOMMENDATIONS FOR SCIENTIFIC COMMUNITY

V. AGRICULTURAL ENGINEERING

Twenty two recommendations were made by agricultural engineering disciplines for scientific communities which are described below:

Year: 2004-05

Recharging of well

The scientists are advised to consider the following parameters for recharging of well in North Saurashtra Agro-climatic Zone.

1. Following equation can be used for calculating the runoff from rain fall in shallow soil and poor hydrological soil group C in small watersheds.
   Runoff (mm) = -1.075 + 0.0534 Rainfall (mm).
2. Recharge rate has significant relation with storage head of the well.
3. For trapping the sediment load from the runoff water, filter of 7.0 m x 1.5 m with three layers of 20 cm each of sand 1 mm (top layer), followed by gravel (10 to 20 mm) and pebbles (30 to 40 mm) should be used which can retain average sediment load of the runoff water up to 67 per cent.

(*Main Dry Farming Research Station, JAU, Targhadia*)

Year: 2005-06

Micro tube emitters

The technology is recommended to scientist, 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/manufacture 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.

(*Department of Soil & Water Conservation Engg., CAET, JAU, Junagadh*)

Greenhouse soil temp model

The mathematical model "GREENHOUSE SOILTEMP" given below can be used by the scientific community to predict the soil profile temperature of solarized (covered) and non-solarized (uncovered) soils inside the greenhouse by incorporating various input data like weather data i.e. solar radiation intensity and ambient temperature; soil properties i.e. bulk density, porosity, moisture content, thermal conductivity and specific heat of local place; physical properties of greenhouse covering and mulch cover i.e. specific heat and bulk density and optical properties of soil and covering material i.e. transmissivity, absorbtivity, and emissivity.

1. Uncovered soil

For greenhouse covering:

$$M_{co}C_{co}dT_{co}/dt = \alpha_{co}I - h_{cogh}(T_{co}-T_{gh}) + h_{co\text{-}s(1)}(T_{s(1)}-T_{co}) - h_{coa}(T_{co}-T_a) \quad \ldots (1)$$

For greenhouse air:

$$M_{gh}C_{gh}dT_{gh}/dt = \alpha_{gh}I - h_{cogh}(T_{co}-T_{gh}) + h_{co\text{-}s(1)}(T_{s(1)}-T_{co}) \quad \ldots (2)$$

For surface layer:

$$\Delta H\ \rho_s C_s(1-\varepsilon)\ dT_{s(1)}/dt = \tau_{co}\ \alpha_{s(1)}I - h_{s(1)gh}(T_{s(1)}-T_{gh}) - h_{s(1)co}(T_{s(1)}-T_{co}) - K_s/\Delta H\ (T_{s(1)} - T_{s(2)}) \ldots (3)$$

For subsequent layers (I=2,n):

$$\Delta H\ \rho_s C_s(1-\varepsilon)\ dT_{s(I)}/dt = h_{ss}(T_{s(I-1)} - 2T_{s(I)} + T_{s(I+1)}) \quad \ldots (4)$$

2. Transparent polyethylene covered soil

For greenhouse covering:

$$M_{co}C_{co}dT_{co}/dt = \alpha_{co}I - h_{cogh}(T_{co}-T_{gh}) + h_{cog}(T_g-T_{co}) - h_{coa}(T_{co}-T_a) \quad \ldots (5)$$

For greenhouse air: $M_{gh}C_{gh}dT_{gh}/dt = \alpha_{gh}I - h_{cogh}(T_{co}-T_{gh}) + h_{ggh}(T_g-T_{gh})$ *... (6)*

Plastic film on soil surface:

$$M_g C_g dT_g/dt = \tau_{co}\ \alpha_g I - h_{gco}(T_g - T_{co}) + h_{g\text{-}s(1)}(T_{s(1)} - T_g) - h_{ggh}(T_g - T_{gh}) \quad \ldots (7)$$

For surface layer:

$$\Delta H\ \rho_s C_s (1-\varepsilon)\ dT_{s(1)}/dt = \tau_{co}\ \tau_g\ \alpha_{s(1)} I - h_{s(1)g}(T_{s(1)} - T_g) - K_s/\Delta H\ (T_{s(1)} - T_{s(2)}) \quad \ldots (8)$$

For subsequent layers (I=2,n):

$$\Delta H\ \rho_s C_s (1-\varepsilon)\ dT_{s(I)}/dt = h_{ss}(T_{s(I-1)} - 2T_{s(I)} + T_{s(I+1)}) \quad \ldots (9)$$

Nomenclature

C	*specific heat*
f	fraction
H	depth of soil bed, m
h	heat transfer coefficient
I	radiation
K	thermal conductivity
M	mass, kg/m^2
T	temperatuire, ^{o}C
t	time, sec
V	volumetric, m^3

Greek

α	solar absorptance
ρ	density, kg/m^3
τ	solar transmittance
ε	*porosity, decimal*
ΔH	*spacing between two successive soil layers, m*

<u>*Subscript*</u>

a	*ambient*
co	greenhouse cover
cog	cover-mulch
co-gh	cover-greenhouse air
g	*mulch glazing*
gh	greenhouse air
ga	*glazing-ambient*
gs	*glazing-soilith layer*
s	*soilsg soil-glazing*
ss	*soil-soil*
t	*transparent*
(1)	*first layer*
cl	clay fraction

(*Dept. of Renewable energy Engg., CAET and Directorate of Research, JAU, Junagadh*)

Year: 2009-10

Determination of aquifer properties of the wells of Junagadh region

The aquifer properties *viz.*, transmissibility and storage coefficient for different talukas of the Junagadh district are recommended for the scientific community, Government/Non-Government Organizations for crop planning and simulating groundwater behavior for adopted cropping pattern as below.

Aquifer properties of different talukas of Junagadh District

Sr. No.	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	Visavadar	Visavadar	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	Mendarda	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		

(*Department of Soil and Water Conservation Engineering, CAET, JAU, Junagadh*)

Determination of water front advance under different dripper (emitter) discharge rate in medium black soil

(i) At any given duration of water application, the wetted diameter at soil surface increased with increase in dripper discharge rate.

(ii) Time to reach a particular wetted soil depth is more with low discharge rate of the dripper as compared to higher discharge rate of the dripper.

(iii) The following relationships between time of application and depth of soil can be used in medium black soils for emitter discharge rate of 2, 4, 8 and 16 lph respectively.

$t = 16.889\ Z^{1.1951}$

$t = 12.474 Z^{1.3325}$

$t = 11.574 Z^{1.2625}$

$t = 6.0753 Z^{1.5547}$

where, t = Time of application (time to reach water at funnel outlet), min.

Z = Depth of soil (depth of funnel placement), cm.

(iv) The following relationships between diameter of wetted soil at surface and depth of soil can be used in medium black soils for emitter discharge rate of 2, 4, 8 and 16 lph, respectively.

$W = 7.175\ Z^{0.4534}$

$W = 7.242\ Z^{0.5545}$

$W = 7.807\ Z^{0.6138}$

$W = 8.208\ Z^{0.6858}$

where, W= Diameter of wetted soil surface, cm ; Z= Depth of soil, cm.

(*Main Dry Farming Research Station, JAU, Targhadia*)

Year: 2010-11

Drying air variables tomato slices

The influence of drying air variables i.e. drying air temperature and velocity on drying rate constant "k" of tomato slices is recommended in the form of Arrhenius-type model, given below, for describing the thin layer drying behavior of 5.0 ± 0.5 mm thick tomato slices. The value of constant "c" did not show any regular dependence on drying air variables and recommended to be equal to mean value of 1.005.

$k = 587.83\ v^{0.36} \exp(3487.79 / T_{ab})$

(COD, $r^2 = 0.998$, $\chi^2 = 9.541 \times 10^{-8}$ for $0.25 m/s \leq v \leq 1 m/s$ and $50°C \leq T \leq 80 °C$).



(*Department of Renewable energy Engg., CAET, JAU, Junagadh*)

Year: 2011-12

Water balance and assessment of groundwater recharge in Meghal river basin of Saurashtra region

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 was found 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 9,084 ha of wheat crop (irrigation water requirement 457 mm) can be irrigated using 5,187 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 3,669, 1,005 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 5,595, 1,602 and 796 ha area water required is 6,137, 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 2,866 ha (31.6 %) of wheat crop.

(*Department of Soil &Water Conservation Engg., CAET, JAU, Junagadh****)***

Rainfall analysis for crop planning

1) Rainfall amount of 25.4 mm & 37.1 mm and 8.98 mm & 30.64 mm will be received at 75% and 60% probabilities in 27th and 29th Meteorological Standard Week (MSW), respectively. The conditional probability of getting 30 mm is 66.64 % and 65.17 % during 27th and 29th MSW, respectively. Therefore sowing operation can be carried out during this period.
2) Annual, seasonal rainfall and rainy days followed the increasing trend after 2000. The average length of the rainy season was observed 99 days. Drought resistance, low water requirement, short duration crop and its varieties having crop growth period maximum 99 days should be grown.
3) During 32 MSW, probability of a dry spell of length 7 is higher (0.64).Therefore, this period can be used to carry out interculturing operations and formation of ridges. Fertilizer top dressing needs to be done when the soil is sufficiently moist i.e. before 32 MSW. During 35 MSW to 37 MSW, probability of a dry spell of length 21 or more is higher; therefore spraying of anti-transparent and mulching can be done to reduce evapo-traspiration losses.
4) Excess rain water received during 28th to 31st MSW can be harvested and later used as lifesaving irrigation at times when prolonged dry spells occur.

(Main Dry Farming Research Station, JAU, Targhadia)

Year: 2012-13

Summer sesame response to irrigation under drip and mulching technology

The models for summer sesame crop response to irrigation scheduling levels and seasonal irrigation depth under drip irrigation with and without mulch are proposed for the scientific community**.**

(a) The yield response to irrigation scheduling level with and without mulch for summer sesame crop can be described by the mathematical model as below.

$Y = -400.0 (IW/ET_c)^2 + 998.3 (IW/ET_c) + 592.2$ for no mulch application.

$Y = -808.6 (IW/ET_c)^2 + 1874 (IW/ET_c) + 355.7$ for mulch application.

Where, Y is the sesame grain yield (kg/ha) and IW/ET_c is the ratio of irrigation water depth (mm) to crop evapo-transpiration depth (mm).

(b) The yield response to seasonal irrigation depth under no mulch and mulch application for summer sesame crop can be described by the mathematical model as below.

$Y = -0.002 (W)^2 + 2.537 (W) + 652.8$ for no mulch application.

$Y = -0.006 (W)^2 + 4.977 (W) + 444.6$ for mulch application.

Where, Y is the sesame grain yield (kg/ha) and W is the seasonal irrigation depth (mm).

(*Department of Soil &Water Conservation Engg., CAET, JAU, Junagadh*)

Drought investigation using Standardized Precipitation Index (SPI) index for Junagadh

The recommendation is Scientists, Policy makers and Irrigation planners of South Saurashtra Agro-climatic Zone are advised to plan their irrigation water schedules to the crop based on the following guidelines:

1) Moderately dry and severe dry years appear once in seven years 7 years and 10 years from 2002

2) Moderately dry July, August and September months appear once in 10 years, 9 years and 5 years respectively from 2002
3) Severe dry July, August and September months and years appear once in 9 years, 18 years, and13 years respectively from 2002
4) Abnormal weeks appear once in six years from 2002
5) Severe dry spell of 15 days occur once in 15 years during July and August
6) Dry spells of 10 days occur once in 7 years in July (July 1-10) and once in 13 years in August (Aug 10-20).

(*Research, Testing & Training Center, JAU, Junagadh*)

Year: 2013-14

Geometry of wetting pattern under trickle irrigation

The scientists of South Saurashtra agro-climatic zone are advised to keep the following suggestions while using the following developed equations by various scientists for predicting the wetting geometry in Loamy Soils.

a) Healy and Warrick (1981) model predicted wetting geometry (width (R^2 = 0.3141) and depth (R^2 = 0.1918) at lower discharges with poor accuracy and failed to predict at higher emitter discharges (> 8 lph).
b) Philips (1984) model predicted wetting geometry (both width and depth) at lower and higher emitter discharges with good accuracy.
c) Accuracy of original Debral (2012) dimensional analysis model is low in predicting wetting geometry (both depth below the emitter (R^2 = 0.845) and width at the surface (R^2 = 0.895)).
d) BEN-ASHER Hemi Spherical Model (1985) predicted both depth (R^2 = 0.962) and width (R^2 = 0.9774) with good accuracy.
e) Steady state Wooding model (1968), Steady state Raats model and moment analysis approach predicted both steady width with low accuracy.

(*Research, Testing & Training Center, JAU, Junagadh*)

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

1. Weekly maximum temperature showed significantly increasing trend in MSW 8, 14, 15 and 18 whereas significantly decreasing trend was observed in MSW 28, 37 and 39. Generally 28th MSW (9th July to 15th July) is the initial stage of groundnut, cotton and other *kharif* crops. Whereas MSW 37 and 38th (10^{th} Sept. to 23^{rd} Sept.) is the pegging stage of groundnut.
2. Weekly minimum temperature showed significantly increasing trend in MSW 3, 8, 9, 12, 13, 15, 19, 44, 45, 48, 51 and 52. The MSW 44-45^{th} (Oct. 29 to Nov. 11) is the mid-season of cotton crop. MSW 48 (Nov. 26 to 2^{nd} Dec.) and MSW 51 and 52 (Dec. 17^{th} to 30^{th} Dec.) is the germination and booting stage of wheat and growing and flowering stage of cumin, respectively.

(*Main Dry Farming Research Station, JAU, Targhadia*)

Year: 2014-15

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	$EC_{PM} = 0.6364(EC_{bm}) - 0.00166(RF) + 2.9495$	0.83
2	5-10 km	$EC_{PM} = 0.6965(EC_{bm}) - 0.000359(RF) + 1.2837$	0.64
3	10-15 km	$EC_{PM} = 0.4171(EC_{bm}) - 0.000267(RF) + 1.5592$	0.64
4	15-20 km	$EC_{PM} = -0.3577(EC_{bm}) - 0.0000683(RF) + 1.8636$	0.82

(*Dept. of Soil & Water Engg., CAET, JAU, Junagadh*)

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.

(*Department of Soil & Water Engg., CAET, JAU, Junagadh*)

Year: 2015-16

Response of groundnut to supplemental irrigation

The farmers of North Saurashtra Agro-climatic Zone growing groundnut GG-20 are advised to apply supplemental irrigation at soil moisture deficit of about 40 % (about 20% soil moisture content) for obtaining higher productivity, maximum net returns and improving crop and field water use efficiency under dry farming conditions.

(*Main Dry Farming Research Station, JAU, Targhadia)*

Performance of MIS in canal command area

Irrigation planners are advised to use either the regression formula or ANN approach for determining seasonal runoff from the seasonal rainfall for Uben command area:

$Y = 0.010X^{1.118}$, $R^2 = 0.754$…… and

ANN model architecture 1 - 6 – 1 with $R^2 = 0.82$, $\eta_{model} = 80\%$

- Irrigation planners are advised to adopt the following optimal cropping pattern under surface irrigation system for Uben command area:
  Under surface irrigation system, 250 ha groundnut and 2250 ha green gram during the *Kharif* season and 50 ha wheat and 1529 ha onion during the *Rabi* season can be irrigated to get maximum return with cropping intensity of 163.15.
- Irrigation planners are advised to adopt the following optimal cropping pattern under drip irrigation system for Uben command area:
  Under drip irrigation system, 2475 ha groundnut and 25 ha green gram during the *Kharif* season and 50 ha wheat and 1992 ha onion during the *Rabi* season i.e. an additional 463 ha area can be brought under irrigation in *Rabi* season by constructing 315 intermediate storage structures having 260 m^3 capacity each to serve one chuck (8 ha area).

Type of Irrigation system in Command Area	Season	Crop	Crop Area (ha)	Cropping Intensity (%)	Remark
Surface	*Kharif*	Ground nut	250	163.15	
		Green gram	2250		
	Rabi	wheat	50		
		Onion	1529		
Pressurized	*Kharif*	Ground nut	2475	181.68	315 intermediate storage structures having 260 m^3 capacity (9m x 9m x 3.2m) each to serve a chuck of 8 ha area will bring additional area of 462 ha in *Rabi* season under irrigation.
		Green gram	25		
	Rabi	wheat	50		
		Onion	1992		

(*Post Graduate Institute of Agri. Business Management, JAU, Junagadh)*

Online HRD Programme

It is recommended to staff members of JAU to use the online HRD programme developed by Junagadh Agricultural University to obtain the permission from concerned authority for participating or attending the programmes as per statute 121 Item No. 28.

(Department of Processing & Food Engg., College of Agril. Engg. & Tech., JAU, Junagadh)

Assessment of microbial floral strength during post-harvest handling of mango, custard apple and lemon

The presence of harmful fungus and bacteria during transportation stage was observed maximum amongst all stages of post-harvest handling in mango, custard apple and lime fruits and found increasing in subsequent stages. Therefore, farmers and traders are recommended to take control measures to check microbial growth prior to transportation.

(Department of Processing & Food Engg., College of Agril. Engg. & Tech., JAU, Junagadh)

Year: 2016-17

Vibration study and its attenuation through coating on mini tractor seat

Mini tractor operators / manufacturers are recommended to use operator's seat coated on both sides by natural rubber [density-0.978 g/cc; thickness-10 mm & hardness-50], which resulted in significant attenuation of whole body vibration of operator along with enhanced operating time, as per BIS / ISO standards under all operating conditions with & without trailer on tar road, farm road and field.

(Department of Farm Machinery & Power, CAET, JAU, Junagadh)

Year: 2017-18

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

(Department of Soil & Water Consr. Engg., CAET, JAU, Junagadh)

Estimation of irrigation demand for different crops of ozat river basin using remote sensing and GIS

The Planners, NGOs, Field Officers and Government Departments are recommended to use the following relationships to find out crop coefficients of wheat crop with remote sensing images (Landsat) based vegetation indices like Soil Adjusted Vegetation Index (SAVI) and Normalized Difference Vegetation Index (NDVI) for the estimation of crop water requirement.

K_c = 1.2588 SAVI + 0.4347

K_c = 1.6741 NDVI + 0.5387

Where, K_c = Crop coefficient of wheat crop, NDVI = Normalized Difference Vegetation Index, SAVI = Soil Adjusted Vegetation Index.

(Department of Soil & Water Conservation Engg., CAET, JAU, Junagadh)

Evaluation of rainfall erosivity index and soil erodibility factor in medium black soil under different cropping systems

Maximum runoff and soil loss was observed in sole cotton cropping system and cultivated follow respectively, Minimum runoff with soil loss was observed in absolute fellow followed by sole groundnut cropping system. Soil erosivity factor (45.74) and soil erodibility factor (0.41) were observed in cultivated fellow in medium black soil.

(*Main Dry Farming Research Station, JAU, Targhadia*)