Irrigation Modernization and Design of Pipe Distribution Networks

FIXING PIPE DESIGN DISCHARGES (CROPPING PATTERN ET AND PRECIPITATION DEFICIT, EFFICIENCIES, FLEXIBILITY FACTOR)

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Design Steps

- Determine rainfall and climatic data for Command Area.
- Consider various cropping patterns: (i) perennial, (ii) 2-season, (iii) seasonal, Rabi, Kharif, and Summer. Note: avoid a sharp high peak in demand as this is very expensive.
- For adopted water application and conveyance infrastructure, adopt appropriate efficiencies.
- Calculate water demands and peak flow requirement (duty, l/s/ha or mm/d).
- For command area determine 10-day (or monthly) flows and peak flow.
- Undertake surface water accounting and adjust (reduce) cropping if needed to match design to available water. Farmers will need to pump groundwater to make up the shortfall.

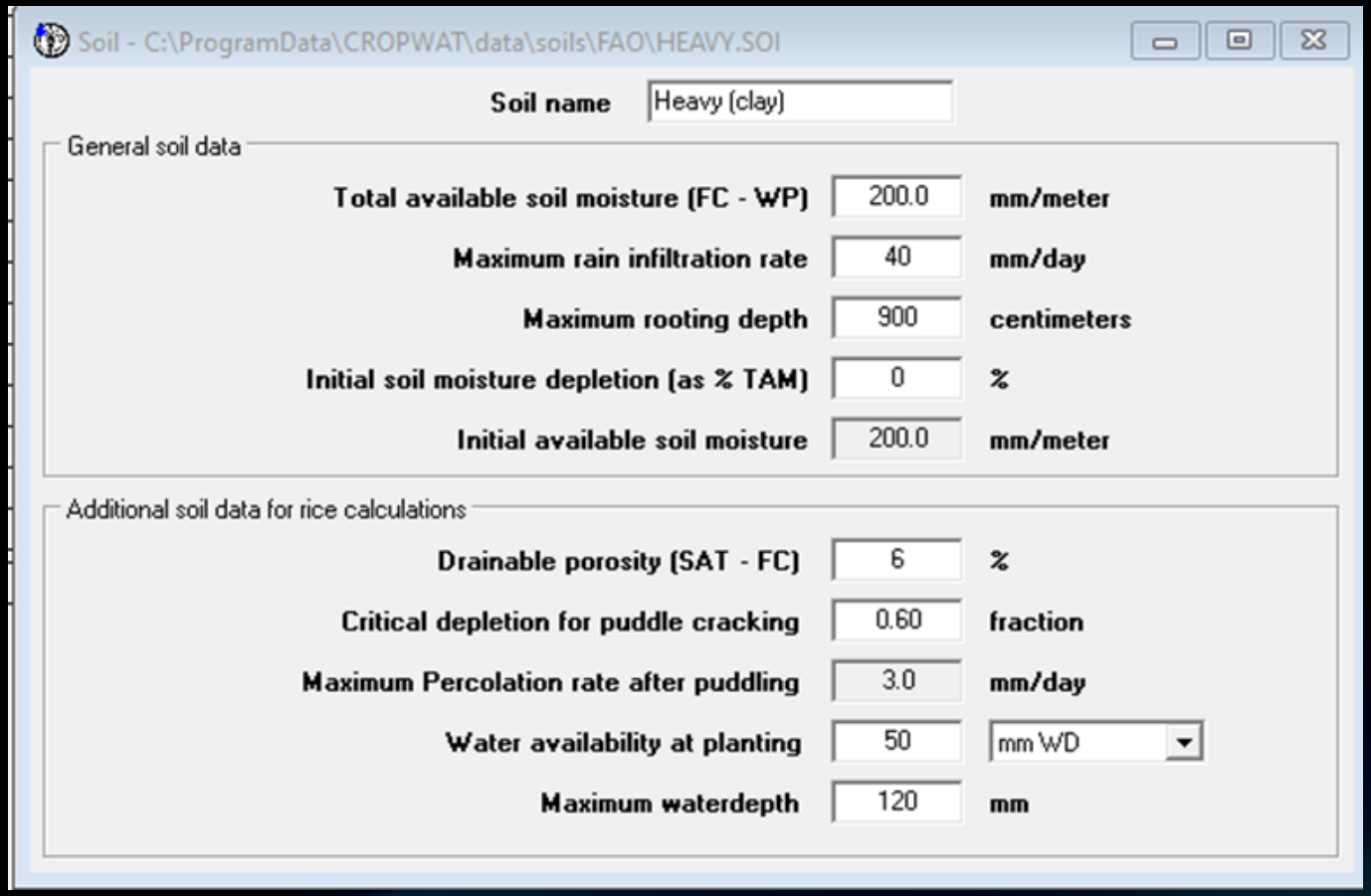
Crop Precipitation Deficit

- Averagely monthly rainfall and climatic data from nearby stations used to estimate effective rainfall and reference ET values (ETo)
- Precipitation deficit is the crop ET (i.e., Kc ETo) less effective rainfall and is calculated for the with-project cropping pattern. Calculate using the Modified Penman Method. Use of the FAO software program CROPWAT-8 is suggested.
- Soils data are also required as these inform (i) irrigation application efficiencies, (ii) deep percolation losses for any paddy, and (iii) the frequency of irrigations required, etc.

A	**Settings/ Assumptions -Cropwat8**	
1	**Climate / Eto**	
	Eto	calculated from climate data
	Temp	Min and max temp
	Units:	Relative humidy in %
		windspeed in km/d
		Sunshine in hrs
		Eto in mm/d
2	**Rainfall**	USDA Soil Conservation Service (SCS) formula
3	**Non-rice crop scheduling**	
	-	irrigation at critical depletion
	-	refill soil to field capacity
	-	irrigation efficiency: depends on application method, etc (usually 60% for basin irrigation)
4	**Rice scheduling**	
	-	irrigate at fixed WD/desuration/critical depletion per stage
	-	refill to fixed water depth (say 50 mm)
	-	irrigation efficiency, 70%
5	**Land preparation**	
	-	max percolation rate after puddling (3-5 mm/d for heavy soils)
	-	daily decrease in deep percolation rate (adopt FAO formula)
6	**Scheduling Pre-puddling (and puddling)**	
	-	fill soil to saturation for puddled depth + 50 mm
	-	irrigate at fixed percentage desaturation (say 20%)
	-	refill to fixed % saturation (100%

Soils

Soils	
-	adopt appropproporiate values (FAO gives for heavy, medium, light soils)
-	water availability at planting (suggest 50 mm WD)
-	Maximum water depth (suggest 100 mm)



Irrigation application efficiencies

Application Efficiency (non rice crops)				
Basin Irrigation				
		Deduct	**Adopt, %**	**Remarks**
1	Poor land preparation	10-20	15	Assume farmers to a good job
2	Different soils types in basin	5-10	5	uniform clayey loam
3	Fixed irrigation schedule	10-20	10	On demand within limits
	Total		30	Subtract from 90%
	Irrigation Efficiency		**60**	

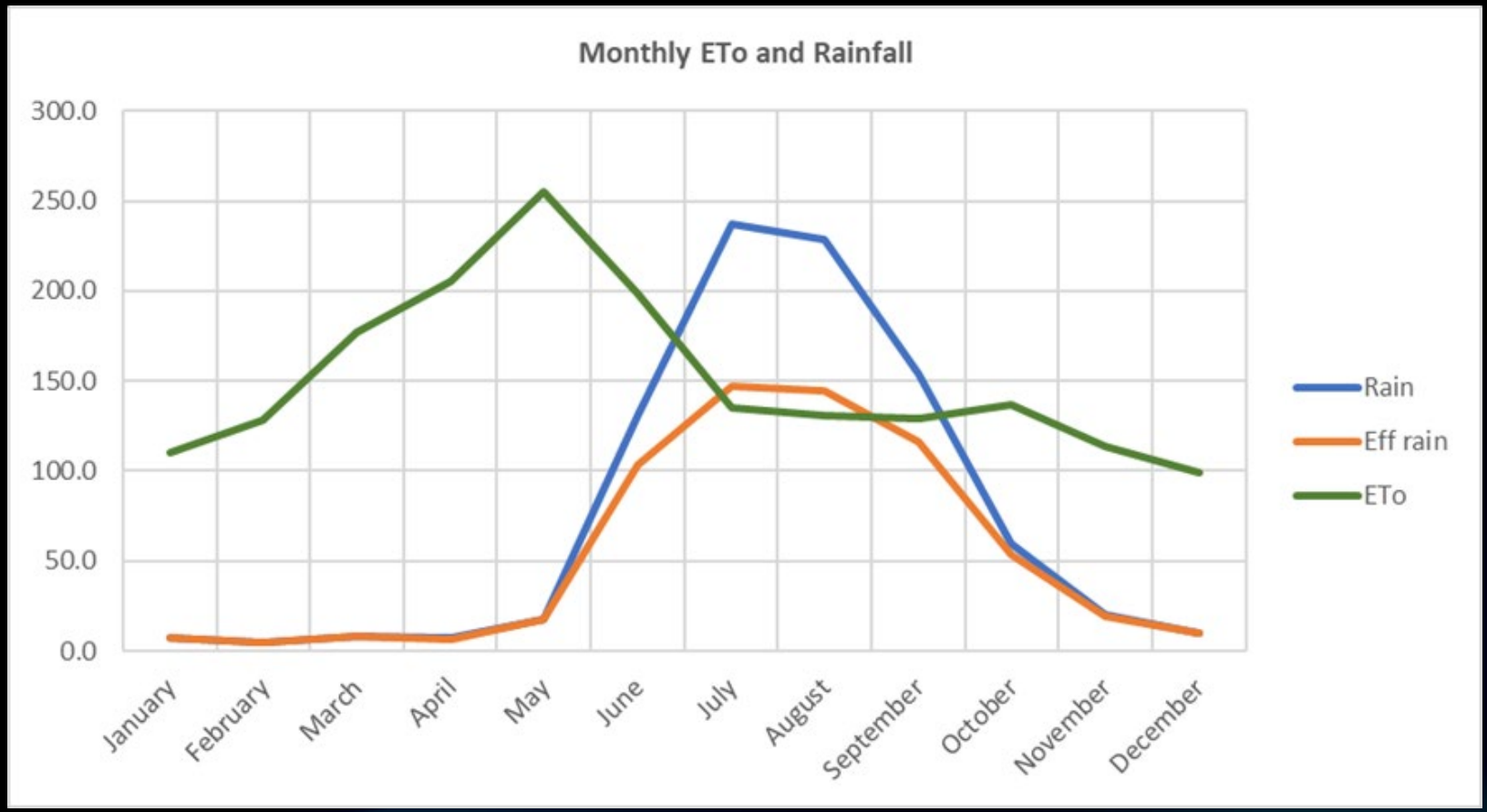
Drip Irrigation	**80%**	FAO pressure irrigation techniques, 2007; FAO Irrigation Manual,Vol. IV. 2002
	90%	CWC Guidelines
Sprinker Irrigation	**75%**	high evaporation

Conveyance Efficiencies and Design Duty for Pipe Systems

- Conveyance efficiencies: suggest 95% for pipe distribution system if this extends up to farmers' field.
- For pipe system providing bulk supply only to the heads of chaks then losses in field channels need to be considered. Suggest conveyance efficiency about 85%.
- Flexibility factor – the larger the more flexibility. Adopting a factor between 1.10 and 1.50 is recommended.
- Design duty = (consumptive use/ efficiencies) x flexibility factor.

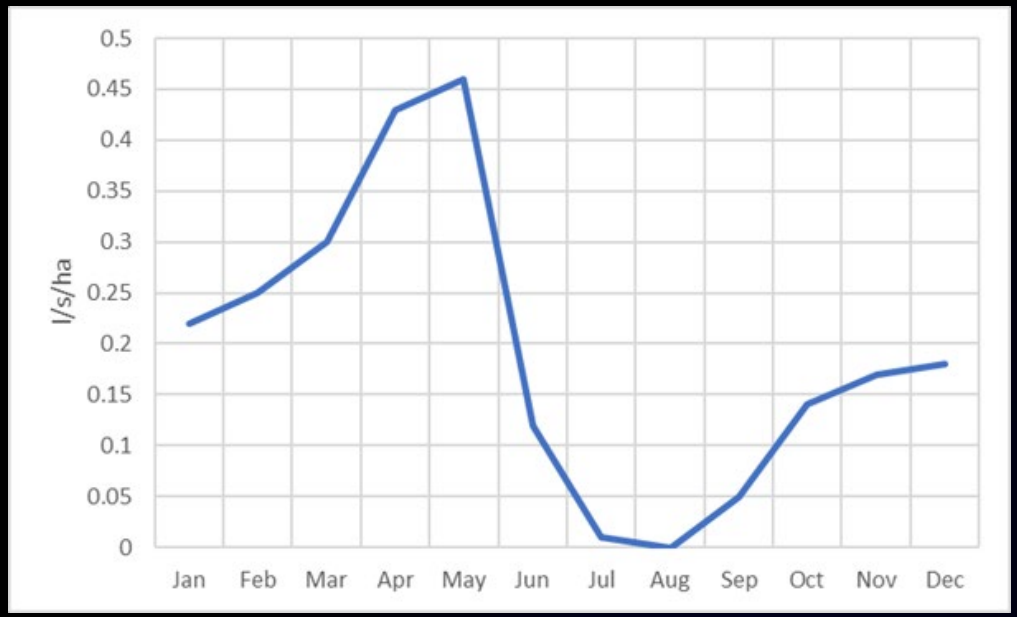
Climate Data – Example

- Annual average rainfall: 886 mm; 640 mm effective rainfall.
- Annual average ET_0: 1,819 mm, peak 8.2 mm/d in May



Precipitation Deficit - Example

- Existing cropping pattern: 157% cropping intensity with mix of sugarcane and seasonal crops
- Peak precipitation deficit is 4.0 mm/d, 0.46 l/s/ha in May.
- With project expansion in cropping expected, and peak precipitation of deficit is 4.7 mm/d, 0.54 l/s/ha adopted for design of pipe systems.



Design duty - Example

Duty given by crop precipitation deficit increased by consideration of:

- Application efficiency (81% adopted assuming mix of drip & surface)
- Conveyance efficiency (95% for pipe system)
- Flexibility factor (adopted 1.17)

Pipe system design discharge = Duty x CCA

		Oct/ Nov to Mar/ Apr	
Precipitation deficit adopted for design	l/s/ha	0.54	
Cropping intensity	%	100%	
Application Eff.	%	81%	Drip & surface
Pipeline efficiency	%	0.95	
Flexibiliity factor		1.17	CWC - (12 days irrigation out of 14 days)
Design duty	l/s/ha	0.82	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Thank you