A Glimpse on the Use of Climate Change Data on the Hydrologic Design of Irrigation Projects

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Orientation and Workshop on Application of Climate Change Data on the Hydrologic Design of Irrigation Projects.
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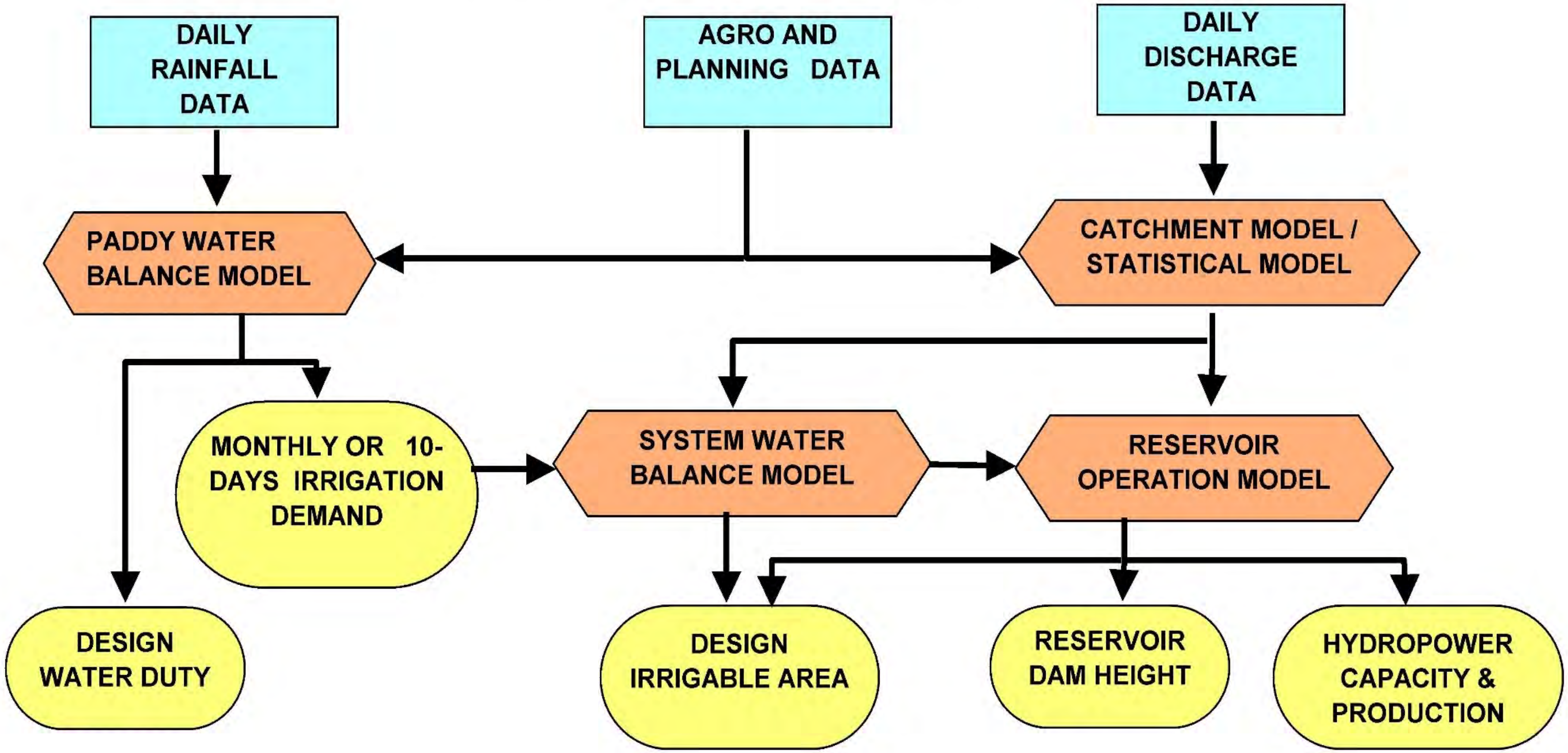
What is hydrologic design:

Process of determining the design parameters for the irrigation project by applying appropriate hydrologic analysis.

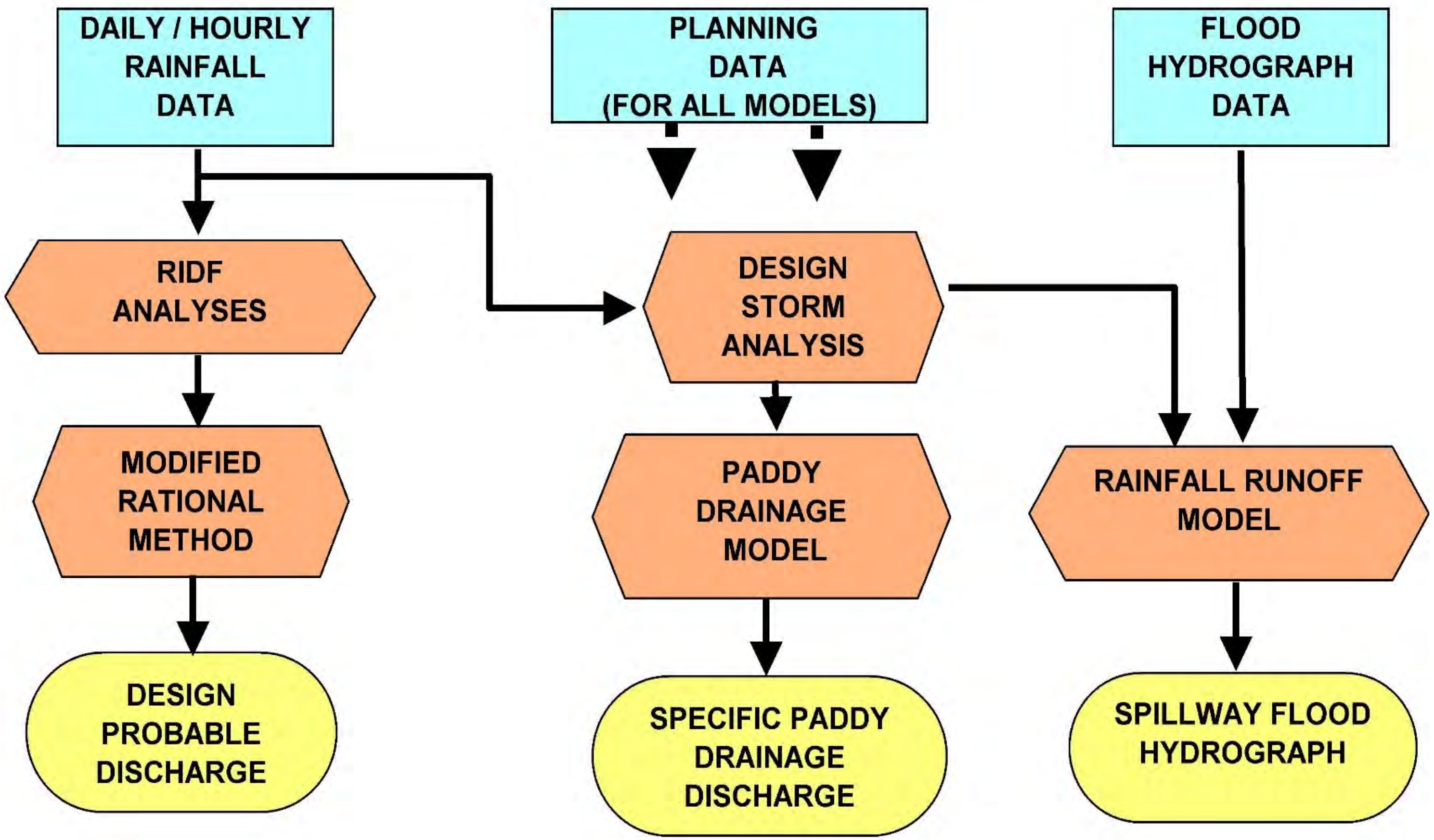
What are these design parameters:

- Water Duty (lps/ha)
- Design Service Area (ha.)
- Optimum Reservoir Capacity (mcm) or Height (m)
- Probable Design Flood of Major Structures
- Design Flood for Spillway & Temporary Diversion Works
- Farm Drainage Unit Discharge

WATER RESOURCES STUDY



FLOOD AND DRAINAGE STUDY



An example of how climate change data is used in Impact Assessment is the Irrigation Water Requirement Computation

- Computes the design water duty (lps/ha)
- Use to compute irrigation canal capacities

  Water Duty X Service Area = Canal Discharge

- Design level of risk : 1 in 5 year drought
- Assumption farm level computation and uses point rainfall.

Procedure for Computation of Irrigation Water Requirement

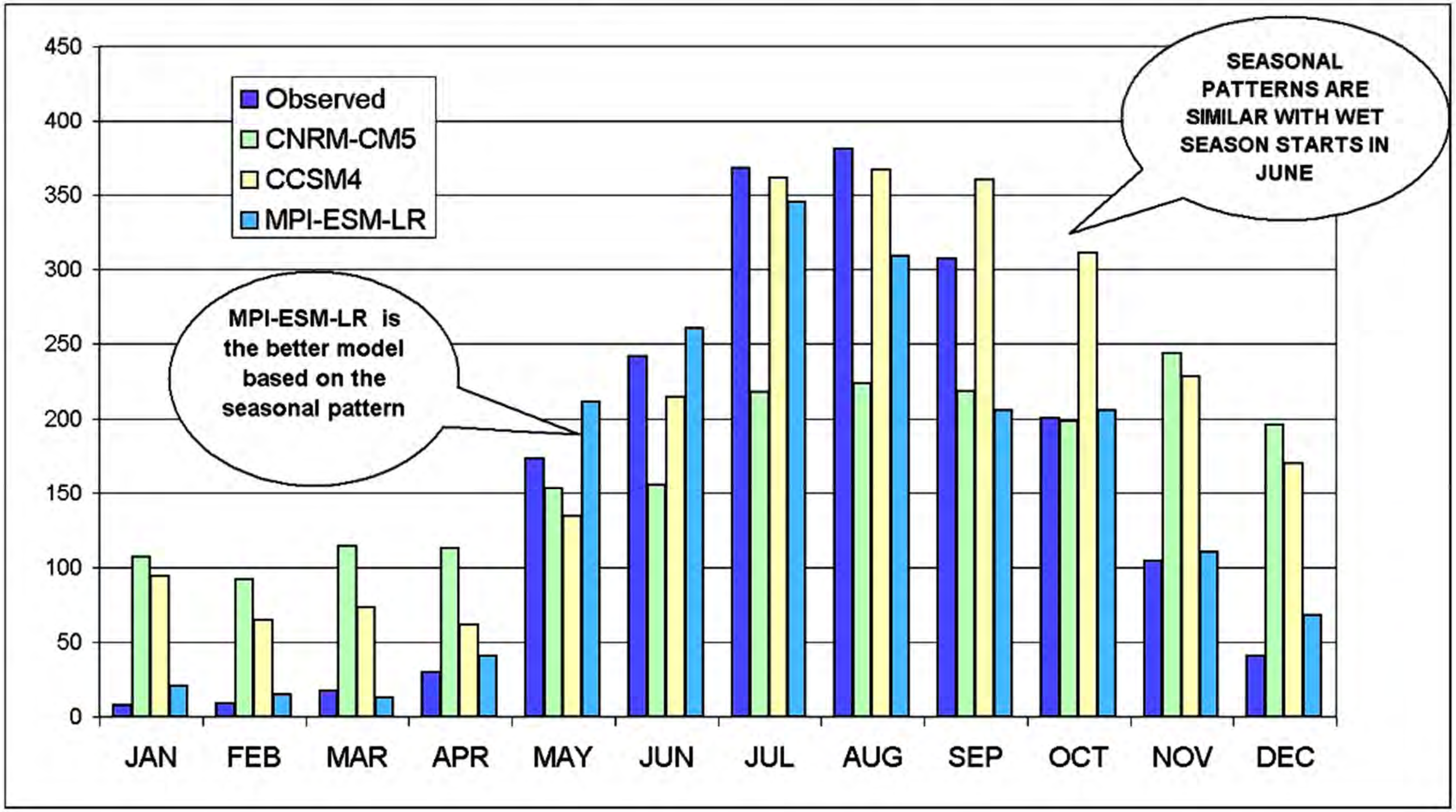
1. Define Objective (Design Water Duty)
2. Get Climate Data from PAGASA
3. Process and Validate Climate Data (10-days)
4. Compute Probable 10-days Rainfall (5-yr RT)
5. Perform Paddy Water Balance Computation
6. Compare Computed Water Duty
7. Design Irrigation Canal
8. Compute Cost of Canal

Hydromet and Climate Change Data

- Daily Rainfall Data
  - Historical – 1979 to 2000
  - Baseline Data – 1979 to 2000
  - Long-Term Projected Data – 2036 to 2065
- Mean Monthly Temperature (optional)
  - Historical – 1979 to 2000
  - Baseline Data – 1979 to 2000
  - Long-Term Projected Data – 2036 to 2065

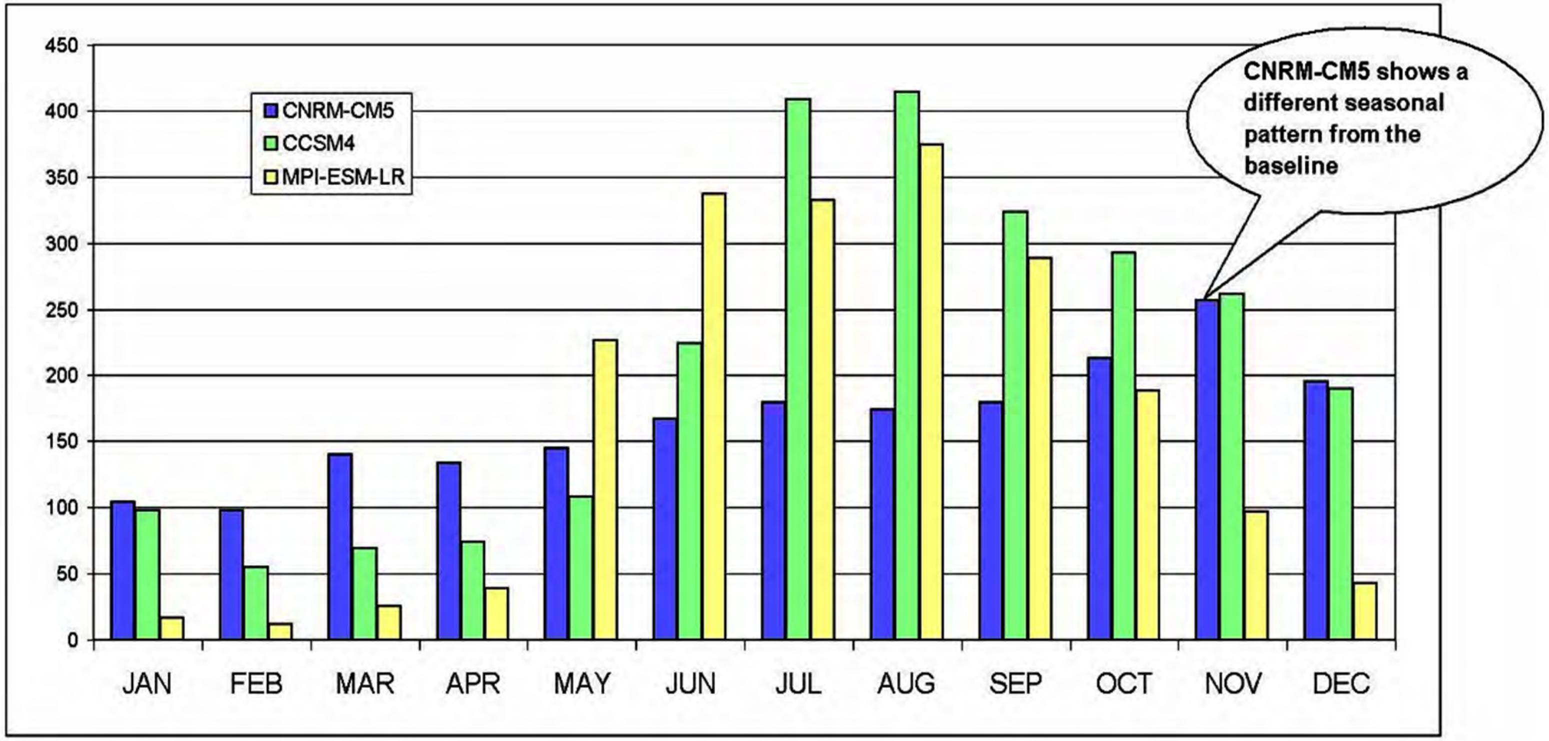
RAINFALL COMPARISON FOR BASELINE PERIOD (1979-2000)

DATA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	REMARKS
Observed	8.0	9.2	17.3	29.6	173.1	242.1	368.4	381.4	307.3	200.4	104.1	40.6	1877.7	NORMAL
CNRM-CM5	106.9	92.1	114.2	112.8	153.0	155.4	217.9	223.8	218.3	198.6	243.8	195.9	2032.6	DRY
CCSM4	93.9	64.7	73.4	61.9	134.1	214.8	361.6	367.3	360.8	311.1	228.5	170.0	2442.1	WET
MPI-ESM-LR	20.6	14.7	12.7	40.8	211.1	260.8	345.7	309.6	205.4	205.5	110.4	68.0	1805.4	MEDIAN



RAINFALL COMPARISON FOR PROJECTED PERIOD (1979-2000), NO CORRECTION

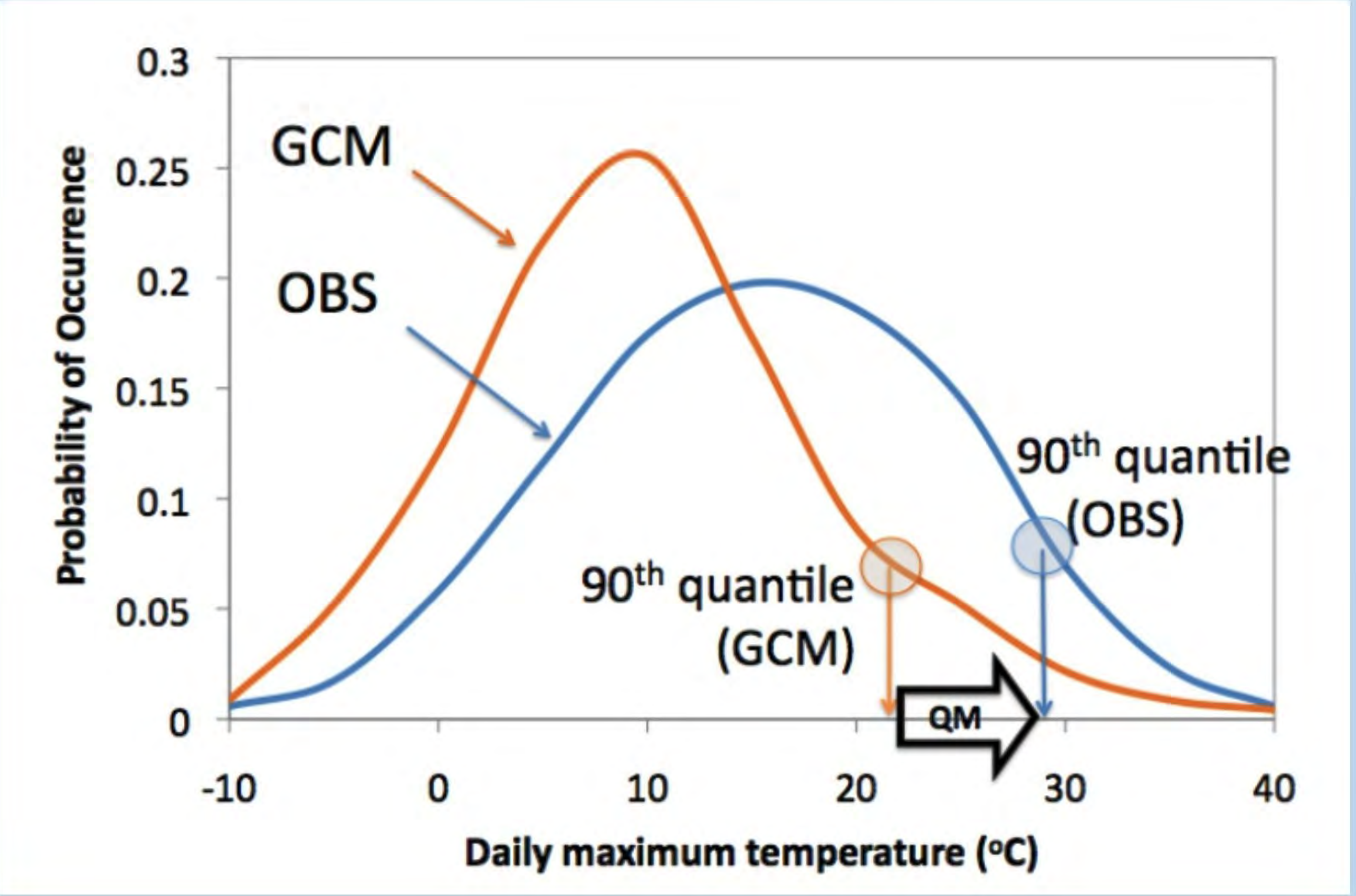
DATA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	REMARKS
CNRM-CM5	103.8	98.1	140.2	133.8	144.8	166.6	179.4	174.3	179.6	212.9	256.7	195.6	1985.8	DRY
CCSM4	98.1	55.0	69.4	73.6	107.9	224.4	408.6	414.1	323.9	292.5	261.5	190.0	2519.0	WET
MPI-ESM-LR	16.9	11.8	25.2	39.1	226.6	337.1	332.4	374.6	288.4	188.4	96.9	43.1	1980.6	MEDIAN



Data Downscaling and Validation

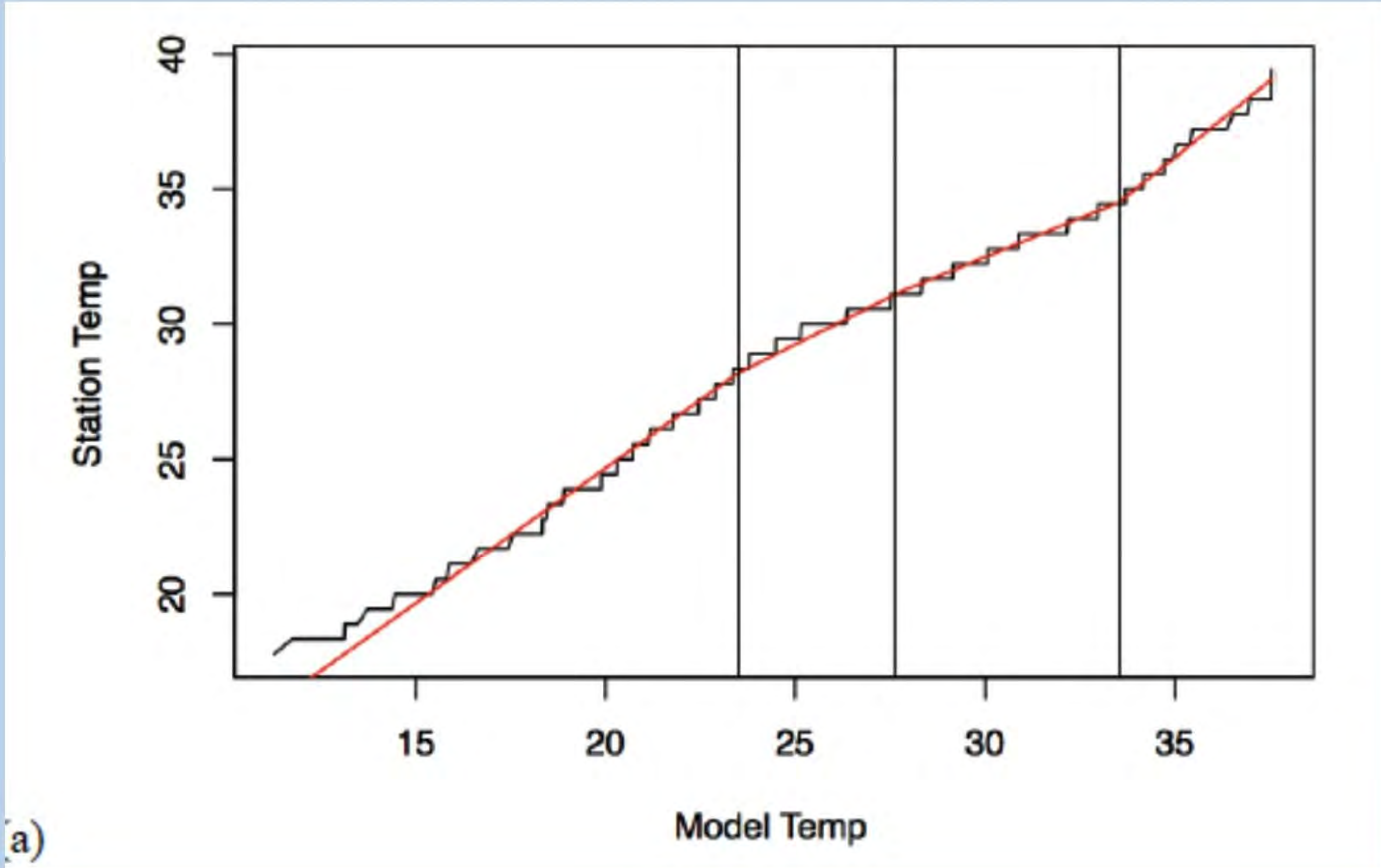
- Screening of Historical and RCM Data
  - Seasonal Monthly Pattern
- Statistical Data Downscaling:
  - BCM Bias-Correction Method (Not recommended)
  - BCSD Bias Correction Spatial Disaggregation
  - SAR Statistical Asynchronous Regression
  - SDSM Statistical Downscaling Model (by regression)
- Validation of Projected data
  - Range of Values

Quantile mapping used in BCSD downscaling approach



By John Walsh, NOAA

Quantile mapping and regression used in SAR approach



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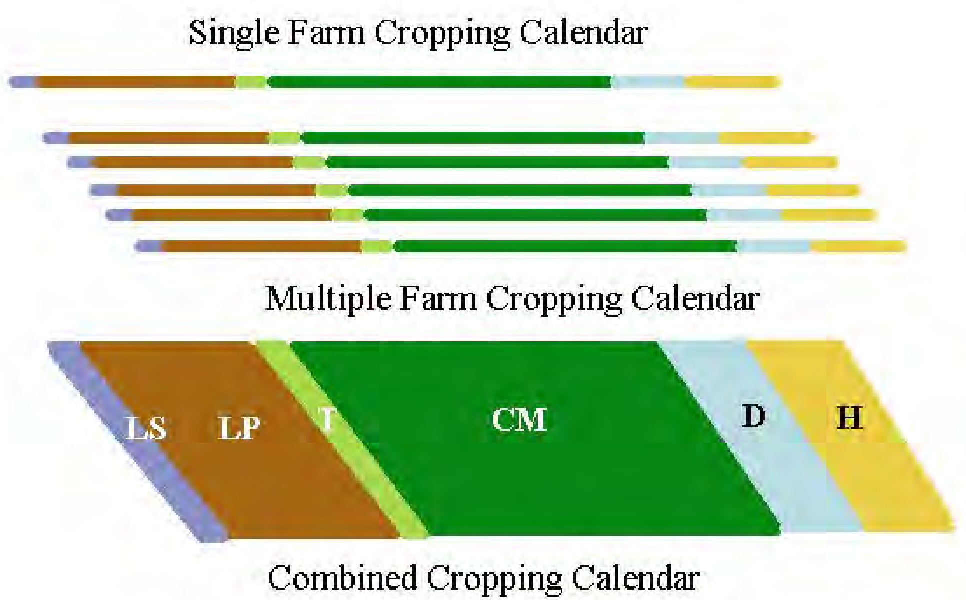
Introduction on Cropping Calendar

- WHAT IS A CROPPING CALENDAR

  It is the schedule of farming activities in planting certain crops.

- HOW IS A CROPPING CALENDAR PRESENTED

  The graphical presentation is the cropping pattern showing the different stages of farm operation



First Crop – Rice	James Cruz
Land Soaking	Jun 1-3
Seedbed Prep	Jun 2-3
Seedbed Sowing	Jun 4
Land Preparation	Jun 5-20
Transplanting	Jun 21-25
Crop Maintenance	Jun 26- Sept 9
Drainage	Sept 10-19
Harvest	Sept 20-30
2nd Crop – Vegetable	
Land Preparation	Nov 3-23
Sowing	Nov 24-30
Crop Maintenance	Dec 1- Jan 31
Harvest	Feb 1-20

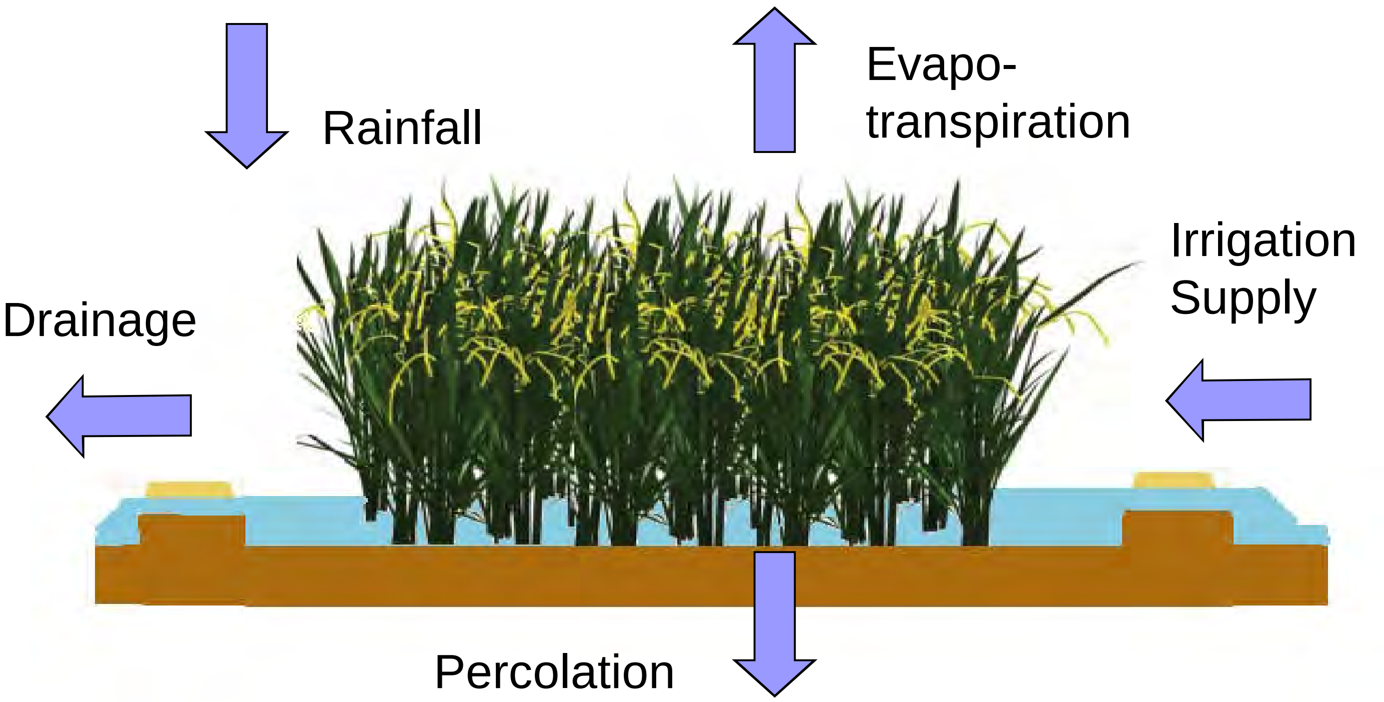
Preparation of Cropping Calendar

Considerations :

- **Type of Crops (Paddy Rice, Diversified)**
  Commonly Rice, Corn and cash crops (vegetables)
  Crop Variety (will affect the growing period)
  Market Demand and Farmgate Price
- **Start of first and second crop**
  Typhoon Season
  Holiday periods (Christmas, Holy Week and Ramadan)
  Monthly Rainfall and Runoff Pattern/Distribution
- **Duration of Staggered Period**
  Size of irrigable area and labor force
- **Duration of Crop Stages (manual, mechanized)**

Two concepts applied in irrigation water requirement

1. Paddy Water Balance Concept



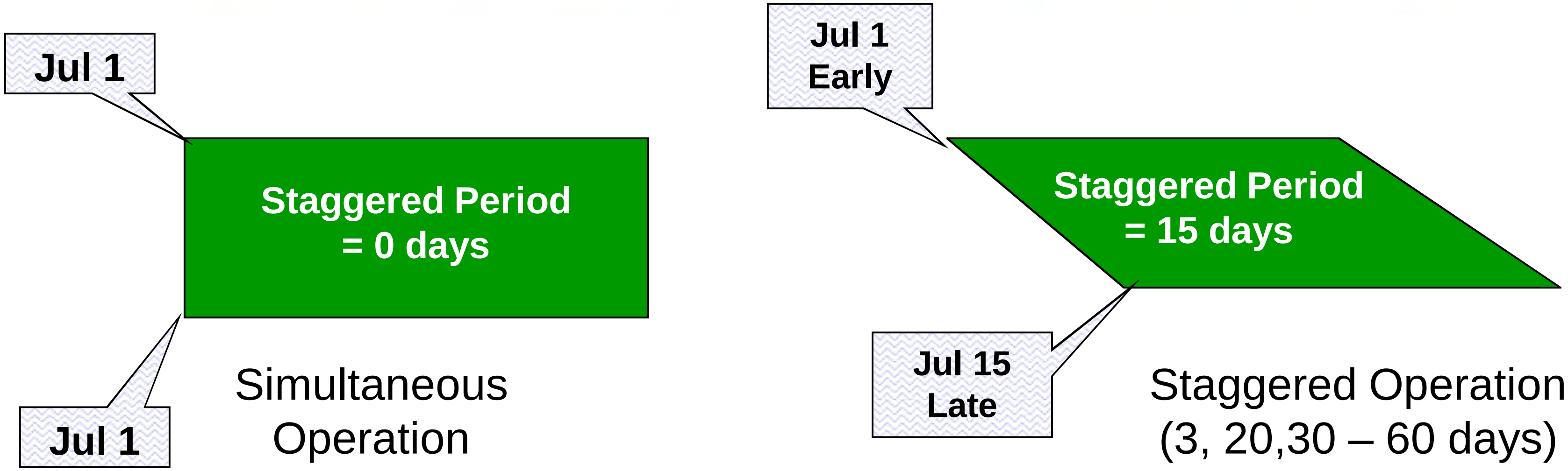
- (Rain – Drain) 0

Irrigation + Rainfall = Evapo-trans + Percolation + Drain + Δ Storage

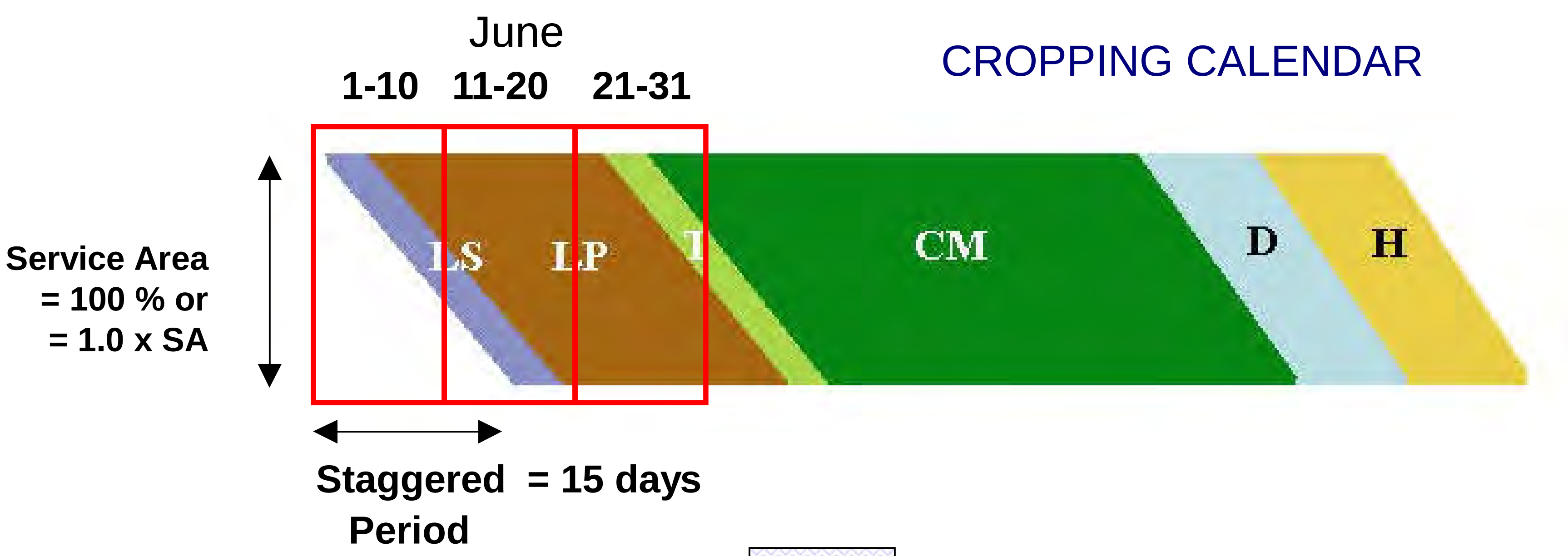
Irrigation = Evapo-trans + Percolation – Eff. Rainfall

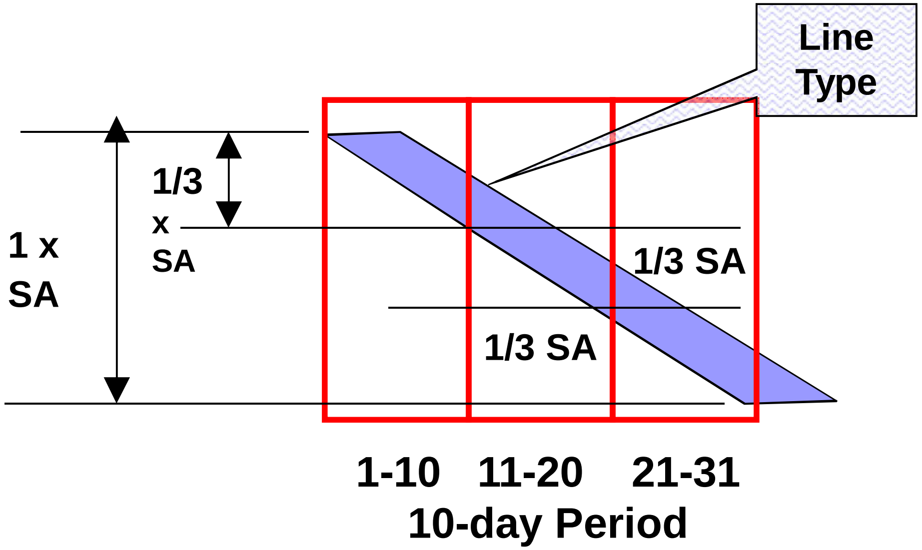
Two concepts applied in irrigation water requirement

2. Application of Area Factor



Computation of Area Factor



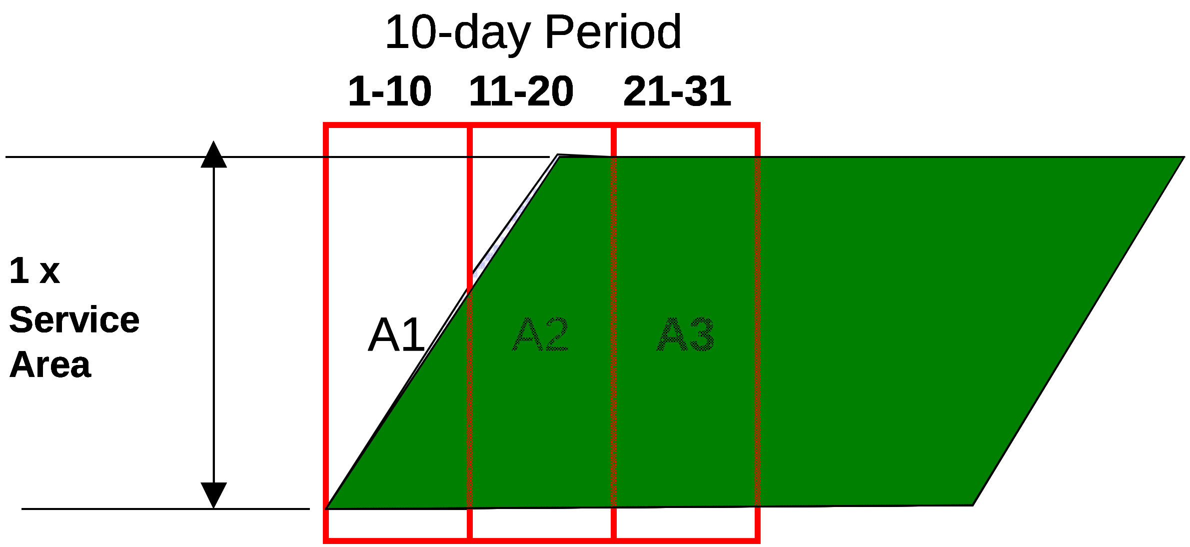


Line Type – Area Factor

Use for : Land Soaking
and Transplanting

Example : Area Factor = 0.33

Computation of Area Factor



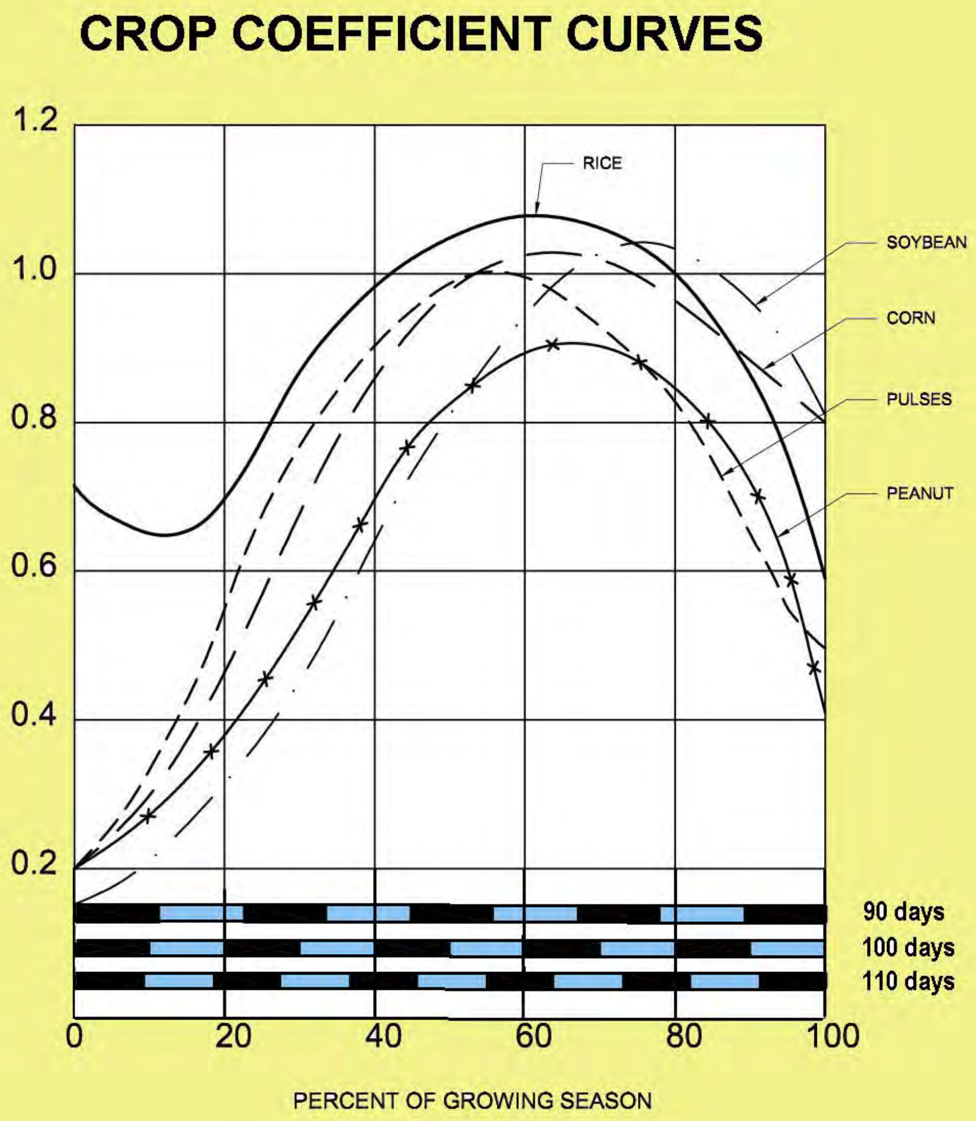
AREA TYPE – AREA FACTOR

A1 = 1/2 LH = (1/2)x10x(1x10/15) = 3.33   A of 10-day = 1 x 10 = 10
Area Factor for A1 = A1 / A of 10-day = 3.33/10 = 0.333

A2 = LH – 1/2 L_1H_1 = (1x10) – (1/2)x5x(1x5/15) = 9.167
Area Factor for A2 = A2 / A of 10-day = 9.167/10 = 0.9167

A3 = LH = 1x 10 = 10
Area Factor for A3 = A3 / A of 10-day = 10/10 = 1.0

Derivation of Crop Coefficient



Ave. Growing Period :

- Rice = 110 days
- Corn = 110 days
- Peanut = 110 days
- Monggo = 70 days
- Tobacco = 120 days
- Sugar Cane = 11 months
- Cotton = 115 days
- Onions = 100 days
- Garlic = 100 days
- Soy Bean = 110 days

2.4 Computation of Diversion Requirement & Water Duty

Applicable Equations (Units in MM)

- **LAND SOAKING REQUIREMENT (LS)**

  LS = 130 (Wet) x AF for LS

  100 (Dry)

- **LAND PREPARATION REQUIREMENT (LP)**

  LP = (Evap + Perc) x AF for LP

- **EVAPOTRANSPIRATION (ET)**

  ET = (Evap x Crop Coef.) x AF for CM

- **DEEP PERCOLATION (PERC)**

  Perc = Perc x AF for CM or LP

- **FLOODING AFTER TRANSPLANTING (FL)**

  FL= 25 x AF for FL

2.4 Computation of Diversion Requirement & Water Duty

Applicable Equations (Units in MM)

- **FIELD WATER REQUIREMENT (FWR)**

  FWR = LS + LP + FL + ET + PERC

- **EFFECTIVE RAINFALL (ER)**

  ER = Pot ER x AF for EFF RAIN

  However, ER <= FWR

- **NET WATER REQUIREMENT (NWR)**

  NWR = FWR – EFF RAIN

- **DIVERSION WATER REQUIREMENT (DWR)**

  DWR = NWR / IRRG EFF.

- **WATER DUTY in Liter/Sec/Ha (WD)**

  WD = DWR / 86.4 (based on 10-day interval)

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End of Presentation

Workshop : Part 1
IRRIGATION WATER REQUIREMENT

Given : Cropping Calendar, Staggered Period,
Monthly Probable Rainfall, Mean Monthly Evaporation

Procedure:

1. Prepare cropping calendar for two crops of paddy rice, assign different starting dates and staggered periods for each group.
2. Compute the irrigation requirement and design water duty for intake, canals and terminal facilities.
3. Select the most suitable cropping calendar to adopt among the different combination of starting dates and staggered periods and give your reasons.

Workshop : Part 2

Design Main Canal and Estimate Cost

Given : Design Service Area, Water Duty, Canal Slope and Unit Cost of Common Excavation

Procedure:

1. Compute the Canal Design Capacity, Q(cms)
2. Determine the Design Canal Elements using the given design criteria.
3. Compute the volume of excavation and apply the unit cost.