LECTURE 11

NEED FOR INTERDISCIPLINARY APPROACH

- Competing social, ecological, and economic demands for water challenge the sustainable management of freshwater systems. Sustainability under increasing water demands and a changing climate requires an adaptive interdisciplinary approach.
- The complexity of decision -making within a watershed includes the potential for positive and negative feedbacks across multiple levels of organization, which are envisioned here as a hierarchy of freshwater decision systems.

IRRIGATION BENEFICIARIES

- The person who gets benefits from the irrigation are called as irrigation beneficiaries.
- Irrigation beneficiaries are basically classified into 2 kinds. They are
  1. Direct beneficiary
  2. Indirect beneficiary

- Direct Beneficiary:

  Direct beneficiaries are the land owners whose land value increases because of its access to water and the farm operators who produce more because of assured water supplies.

- Indirect Beneficiary:

  Indirect beneficiaries includes the Government and general food consuming public, manufacturer, agricultural businessmen, retail business merchants and laborers.

IRRIGATION EFFICIENCIES

- These irrigation efficiencies are brought about by the desire not to waste irrigation water, no matter how cheap or abundant it is.

- The objective of irrigation efficiency concept is to determine whether improvements can be made in both the irrigation system and the management of the operation programmes, which will lead to an efficient irrigation water use.

- Not all water available at the head works of an irrigation project is available to fulfill the net irrigation requirements. Losses to deep percolation, evaporation, and surface runoff, as leaching requirements, must be accounted for in the conveyance system sand in the farm application system.

Application Efficiency

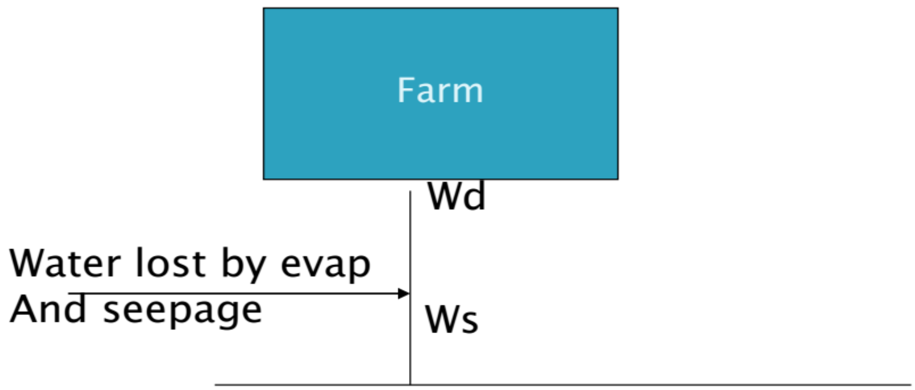
$$E_a = \frac{Water\ in\ root\ zone\ after\ irrigation}{Total\ volume\ of\ water\ applied}$$

$$\frac{Total\ vol.of\ water\ applied - (Vol.of\ Tailwater + Vol.of\ deep\ percolation)}{Total\ water\ applied}$$

E_a is inadequate in describing the overall quantity of water since it does not indicate the actual uniformity of irrigation, the amount of deep percolation or the magnitude of under-irrigation.

Water Conveyance Efficiency

$$E_c = \frac{Water\ delivered\ to\ the\ Farm\ (W_d)}{Water\ of\ water\ diverted\ from\ a\ stream,\ reservoir\ or\ well\ (W_s)}$$



Water Storage Efficiency (E_s)

$$E_s = \frac{Volume\ of\ water\ in\ the\ root\ zone\ after\ irrigation}{Volume\ of\ water\ needed\ in\ root\ zone\ to\ avoid\ total\ water\ moisture\ depletion}$$

Distribution Efficiency:

Distribution efficiency $\eta_d = \left(1 - \frac{y}{D}\right)$ ж 100

Water use Efficiency:

$$\text{Water use efficiency} = \frac{\text{Economic yield}}{\text{C.W.R}}$$

Project Efficiency

- Project efficiency = $\eta_p = \frac{W_s}{W_d} \times 100$

Ws = amount of water stored in crop root zone
Wd = amount of water diverted from source

Operational Efficiency

$$\text{Operational efficiency} = \frac{\text{Actual project efficiency}}{\text{Project efficiency of ideal system}}$$

IRRIGATION SCHEDULING

- Maintain soil moisture within desired limits
  - direct measurement
  - moisture accounting
- Use plant status indicators to trigger irrigation
  - wilting, leaf rolling, leaf color
  - canopy-air temperature difference
- Irrigate according to calendar or fixed schedule
  - Irrigation district delivery schedule
  - Watching the neighbors

The Theory and Practice of Farm Irrigation Scheduling

1. In theory, a farmer should be able to apply irrigation water when he considers soils to have reached an acceptable soil water depletion or Management Allowed Deficit (MAD).

2. At that time, he should be able to apply an amount of water which will either fully or partially refill the soil profile.

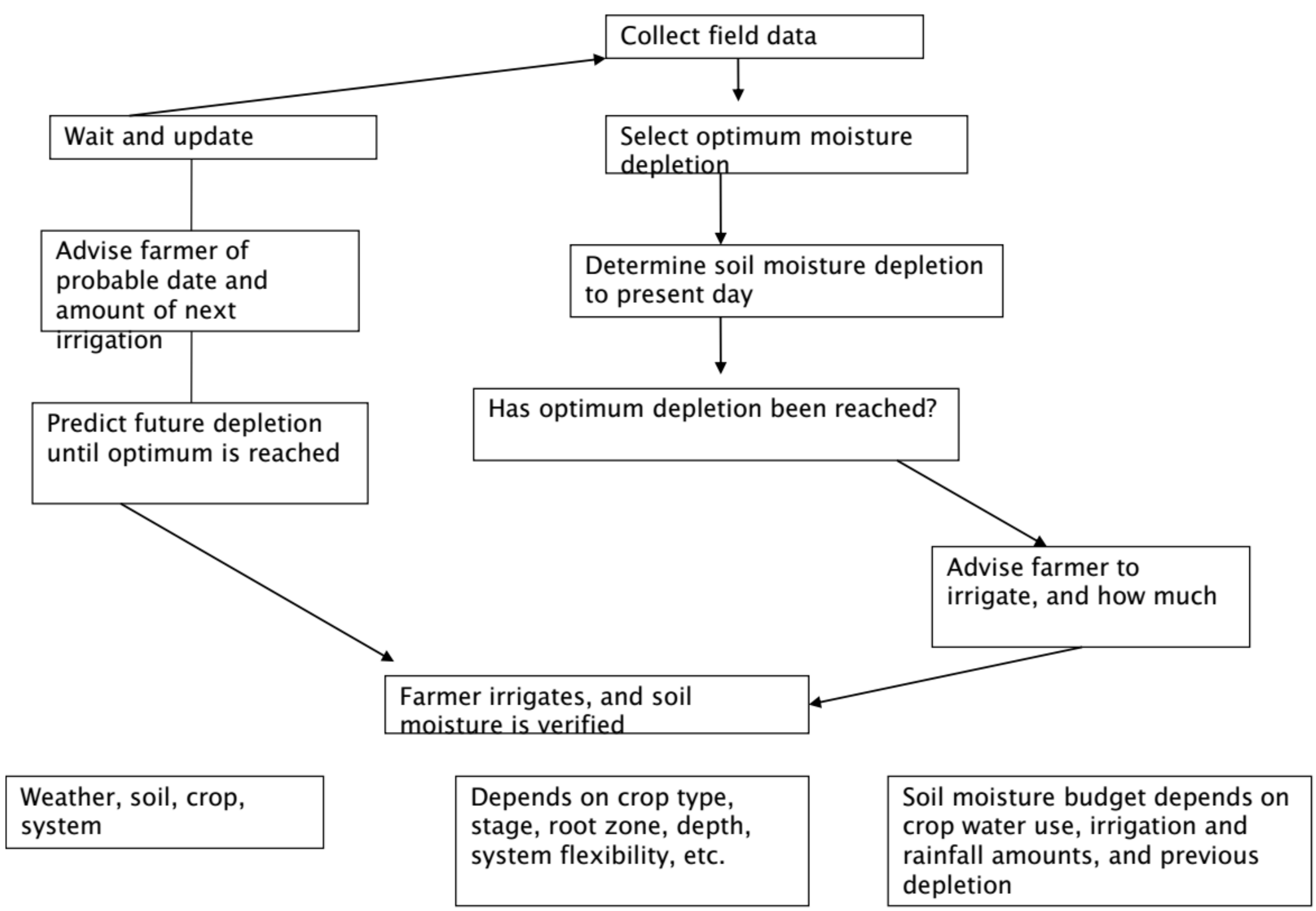
3. He may opt to only partially fill the soil profile if his water supply is limited; if he wants to avoid deep percolation and leaching; or if he wants to leave room for precipitation storage.

Concept of irrigation Scheduling

► It is graphically represented in figures 1A through 1C. By graphing cumulative deficits below field capacity in the root zone between irrigations and MAD, we can determine the dates of irrigation (I_i through I_n)

Techniques for Scheduling the Farm System

- Modeling of the crop- soil-climate-irrigation system through water balance, etc.;
- Soil based measurements;
- Plant based measurements; and
- Lysimeters and evaporation devices



Possible Irrigation Scheduling Management Objectives

- Maximum yield/biomass production
- Maximum economic return
- Functional value of plants (e.g., athletic fields)
- Aesthetic value of plants (e.g., landscapes)
- Keeping plants alive

Plant Root Zones

- Depth used for scheduling vs. maximum depth where roots are found
- Influenced by soil characteristics
  - Soil texture
  - Hardpan
  - Bedrock
- Perennial vs. annual plants

4-3-2-1 Rule-of-Thumb

- Divide the crop root depth into quarters
- Upper ¼ provides 40% of water uptake
- 2nd ¼ provides 30% of water uptake
- 3rd ¼ provides 20% of water uptake
- Lowest ¼ provides only 10% of water uptake
- Applies only when most of root zone irrigated to field capacity
- Dictated by distribution of root mass

Table 6.2. Range of maximum effective rooting depths for fully grown plants.

Crop	Maximum Effective Depth, ft	Crop	Maximum Effective Depth, ft
Alfalfa	3.0 - 10	Onions	2.6 - 6.6
Banana	1.3 - 2.6	Other small grains	3.3 - 5.0
Barley	3.3 - 4.3	Palm trees	2.3 - 3.6
Beans	1.3 - 2.6	Peas	2.0 - 3.3
Cabbage	2.0 - 3.3	Peppers	1.7 - 3.3
Carrots	1.6 - 3.3	Pineapple	1.0 - 2.0
Celery	1.0 - 1.7	Potatoes	1.3 - 2.6
Citrus	3.3 - 5.9	Safflower	3.3 - 6.6
Clover	2.0 - 3.0	Sisal	1.7 - 3.3
Cotton	3.3 - 6.6	Sorghum	3.3 - 6.6
Cucumber	2.3 - 4.0	Soybeans	2.6 - 5.0
Dates	5.0 - 8.3	Spinach	1.0 - 1.7
December orchards	3.3 - 9.9	Strawberries	0.7 - 1.0
Flax	3.3 - 5.0	Sugarbeet	2.6 - 6.6
Grapes	3.3 - 6.6	Sugarcane	4.0 - 6.6
Grass	1.7 - 5.0	Sunflower	3.3 - 8.3
Groundnuts	1.7 - 3.3	Sweetpotatoes	3.3 - 5.0
Lettuce	1.0 - 1.7	Tobacco	1.7 - 3.3
Maize	3.3 - 6.6	Tomatoes	2.3 - 5.0
Melons	3.3 - 5.0	Vegetables	1.0 - 2.0
Olives	2.6 - 6.6	Wheat	3.3 - 6.6

Modified from Doorenbos and Pruitt (1977).

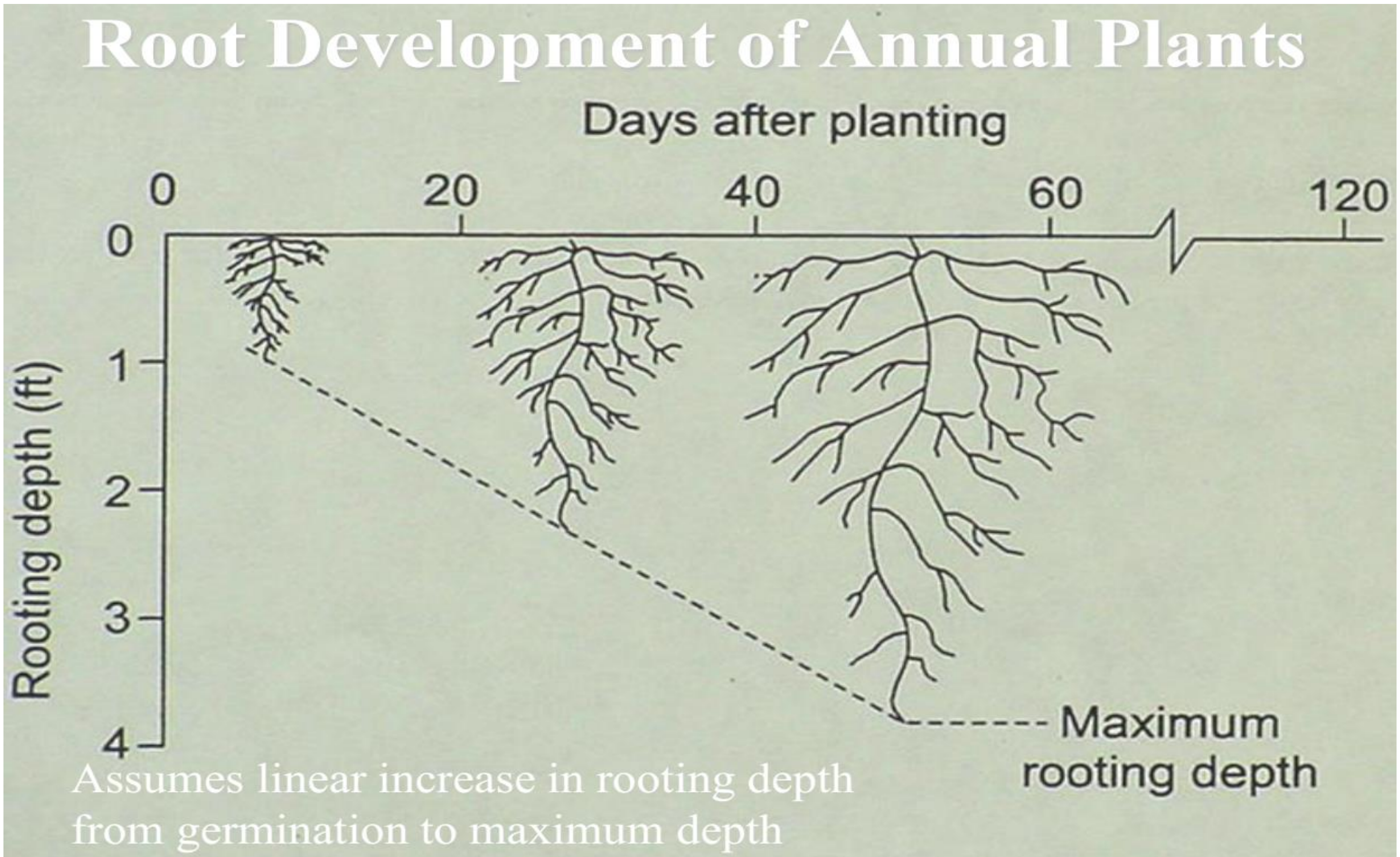


Figure 6.3. Development of a corn plant's root zone.

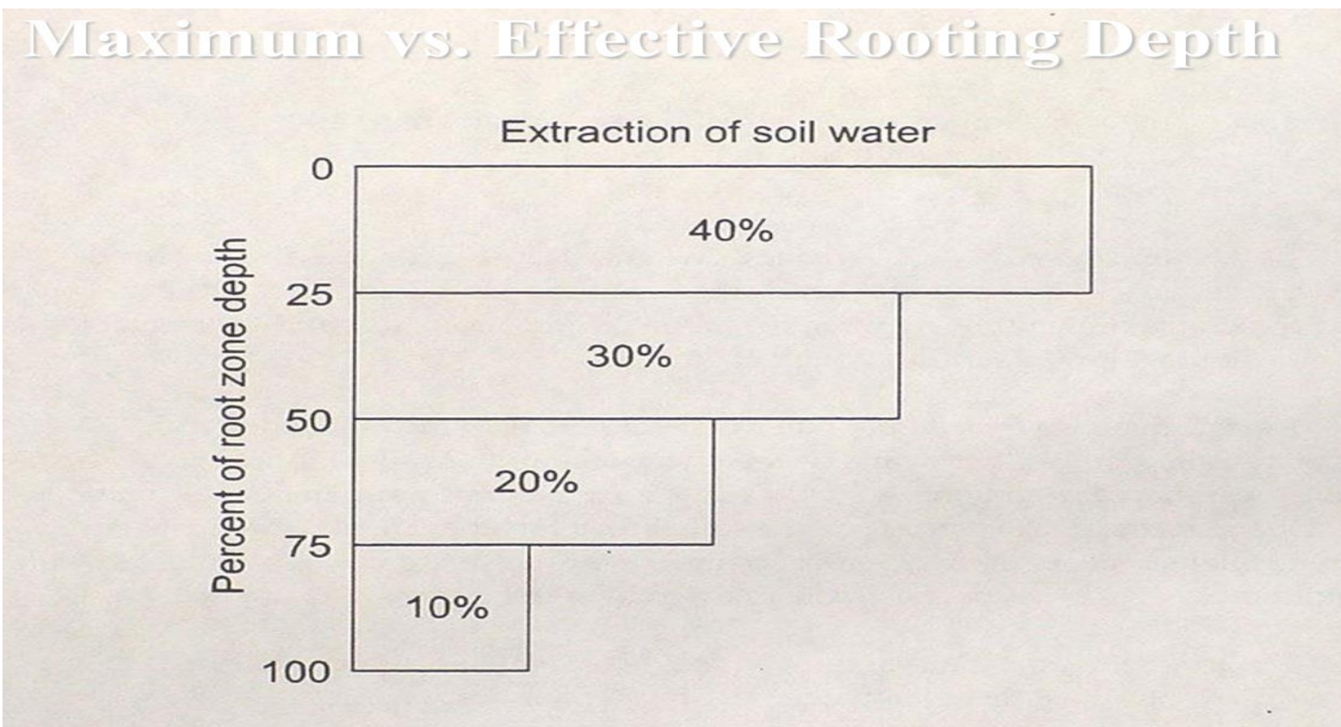


Figure 6.4. Average moisture extraction from the plant root zone, the 4-3-2-1 rule.