Introduction to Irrigation

Presentation · April 2017

DOI: 10.13140/RG.2.2.13991.75687

CITATIONS
0

READS
67,965

1 author:

Sanjeev Gadad
Indian Institute of Technology Bombay
9 PUBLICATIONS **40** CITATIONS

SEE PROFILE

IRRIGATION ENGINEERING

Topics

- Introduction
- Need for irrigation
- Advantages and disadvantages of irrigation
- Environmental impacts of irrigation
- Systems of Irrigation:
  - Gravity irrigation,
  - Lift Irrigation,
  - Well and Tube well Irrigation,
  - Infiltration galleries,
  - Sewage irrigation,
  - Supplemental irrigation

Visit: http://waterresources.kar.nic.in/irri_in_kar.htm

Cauvery water war: What Karnataka and Tamil Nadu are fighting for

How the Cauvery water dispute between Karanataka and Tamil Nadu played out over the years, pre- and post-Independence

Rahul Chandrasekharan

The dispute over the sharing of Cauvery river water has lasted for more than a 150 years during which Karnataka and Tamil Nadu have accused each other of reneging on several agreements. Photo: AFP

Irrigation

- Defined as – *the process of supplying water to land by artificial means*
- Basic objective to supplement natural supply of water,

  for raising crops with economic and efficient system.
- Controlling and harnessing various natural resources.
- To achieve it, irrigation systems are required
- Irrigation system includes
  - *Planning, Design, Construction, Operation and maintenance of structures*
- Efficient irrigation system is engineer's responsibility.

Need for Irrigation

- In India majority of agricultural production is monsoon driven.
- Due to non uniform distribution of rainfall with space and time, it is essential to have scientific and engineering solution.
- Irrigation is required when,

➢ Inadequate/Less rainfall
  - ➢ Transfer from abundance to deficit area
  - ➢ Indira Gandhi canal – from Sutlej to Thar desert

➢ Uneven distribution
  - ➢ Area
  - ➢ Intensity and Time scale
  - ➢ Average annual rainfall: Thar (100mm) to Assam (>2500mm)
  - ➢ Mawsynram, Meghalaya, India (highest avg. annual rainfall 11,873 mm)

➢ Number of Crops in a year

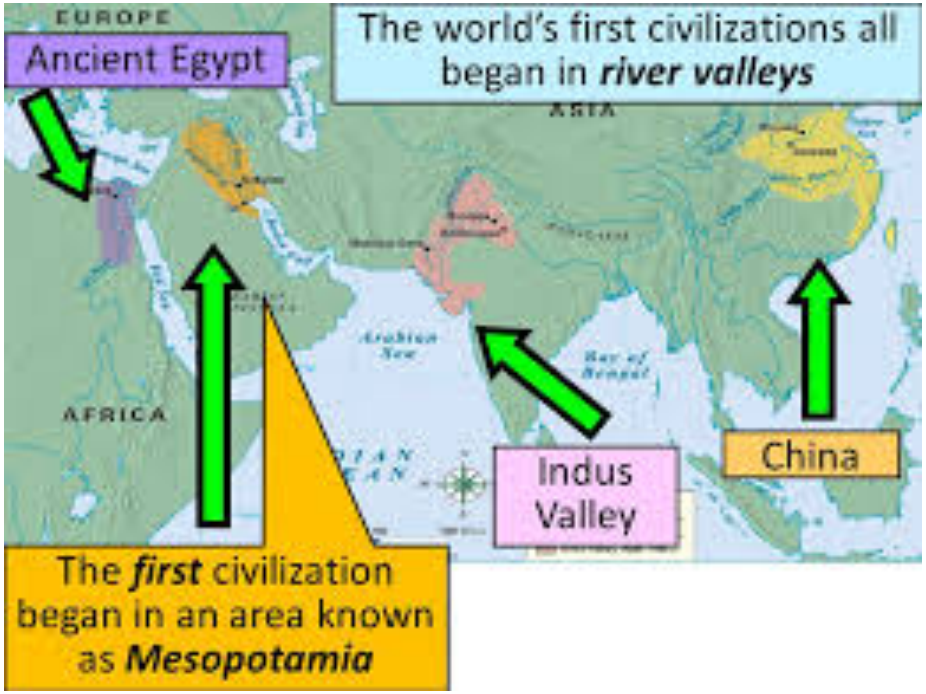
➢ Superior Crops (cash crops)

Scope of Irrigation Engineering

- Engineering Aspect
  - Development of sources of water: *first phase*
    - Dams – when non-perennial rivers are source
    - Weirs/Barrages – when water is diverted to canals, perennial rivers
  - Arrangement of conveyance: *second phase*
    - *Reservoirs, canals/diversion structures*
    - *Groundwater extraction system*

- Agricultural Aspect
  - Systematic and Timely application to fields
  - Proper leveling and shaping of fields
  - Soil type and classification
  - Appropriate cropping pattern, climatic factors
  - Conservation of soil (against erosion)

- Management Aspect
  - Deals with successful implementation and efficient management
  - Cultivation of crops in scientific manner
  - Training of farmers
  - Sufficient and Rational distribution of waters to farmers
  - Charging of water using suitable and scientific methods



Visit this link

http://study.com/academy/lesson/rivers-impact-on-early-civilizations.html

Advantages	Disadvantages
Increase in crop yield	Waterlogging
Protection from famines	Mosquito breeding
Cultivation of superior crops	Unhealthy climate: due to cold climate
Elimination of mixed cropping	Pollution of rivers and groundwater
Prosperity to farmers and Country	
Hydroelectric power generation	
Domestic and Industrial water supply	
Inland navigation	
Increase in ground water storage	
Canal plantations: supply timber	

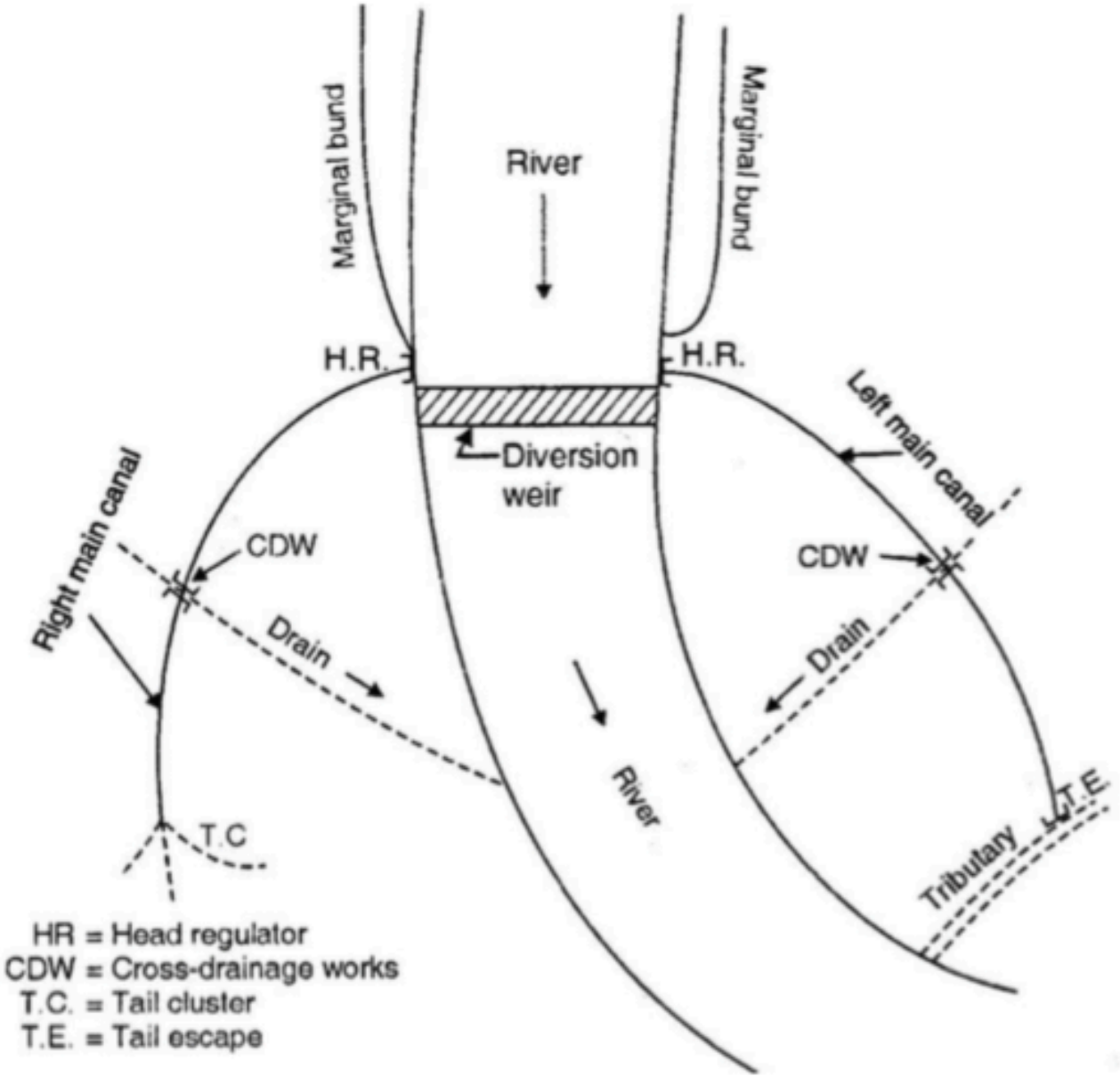
Types of Irrigation

Based on the availability of irrigational water

- Flow irrigation system: conveyance using gravity
  - Direct Irrigation system
  - Reservoir or Storage Irrigation system
- Direct Irrigation system – is without storing water
  - Weir/Barrage is constructed across river, raising water level
- Reservoir – is when structure is constructed to store
  - Dams and then water is fed through canals

- Lift irrigation system: water needs to irrigated at higher elevations
  - Pumping from lower height (source) to required land
  - Pumps or other mechanical devices
  - Eg: irrigation from wells

Direct Irrigation system



Storage Irrigation system

Almatti Dam, Bijapur, Karnataka

Types of Irrigation

Based on *duration of irrigation*

- Inundation Irrigation system
  - Rivers is allowed to flood the cultivable land.
  - Practised in delta regions
  - Also by artificially built inundation canals

- Perennial Irrigation system
  - Water is supplied when required, at regular intervals
  - Source may be river, wells or other perennial water source

- **Bandhara** Irrigation: a special irrigation scheme
  - Adopted across small perennial rivers.
  - This system lies somewhere between inundation type and perennial type of irrigation.
  - A Bandhara is a low masonry weir (obstruction) of height 1.2m to 4.5m constructed across the stream to divert water into a small canal.
  - The length of the main canal is usually restricted to about 8km.
  - Economical and can irrigate a small area up to 400 ha.
  - Trapezoidal section – u/s is vertical

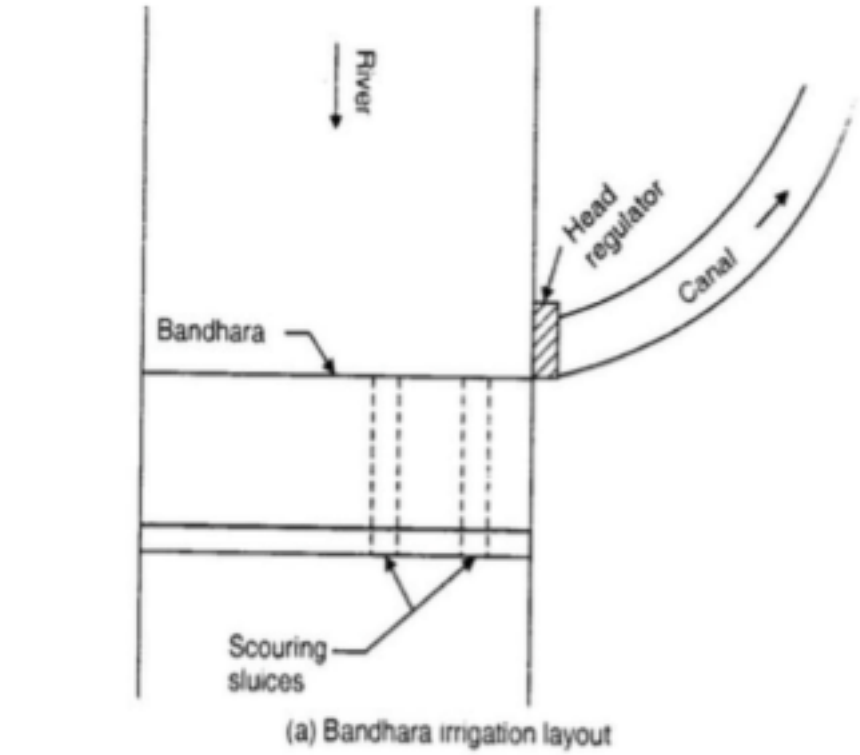
    d/s slope is 1:2 to 1:5

    Crest width = $(H)^{1/2}$, minimum of 1.2m

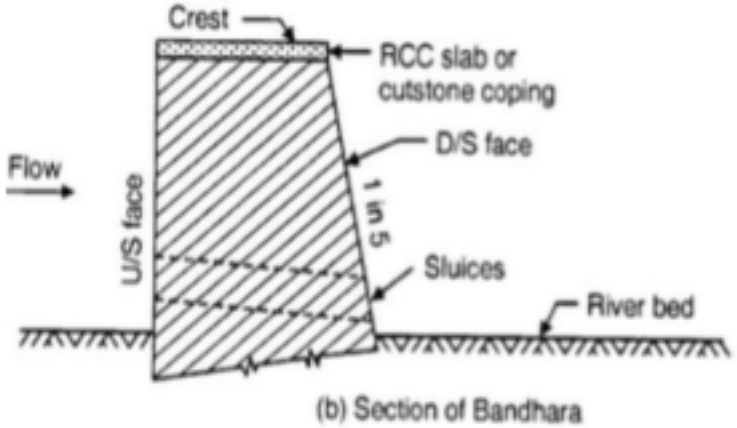
    Discharge $Q = 1.7\ L\ (h)^{3/2}$.

Bhandara Irrigation

This method of irrigation is followed in Central Maharashtra and is commonly known there as the `Phad‘



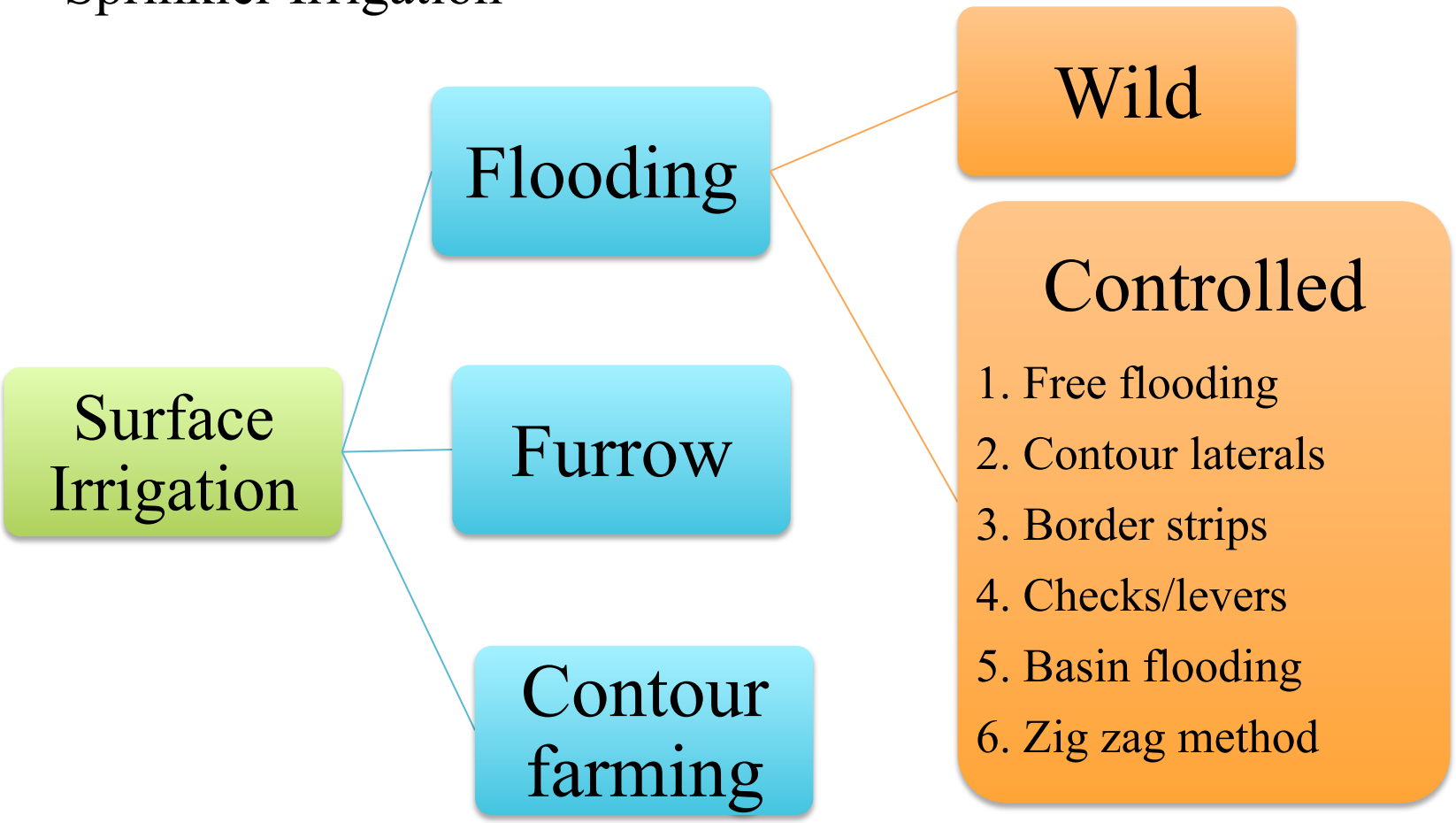
(a) Bandhara irrigation layout



(b) Section of Bandhara

Methods of Irrigation

- Surface Irrigation
- Sub surface Irrigation
- Sprinkler Irrigation



Factors affecting choice of method of irrigation

- Soil characteristics of land to be irrigated
- Topography – slope, roughness of surface
- Size of stream supplying irrigation water
- Available water supplies
- Rate of infiltration of soils
- Depth of root zone of plants
- Depth of water table
- Possible erosion hazard
- Amount of water to be applied during each irrigation

Select method of irrigation should fulfill following objectives

- Adequate amount of water is stored in the root zone of plants
- Light irrigation uniform application of 6cm
- Heavy irrigation, uniform depth of water application of 15 to 20cm should be possible.
- Minimum soil erosion.
- Reduce wastage of water
- Reuse of water is made possible
- Minimum land (of fields) is used for irrigation systems
- Method properly fits the boundary of land to be irrigated

Surface Irrigation: Wild Flooding

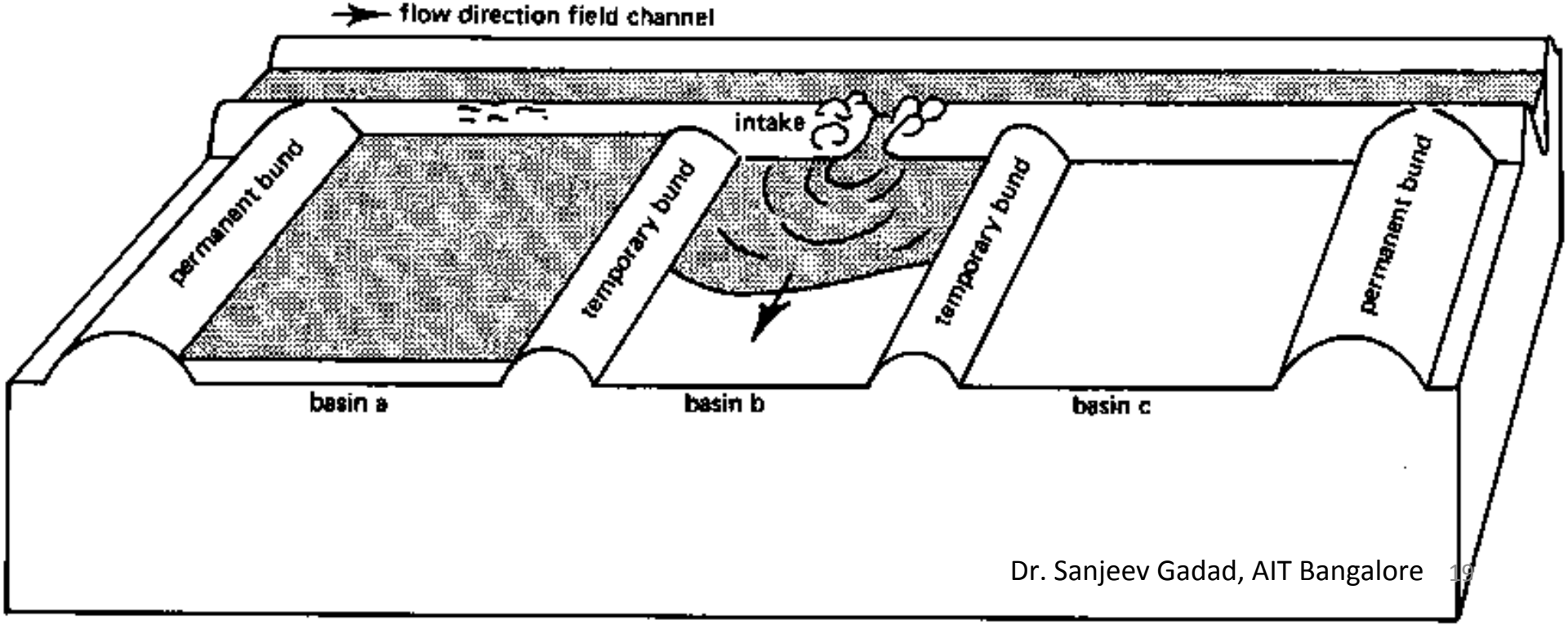
- a.k.a Uncontrolled flooding
- Water is applied by spreading it over land, without any preparation of land (to guide the flow).
- During high stream flow, water from source is allowed on land and is to made to spread along natural slope.
- Suitable for smooth, flat land
- Wastage of water is high
- Practised in areas with abundance and irrigation is less expensive.

Controlled Flooding

- Here quantity of irrigation water is controlled.
- Prior preparation of land is essential.

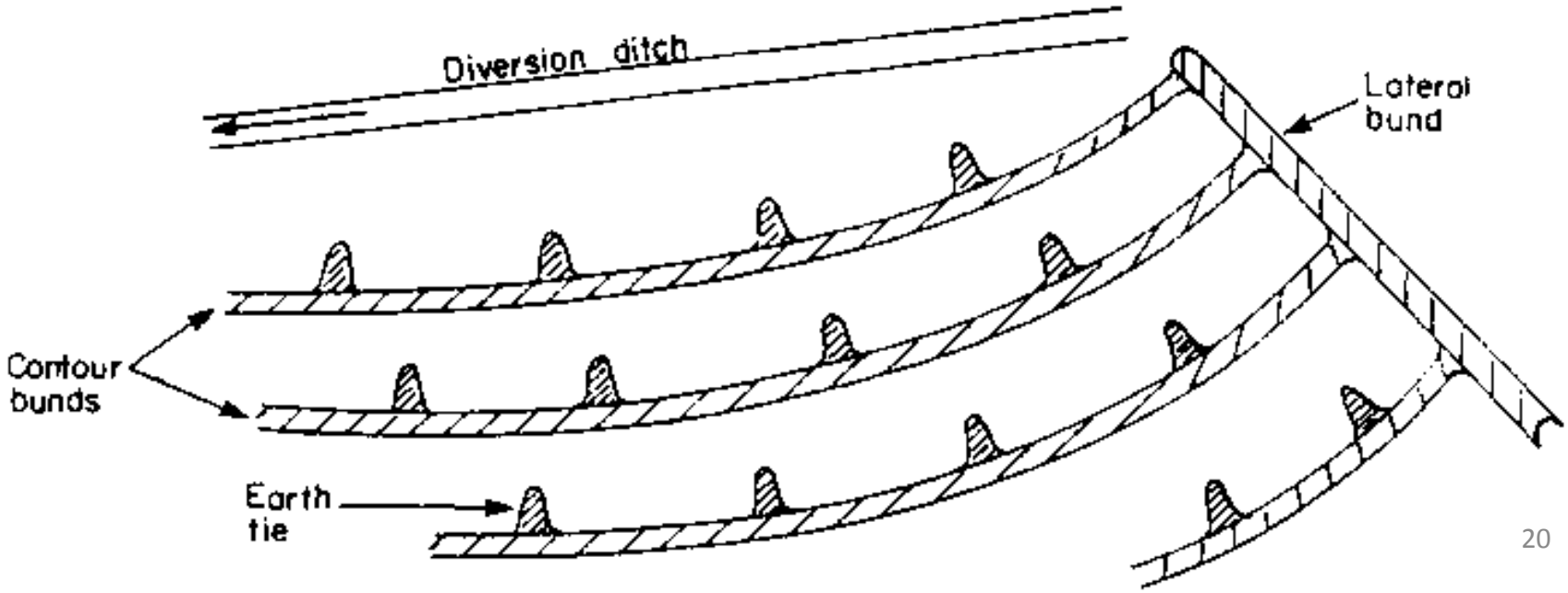
- Free Flooding
- Commonly adopted in India
- Field is divided in to small size plots having horizontal surfaces
- Water is fed at the higher end and made to flow till the end and then cut off.
- Size of plot depends on the porosity.

Free flooding method



Contour Laterals

- Practised when terrain is steep
- Laterals are aligned along contour lines
- Laterals are aligned perpendicular to contour lines, land on both sides of channel can be irrigated



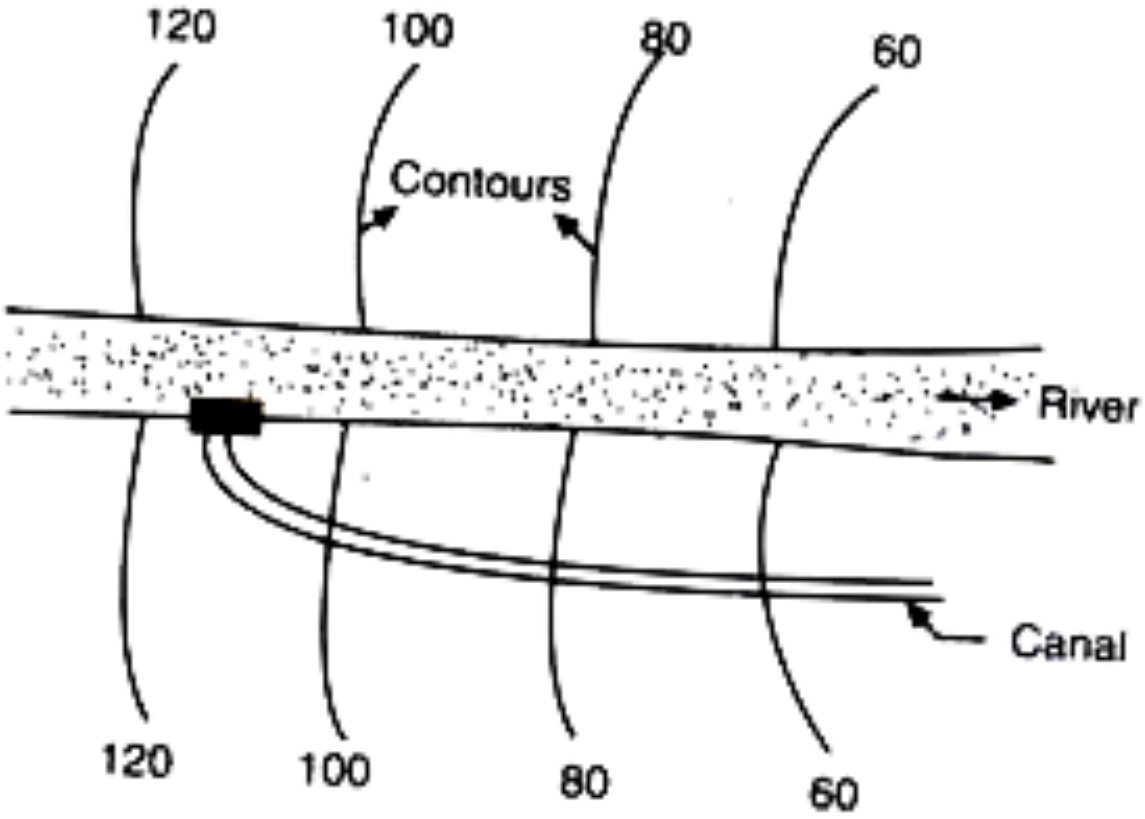


Fig. 8.5. Side slope channel

Border strip method

Dr. Sanjeev Gadad, AIT Bangalore

- Land is divided in to narrow strips (width about 20m & length about 200-300m), separated by borders/levees.
- Each strip (of gentle slope) is irrigated independently.
- Flow of water is sheet like, (Q = 14 to 28 litre/s)
- Slope is lengthwise between 0.5 to 1.5%
- Initial 6 to 12m length is made level for uniform spreading of water
- Length of strips depends on infiltration rate of soil, slope and size of irrigation stream.
- Longitudinal Slope depends on type of soil.
- Steeper: soil erosion, insufficient at upper reaches
- Flat: slow movement of water, percolation losses, insufficient at lower reaches

Type of soil	Length of strip (m)	Slope (%)
Sandy and sandy loam	60-120	0.25 to 0.60
Medium loam soils	100-120	0.2 to 0.40
Clay loam & clay soils	150-300	0.05 to 0.20

Check Flooding

- Similar to Ordinary flooding.
- Comparatively large stream supplies water w.r.t plot size
- Water is controlled by surrounding the check area with low and flat levees.
- Surrounded by levee- width: 2-3m (at bottom) and height: 15-30 cm.
- The check is filled with water at a fairly high rate and allowed to stand until the water infiltrates
- The confined plot area varies from 0.2 to 0.8 hectares.
- If the ground has slope, then levees follow the contours.
- Suitable for low as well as high intake soils and for rice or other crops which can withstand temporary flooding.

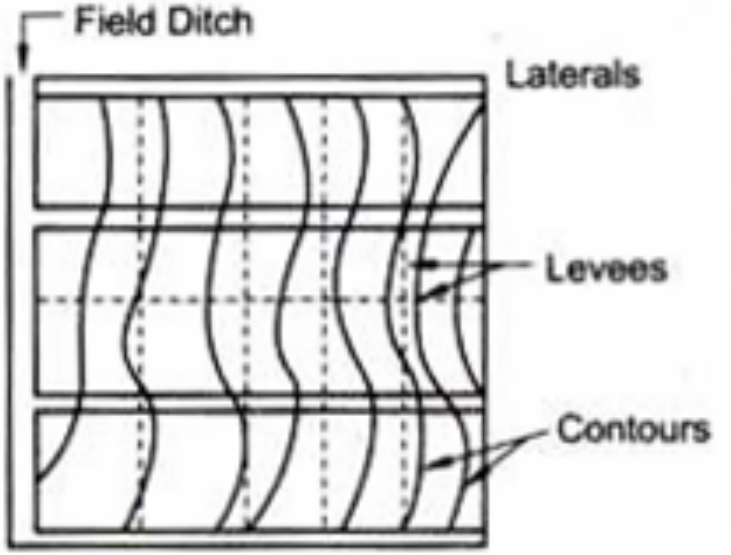


Fig. 6.3. Rectangular check

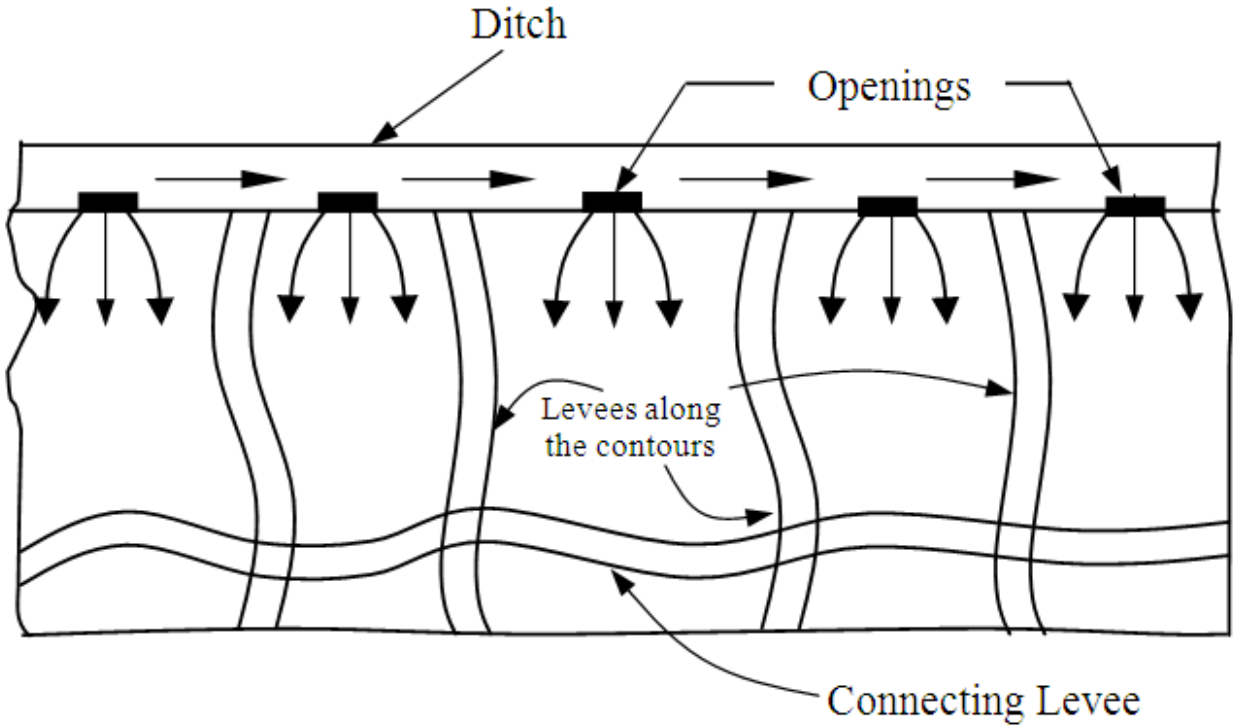


Fig: Check flooding (Plan view)

Basin Flooding

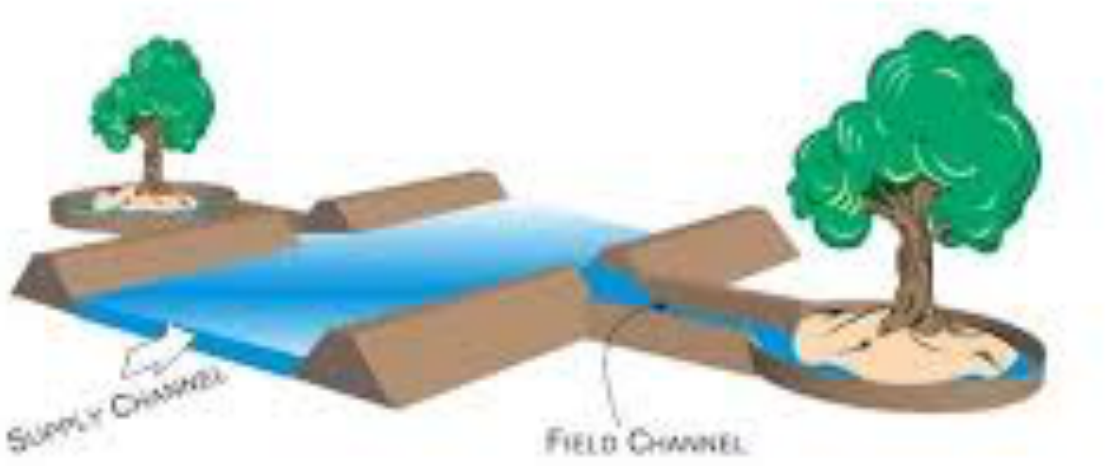


FIGURE 8. Ring basin method of irrigation

- Special type of check flooding
- Adopted specially for “Orchard trees”
- One or more trees are generally placed in the basin
- Surface is flooded as in check method by ditch water.
- Pipes also can be used to supply water to individual trees

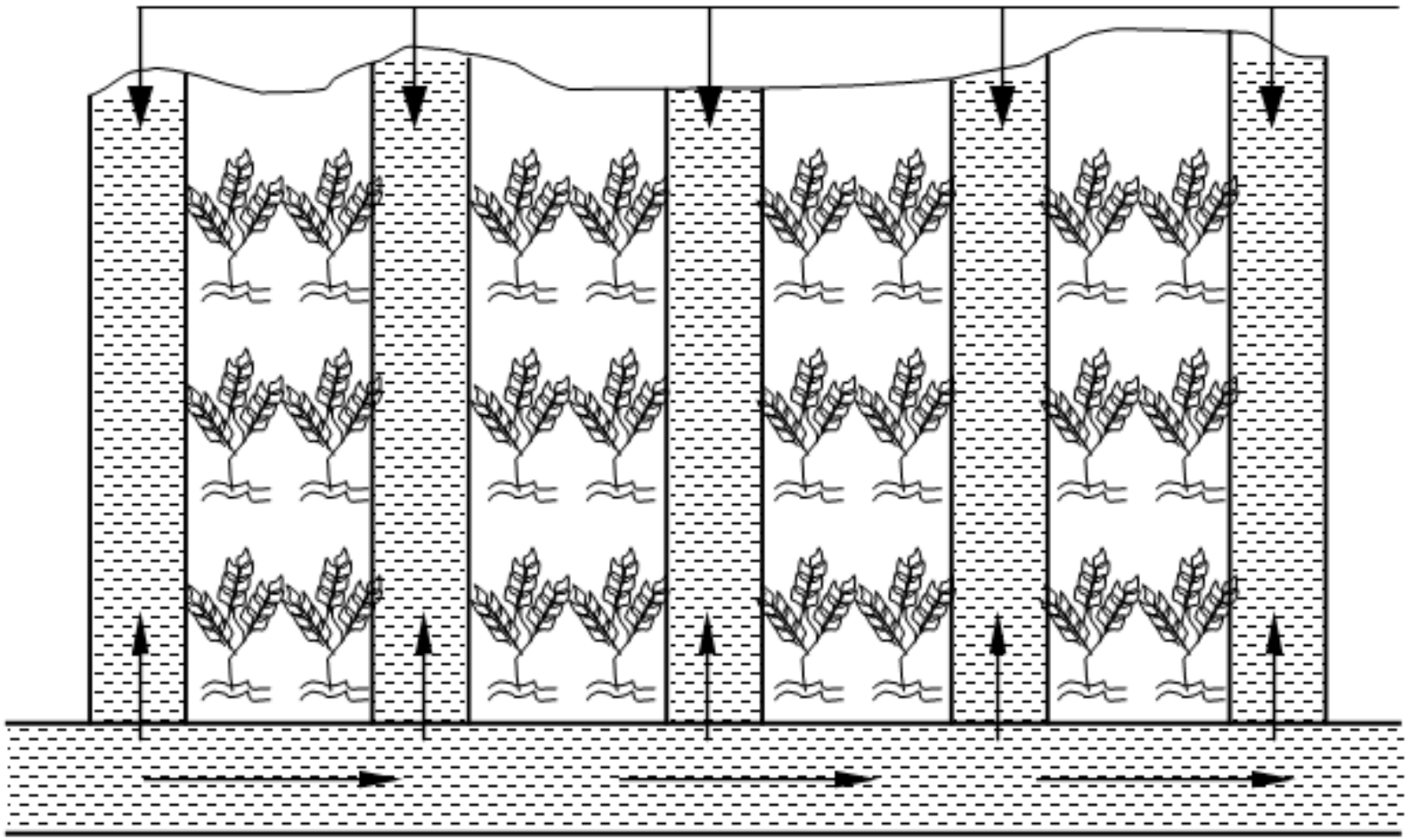


Fig: Plan view (Furrow irrigation method)

Advantages:

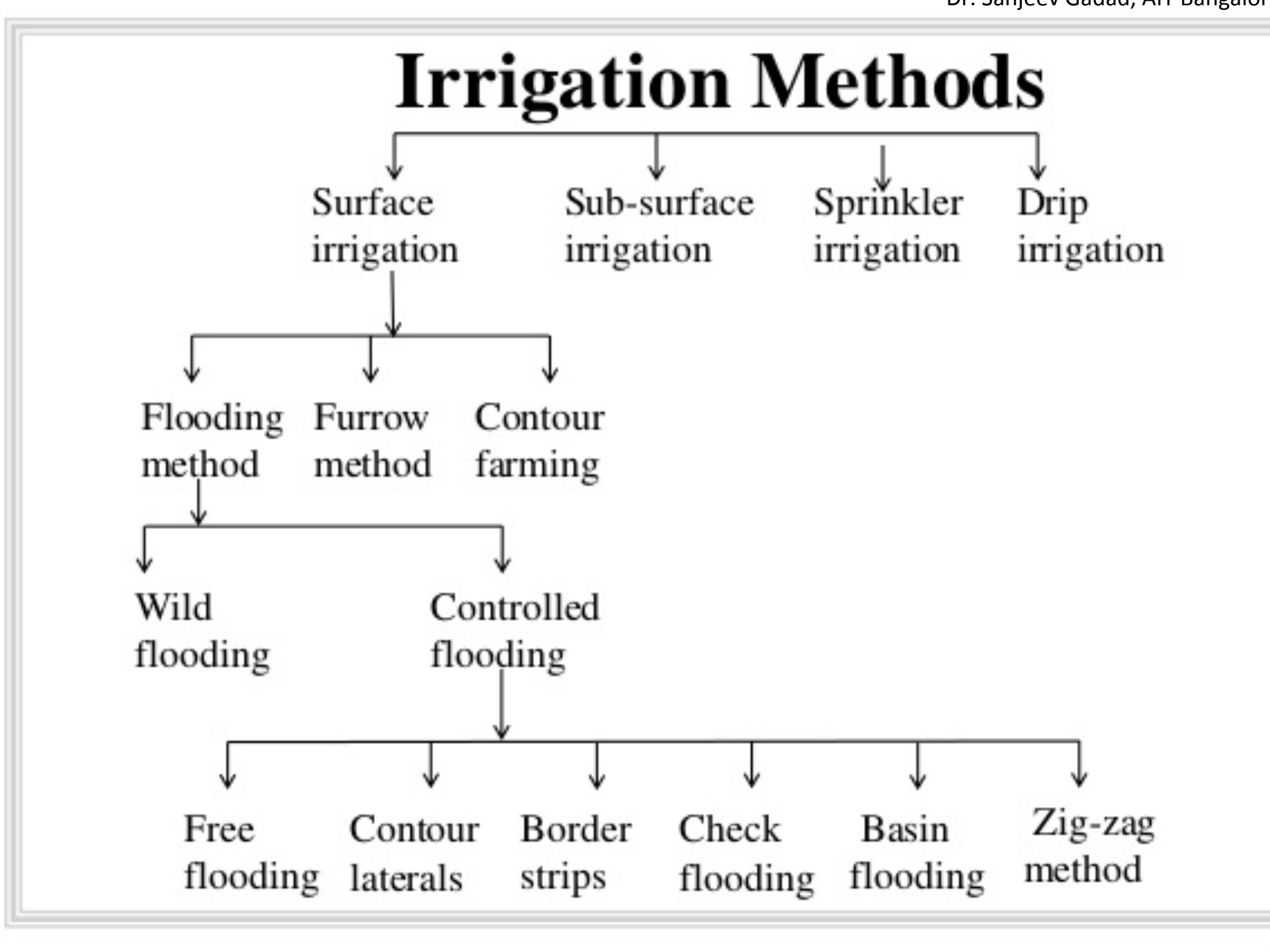
- Effective leaching
- Maximum use of seasonal rainfall
- High application efficiencies.

Limitations:

- Soil crusting
- Unsuitable for crops that cannot accommodate inundation.
- Application efficiency is comparatively high.

Zig-Zag method

- Plot is sub divided into number of strips.
- Separated by bunds/levees in a zig-zag manner.
- Water flows and covers entire area.
- When desired depth is attained, water supply is closed
- Suitable for level plots but not for machine farming


Irrigation Methods
Surface irrigation
Sub-surface irrigation
Sprinkler irrigation
Drip irrigation
Flooding method
Furrow method
Contour farming
Wild flooding
Controlled flooding
Free flooding
Contour laterals
Border strips
Check flooding
Basin flooding
Zig-zag method

Furrow Method

- Suitable for crops grown & planted in rows.
- Wetting is done of only a part of the field, unlike flooding.
- The area wetted varies from 1/2 to 1/5 of total area over which crops are grown.
- Losses due to evaporation, deep percolation, etc., are reduced
- The longitudinal slope of a furrow may be from 2-10m/1000m.
- Length of furrows may be up to 500m for field crops, about 30m or less for gardens.
- Spacing of furrows depend on the type of crop.
- In case of orchards it is around 1-2m
- Common size of furrow is 25cm wide and 8-10cm high.

Types of Furrow method

- Sloppy Furrow
- Leveled Furrow
- Contour Furrow
- Serial Furrow
- Corrugated Furrow: used along permanent slope, uneven land, small area

Advantages

- Large areas can be irrigated at a time.
- It saves labor.
- It is a reasonably cheaper method.
- Plants get proper quantity of water by this system.

Contour Farming

- Practised in hilly area, generally land have steep slopes
- Reduces erosion due to rainfall/irrigation
- Land is divided in to strips called terraces/benches
- Terraces follow contours, vertical interval of 300-600m.
- The 1st contour will be at 1.2-1.5m below the top.
- Strips have gentle slope along length, for efficient irrigation & drainage of excess water
- Bunds are provided at the end of strips, to allow retention of sufficient depth of water.

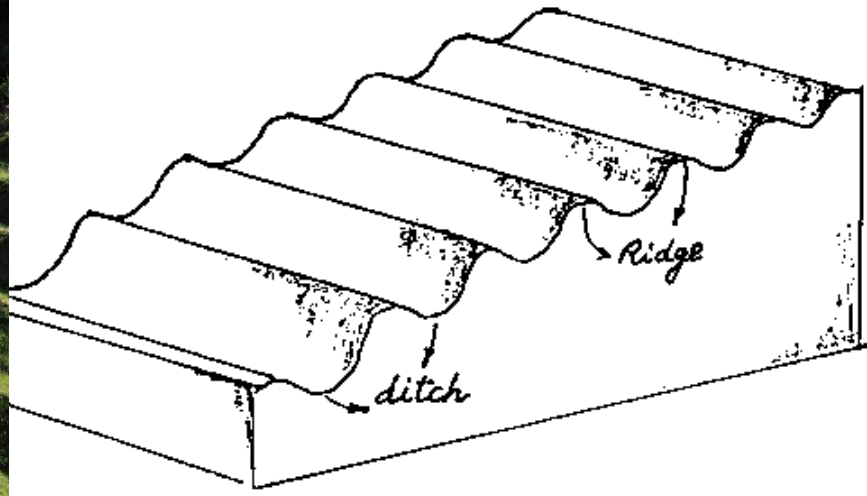
For the design of contour bunds, selection of horizontal & vertical contour intervals

and

Dimensions of cross-section of bund

Gadkary's recommendation for spacing of contours

Slope of land (%)	Vertical interval (m)	Horizontal distance (m)
0-1	1.05	105
1-1.5	1.2	98
1.5-3	1.35	70
2-3	1.5	60
3-4	1.65	52



Ghumare's recommendation for dimensions of contours bunds

Depth of soil	Base width (m)	Top width (m)	Height (m)	Side slope
Shallow soil (7.5 to 27.5 cm)	2.67	0.38	0.75	1.5:1
Medium soil (22.5 to 45 cm)	3.12	0.60	0.85	1.5:1
Medium deep soil (45 to 90 cm)	4.25	0.90	0.90	2:1

Sub-surface Irrigation

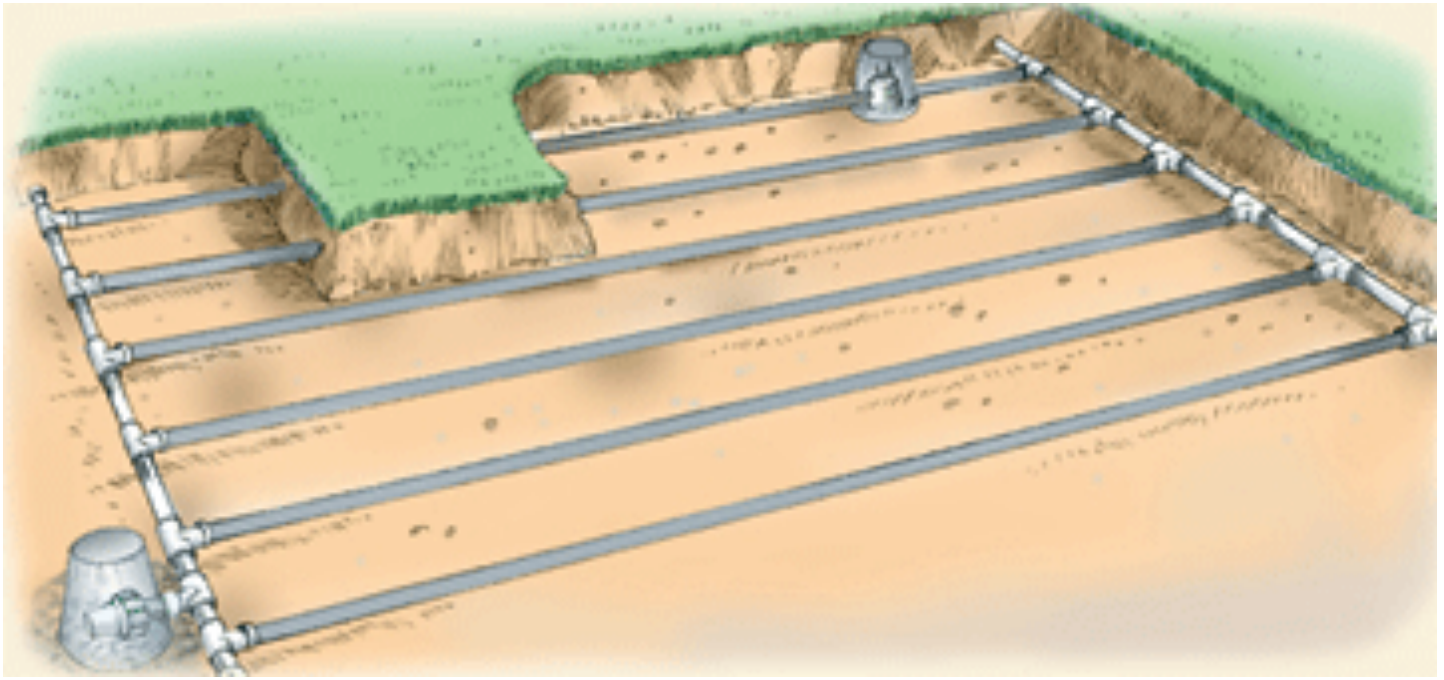
- Here supply of water is direct to root zone
- Suitable when
  - High water table
  - Impervious sub soil at reasonable depth (2-3 m)
  - Uniform topography
  - Moderate slopes
  - Good quality of water
- Precaution: alkali accumulation & excess water logging.
- Advantages:
  - Economical use of water
  - High yield
  - Low cost of labor required for preparation
- Two classes
  - Natural
  - Artificial

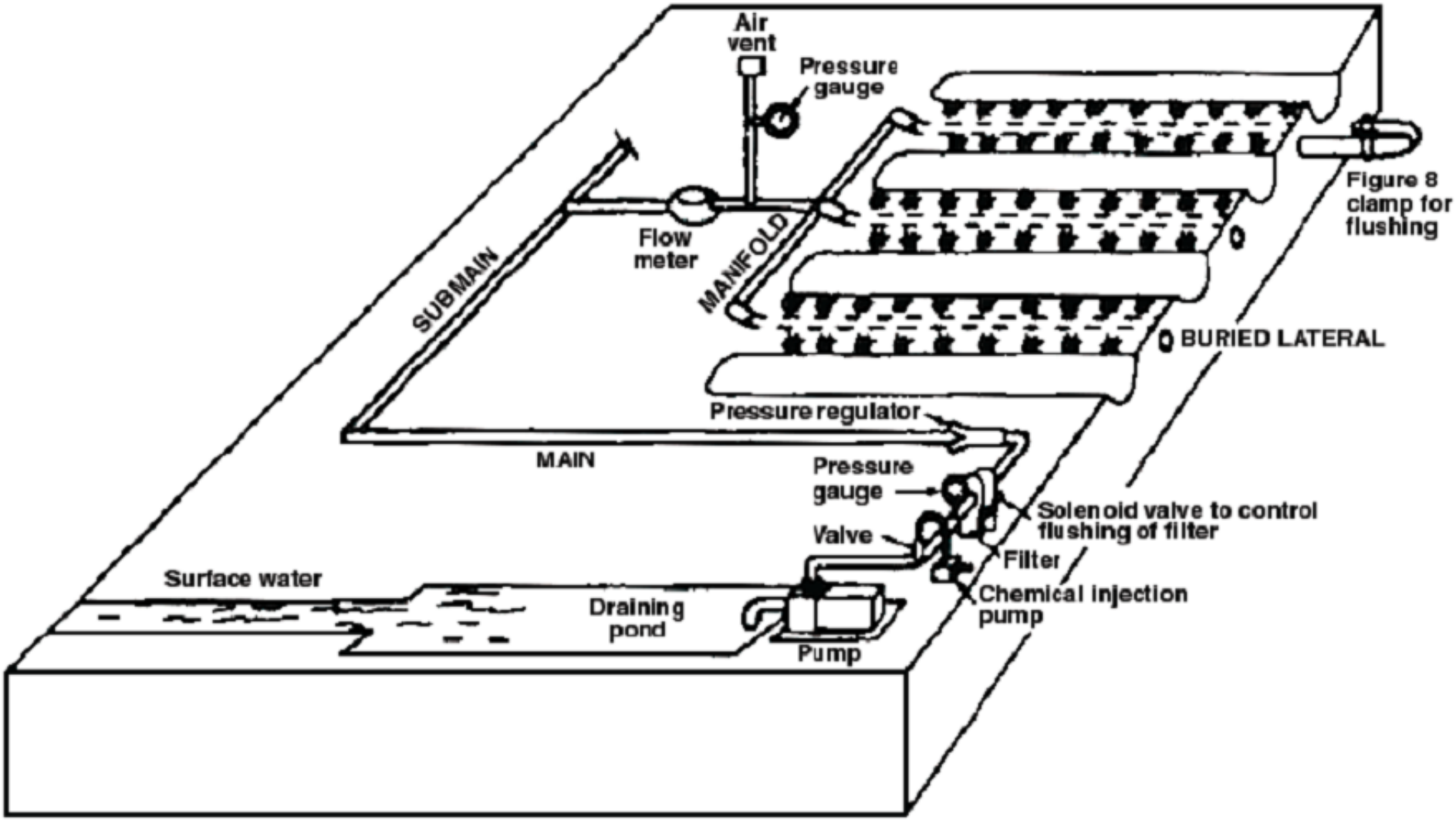
Natural sub-surface irrigation:

- Water is supplied to root zone by controlling the local water table.
- The water seeping from earthen canals, drains, rivers etc, cause raise in water table, due to geological & topographical conditions.
- To ensure requisite depth of water supply, water table needs to be maintained.
- Series of channels: up to 1 m deep, 25-50 cm wide & vertical sides are used.
- Channels are spaced: 15 – 100 m apart, depending up on permeability of soil & topography of land.
- Flat channels, so water can reach & maintain water table level.
- In case of shallow water table, upward capillary flow may result in saline & alkaline conditions.

Artificial sub-surface irrigation:

- Supply water to root zone using network of perforated pipes.
- Used in soils, which have high lateral flow, high horizontal permeability and low vertical permeability.
- Pipes are at a depth of 0.3 to 0.4 m deep.
- Spaced at 0.4 to 0.5 m horizontally for uniform distribution.




Air vent
Pressure gauge
Figure 8 clamp for flushing
Flow meter
MANIFOLD
SUBMAIN
BURIED LATERAL
Pressure regulator
MAIN
Pressure gauge
Solenoid valve to control flushing of filter
Valve
Filter
Chemical injection pump
Surface water
Draining pond
Pump

Sprinkler Irrigation

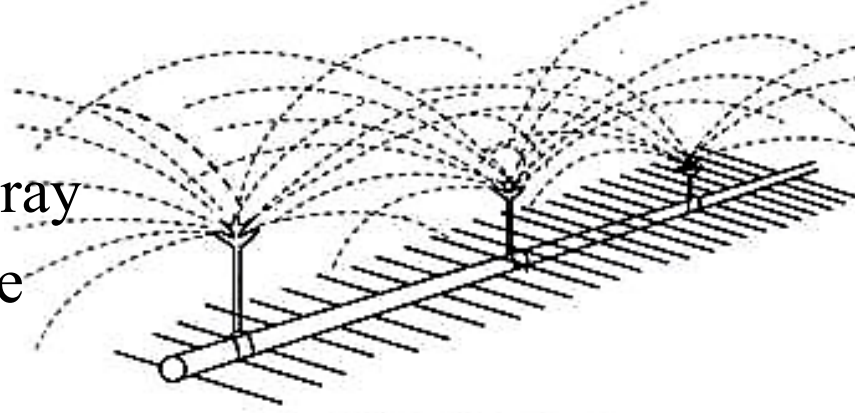


Fig. 6.6. Sprinkler irrigation

- Application of water in form of spray
- More efficient method than surface
- Advantageous when –
  - Land cannot be prepared for surface methods
  - Slopes are excessive
  - Topography is irregular
  - Soil is erosive
  - Soil is excessively permeable/impermeable
  - Depth of soil is shallow over gravel/sand.
- Large investment: pumping, distribution sets
- Classification
  - Permanent: pipes are buried & no interference to agricultural process
  - Semi-permanent: main lines are buried, laterals are portable
  - Portable: main & lateral lines are portable

Types of Sprinklers

- Fixed nozzle pipe system
  - 15 m apart
  - By turning pipes through 135° entire width of 15m can be covered
- Perforated pipe system
  - Spacing at 6 to15 m
- Rotating sprinkler system
  - Discharge required through each sprinkler is given by

$$q = \frac{S_l \times S_m \times I}{3600}$$

where, q: discharge required (l/sec)

S_l: spacing of sprinklers along laterals (m)

S_m: spacing of laterals along mains (m)

I : optimum water application rate (mm/hr)

- Efficiency of water application (η_a) is given as -

$$\eta_a = \frac{W_s}{W_f} \times 100$$

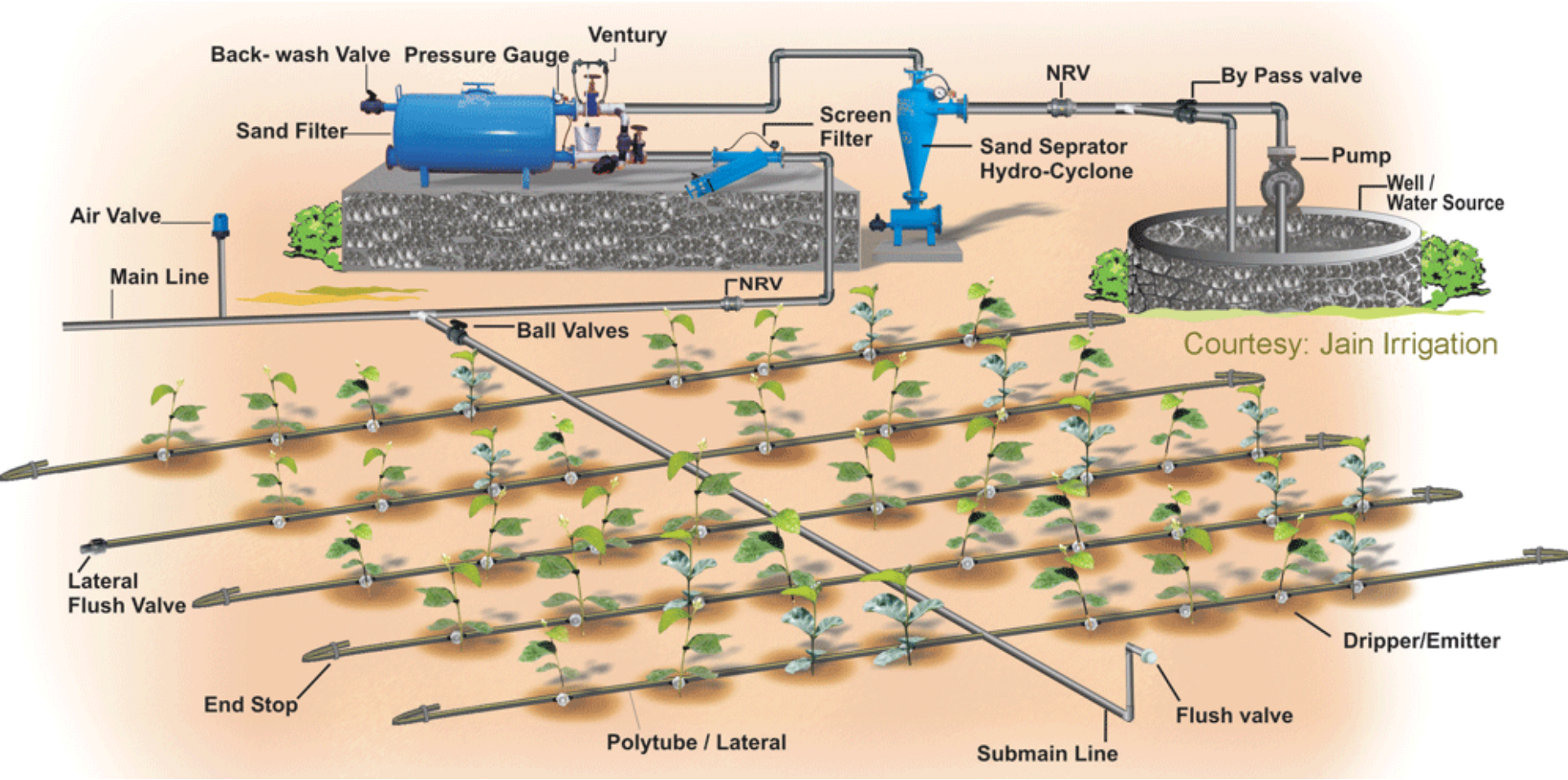
- W_s : irrigation water stored in root zone'
- W_f : water pumped into system
- About 80% efficiency can be achieved with sprinkler

Advantages	Limitations
Erosion can be controlled/reduced	Wind may distort system
Uniform application of water	Constant supply is needed
Irrigation is better controlled Light irrigation: when seedling & young plants	Heavy soil, poor intake cannot be irrigated
Land preparation is not required	Power requirement is high
Larger area available for cropping	Water must be clean
Small streams can be used efficiently	
Controlled application of fertilizers	
Crop damage can be reduced from frost	

Drip Irrigation

- aka Trickle irrigation.
- Water is applied in form of drops, using nozzles to plants
- Using system of pipe lines – flexible, operating at low pressure
- It limits water supplied for consumptive use, maintains soil-moisture (= field capacity)
- Irrigation water + nutrients can be applied
- Helps in controlling water & nutrient supply frequency
- 1st introduced in Israel
-

- Drip irrigation arrangement consists of
  - Pump
  - Head tank: stores water & maintains pressure head (5-7 m)
  - Central Distribution system: filters, added nutrients, regulates pressure & water quantity
  - Mains & secondary lines: polythene/PVC material. Diameter between 20 - 40 mm
  - Trickle lines: dia 10 – 20 mm. PVC with perforations, at equal spacing of crops. Fitted to secondary lines.
  - Nozzles: designed to maintain min flow rate, drop size. Rate is 2 to 10 litres/hr


Back- wash Valve
Pressure Gauge
Ventury
Sand Filter
Screen Filter
NRV
By Pass valve
Sand Seprator Hydro-Cyclone
Pump
Well / Water Source
Air Valve
Main Line
NRV
Ball Valves
Courtesy: Jain Irrigation
Lateral Flush Valve
Dripper/Emitter
End Stop
Polytube / Lateral
Flush valve
Submain Line

Advantages	Limitations
Less water requirement	High initial cost
Water supply at optimum level	Blockages of nozzle
Water logging is avoided	Change in spacing of nozzles
High yield, cash crops	Shallow root depth
No over irrigation, Variation in application rate	
Weed/Pest control	
Increase in net irrigable area	
Suitable for saline soils, No erosion	

Sewage canal

- Waste water, in solution or suspended
- Intended to be removed from society
- Recently being applied for irrigating agricultural fields
- Urban waste, including sewage is being applied.
- Limitation – water is full of pathogens, can impact health of humans after consumption of agricultural produce

Infiltration galleries

- Infiltration galleries are horizontal tunnels (with holes on sides)
- constructed of masonry walls with roof slabs to tap ground water flowing towards rivers or lakes.
- Constructed at shallow depths (3-5m) along the banks of river either axially along or across ground water flow.
- If large ground water quantity exists, porous drain pipes are provided and they are surrounded by gravel and broken stone.
- The yield from infiltration galleries may be 15,000 L/day/Meter length.
- A collecting well at shore end of gallery serves as sump from where water can pumped out to required destination.