



بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ



WATER HARVESTING

Taha M. Tahir

**Civil Engineering Department, Water and Environment
Center (WEC) Sana'a University, Yemen**



Definition

- collection of runoff for its productive use:
 - domestic and livestock water,
 - concentration of runoff for crops,
 - fodder and tree production and,
 - less frequently, water supply for fish and duck ponds.
- inducing, collecting, storing and conserving local surface runoff for agriculture in arid and semi-arid regions



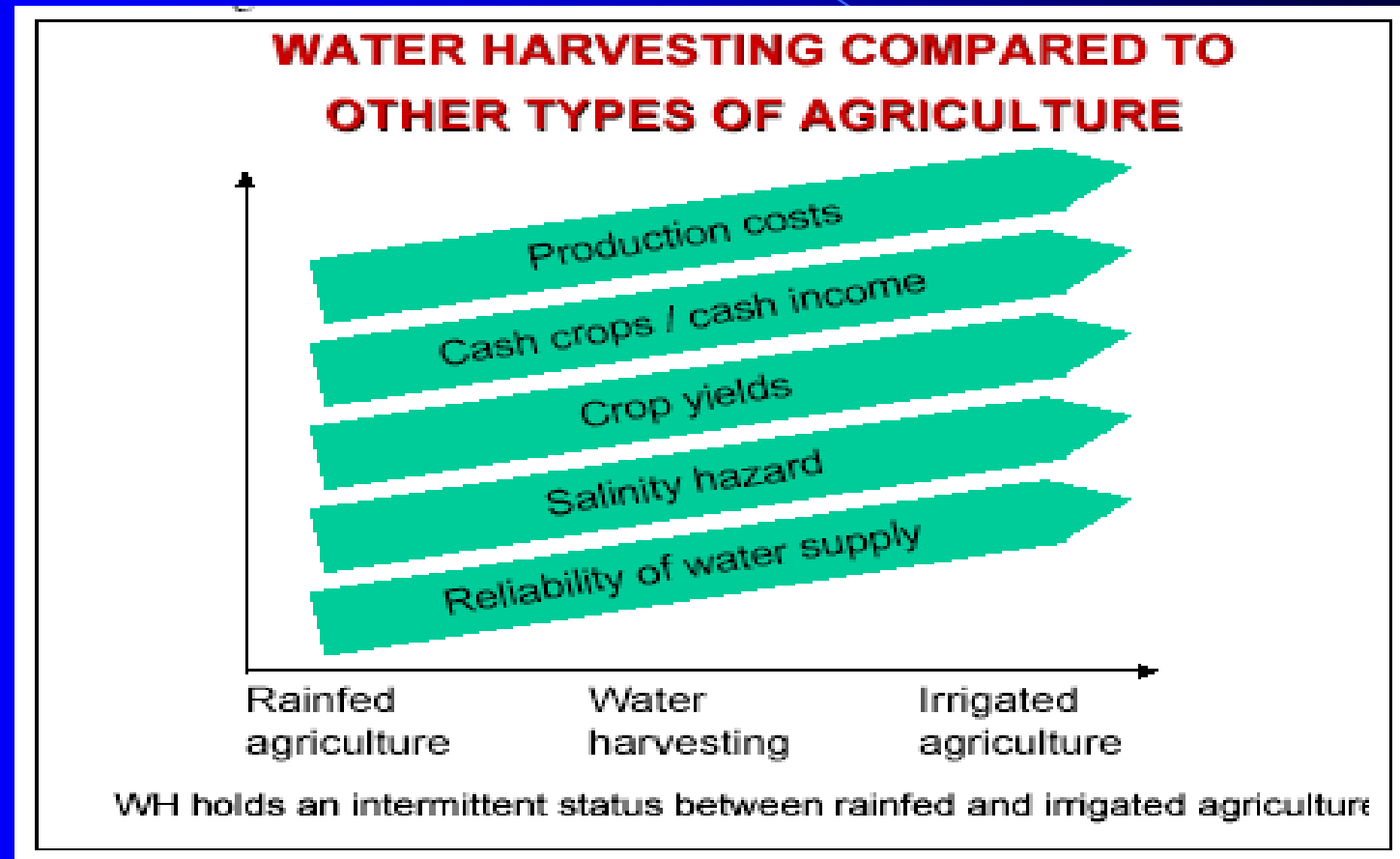
*** Water harvesting is considered as a management technique for :**

*** collecting, storing, and distributing rainwater for any productive use.**

*** It can make water available in regions where other sources are too distant or too costly, making water harvesting able for supplying water for small villages, households, livestock, and agriculture**



WH compared to other types of Agriculture



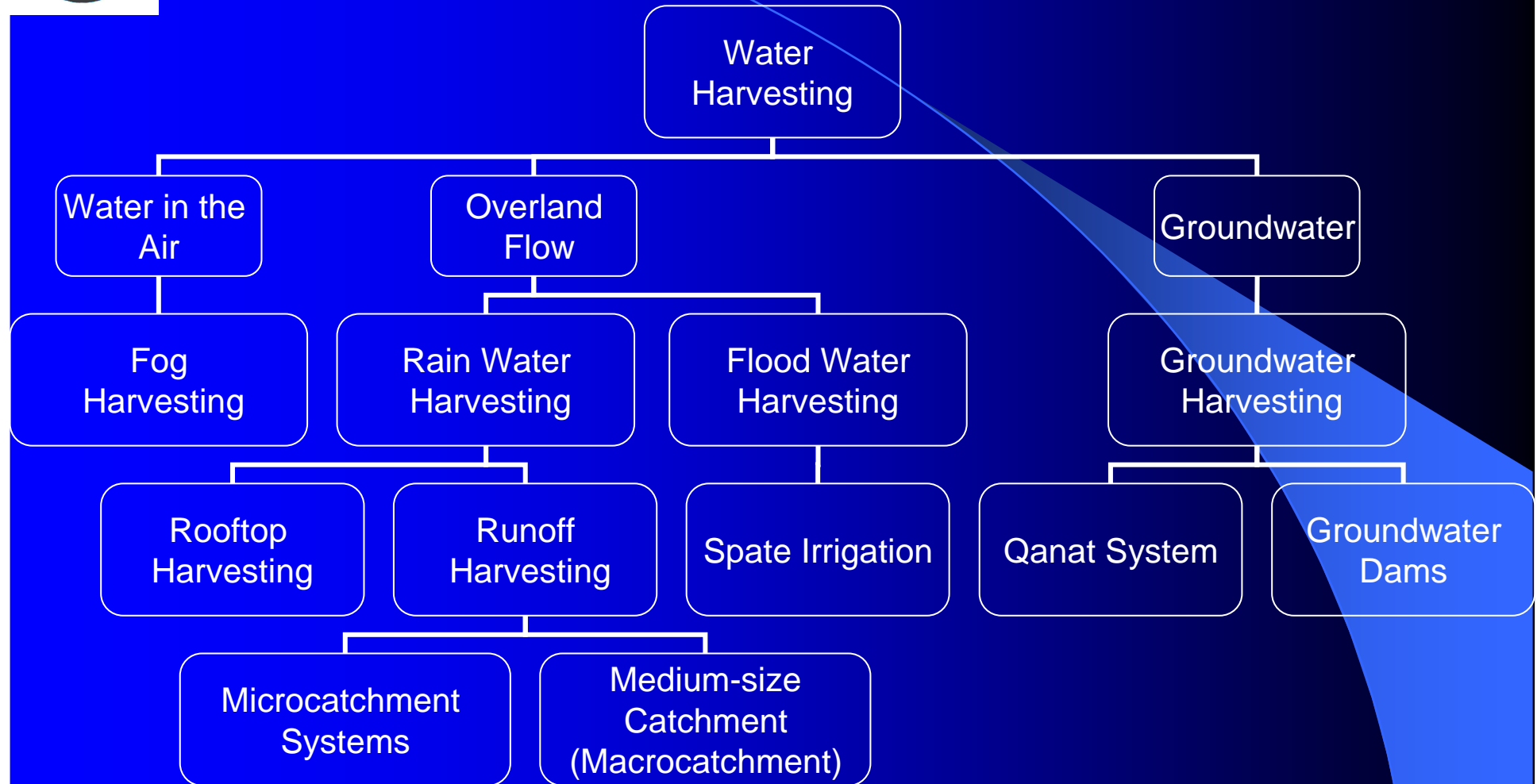
WH holds an intermittent status between rainfed and irrigated agriculture (Prinz 1996).

Rainwater harvesting techniques used in the Arab Region

Water Sources	Objectives	Water Harvesting Techniques	Country
Rainfall	<ul style="list-style-type: none"> -Increase rainfall effectiveness -Conserve water (and Soil) 	<ul style="list-style-type: none"> Terraces Contour-ridge terracing Dams 	Yemen, Jordan Tunisia,Libya, Syria, Egypt
Local runoff	<ul style="list-style-type: none"> - Collect water - Store harvested water 	<ul style="list-style-type: none"> Micro-catchment Cisterns 	Yemen; Egypt, Libya, Syria, Jordan, Morocco,
Wadi flow (flood and base flow)	<ul style="list-style-type: none"> - Protect land against flood 	<ul style="list-style-type: none"> Earth dykes (spate irrigation & earth canals) Wadi -bank enforcement 	Yemen, Egypt, Libya,Tunisia, Jordan
Spring water	<ul style="list-style-type: none"> -Deliver water within water rights limits - Store limited quantities for short periods 	<ul style="list-style-type: none"> Earth canals, Cisterns 	Yemen, Egypt, Libya,Morocco
Ground water	<ul style="list-style-type: none"> - Abstract water from shallow aquifers -Exploit water stored in the coastal sand dunes 	<ul style="list-style-type: none"> Shallow dug wells and pits, Galleries 	Yemen,Egypt,Tunisia Jordan, Oman Morocco, Libya
Water in the air	<ul style="list-style-type: none"> - Collect water - Store harvested water 	<ul style="list-style-type: none"> Fog net collector (mesh), Trees Plates 	Yemen, Oman



Classification of water harvesting techniques





WH (Fog Collection)

- Water can be collected from fogs under favorable climatic conditions
- The technology is simple and can be maintained and managed by the users.
- The site must be in an area where fog occurs frequently throughout the year and the water content of the fog should be high.
- Fog droplets coalesce on mesh screens and flow by gravity into a supply network



WH (Fog Collection)



Small Fog Collector in Hajah area(SFC)₉



Rooftop harvesting

The roof water harvesting in Yemeni highland is important due to:

- Difficult topographical conditions
- Villages and hamlets are scattered
- No groundwater sources available



Villages and hamlets are scattered

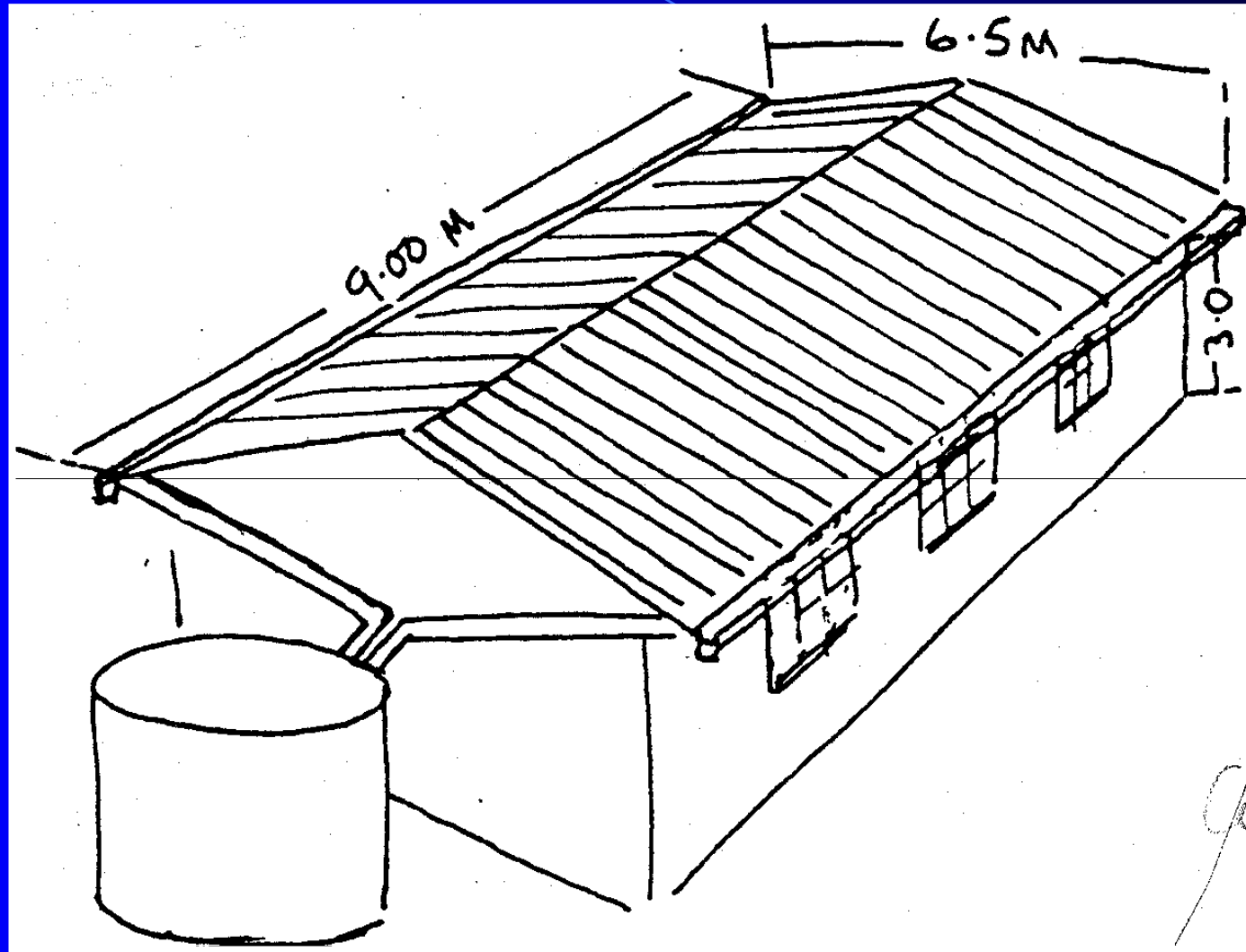


Difficult topographical conditions





Rooftop harvesting





Rooftop harvesting



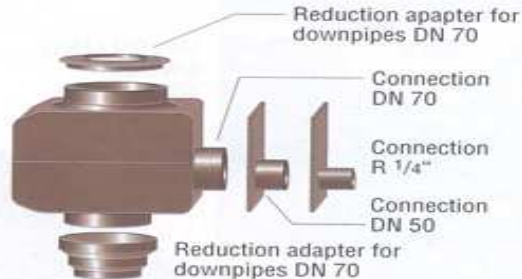


Rooftop harvesting

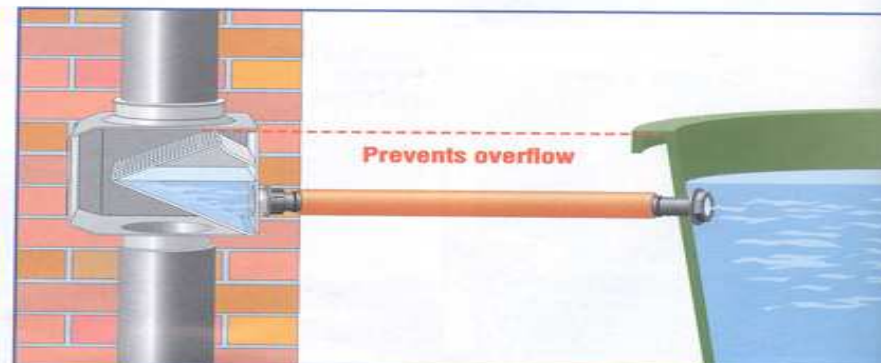
- New, revolutionary rainwater-filter, which is easily installed in the downpipe of your house.
- The filter is self-cleaning through sloping filter surface.
- The RAINTHIEF also prevents overflow of a full water container.



Three types of connection and a reduction adapter for smaller downpipes are also available.



Prevents overflow – it is therefore secure and convenient!





Rooftop harvesting





RUNOFF HARVESTING



runoff harvesting

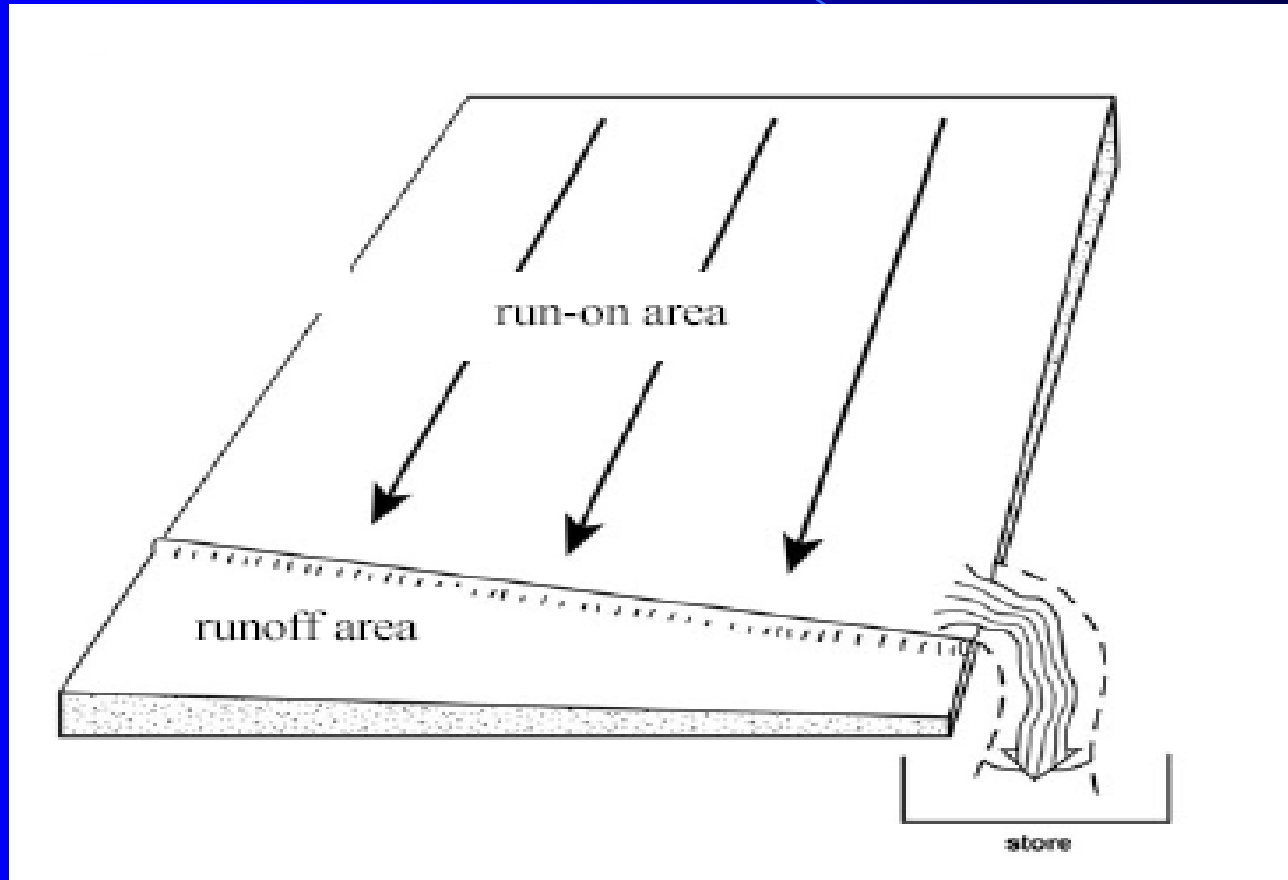


runoff harvesting





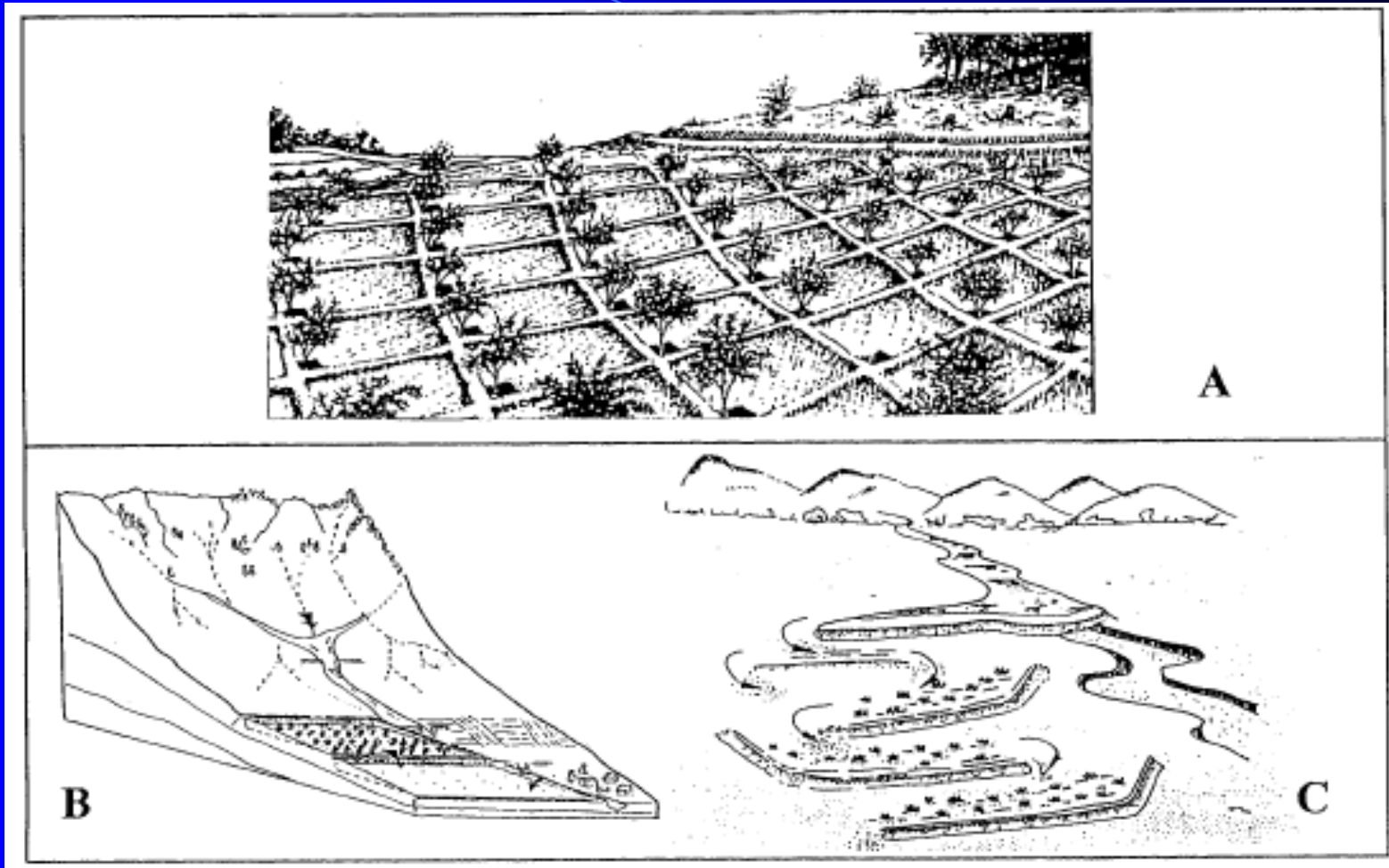
Runoff Harvesting



Runoff farming external catchment, Prinz (1996)



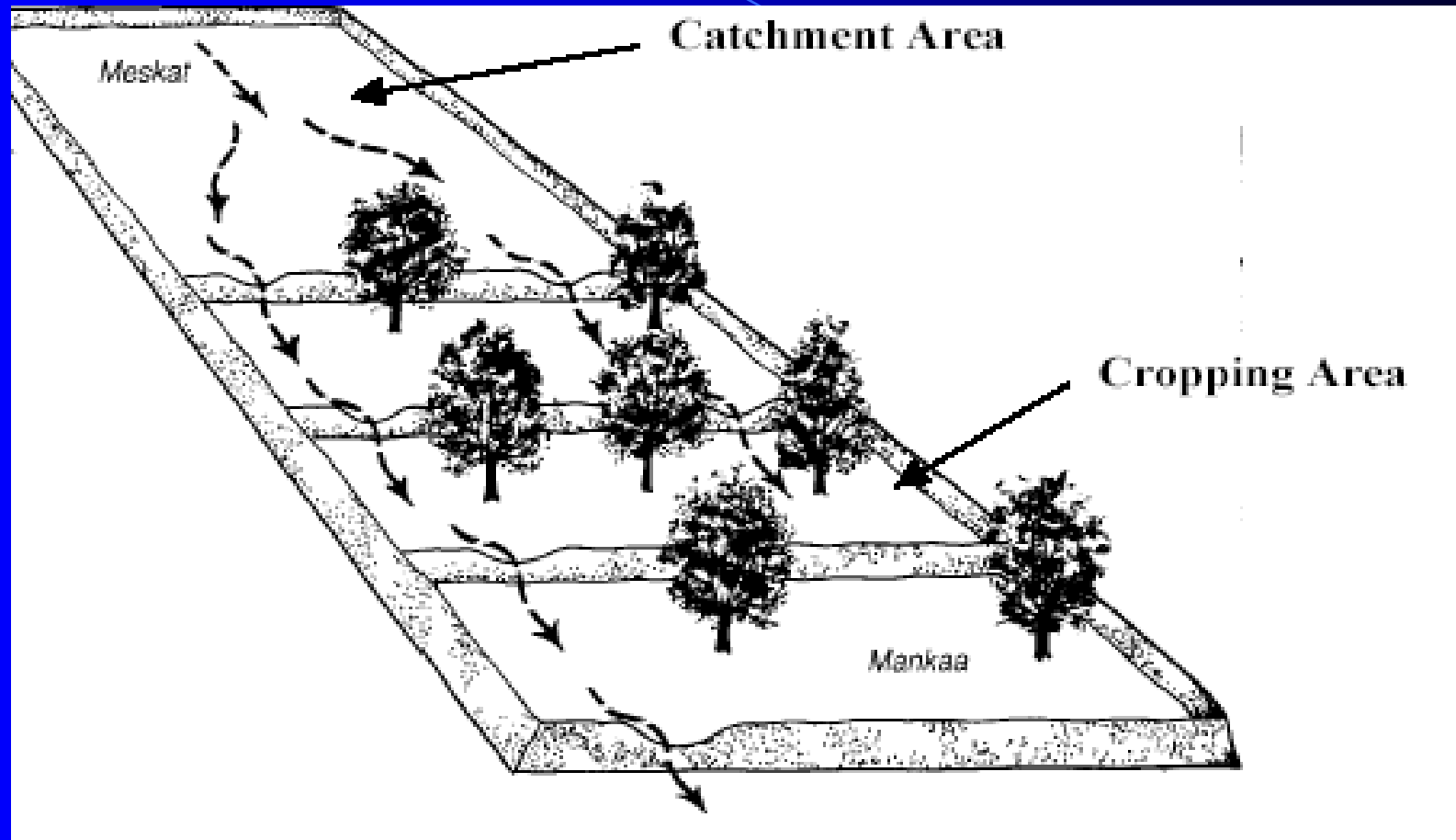
Runoff Harvesting



A: Microcatchment 'Negarin' Type, B: Macrocatchment 'Hillside Conduit' system, C: Floodwater Harvesting: Floodwater diversion system, Prinz (1996)



Runoff Harvesting

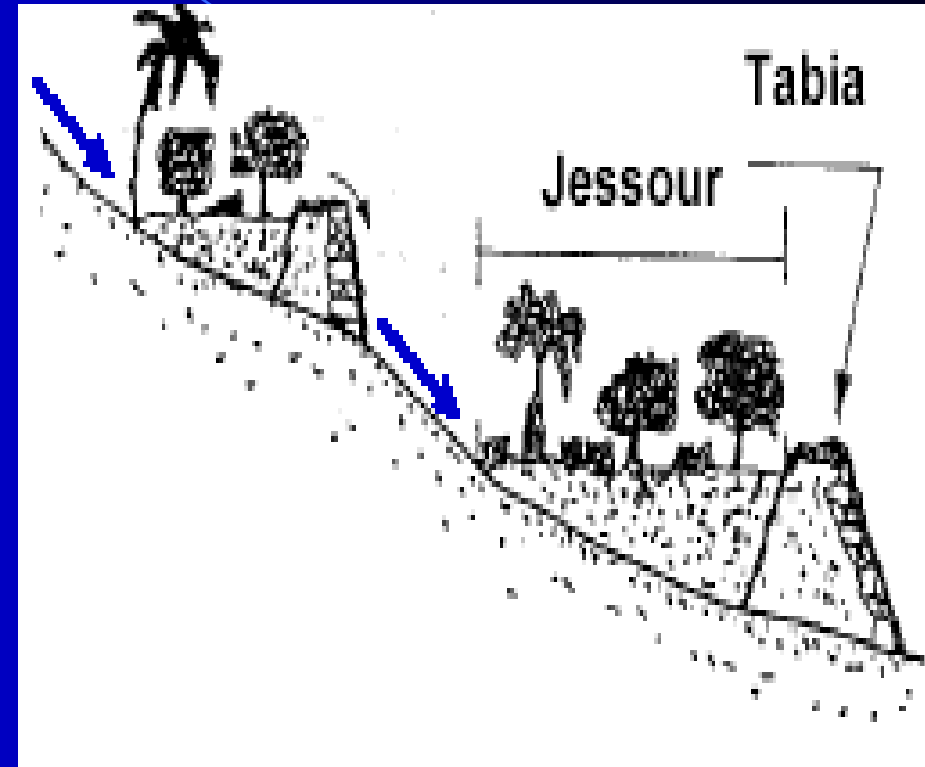
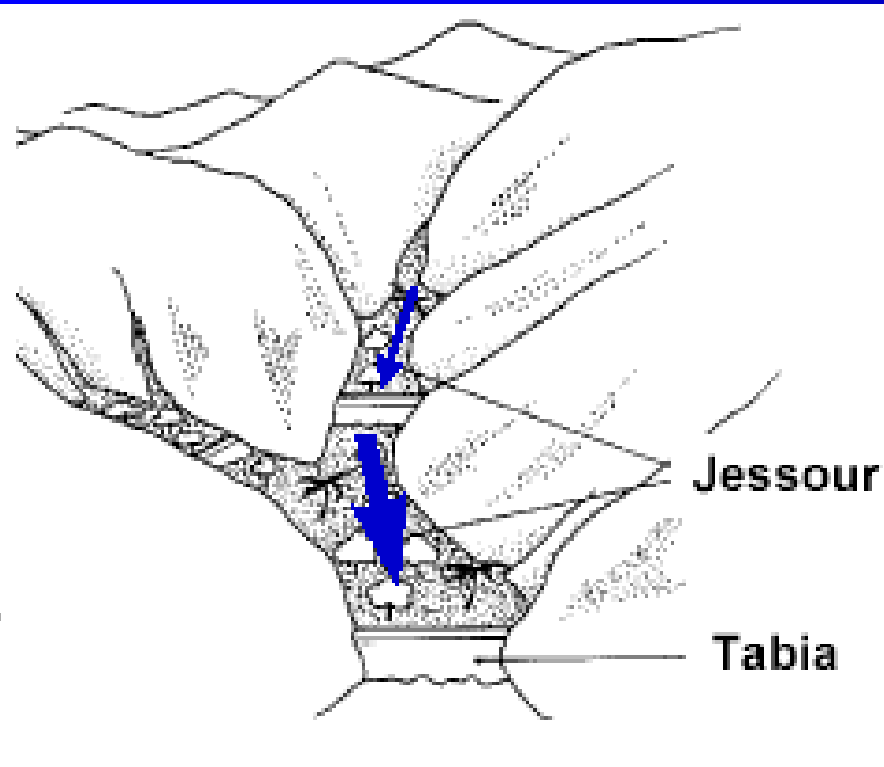


MICROCATCHMENT SYSTEM

The Tunesian "Meskat" microcatchment system. (El Amami 1983)



FLOODWATER HARVESTING



Floodwater Harvesting within the stream bed. "Jessour" in the South of Tunisia. El Amami 1983

FLOODWATER HARVESTING





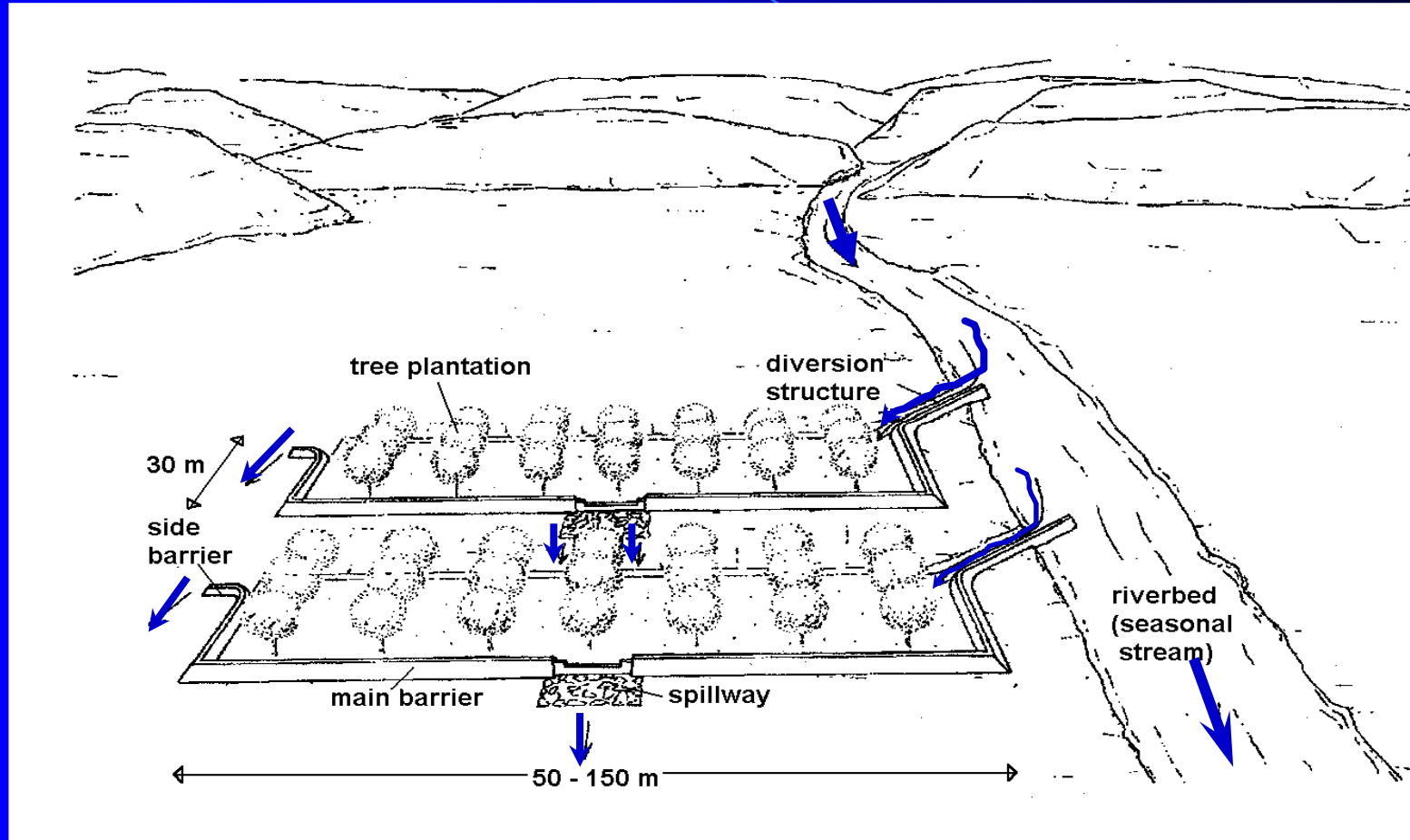
FLOODWATER HARVESTING



Floodwater Harvesting within the stream bed
(Terraces in U/S Wadi Zabid)

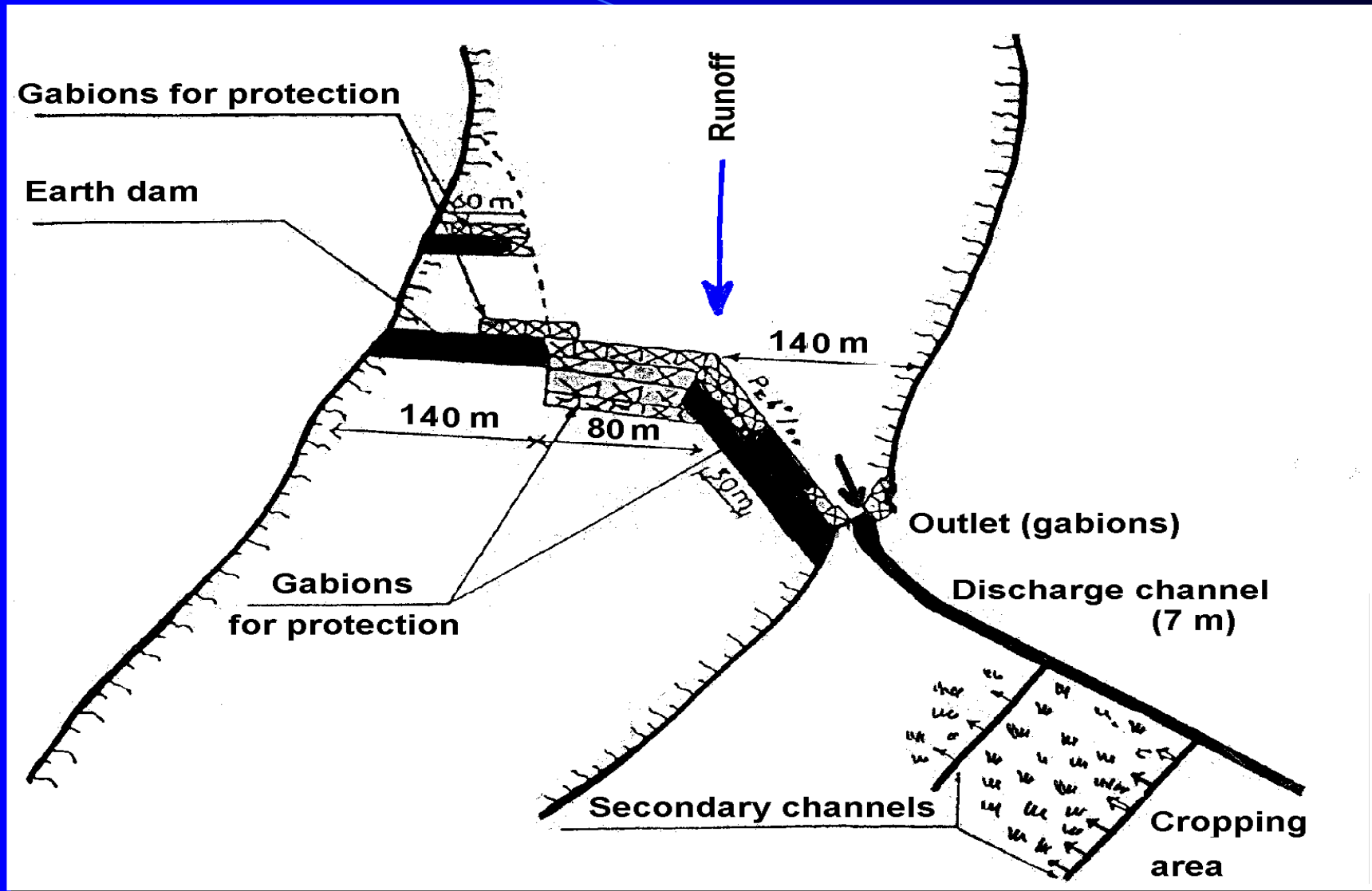


Flood WH (Spate Irrigation in Wadis)

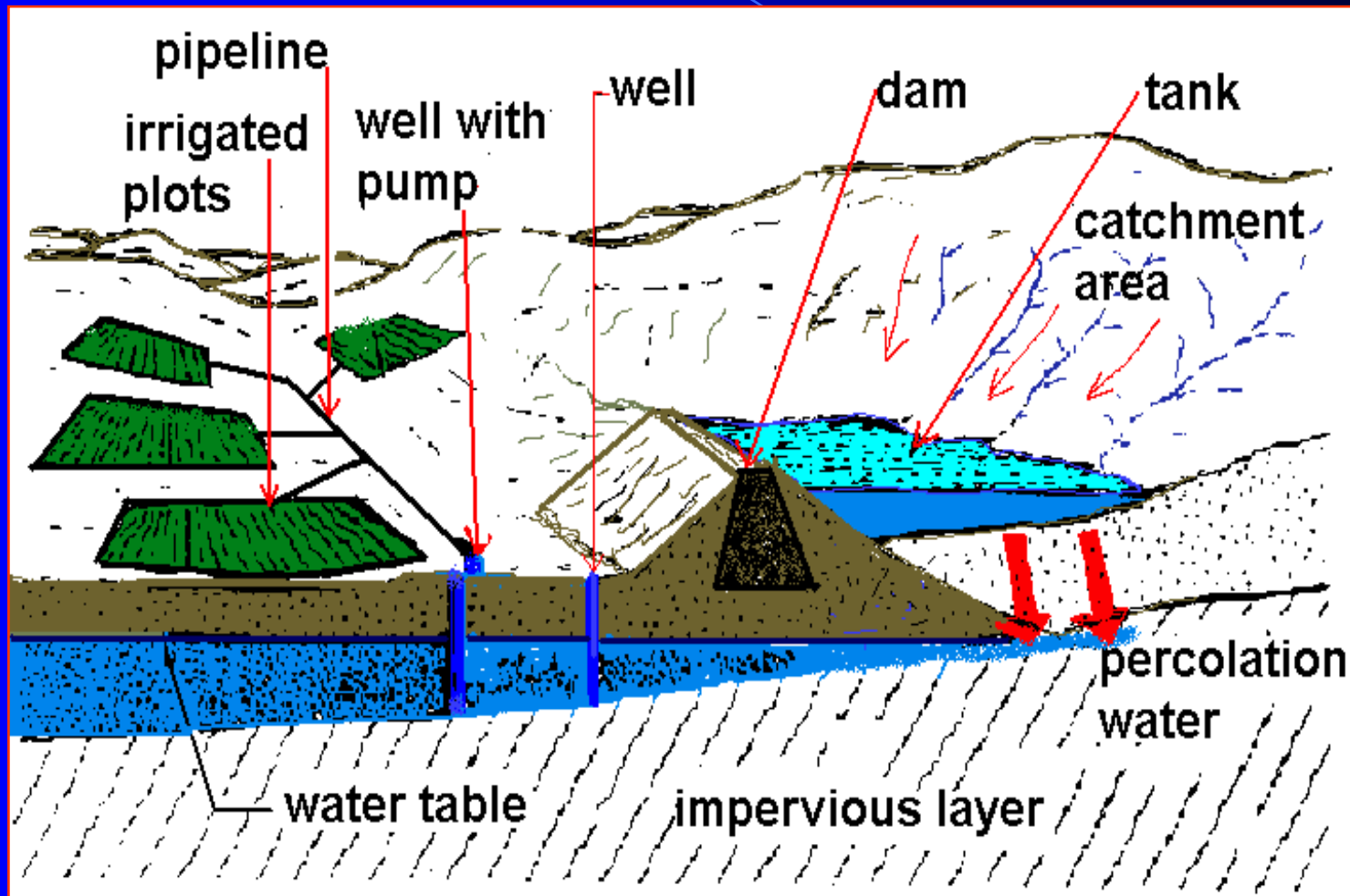


تحويل مياه السيول باستخدام منشآت تحويلية (أحجار أو خرسانة) وحواجز
مع قنوات تصريف ؛ المصدر GTZ 1993م

Floodwater Harvesting (spate Irrigation)



GWH (Groundwater Dam)



المصدر : مقتبسة من
باسي و كوليس 1986م



Runoff water harvesting in Yemen

Total cultivated Area = 1.5 Million ha

Runoff Water Harvesting
62% of total cult.area
annual rainfall > 200mm

Rainfed Agric. 61%
-Terraces in the mountains
-Flat Land

-Dams (Irrigation)
-Cisterns and Ponds (livestock)



Rain fed Terraces



Another view of Rainfed Terraces



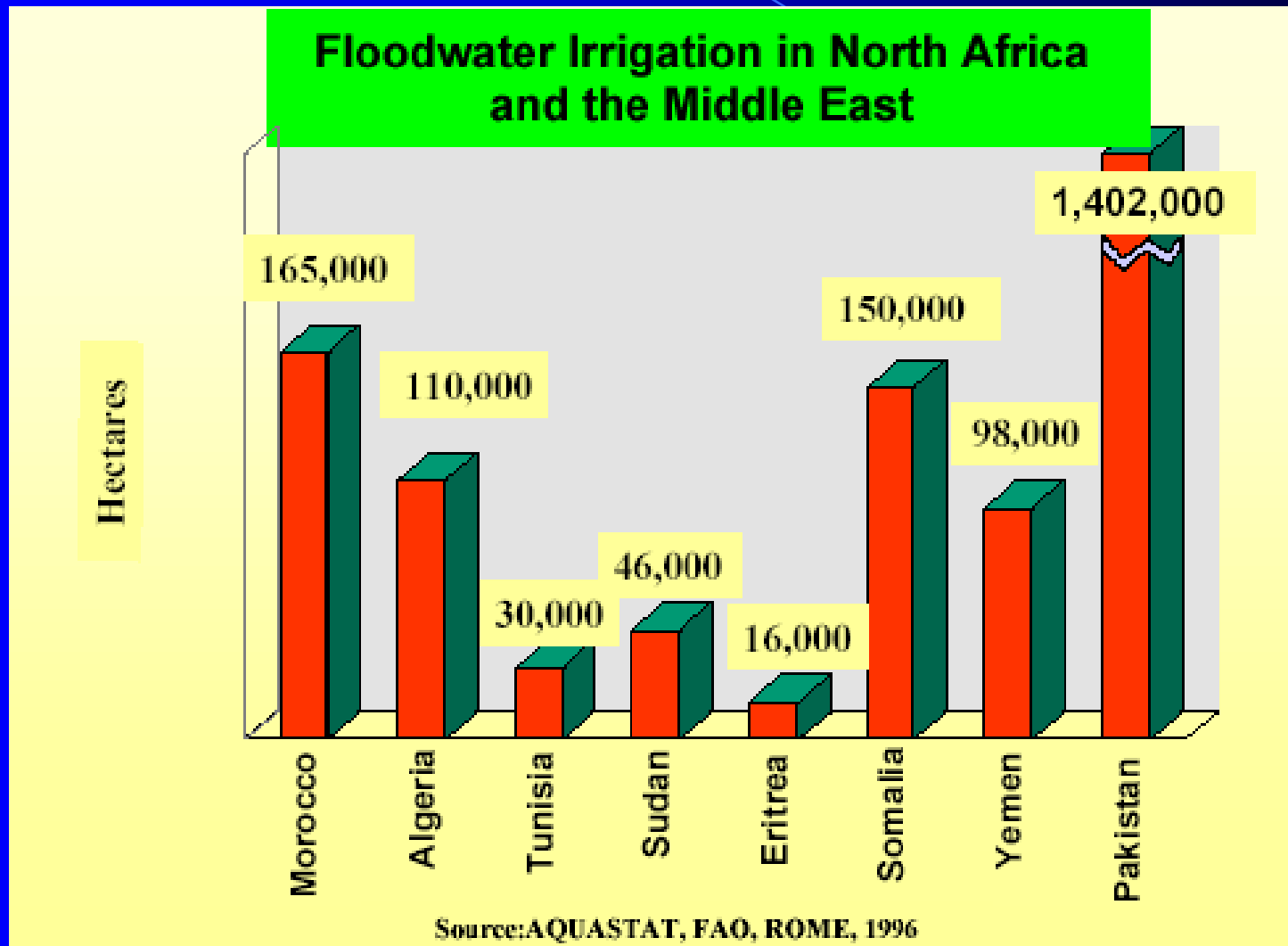
Flood water harvesting and spate irrigation in Yemen

Flood Water Harvesting

- Spate Irrigation in wadis
 - diversion structures
 - traditional

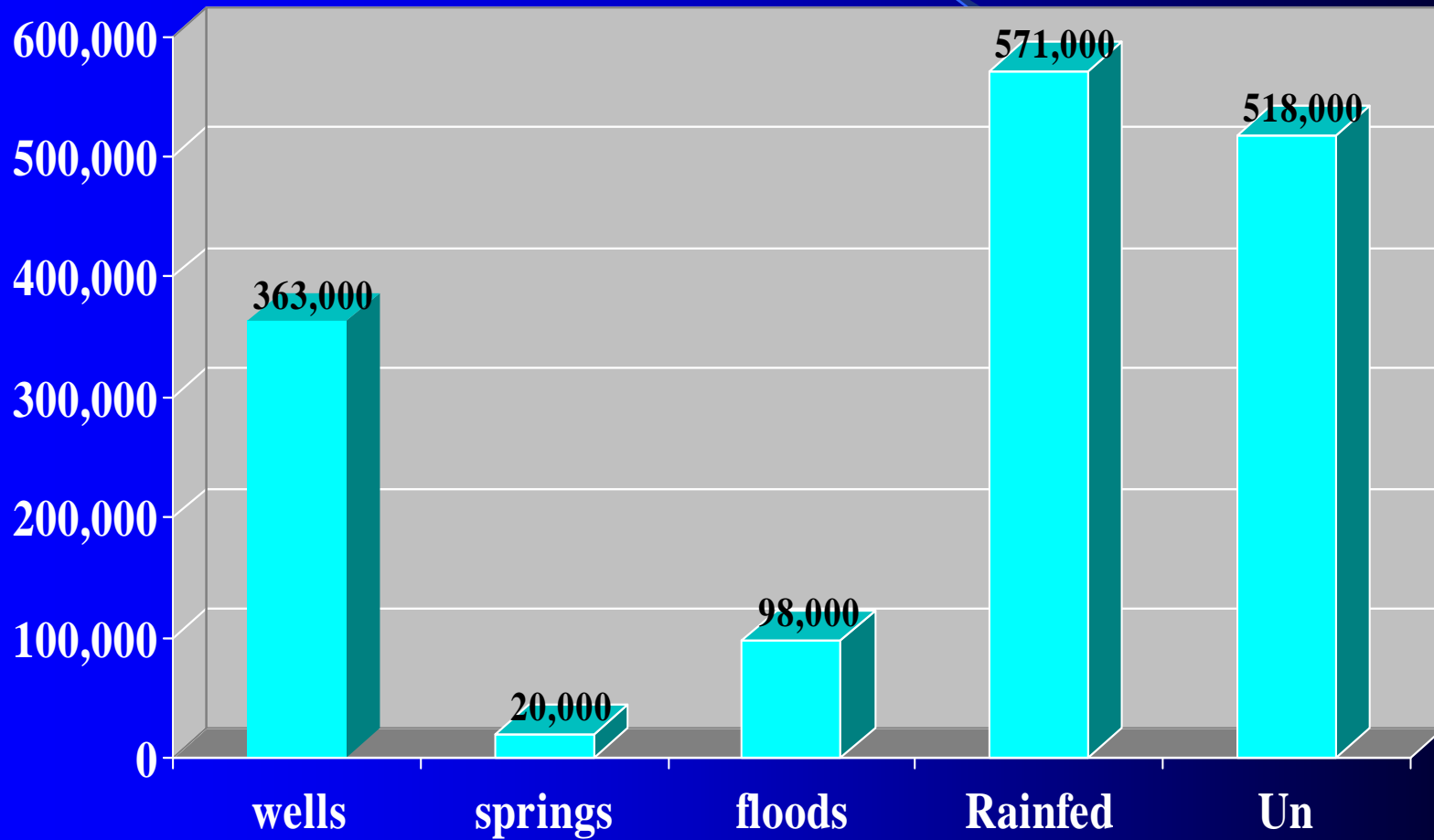


Area under spate irrigation in Yemen and others countries





Total areas cultivated with different Practices





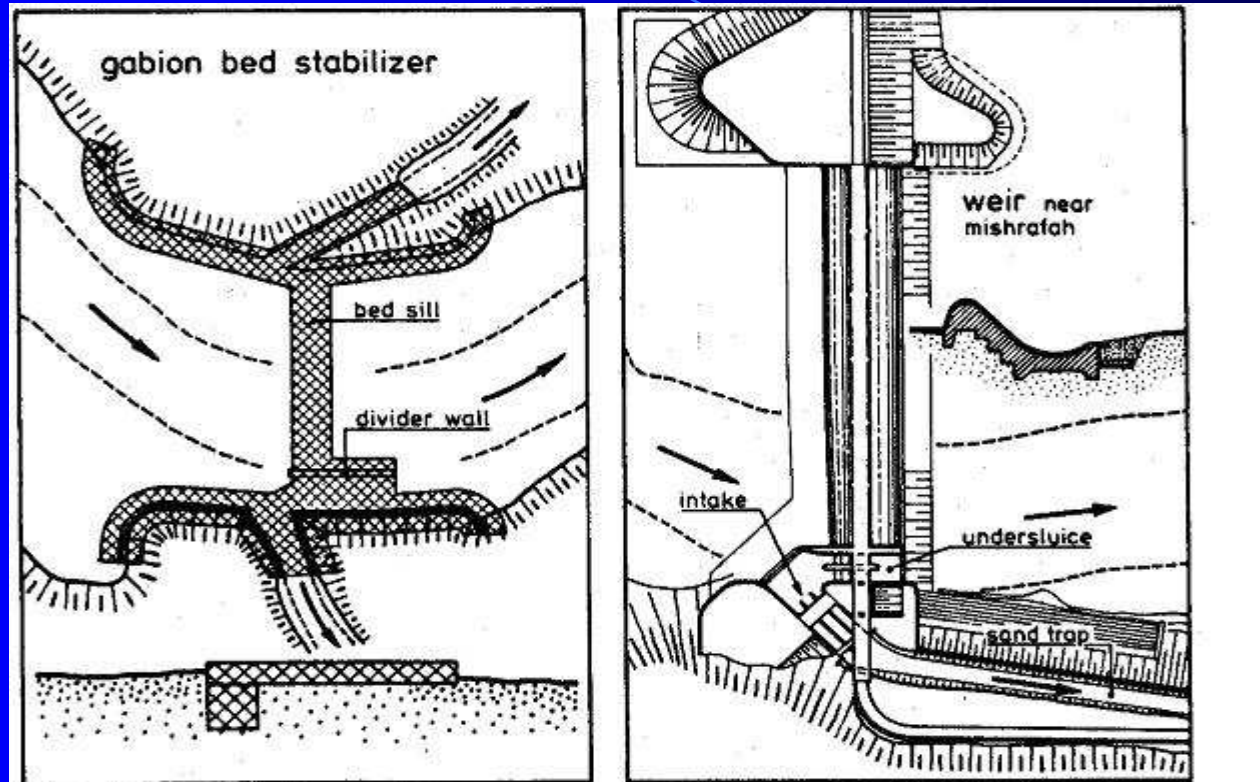
SPATE IRRIGATION IN YEMEN



Diversion structure in Wadi Rima', Yemen 36



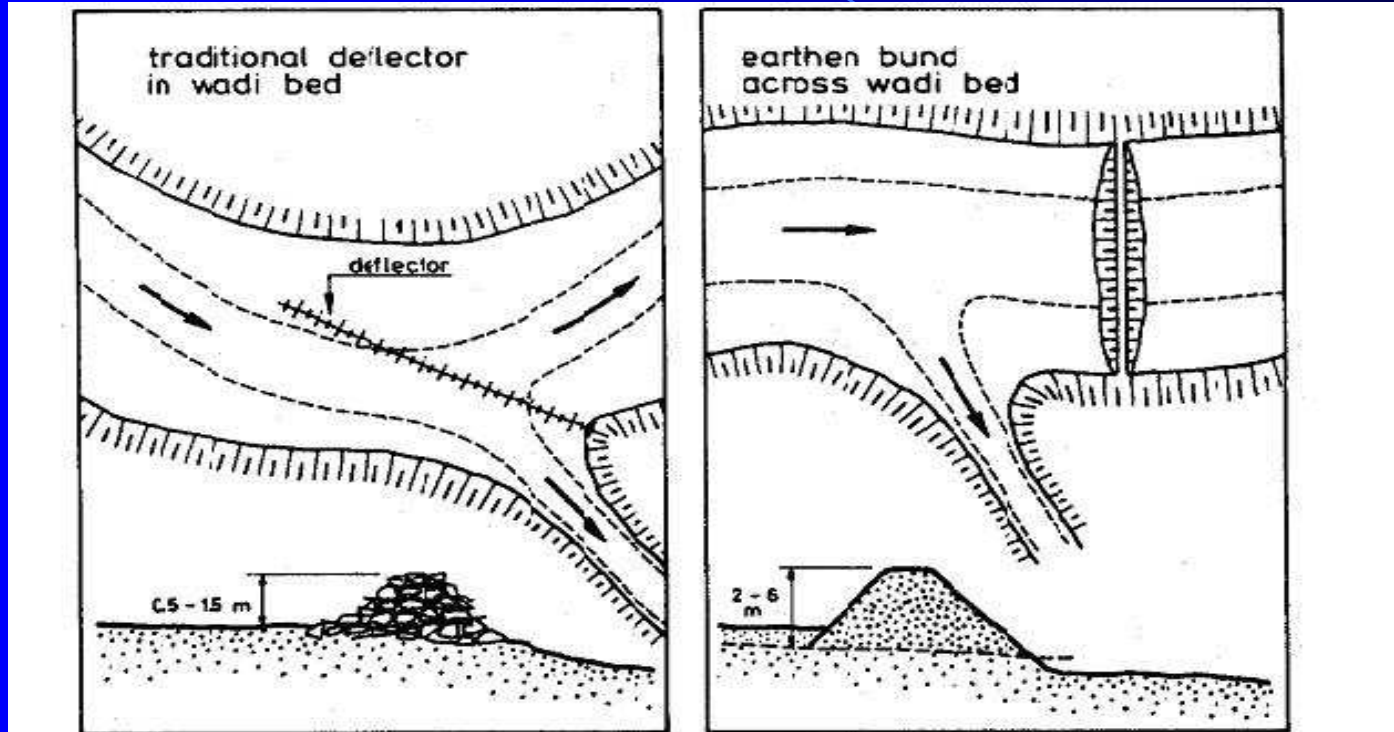
Spate Irrigation in Yemeni Wadis



Diversion structures in Wadi
Rema'a



Spate Irrigation in Yemeni Wadis



Traditional deflectors and earthen bund in
Wadi Rema'a

Existing Traditional Spate in Wadi Surdud

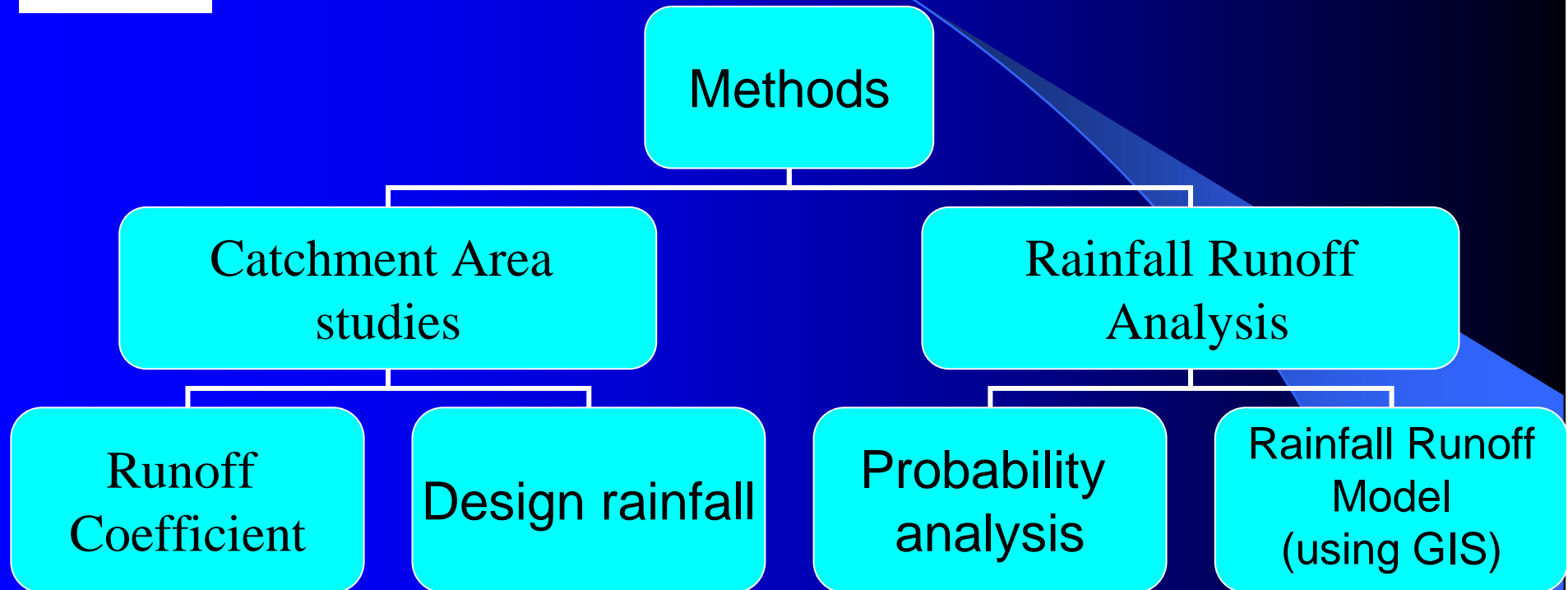


Existing Traditional Spate in Wadi Zabid





Approaches to determine water harvesting potential





Catchments area Studies

$$\frac{CA}{CUA} = \frac{CWR - DR}{DR \times RC \times EFF}$$

CA = Catchments Area

CUA = Cultivated Area

CWR = Crop Water Requirement

DR = Design Rainfall

RC = Runoff Coefficient

EFF = Factor Efficiency

Socio- economic aspects

If the technical and economic feasibility of a water harvesting project is given, the success will depend on the following aspects related to sociology



Socio- economic aspects

PEOPLES' PRIORITIES

Main interest: subsistence

- food security
- sanitation
- safe water
- independence
- jobs / income



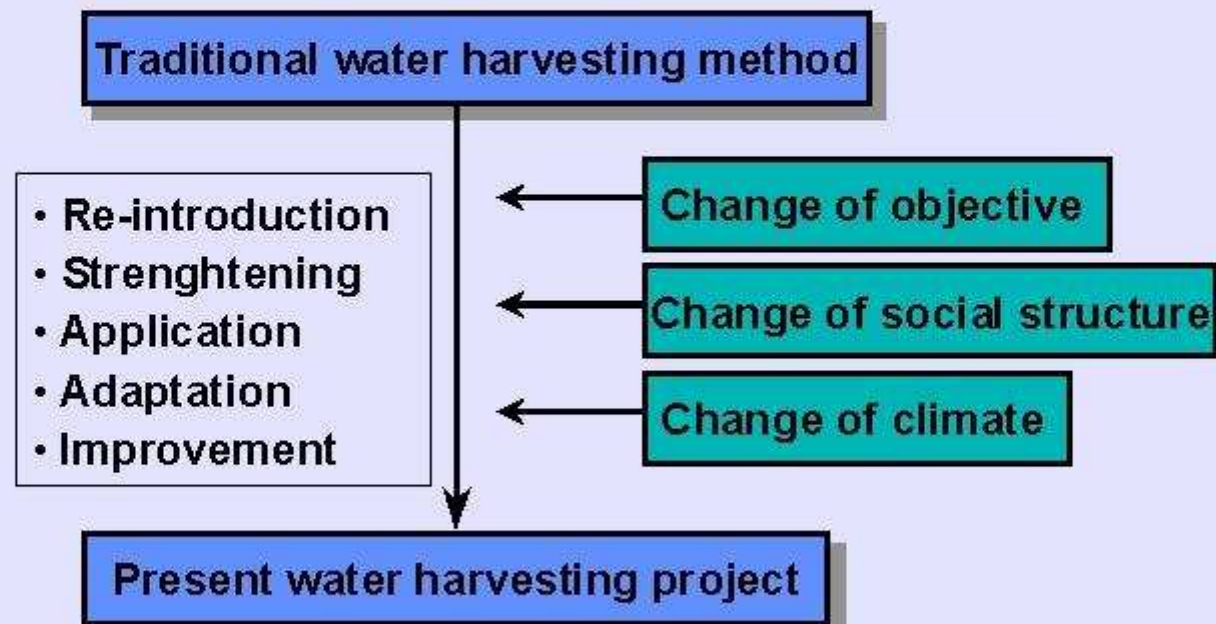
Interest in water harvesting ? Interest in sustainability ?



- small-scale projects
- low-cost projects
- low labour input
- fast pay-off of investments
- integrated projects
- fields close to homesteads (4-5 km)
- information / motivational campaigns

Socio- economic aspects

PEOPLE'S EXPERIENCE WITH WATER HARVESTING TECHNIQUES



Socio- economic aspects

AGRICULTURAL PRACTICE

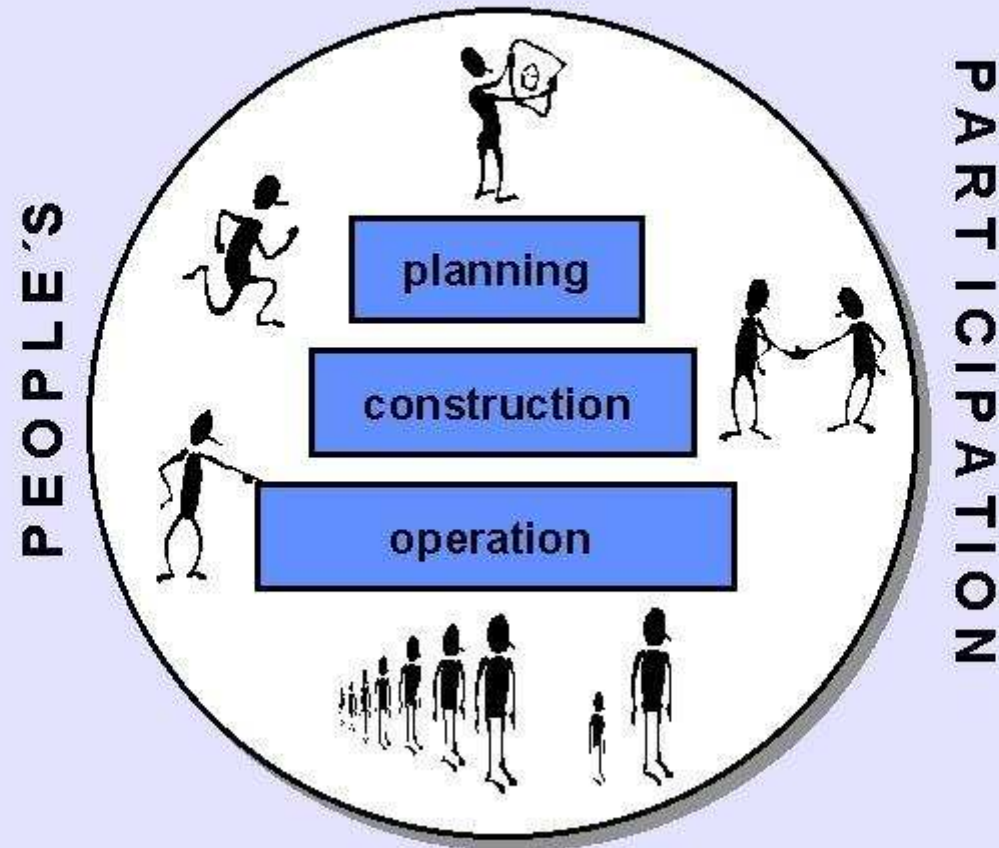
- Farming system
 - Crops only
 - Crops + livestock, etc.
- Cropping system
 - Terraces, etc.
- Tillage
 - With animals
 - By hand
- Crop preference
 - Sorghum
 - Maize, etc.



Try to keep to previous agricultural practice

Socio- economic aspects

PEOPLE'S PARTICIPATION



Socio- economic aspects



SOCIO-ECONOMIC FACTORS - SUMMARY

- The farmers should be aware of the advantages and benefits of WH
- The farmers / village council should be
 - x involved in the planning process
 - x able and willing to organize construction, management + maintenance
- Implementation is easier in case of small scale, quick pay-off, low cost, low labour input, if group work is customary and land tenure individual
- Local experience with water harvesting should be taken into account
- Men and women, elders and young as well as the poorest should participate in all aspects of water harvesting (depending on the culture)

Role of Water Harvesting

- Increases the productivity of land, which suffers from inadequate rainfall.
- Combats desertification by tree cultivation
- Reduces dependency on groundwater as an alternative source for irrigation

Role of Water Harvesting

- Conserves land and protect it from erosion
- Encourages the application of traditional techniques.
- Enhances community participation and awareness.

Research Needs

- Evaluate the possibilities for optimizing water use efficiency.
- Studies that critically evaluate the experiences with the implementation of WH systems.
- The use of traditional water harvesting systems as a starting point for the new WH projects.

Conclusion

- Appropriate systems should ideally evolve from the experience of traditional techniques
- The government must strengthen rain fed agriculture and traditional methods of RWH.
- Using harvested rainwater helps in decreasing the use of groundwater
- Rainwater harvesting should be accepted by local population, and be sustainable in local environment
- With good maintenance, terraces will continue to supply households with crops

Conclusion

- The selection of the spate irrigation system requires a very clear understanding and appreciation of traditional water rights and operating arrangements
- Future interventions in spate irrigation should favor low-cost diversion structures and avoid sophisticated technical solutions
- WH require local capacity building agriculture extension services, and training

Recommendation

- The planning of WH systems should be part of IWRM plan
- Beneficiaries should be involved in all aspects project cycle of WH systems
- **Attention must be given to social and economic aspects: gender land tenure, water rights etc..**

Recommendation

- The rich knowledge in WH in Arab world should be researched and documented
- Cooperation between scientists and practitioners involved in water harvesting in the Arab countries and globally.
- The necessity of Institutional capacity building in WH

Recommendation

- Learning from failures and successes, a high degree of sustainability might be reached.
- Local resource users should be involved in all aspects of the planning and implementation of water harvesting systems.

Recommendation

- Planning should consider the effect on downstream water users by the implementation of WH
- More investigation is needed on the various parameters contributing to the fog collection

Water is Life

Thank You