Small-Scale Projects to Put People to Work At Rehabilitating Degraded Watersheds In Afghanistan

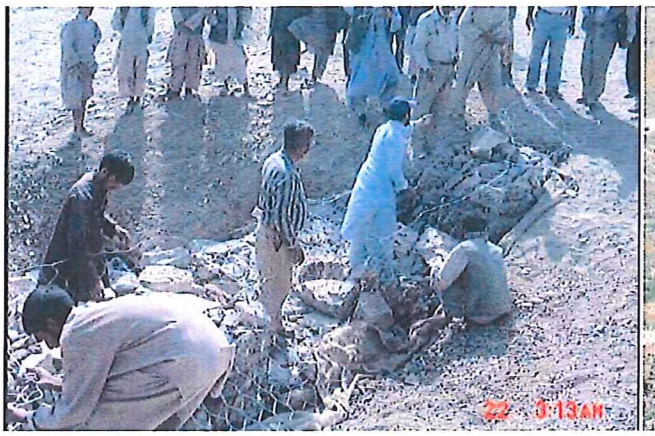
Fort Worth, Texas
13-17 August, 2012

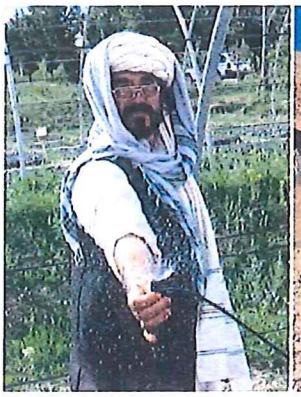
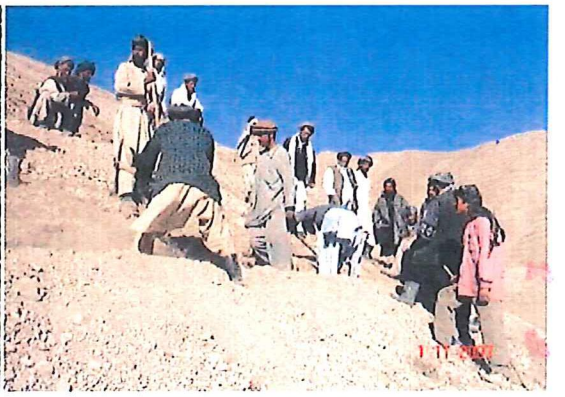
Training provided by the U.S. Department of Agriculture for the Nebraska, Wisconsin, and Georgia National Guard Agribusiness Development Teams

The following pages are excerpts from the Watershed Rehabilitation training manual and materials developed by Jon Fripp (Civil Engineer, USDA/NRCS) and his colleagues. Five modules are included. The complete manual includes 30 modules and technical annexes. For additional information on this manual and other training materials, contact Jon Fripp – jon.fripp@ftw.usda.gov.

(TRAINING MATERIALS EXCERPTS)

Small-Scale Projects to Put People to Work At Rehabilitating Degraded Watersheds In Afghanistan

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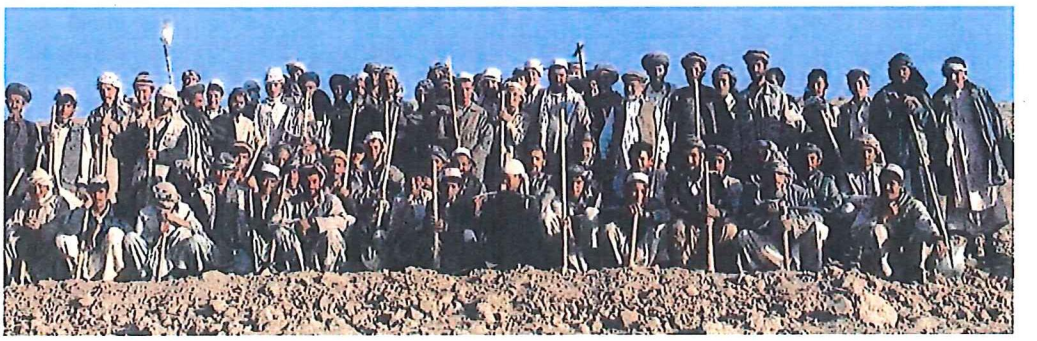

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U.S. Army National Guard

Agribusiness Development Team (ADT) Training Manual

This document provides an overview of the topics covered and training materials used for training of National Guard troops prior to their mobilization to Afghanistan as ADT Teams. The training consists of classroom presentations, classroom exercises and field exercises.

Training Materials Cover page

Credits

Table of Contents

Sample modules:

5 - History of Greening Work in Afghanistan

6 - Nursery Design and Operations

7 - Overview of Effective Reforestation

8 – Windbreaks and

18 - Water Supply Overview and Sources

This watershed rehabilitation and restoration training was prepared and presented by the U.S. Department of Agriculture (USDA) team of Melvin Westbrook (Director USDA-NRCS/IPD), LeRoy Duvall (International Program Specialist, USDA-NRCS/IPD), Matt Stellbauer (Development Resources Specialist - USDA Foreign Agricultural Service), Jacob Robison (Civil Engineer – USDA/NRCS), Phuc Vu (Civil Engineer – USDA/NRCS), Richard Weber (Civil Engineer – USDA/NRCS), Chad Ellis (Rangeland Management Specialist – USDA/NRCS), and Jon Fripp (Civil Engineer – USDA/NRCS).

Contact Jon Fripp at jon.fripp@ftw.usda.gov for more information on this workshop.

U.S. Department of Agriculture (USDA) Training with the Nebraska, Wisconsin, and Georgia National Guard Agribusiness Development Teams On Small-Scale Projects To Put People to Work at Rehabilitating Degraded Watersheds in Afghanistan

Fort Worth Texas
13-17 August, 2012

Workshop Description

Summary: This 4 day workshop will address a variety of basic soil and water conservation techniques that are potentially useful in the rehabilitation of degraded watershed. Learning will be accomplished with a combination of the following:

- Lecture and discussion of different techniques grouped as training modules
- In class exercises and demonstrations
- Field exercises and demonstrations

Basic materials/equipment will be available. The use of the equipment will be discussed during the workshop modules. The materials and equipment will be sufficient to conduct basic level investigations, create designs, and implement projects along the lines of what is presented in the workshop. Students should bring a calculator and materials for taking notes.

Module Topics:

The following topics will be presented and discussed on a basic / low tech level.

- Upland Watershed Rehabilitation
- Reforestation
- Rangeland Management
- Streams and River Bank Stabilization
- Irrigation
- Water Supply /Water Filtration
- Small pond design, stakeout, and construction
- Design, survey and stakeout of basic soil conservation practices

Agenda:

The following agenda indicates the topics that will be covered by day. The schedule is flexible and additional time may be allocated to topics based on the interest of the workshop participants.

Day 1 (Monday, 13 August)

Morning (start at 1:30):

- Greetings (0.5 hr) **GM**
- Overview of Workshop / Introductions (0.5 hr) **JF 1**
- USDA NRCS-IPD roles and capabilities(0.5 hr) **MW 2a**
- USDA-FAS roles and capabilities(0.5 hr) **MS 2b**
- Development Issues (0.5 hr) LD **3a**
- Example Development Project – Water Development in Guatemala (1 hr) **PV 3b**

(end at 5:00)

Day 2 (Tuesday, 14 August)

Morning (start at 9:00):

Introduction

- Watershed Zones (0.5 hr) **JF 4**

Reforestation

- History of greening in Afghanistan / development work (0.25 hr) **JF 5**
- Nursery Design and Operations (0.25 hr) **JF 6**
- Overview of Effective Reforestation (0.25 hr) **JF 7**
- Windbreaks (0.25 hr) **JF 8**

Upland Watershed Rehabilitation

- Soils for Planners (1 hr) **PV 9**

Lunch 11:30- 12:30

Afternoon:

Upland Watershed Rehabilitation (cont'd)

- Planting in dry areas (0.5 hr) **JF 10**
- Basic Surveying (0.5 hr) **JR 11**
    - Class Room Exercise: Survey Hand Levels (0.5 hr) **JR**
- Terraces and Hillside Ditches (0.5 hr) **JF 12**
- Example Development Project – Agriculture Development in Afghanistan (0.5 hr) **MM 13a**
- Rangeland Management Overview(0.5 hr) **MM 13b**
- Rangeland Management in Afghanistan (0.5 hr) **MM 14**
    - Field Exercise: Grazing measurements (1 hr) **MM 15**

(end at 5:00)

Day 3 (Wednesday, 15 August)

Morning (start at 9:00):

Upland Watershed Rehabilitation (cont'd)

- Check Dams (0.5 hr) **JF 16**
- Gabions (0.5 hr) **JF 17**
    - Class Room Exercise: Gabion Construction (0.5 hr) **JF**

Water Supply and Treatment

- Water Supply Overview and Sources (Diversions, wells, etc) (0.5 hr) **JF 18**
- Spring Development (0.5 hr) **JF 19**

Lunch 11:30-12:30

Afternoon:

Water Supply and Treatment (cont'd)

- Filtration (1.0 hr) **JF 20**

Soil Investigation

- Soil Science (0.5 hr) **PV 21**
    - Class Room Soil Exercise (0.25 hr) **PV**
- Soil Mechanics (0.5 hr) **PV 22**
    - Class Room Soil Exercise (0.25 hr) **PV**

- Compost and its uses (0.5 hr) **PV 23**

Irrigation

- Overview of types (0.5 hr) **RW 24**
- Drip Bucket (0.5 hr) **JF 25**
    - Field Exercise Drip Bucket Construction (0.5 hr) **JF**

(end at 5:00)

Day 4 (Thursday, 16 August)

Morning (start at 9:00):

Small Ponds

- Community Pond Design Overview (0.5 hr) **RW 26**
    - Field Exercise: Survey and Pit Pond Stakeout (2 hr) **RW**

Lunch 11:30- 12:30

Afternoon:

Streams and Rivers

- Riparian Buffers (0.5 hr) **JF 27**
- Soil Bioengineering (0.5 hr) **JF 28**
- Riprap Design (0.5 hr) **JF 29**
- Stream Deflectors (1 hr) **JF 30**

Survey and Design of Soil Conservation Practices

- Field Exercise: Site Survey (2 hr) **JR**

(end at 5:00)

Day 5 (Friday, 17 August)

Morning (start at 9:00)

Survey and Design of Soil Conservation Practices (cont'd)

- Class Room Exercise: Survey Reduction and Design of Watershed Practices (1 hr) **JR**
- Field Exercise: Stakeout of watershed practices (1.5 hr) **JR**

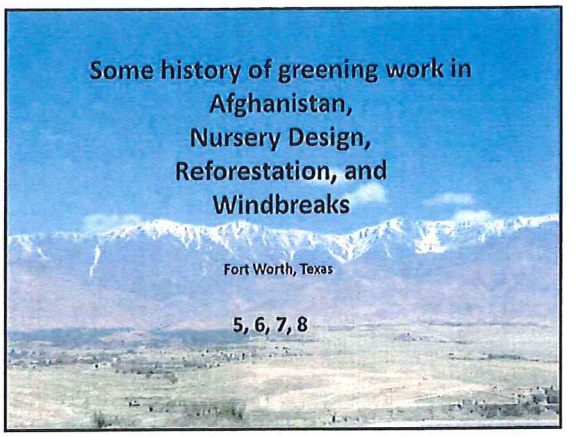
Summary and closeout (0.5 hr) **GM/JF**

Class End 12:00

Instructor Cadre

GM: Maj. Guy Moon
MW: Melvin Westbrook
MS: Matt Stellbauer
LD: LeRoy Duvall
MM: Matt Machacek
PV: Phuc Vu
JR: Jacob Robison
RW: Rich Weber
JF: Jon Fripp

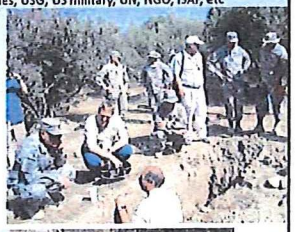
Modules 5, 6, 7 & 8



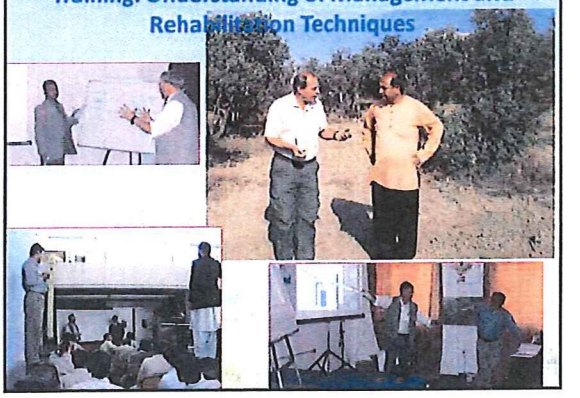
Training, demonstrations and workshops

Afghan Government Ministries, ACC, Universities, USG, US military, UN, NGO, ISAF, etc

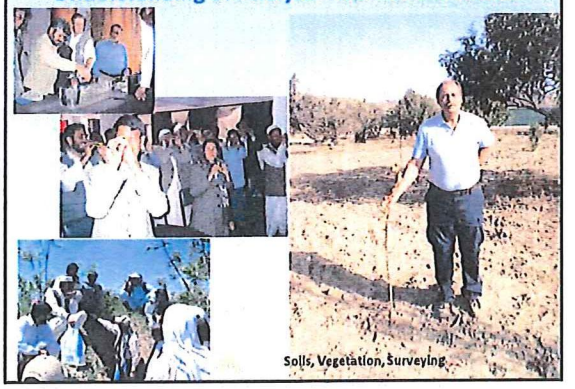
- Basic Surveying
- Terraces and hillside ditches
- Gabion construction
- Stream bank soil bioengineering
- Rip rap design
- Stream deflectors
- Riparian buffers
- Windbreaks
- Irrigation
- Soils
- Grazing Management
- Planning
- Watershed assessments
- Compost and soil amendments
- Compost Toilets
- Water treatments
- Water testing
- Slow and fast sand filters
- Reforestation
- Water supply
- Cisterns
- Nursery design
- Nursery operation
- Check dams



Training: Understanding of Management and Rehabilitation Techniques



Understanding of Analysis and Measurement



Understanding of Management and Rehabilitation Techniques

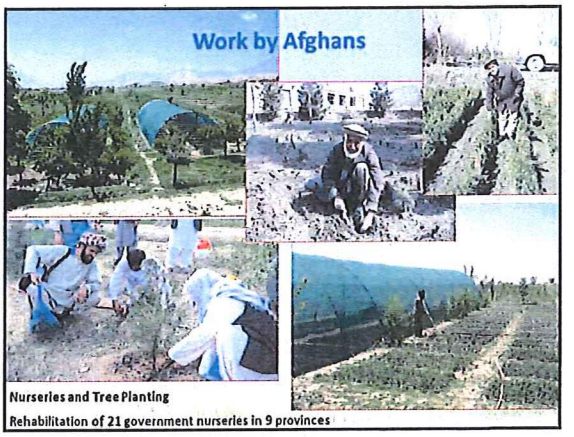
Nurseries and Tree Planting

3.5 million saplings produced

Farmers- managed on-farm demonstration

Farmers- managed on-farm demonstration

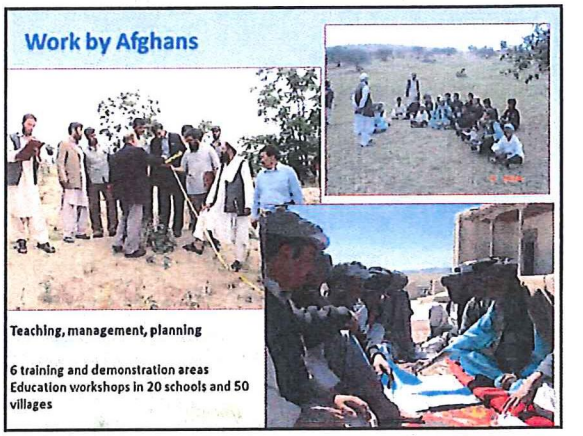
Work by Afghans



Nurseries and Tree Planting

Rehabilitation of 21 government nurseries in 9 provinces

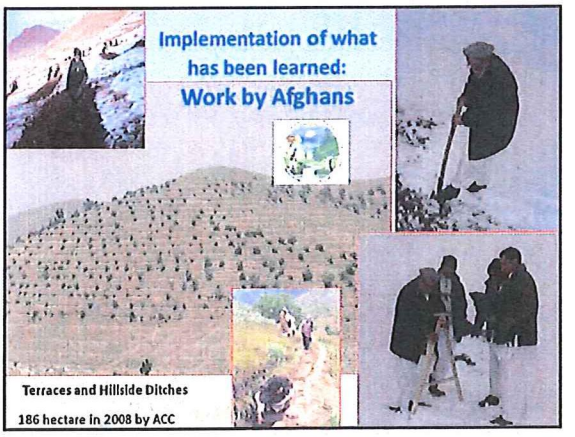
Work by Afghans



Teaching, management, planning

6 training and demonstration areas
Education workshops in 20 schools and 50 villages

Implementation of what has been learned: Work by Afghans

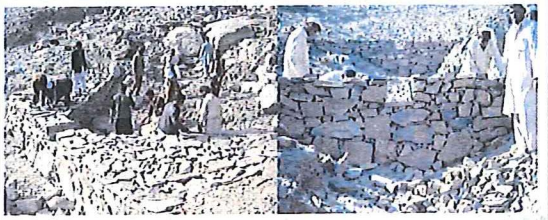


Terraces and Hillside Ditches

186 hectare in 2008 by ACC

RESULTS IN FIRST MONTH- JANUARY 2011

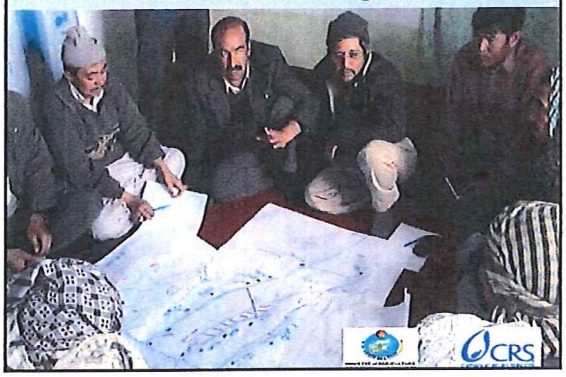
- 193 CHECK DAMS IN 15 DISTRICTS
- AVERAGE COST PER DAM = $48

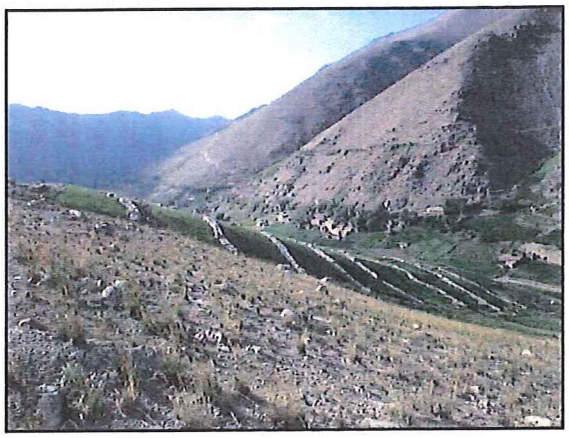


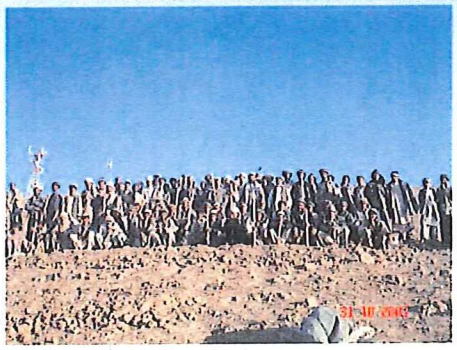
OTHER RESULTS IN JANUARY 2011

- 2800 m of TERRACE IN 4 DISTRICTS
- FOUR TRIBAL ENGAGEMENTS
- COLLABORATION WITH UN WORLD FOOD PROGRAM for DELIVERY OF 72 TONS OF FOOD IN 18 DISTRICTS WITHOUT ANY UNACCOUNTED COMMODITY LOSSES OR SECURITY INCIDENTS

NRM Planning





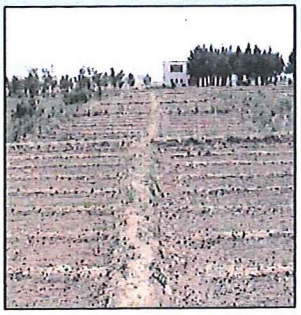


Nursery Design

1.) Site Selection
- •Soil Considerations
- •Climate Considerations
- •Water Considerations

2.) Layout & Irrigation
- •Nursery Layout
- •Roads & Drainage
- •Irrigation Water

3.) Site Preparation
- Soil Management
- Field Cultivation
- Seedbed Preparation



Site Selection

•Water Considerations

1.) Availability

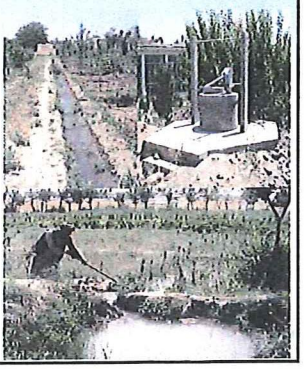
Available in reliable quantities sufficient for irrigation (1/2 inch in 8 hours).

2.) Quality

Water quality for irrigation (No harmful minerals or organic substances).

3.) Proximity

Close enough to the nursery to be gravity fed.



Layout & Irrigation

•Irrigation

1.) Forest nurseries need 4 to 6 inches of rainfall a month over during the growing season.

2.) Water sources may be wells, streams, springs or surface flow.

3.) Two characteristics of water must be known in order to estimate quality:
- •Total concentration of salts
- •Percent of sodium

4.) Water with a high silt or colloidal content may the soil surface and reduce aeration.

5.) Water containing 500 ppm of calcium , or a pH above 8.3, is likely to raise the pH of the soil.

Nursery Operations

1.) Types of Forest Seedling Production

2.)Advantages and Disadvantages of Production Methods

3.) Seedling Production
- Container
- Bareroot
- Polybag
- Recycled Water Bottle

4.) Greenhouse Operation

5.) Shadehouse Operation

6.) Seed Handling

Nursery Production of Forest Tree Seedling

There are two main nursery production methods of forest tree seedlings:

Bareroot

Container

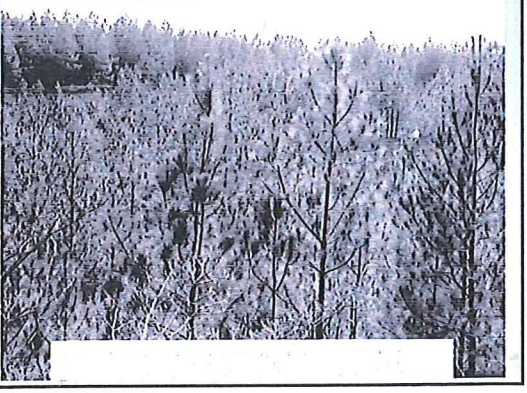
Polybag*

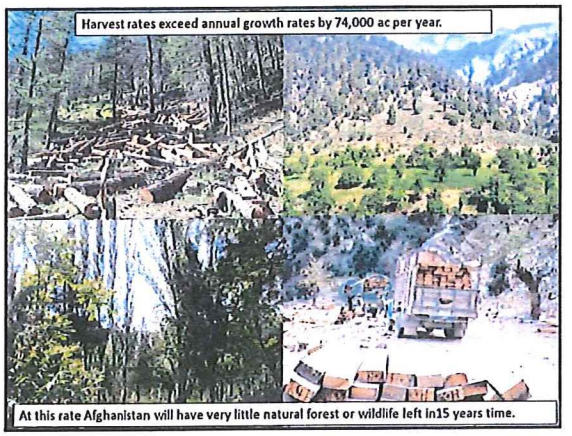
*Polybags are a type of container that are an appropriate technology that is unique to the developing world.

Water Bottle Container Seedling Production

Principles:
1. Bottom hole allows for drainage (reducing salt accumulations).
2. Side slits reduce root spiraling.
3. Pruning of lateral and tap roots through aeration
4. Large top opening allows for development of large seedling diameter.
5. Long container length allows for long root development
6. Smaller containers (.5 l) for seedling production (1-2 years)
7. Larger containers (>1 l) for sapling production (> 2 years)

Reforestation





Definition of "Effective Reforestation"

Sustainable (healthy, long-term viability.

The project meets desired goals and objectives.

Planting the right trees in the right places.

Components of "Effective Reforestation"

First part: Planning (one-third)

Second part: Execution (one-third)

Third part: Monitoring (one-third)

Examples of Effective Reforestation in Afghanistan

Four Steps For Effective Reforestation in Afghanistan

1. Clearly Stated Objective (Goal) of Planting

Why It's Important:

a. This becomes the "what"
b. "Desired Future Condition" is identified
c. "If you don't know where you are going, any road will get you there."
d. Must be attainable.
e. Must be "ecologically compatible" (Douglas-fir for Kabul Greenbelt is very poor choice)

Examples:

a. *Populus* pole production for houses
b. Re-establish natural woodlands for fruit production
c. Re-establish natural woodlands for wood production

2. Consultation/Community Involvement

Why It's Important:

a. This becomes the "who"
b. Understanding of need of the project
c. Increased participation (historical record, reduced vandalism)
d. Potential for improved project through collaboration
e. Greater chance for longevity of project after project life

Examples:

a. Meet with community leaders on project acceptance
b. Meet with local farmers on local practices
c. Identify local expert or "champion"

3. Establish Standards and Guidelines

Why It's Important:

a. This becomes the "how"
b. These become the "roadmap"
c. These become the details; must be specific
d. The more complete the details, greater chance of success
e. Identifies weakness to strengthen

Examples:

a. What tree species to plant?
b. Where is the source?
c. Identifying the "target seedling" for the specific sites.
d. What is the site preparation prior to plantings? How? Who?
e. What is the post-planting care? How? Who?
f. Where will the funding come from? 'For how many years?
g. Provide training workshops to employees.
h. Seek out and retain skilled advisors.

4. Monitor the Process and Results

Why It's Important?

a. Did we reach our destination?
b. Did we begin to accomplish our stated objective?
c. Did we follow the established standard and guidelines?
d. Does the community still support our joint project?
e. Could we improve our results with a change standards/guidelines?
f. Is this objective simply unobtainable; should it change?
g. Monitoring should occur all long the process, not just at the end.

Examples:

a. Seedling survival surveys every first, third, fifth years.
b. Changes in technology from planning stage to implementation stage.
c. Are there standards/guidelines that could be changed to get same or improved result?

3.) Standard and Guidelines: Target Seedling Concept
"Planting the Right Size Trees in the Right Places"

Rural Planting Sites

Urban Planting Sites

4.) Technology Transfer Needs

Sapling Handling at the Nursery

1. Limiting factor in tree growth and development is moisture;
2. Limit root exposure to sun/winds to 30 seconds;
3. Remove trees from nursery soils when soils are moist;
4. Use moist soil for packing roots for temporary storage;
5. Minimum root length should be 25 cm;
6. Keep roots out of direct sunlight (prevents drying);
7. Once trees are harvested from nursery, move quickly to temporary storage;
8. Trees should be dormant (not actively active) when harvested.
9. Trees must have adequate root mass when harvested.

Transporting Saplings to Planting Site

1. Protect trees' roots from drying (sun, wind) by covering;
2. Avoid damage to trees by rough handling;
3. Avoid contact of trees with petroleum;
4. Transport trees quickly to planting site;
5. Provide protection for seedlings at planting site.

Tree Planting

1. Harvest from nursery only enough trees for that day's planting;
2. Have an adequate sized crew;
3. Have the tools and supervision available;
4. Crew should receiving training in tree handling and planting prior to planting;
5. There must be adequate soil moisture before planting;
6. Select planting sites well before planting day; match tree species and sizes to the sites.

Site Preparation

1. Dig holes immediately prior to planting;
2. Must have adequate soil moisture at planting;
3. Avoid digging holes days prior to planting;
4. Pre-dug holes could be dry (too dry);
5. Pre-dug holes could be full of water (too wet);
6. Dig hole just large enough for root system;
7. If necessary remove weeds from planting hole prior to planting.

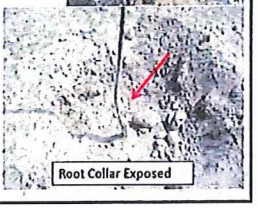
Hole Too Large for Root Mass

Planting Depth

1. Trees must be planted at the "root collar " (the same depth they grew in the nursery);
2. No roots must be exposed to sun and drying winds before planting;
3. Planting depth = that point where above-ground and below-ground meet;
4. Firmly pack loose soil around seedlings' roots (no air pockets);
5. Create shallow "bowl" (2 cm depth) for water collection.

Trees Planted Too Deep

Trees Planted Too Shallow



Root Collar Exposed

Pruning After Planting

1. Prune no more than 50% height of planted tree (2m height = 1m pruned);
2. Leaves produce food for tree;
3. Limited leaves = reduced food production for tree = greater chance of mortality.

Poor pruning

Poor Root Systems Are Tree Killers

1. Poorly developed root systems will restrict moisture update;
2. Fibrous roots are critical for moisture uptake;
3. Larger roots are critical for support;
4. Long roots absorb sub-surface soil moisture during dry periods;
5. Minimum root length for conifers 25 cm;
6. The larger the top of the conifer, the larger the root system needed;
7. Ideal conifer shoot/root ratio is 1/1.

Tree Mortality Caused by Poor Root Development; Trees Planted with Too Small Root Ball

Post-Planting Care: Irrigation

1. Helps eliminate air pockets after planting;
2. Keeps root zone moist;
3. Must be thorough watering;
4. Must be done every 2 weeks during first growing season.

Post-Planting Care: Protection

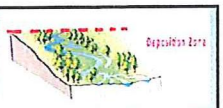
1. Protect saplings from human traffic;
2. Protect saplings from grazing;
3. Protect saplings from housing developments;
4. Protect tree with: fencing, guards, laws with penalties.

Introduction to Windbreaks

2011

8

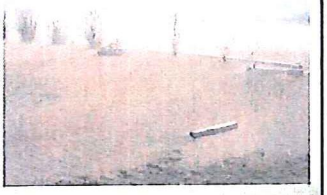
Soils In the deposition zone are poorly developed.



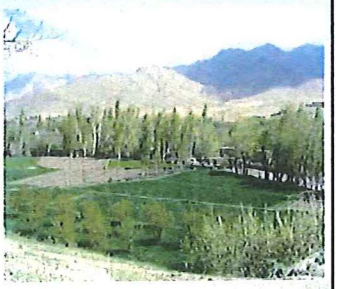
As a result they have little Structure and may be loose.

In open areas with high winds these loose soils become Airborne and damage crops.

Windbreaks can be used to prevent this damage from happening.



- Windbreaks shield agricultural fields from the wind damage
- They can protect livestock from cold winter winds
- They can be planted with fruit and nut trees
- They can trap additional moisture as snow on the downwind side

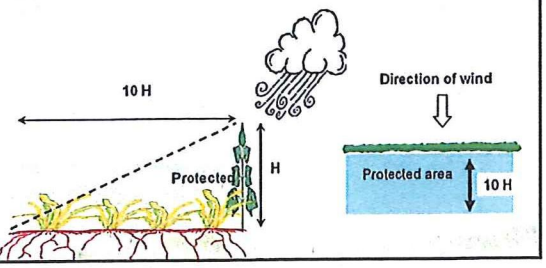


Planning and Design of a windbreak

- Prepare planting bed
  - Dig up planting site
  - Level and pack planting bed
- Layout planting plan
  - Stake rows
  - Mark where holes are to be dug
  - Mark where different plant species go
- Dig holes and put water in the hole
  - Dig holes twice the diameter of the root ball
  - Dig holes deeper than the length of the longest roots
- Plant trees and shrubs
- Care and Maintenance

Planning a windbreak

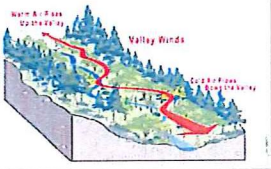
- In general, a windbreak will protect an area that is 10 times the height of the highest tree at maturity
- Some protection will occur from 20 to 25 times the height
- Plant the rows perpendicular to the normal wind direction



Where to place windbreaks on a field

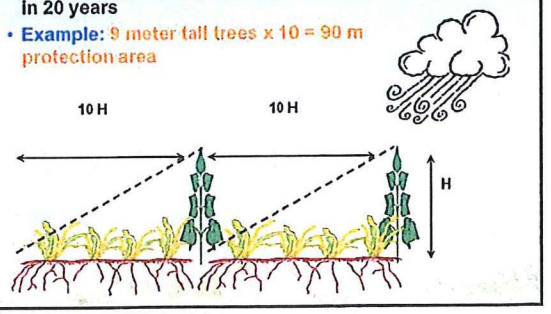
Question
How can you tell what is the most common wind direction?

Answer:
- Ask someone who lives in the area
- Look at existing trees
- Valley winds move along the valley floor, place the windbreaks across the valley



The distance between the windbreaks

- The distance between rows should be 10 times the height the tallest trees will get in 20 years
- **Example:** 9 meter tall trees x 10 = 90 m protection area



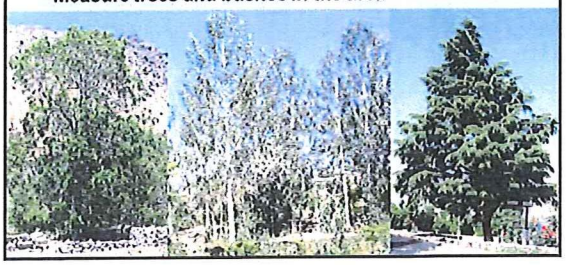
The distance between the windbreaks

Question

How can you tell how high a tree or bush will get?

Answer:

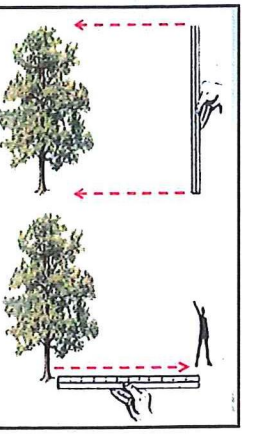
- Ask a plant expert
- Measure trees and bushes in the area



Quick way to measure height

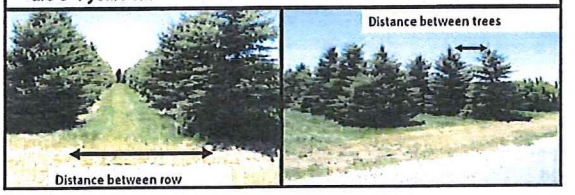
1. Hold a stick at the end of your arm and back away until the top and bottom of the stick is lined up with the bottom and top of the tree.
2. Turn the stick so it is parallel to the ground.
3. Line one end up with the tree trunk.
4. Have a partner measure from the base of the tree until you see him at the end of the stick
5. That is the approximate height of the tree.

Also use this technique to assess tell how effective an existing windbreak is protecting a field

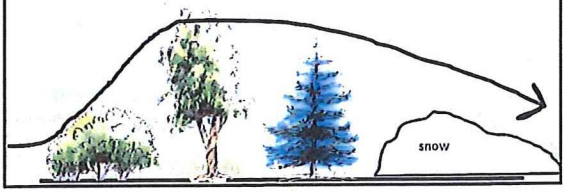


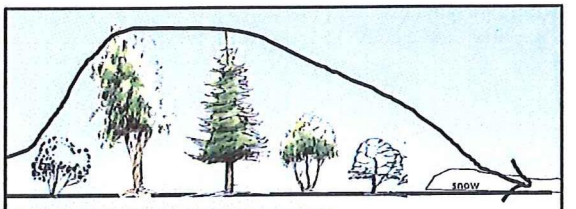
Spacing of the windbreak and how close the plant species should be planted

- 1 to 5 rows of trees or shrubs should be used
- The distance between the trees depends upon the species and the mature height
  - Plant to make a dense barrier
  - Do not plant too close so as to stress the plants
- The distance between the rows should be 3 - 4.5 meter
- Plant grass between the rows to reduce weed growth after the trees are 3-4 years old



- Plant shrubs to increase the density near the ground and help trap snow
- Plant evergreen trees on the downwind side of the windbreak
- Plant the windbreak rows close enough together to make a wind barrier within 10 years
- Plant the individual trees and shrubs close enough to create a barrier but not close enough to stress the plants

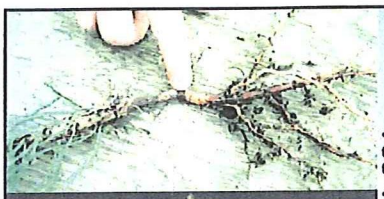




- 5 row windbreaks spread the snow out more than 3 row windbreaks
  - Spreads snow out more
  - Less big drifts
  - Snow is easier to manage

Layout the Planting design on the ground

- Mark the beginning and end of each row
- Identify which species goes in each row
- Mark each hole location based on the spacing for the species
  - This will be different for trees and shrubs

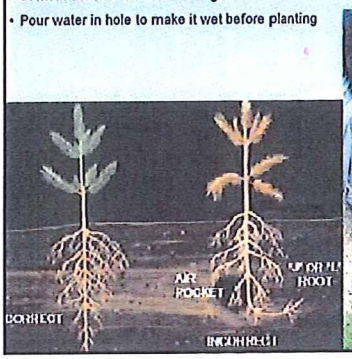


Planting a windbreak

- Collar is where the stem tissue meets the root tissue
- Plant the collar at or slightly below the ground surface

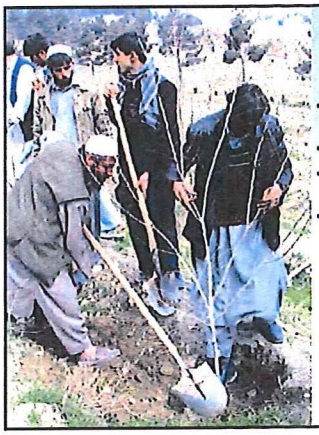
- Dig the hole twice as wide as the root ball
- Dig the hole deep enough that all the roots hang down in the hole without curving
- Pour water in hole to make it wet before planting

Planting a windbreak



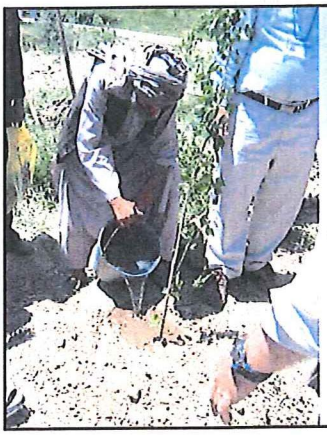
Planting a windbreak

- Place root ball in the hole
- Hold tree so collar is at ground surface
- Place soil back in hole around the root ball
  - Use compost to improve soil organic matter and fertility
- Use soil and water mix to prevent air pockets around roots
- Make sure roots hang down in the hole



Planting a windbreak

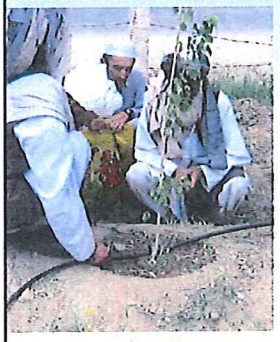
- Pack soil tightly around the root ball and stem
- Keep collar at soil surface
- Build a small dam around the plant outside of the root diameter
- Place mulch around the stem and covered root ball
  - Not too thick
  - Reduces weeds
  - Keeps water around plant for 4-5 days longer than bare ground
  - Anchor mulch to prevent blowing away



Planting a windbreak

- Pour water all around the hole
  - Give plants a good drink
  - Settles the soil
  - Removes remaining air pockets
- Put more soil in the hole to make sure the collar is at the ground surface

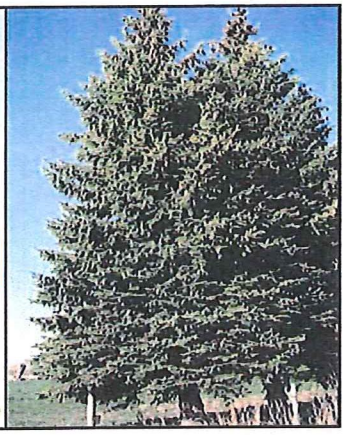
Care and Maintenance of a windbreak



- Irrigate until established
- Replace dead plants
  - Replace dead plants before live plants get established
  - Replace for the first 2-3 years
- Control weeds
  - Hoe weed around the trees and shrubs regularly
  - Plant grass between the rows
    - Leave 1 meter on both sides of plants with no grass
- Monitor and control pests
  - Watch for rodents
  - Watch for insects
  - Watch for disease

Test Time
What is wrong here?

Trees were planted too close together

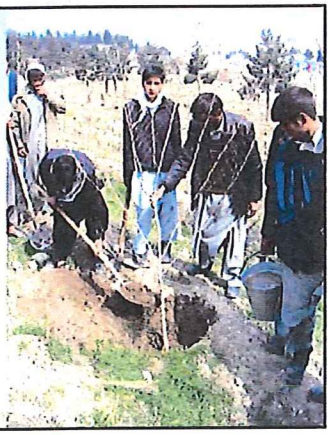


Test Time
What is the area protected by the windbreak if the trees are 25 meters tall?

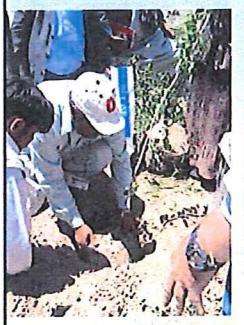
Trees are: 25 meters tall
X 10 = 250 meters
protected from the wind

Test Time
What is wrong here?

Root collar below ground

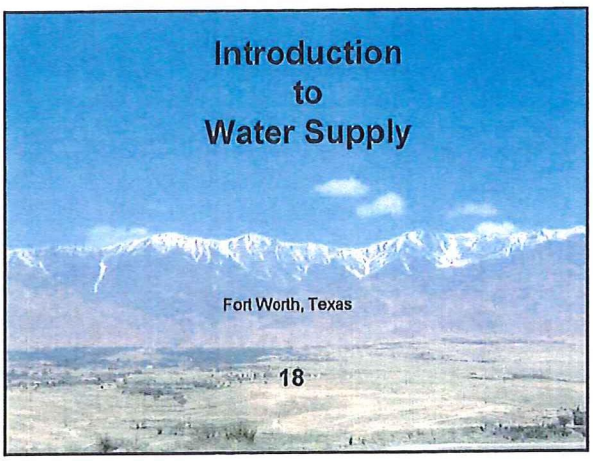


Questions?



Module 18

Introduction to Water Supply

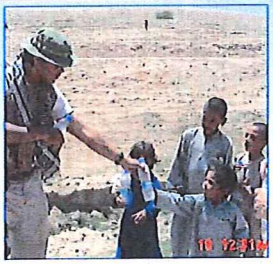


Fort Worth, Texas

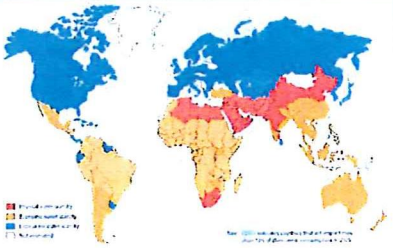
18

Module Topics:

- **Purpose**
- **Techniques**
- **Issues**



Water Supply: **A safe and reliable water supply is important in every zone.**



40% of worlds population live in areas suffering water shortages By 2025, UNEP predicts 2/3rds of world population will be living in conditions of water stress

But we need to remember that it is in the collection zone where the water is collected for the rest of the watershed

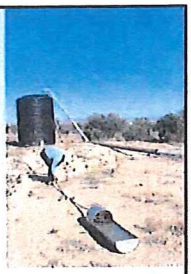
So if there is not enough water or it is of bad quality, it may because there is a problem in the watershed above.

For example: a problem could be a lot of soil erosion caused by lack of vegetation due to poor grazing management.

There can be other causes as well that we have discussed in the class

Water Supply: Purpose

- **Human Use: A safe and consistent quantity is needed.**
- **Animal Use: A large volume is needed in many locations.**
- **Irrigation: A even larger quantity is needed. More water is needed in dry times. Filtration may be necessary for drip irrigation.**
- **Other purposes?**



The identified purpose:

Indicates goal for the water source

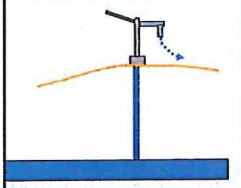
Indicates the quantity and quality needed

Water Supply: Techniques

- Pumps and Wells
- Ponds
- Stream Diversions
- Rain Harvesters and Cisterns
- Spring Development
- Ram Pumps
- Others?

Pumps and Wells

- For human use, irrigation and animal needs.
- Pumps and wells draw water from the ground.
- They are mainly done in the transport and deposition zones.

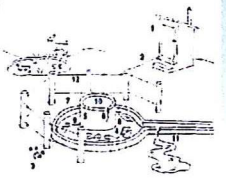


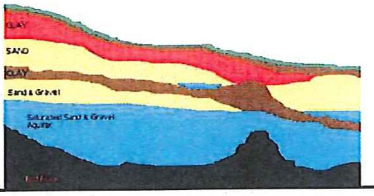
They can be reliable
They can pump from cleaner water that is underground
BUT – a bad well (salt, dry, etc) is worse than no well at all!

Where is the water?

Good and bad locations

- Latrines or outhouses
- Waste disposal areas
- Existing open wells
- Dry wells
- Areas subject to flooding
- Faults
- Road
- Areas of known contamination
- Convenient, public location, owner?

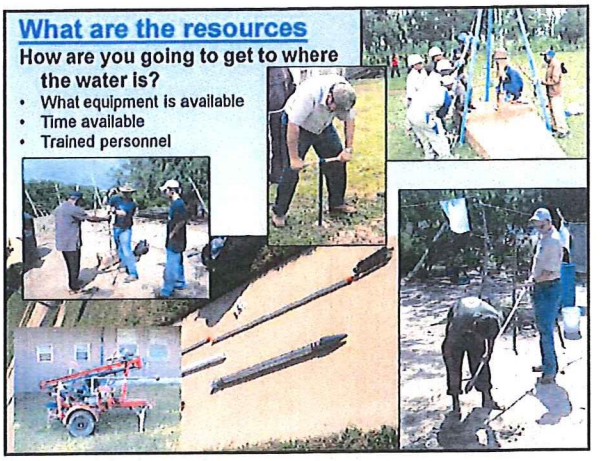




What are the resources

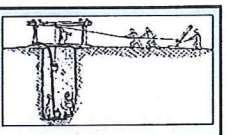
How are you going to get to where the water is?

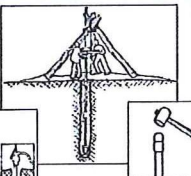
- What equipment is available
- Time available
- Trained personnel

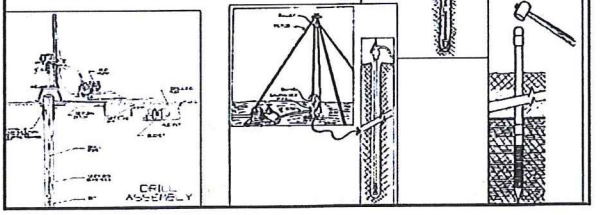


Digging the hole

Hand dug: cheap but dangerous. Limited depth of water.
Jetted: Fast but needs specialized tools. Limited depth
Hand Auger: labor intensive bur cheap, specialized tools. Material issues.
Driven (hand percussion): Simple but very limited depth
Rotary Mud: Can go very deep but specialized equipment and training needed

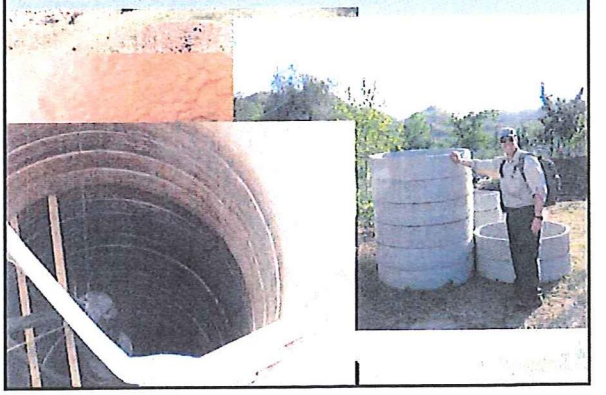






Digging the hole

Hand dug: cheap but dangerous. Use concrete rings to line excavation.



Wells

Test water for contamination if water is to be used for human consumption

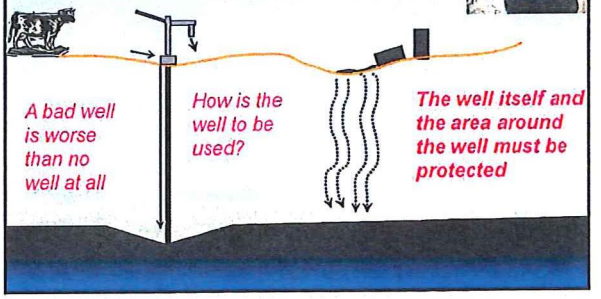
- Shock chlorinate after installation (250ppm)
- Test after installation and run thru of shock *(if bad – seal it!)*
- Test periodically (good practice for any source!)
- Test if reports of sickness
- Test after storms and during drought

Wells

May be reliable but they may not go deep enough to get to clean water

Even deep wells can become contaminated

Protect the well head *(well security!)*



Pumps

How is the water going to get to the surface?

Is the pump sustainable?

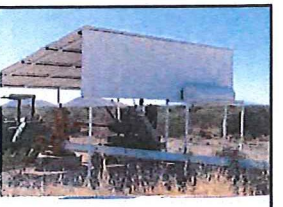
- Hand pumps
- Powered pumps
- Windmill pumps
- Solar pumps
- others

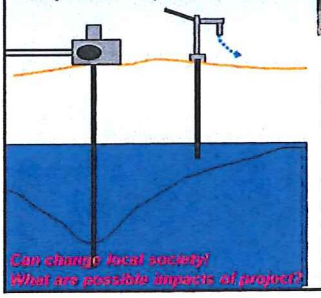
Pumps

Installation of a large pump can supply water more reliably.

But

Withdrawal by large pumps can impact nearby shallow wells





How much can be withdrawn?

- Analysis and monitoring of well output and water table levels
- Empirical (what has worked)

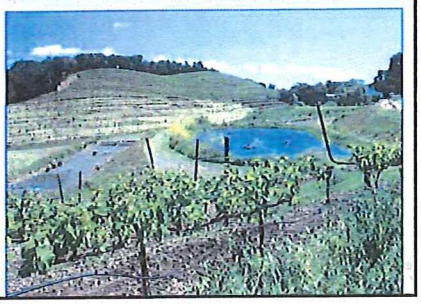
Examples:

- 40 acres – can only remove enough water for 4 head of cattle
- Limited to pump only enough water a year to irrigate to 24" total depth
- Pumping can continue until shallow well depth drops below a defined level

Ponds

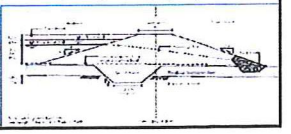
- For fish, human use, irrigation and animal needs.
- Ponds catch the water from a small watershed.
- They are the deposition zone in a small watershed.

- Ponds can store a lot of water.



Ponds

- Can be made by digging a large hole.
  - This is called a "dug-out" or "pit" pond
  - This type may not be able to enough water for the use goal.
- Ponds can also be made by building a small dam.
  - If a small dam is used, it must be designed properly.
  - Leaks in a dam must be controlled
  - Consideration must be given to the performance of a dam during large storms.
  - An engineer may be required to design a large pond.



Ponds

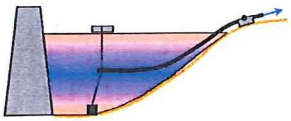
- Most all ponds require rain to fill.
- Need a control for the outlet.
- The bottom of the pond needs enough clay so that all of the water does not soak into the ground.
- If the pond is to be used to produce fish, it must be deep enough to assure that it does not become dry.

Ponds

- Since a pond is in the deposition zone, the water quality is affected by what happens in its collection and transport zone.
- To keep the water clean, manage and rehabilitate the collection and transport zone.
- Loss of vegetation and soil erosion in the collection and deposition zones can contaminate the water in the pond
- Can use a riparian buffer (wetland vegetation) to filter the water as it flows into the pond.
- Still need filtration and disinfection

Ponds

- It may be best to draw drinking water from the middle to upper half of the pond water.
- Additional treatment may still be necessary if the water is going to be used for humans.

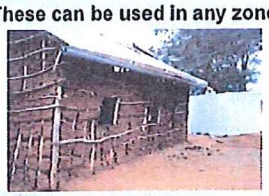


This topic will be discussed in more detail later in the workshop

Rain Harvesters and Cisterns

- Rain Harvesters and Cisterns are used mainly for human needs but can also be used for animals.
- They collect rainfall from a roof or hard surface and store it for use.
- These can be used in any zone.

This topic will be discussed in more detail later in the workshop



- Simple technique
- Rain is clean
- But the roof may be dirty and can contaminate the rain water

later on this topic

Spring Development

- Used to collect water from the ground.
- Typically in the collection zone
- Can be done in any zone.
- The area must be protected from contamination.

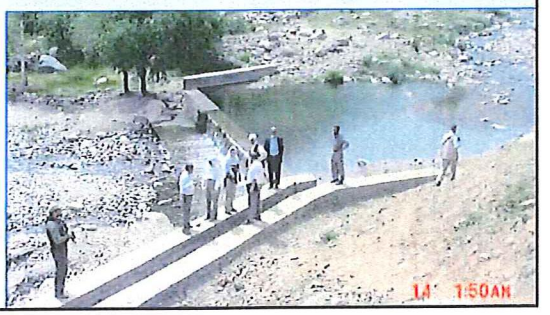
Spring Development

- Water can be used for humans and for livestock.
- Can also be used for irrigation but might not produce enough water.

This topic will be discussed in more detail later in the workshop

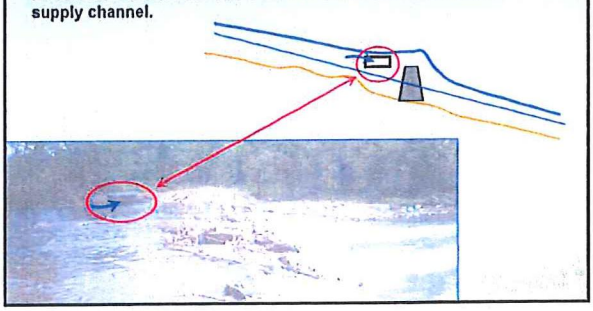
Diversions

- For human use, irrigation and animal needs.
- Diversions take water from a stream or river.
- Diversions are used in the transport zone.



Diversions

- Can be simple or complicated.
- Recall check dam design and issues
- They can supply a lot of water.
- All diversions raise the water level so it can flow into a water supply channel.

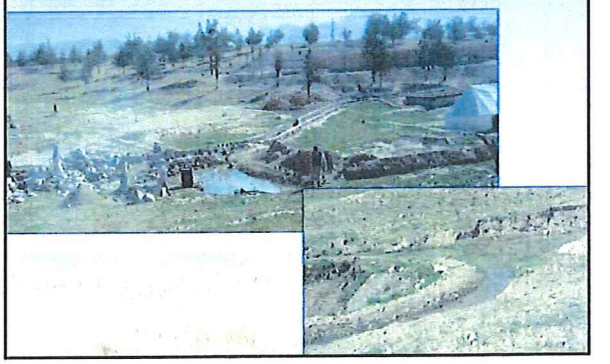


Diversions

- Once the water is in the water supply channel, a control structure is necessary.
- Without a control structure, too much water may be diverted and the people below the structure can be impacted.
- Simple gates can be used.

Diversions

- It is best to line the water supply channel to prevent loss of water.



Diversions

- Different techniques to line diversion ditches
  - Concrete
  - Soil Cement
  - Clay
  - Brick
  - etc

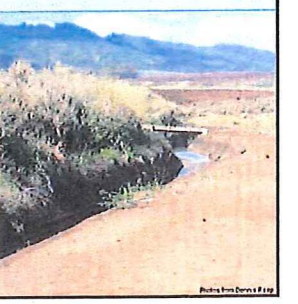
Loss for unlined ditches is about 60%

Loss for lined ditches is about 20%

Water that is lost to infiltration may be recovered in wells or by other vegetation but it may not be used as intended

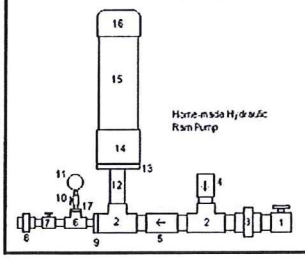
Diversions

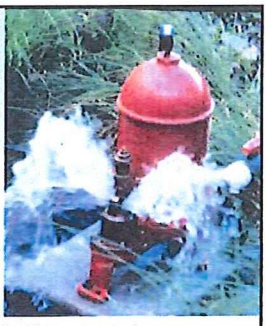
- Care should also be taken to prevent contaminated water from getting into the diversion channel.
- A pipe may be useful to prevent contamination.



Hydraulic Ram Water Pumps

(water hammer pump)





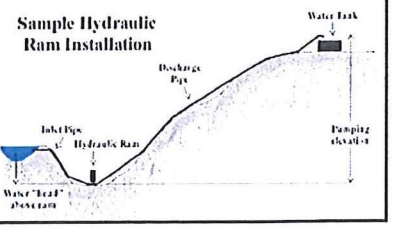
Self powered
Runs on Water/Gravity
Need no external power
Pollution Free

Typical Applications of Ram Pumps

- Village water supply
- Lift irrigation water from streams to raised channels
- Livestock water
- Pump storage for water use during dry periods

In general:
A ram pump can lift 10% of the received volume to a height that is 10x the receiving head

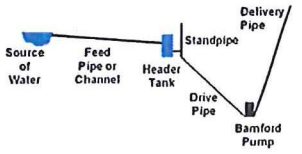
Sample Hydraulic Ram Installation



Different Types of Ram Pumps

- Minimum inlet flow of 8 liters per minute
- Drive head of 1.5 m can provide delivery head of 50 m
- Drive head of 2 m can provide a delivery head of 100 m
- 1000 liters per day delivery head of 20 m from a drive head of 2 m with an inlet flow of 15 liters per minute

General Installation

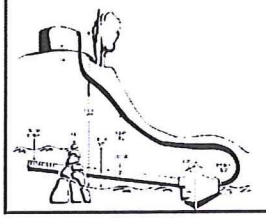


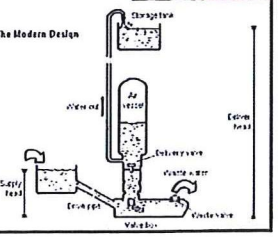
From specs of Bamford Hi-Ram Pump

The Bamford "Hi-Ram Pump ®" Australian Patent No 741898

Maintenance of Ram Pumps

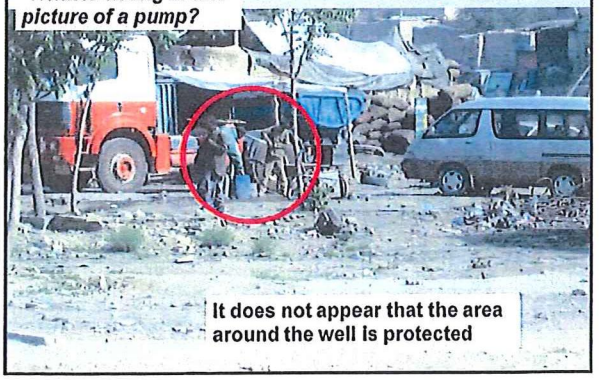
- Delivery pipes leak or get chewed by wild animals
- Reservoirs fill with sediment
- Impulse valves plug and wear
- Check valves & seals wear
- Accumulators and other metal components rust
- Vandalism





Test Time

•What is wrong in this picture of a pump?



It does not appear that the area around the well is protected

Test Time

•What issues can you see with this well?

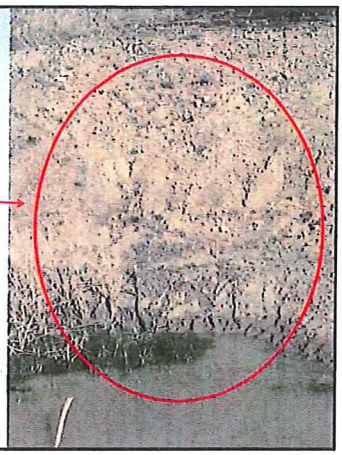
Hint: This is a 115 ft deep hand dug well

Safety Issues
Contamination Issues

Test Time

•What is wrong in this picture of the side of a pond?

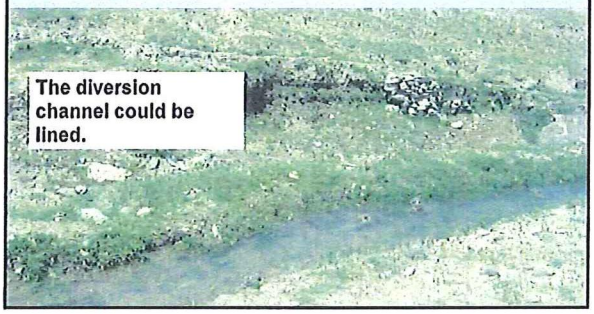
Hint: what is growing here?



No riparian vegetation or wetland plants to filter the water that is flowing into the pond.

Test Time

•How could this water supply channel from a stream diversion be improved to reduce loss of water



The diversion channel could be lined.

Example Calculation

- Given 15 pair of cattle
- Assume: Average use 20 gallons/day/pair
- Will a 5 gpm pump run 1.5 hours per day be sufficient?

Note: cows water once in morning and once in evening. We usually calculate for a 6 hr fill time maximum

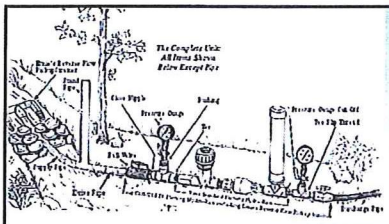
1. What is needed for cows:15 pair x 20 gallons/day/pair = 300 gallons per day
2. What is can be provided from the pump: 5 gpm x 1.5 hr x 60 min/hr = 450 gallons

...so the 5 gpm pump is sufficient

Bonus Question 1: How much land needed? (assume 25 acres per pair required)
25 x 15 =375 acres

Bonus Question 2: How many pairs of sheep (ewes with lambs) can be watered with this pump (assume 3 gallons per day per pair required)
5 x 1.5 x 60 / 3 = 150

1 gal = 3.78 liter
1 acre = 0.4 hectare



The End

Don't wait until you are thirsty to dig the well. - *Chinese Proverb*

For additional information on these or other available training materials, contact:

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