Sustainable Irrigation Practices

In Afghanistan, with its semi-arid climate, irrigation is a fundamental aspect of agricultural production. Increased demand for water along the degraded and increasingly scarce water resources call for more efficient – i.e. water-saving - irrigation practices. Sustainable irrigation provides the right amount of water for crops' water requirements, preventing over-irrigation and erosion.

Water requirements

Before discussing efficient irrigation practices, one must know a crop's water requirement. In a semi-arid climate like Afghanistan's it is important to select crops that can cope with a limited amount of water. Crops vary in their water requirement as well as in their sensitivity to drought, i.e. different degrees of drought tolerance. Table 1 summarises the water needs and sensitivity to drought of various crops cultivated in the central highlands of Afghanistan.

There are also differences *within* one crop. Some crop varieties - of potatoes, for example - need less water and are more drought-tolerant than others. Varietal selection plays an important role if water is short.

Table 1: Net crop water requirements (globally) (USDA & UC Davis, 2013)

Crop	Crop water need (mm/per growing season)	Sensitivity to drought
Wheat, Barley	450-650	Low-medium
Potato	500-700	High
Cabbage	350-500	Medium-high
Onion	350-500	Medium-high
Tomato	400-800	Medium-high
Alfalfa	800-1600	Low-medium
Sainfoin[1]	300 and more	Low

Moreover, the crop's water requirement also varies during the vegetative stages of a crop. The vegetative stages are divided thus:

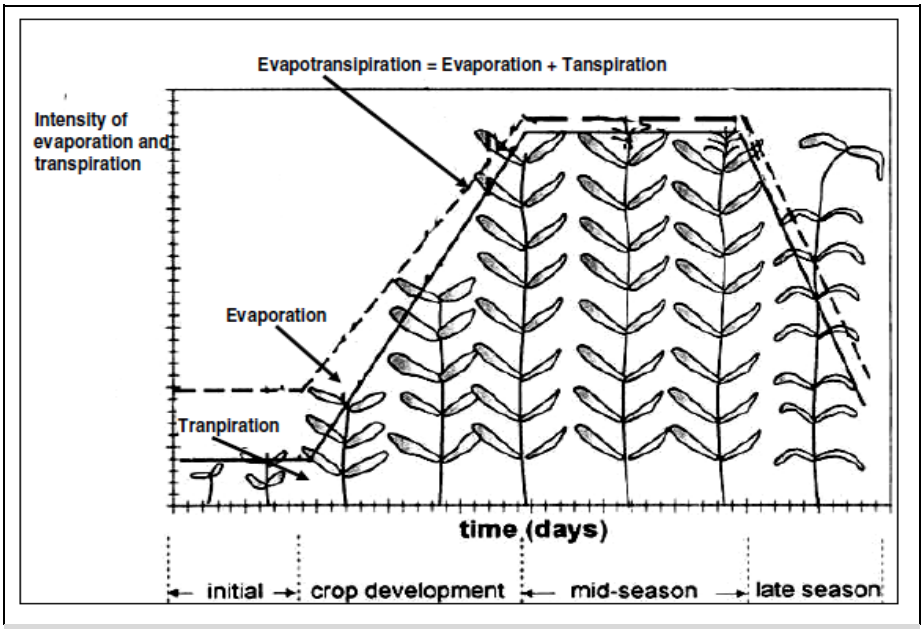

Figure 1: Evapotranspiration curve during the different vegetative stages (FAO, 1985)

1. Initial stage (germination),
2. Crop development stage,
3. Mid-season stage (including flowering and yield formation),
4. Late-season stage (including ripening and harvest).

Generally speaking, the mid-season stage is the most sensitive to water shortages (see Figure 1). This is because it is the period when the crop's water needs are at their peak. A water shortage during this stage has a pronounced negative effect on the yield (ILRI, 2009).

To sum up, the water requirement depends on the crop itself, the crop variety and its development stage, and it varies over the crop's vegetative stages. In a dry climate such as in Afghanistan, crop water needs are higher than global net crop water requirements, and depend a great deal on temperature.

[1] Sainfoin: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/faq14389

The higher the temperature, the higher the crop water requirements. To find out how much irrigation a crop needs one must understand soil moisture.

Soil moisture

The soil provides space for water, which is taken up by plants through their roots. Water uptake is essential for plant growth, because the water contains important nutrients (ILRI, 2009). It is important that (irrigation) water is absorbed by the soil and not lost as runoff or through evaporation or percolation (in case of over-irrigation). This refers to the soil´s infiltration capacity. Bare soil with an even surface, especially on sloping land, has high water loss and a low infiltration capacity (ILEIA, 2010). Infiltration capacity depends on the soil itself, as well as on the cover and type of vegetation.

Box 1: Increase soil moisture through

- Improving soil organic matter through green manure, compost, mulching and the application of organic fertilizers;
- Conservation agriculture: 1. Reduce soil disturbance, 2. Keep the soil covered and 3. Mix and rotate crops.

Another big challenge is to retain the moisture within the soil. In semi-arid areas like the central highlands of Afghanistan, **soil moisture** buffers and ensures water availability to plants even in the absence of rainfall. Soil moisture depends very much on the soil properties. Clays have the highest moisture retention capacity, while sandy soils have the lowest. Soil organic matter improves soil moisture retention capacity. The use of organic fertilisers (farmyard manure, compost, etc.) is especially important for improving soil moisture and reducing the need for irrigation in semi-arid areas. Cultivation practices such as mulching can also improve soil moisture (ILEIA, 2010). A simple test can be performed to assess soil moisture in the field. Watch the video soil moisture by feel.

Sustainable irrigation

The (net) irrigation water need of a certain crop is normally the difference between the crop's water requirement and the amount of water that can be used by the crop (the effective rainfall). The irrigation schedule indicates how much irrigation water has to be given to a crop, and how often it has to be irrigated (ILRI, 2009).

Box 2: Main irrigation rules

- Provide right amount of water
- Provide the water at the right time
- Avoid erosion through irrigation

It is also important to select the most suitable irrigation technique. The most appropriate irrigation technique is the one that suits best local conditions and crop water requirements (USDA & UC Davis, 2013). Furthermore, keep in mind that too much irrigation can also have a negative effect on plant growth, as most crops cannot deal with waterlogged situations. When there is over-irrigation, excess water runs off (over the surface or sub-surface), and nutrients are washed from the soil.

Moreover, irrigation always also includes a social question, namely how water delivery for irrigation is organised. Conflicts over water use (e.g. between up- and downstream users) are common and need to be sensitively addressed.

Irrigation techniques

There are a number of irrigation techniques that are suited to Afghanistan. However, before choosing an irrigation technique always consider (USDA & UC Davis, 2013):

1. Water availability (source, distance, quantity and quality),
2. Local conditions (soil type, infiltration capacity, land topography, climate, labour availability),
3. Crop (water requirement, rooting depth, market value),
4. Resources (labour, electricity, fuel, spare parts),
5. Cost (installation, operation and maintenance, benefits).

Table 2 on the next page provides a short overview of selected irrigation techniques that are of relevance to the country. More comprehensive sets of irrigation techniques are available from sources mentioned in the "Further reading" box.

Table 2: Irrigation techniques				
Picture	Description	Efficiency	Crops	Link
SURFACE	Includes furrow, basin and border irrigation, see below:			Surface Irrigation
	**Furrow** Involves running water in “furrows” between plant rows or raised beds. Water moves from the furrow into the crop root zone (USDA & UC Davis, 2013)	Less efficient than the other techniques	All type of crops, including fruit trees	Video: Advanced Furrow Irrigation
	**Basin** The field is levelled and surrounded by earth banks. The water is applied to the entire basin or field.	Less efficient than the other techniques		
SPRINKLER				
	**Sprinklers** Pipes with sprinkler heads for the water. Different types of the same system are in use.		High value cash crops: vegetables and fruit trees	Sprinkler Irrigation
MICRO				
	**Drip irrigation** Involves a set of pipes with holes, where water drops slowly to the root zone of plants. This technique is water saving, but there is a risk of salinization if the soil is not “washed” at least once a year.	High cost systems up to 90%, low-cost system approx. 70%	High value cash crops: vegetables and fruit trees, suitable for irrigating individual plants	Drip irrigation Video: Drip irrigation video
MANUAL				
	**Irrigation by hand** Simple but effective irrigation method, including: • Watering cans • Pitcher irrigation • Bottle irrigation • Porous pipes		Home-gardens: vegetables	Manual irrigation

Irrigate field crops

Surface irrigation is the most frequent method of irrigating field crops at the moment if, that is, water is accessible and available. Irrigation water is distributed to land holdings by either the *mirab*, a Water User Association or other local organisations. However, surface irrigation is not a very efficient irrigation technique. A lot of water runs off and is lost from agricultural production.

HELVETAS Kyrgyzstan has developed more efficient technologies for irrigating crop fields called **improved furrow irrigation.** Improved furrow irrigation not only reduces water use, but is especially suitable for small plots of land and requires no special tools, making it a cheap irrigation practice. Improved furrow irrigation involves three approaches, which are best described in the Advance Furrow Irrigation video:

- Short-furrow irrigation,
- Every second furrow irrigation,
- Cut-back irrigation.

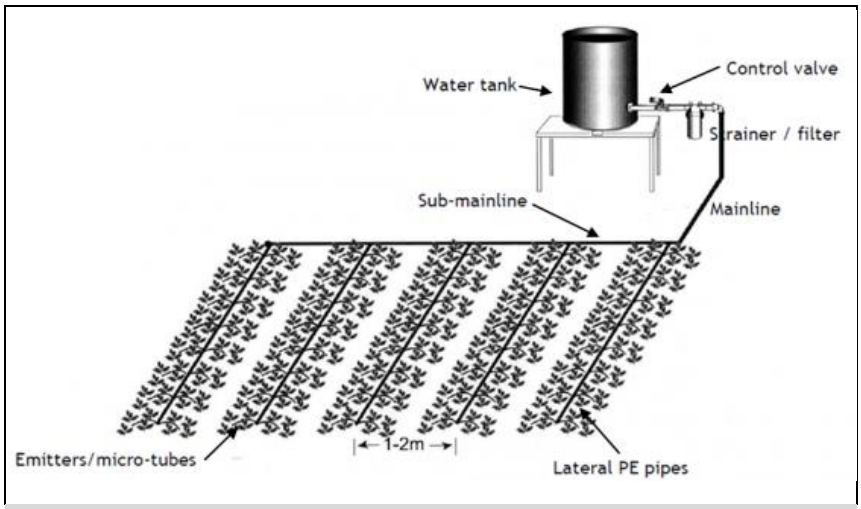

Figure 2: System of drip irrigation with the tank and the system of pipes (http://ssmw.info)

Irrigate horticultural trees and vegetables

Drip irrigation is not only an extremely water-efficient technology; it is also well suited to the irrigation of individual plants in fruit orchards, nut plantations or vegetable cultivation (e.g. melon or tomato production). Drip irrigation provides a, slow, gradual supply of water to the root zone of the crop through a system of pipes with small holes. Drip irrigation uses less water than any other irrigation technique and it is also possible to irrigate primarily rain-fed areas using the attached water tank. However, it is crucial to have a water source close to the water tank. The main challenge at present in Afghanistan, however, is the availability of drip-irrigation sets, as well as low investment capacity, maintanance costs and technical skills.

Irrigate homegardens

Manual irrigation is well suited to irrigating home gardens or vegetable production near the home. Manual irrigation is cheap, but it involves regular work. There are various irrigation methods, such as watering cans, pitcher or bottle irrigation, and porous pipes.

Further reading and references

- FAO, 1985: Irrigation Water Management: Training Manual No. 1 – Introduction to Irrigation. Available at: http://www.fao.org/docrep/r4082e/r4082e00.htm#Contents
- FAO, 1989: Guidelines for Designing and Evaluating Surface Irrigation Systems. Available at: http://www.fao.org/docrep/T0231E/t0231e03.htm#1.2.6%20crops
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- USDA & UC Davis, 2013: Afghan Agriculture Portal. Available at: http://afghanag.ucdavis.edu/

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