Food and Agriculture Organization of the United Nations

Raised beds for improving crop water productivity and water efficiency in irrigated dryland agriculture, Egypt

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Summary

Irrigation is crucial for agricultural activities, however if not managed well, it entails high water losses and can be inefficient in its application. The raised bed system is an improved surface irrigation strategy, which enhances water productivity and makes the application of water in irrigated systems more efficient.

It can be easily implemented by the farmers themselves. This practice describes how raised bed systems can be used to improve crop water productivity in summer and winter crops.

Description

Agriculture in Egypt is mainly building upon irrigation water from the Nile. But, available water resources have been reduced by over 80 percent in the last century. New water cannot be captured in the required amount, because only few major resources of renewable groundwater remain untapped. That means that practices should be adopted, which have the potential to increase the on-farm water-use efficiency when used for irrigating crops.

Often, over-irrigation leads to a rapid degradation of soils. This is when much more water is needed for the raising of a crop, than the crop actually needs.

Water is the limiting factor in Egypt, but the lack of knowledge on how to irrigate, when and how long can tremendously affect the soil and lower its productivity.

Consequences might be high salinity of the soil and water logging.

- High salinity of the soil occurs when there is a high evaporation but only a low precipitation. Then, the solute salts solute from deeper soil layers dissolve in the water provided by irrigation and raise to the soil surface while not washed out again.
- Water logging occurs when the irrigated water does not percolate into the soil and remains near the surface as standing water. Most crops wither due the logged water, because the plant roots do not receive enough oxygen.

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1. Traditional irrigation practices in winter and summer crops in Egypt

Most commonly, surface irrigation is practiced in Egypt. But, it entails high water losses and is inefficient in its application. Currently, there are applied two traditional irrigation methods for raising winter and summer crops.

Usually, winter crops like wheat and berseem are planted on a random broadcasting basis. That means, the seed is distributed randomly by hand or by using a drilling machine. The traditional irrigation practice is of the border irrigation type, which can be best applied at a slope.

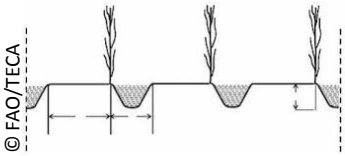
Irrigation water is then applied through an irrigation channel from the top to the bottom. The borders are long and thin strips, where the water then flows down the slope and irrigates the surface of the crop stand. Usually, the application is stopped once the water reaches the end of the border.

When using the raised bed-system in winter crops, this border irrigation turns into a furrow irrigation, where water is applied in the bottom of the furrows. This entails the benefit of reduced irrigation time and reduced amount of water used (Figure 1).

The typical summer crops are maize and cotton. Traditionally, they are planted in a ridge-furrow system with rows of 0.65 cm distance apart. One row of plant is planted on the ridges. 22 cm are left as space between the plants within each row.

The furrows are 20 cm deep and the ends are blocked for preventing runoff from the field. Eventually, the furrows are filled with irrigation water until the water stands at the top of the furrow ridge.

Figure 1. Traditional furrow method of planting summer crops (R. Abo El-Enein, M. Sherif, M. Karrou, T. Oweis, B. Benli and H. Farahani, 2011)



2. Raised-bed system

The raised bed system is an improved surface irrigation strategy, which enhances water productivity and makes the application of water in irrigated systems more efficient. It can be easily implemented by the farmers themselves.

In this system, irrigation water is applied to the bottom of the furrows (Figure 3). Less water for irrigation is needed, due to the furrows collecting the water efficiently, instead spreading it over the whole surface (border irrigation). Water can be saved, because there is less wetted area than in the traditional surface irrigation methods.

When growing winter crops (wheat, berseem), the same amount of seeds is applied, only that they are seeded onto ridges with four rows on each ridge (Figure 2).

In the raised bed system the furrows are wider than in the traditional one. Two furrows are merged, the width of the ridges is double as wide as in the traditional system.

In summer crops, like maize or cotton, the rows are widened to a so-called wide furrow system. Instead of a one plant-row per ridge, there are usually two or more rows of plants planted on one ridge. Hence, two furrows are merged to one row. And this leads to only the half of the furrows and half of the amount of water necessary for irrigating the area.

In the traditional system there is only one plant row per ridge. The widths of the ridges are half of the size of those in the raised bed system. Thus, there are twice as much furrows for irrigation.

However, the same number of crops could be irrigated with half of the amount of water, achieved by the merging of two ridges to one ridge.

Figure 2. Raised bed practice applied in wheat production (R. Abo El-Enein, M. Sherif, M. Karrou, T. Oweis, B. Benli and H. Farahani, 2011)

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Figure 3. Cotton in the wide furrow method (R. Abo El-Enein, M. Sherif, M. Karrou, T. Oweis, B. Benli and H. Farahani, 2011)

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Figure 4. Maize in the wide furrow method (R. Abo El-Enein, M. Sherif, M. Karrou, T. Oweis, B. Benli and H. Farahani, 2011)

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3. Economic and environmental benefits

Raised beds have been proven to increase yields. In both, winter and summer crops, they supported the decrease of the irrigated area, shortened the time needed for irrigation, reduced the amount of water needed and thus reduced costs of irrigation. The water productivity (amount of crop gained per m^3 water) was shown to be higher and the yields increased using less water. Applying this practice can help to spend less money for irrigation, while achieving higher yields and increasing the farm income.

Winter crops:

- The performance of the practice has shown to be more efficient than the traditional border irrigation practice, since less water has to be used to irrigate the entire plot of land. Instead of spreading water throughout the entire surface of the plot, the water is applied only within the furrows, which also means less loss of water through percolation.
- Planting wheat on ridges instead enhances the aeration of the plants and leads to a better growth and better yield.
- Planting wheat on ridges also ensures better use of solar radiation and a more efficient use of fertilizer.
- Ridge planting also enables to better control weeds.

Summer crops:

- The plant density remains the same as in the traditional method, while the number of furrows is halved. Hence, with the raised bed technology considerably less water than with the traditional method is needed for irrigation.

The furrows comprise the same width and depth in both systems. The plant density in the raised bed system remains the same or can even be increased, because more

planting space is available, due to less furrows in the system.

4. Validation of the practice

The raised bed practice has been tested in Egypt within the project "Community-Based Optimization of the Management of Scarce Water Resources in Agriculture in CWANA - Improving Water and Land Productivities in Irrigated Systems".

The project was based on community participation in the research and development, testing, and adaptation of improved water management options at the farm level. The project consisted of three main components; the Badia Benchmark site in Jordan, with two satellite sites in Saudi Arabia and Libya, the Rainfed Benchmark site in Morocco, with three satellite sites in Tunisia, Algeria and Syria, and the Irrigated Benchmark site in Egypt, with two satellite sites in Sudan and Iraq.

The research project was conducted between 2004-2009 by ICARDA's national programs in Jordan, Egypt, Morocco, Algeria, Tunisia, Syria, Sudan and Saudi Arabia. ICARDA's, Integrated Water and Land Management Program was responsible for the project and, together with other ICARDA programs, provided technical support for implementation.

The project was funded by the Arab Fund for Economic and Social Development (AFESD), the International Fund for Agricultural Development (IFAD), the OPEC Fund for International Development (OFID) and the International Development Research Center (IDRC).

5. Further reading

- Karrou, M., Oweis, T., Benli, B., Swelam, A. (eds) 2011. Improving water and land productivities in irrigated systems. Community-Based Optimization of the Management of Scarce Water Resources in Agriculture in CWANA. Report no. 10. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. vi + 195 pp.
- FAO, Irrigation water management, Training manual no. 5, "Irrigation methods": (http://www.fao.org/3/s8684e/s8684e00.htm#Contents)

6. Agro-ecological zones

- Subtropics, warm/mod cool

7. Related/Associated Technologies

- Improved rainwater harvesting for fodder shrub production and livestock grazing: the Vallerani micro-catchment system in the Badia of Jordan
- Supplemental irrigation for improved water use efficiency and productivity of wheat in rain fed agriculture, Morocco
- Water harvesting from concentrated runoff for irrigation purposes in Spain

8. Objectives fulfilled by the project

- Resource use efficiency