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The role of micro-catchment water harvesting techniques in combating desertification in the Syrian steppe

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Abstract:

About 55% of the total area in Syria receives average annual rainfall of less than 250 mm and is affected by desertification. Rainwater falls in intense and unpredictable storms and is mostly lost in evaporation and runoff. To evaluate the performance of micro-catchment water harvesting systems for combating land degradation a study was conducted at the site named, Qaryetein in the Syrian steppe. Since most of the rangelands in this area are common properties and open for grazing, a community-based approach was introduced as an alternative to better manage these resources. Three different micro-catchment water harvesting techniques were tested at this site 1) manually prepared semi-circular bunds 2) mechanically prepared continuous ridges and 3) mechanically prepared intermittent ridges. The mechanically prepared systems were implemented with a special plough, referred to as "Vallerani". Two spacings (6 and 12 m), and three fodder species: *Atriplex halimus*, *Atriplex leucoclada*, and *Salsola vermiculata* were compared, using a split-plot design. Shrub survival rates, shrub growth, soil moisture content and the amount of sediments were observed. The first season was dry and only one runoff event was recorded. This event occurred as a result of 14 mm rainfall. Results, in general, showed higher shrub survival rate at the control plots without water harvesting structures, than the ones with water harvesting. And better shrub growth within the hand-made types as compared to the mechanized ones.

1. Introduction

The Syrian steppe covers a total area of 10.22 M ha, and represents 55.2 % of total land estimated at 18.51 M ha (Abdulal, 2004). This area receives average annual rainfall of less than 250mm and is affected by desertification due to several factors mainly the erratic characteristics of rain, over grazing, over-cutting of the shrubs for fire woods, continuous cultivation of these fragile rangelands, and the expansion of rainfed agriculture.

Rainfall in this area (*Badia*) is the main source of fresh water and mostly falling in winter in form of intense storms to the extent that sometimes the amount of rain falling during a day may exceed the average monthly amount (Abdulal, 2004). This does not only cause soil erosion, but also problems of inadequate availability of water for vegetation, which leads to the degradation of natural vegetation. Hence, efforts should be directed toward a better use of rain and runoff to increase range productivity and reduce land degradation.

Re-vegetation is a pressing issue for environmental improvement in this region; however, the establishment of vegetation is quite difficult due to inadequate availability of moisture. Therefore micro-catchment water harvesting (MCWH), which may be defined as the collection of surface runoff from a runoff area over a distance of less than 100 m length and storing it for consumptive use in the root zone of an adjacent infiltration basin, is the suitable technique (Oweis et.al., 2001).

The ultimate goal of this study is to contribute to efficient methods to combating land degradation in the Syrian steppe, based on community participation in planning and implementation of water harvesting techniques.
The main objective is to: Evaluate the performance of (MCWH) systems including the mechanized "Vallerani system", and the hand-made one in combating land degradation, and to determine the optimal design parameters for micro-catchments with respect to size, spacing between contours for growing three different species of fodder shrubs taking into account rainfall, runoff and soil moisture relationships and the growth of these planted shrubs.

2. Methodology

2.1. Experimental site

This study was conducted at the site named Qaryetein in Syrian steppe. This site was selected based on the following criteria: 1) well-suited to various water harvesting interventions, like average annual rainfall of less than 200 mm/y, 2) community willingness to cooperate and participate in execution and maintenance of these techniques, 3) slope steepness of 2% as minimum, and 4) some other physical and mechanical soil characteristics.
The site is located 120 km northeast of Damascus (Latitude 34˚ 08' N, longitude 37˚ 08' E, and an altitude of 855 m asl). Land properties in this area and the rest of the whole (Badia) in Syria are state lands and open for grazing. The climate is typical Mediterranean arid with hot and dry summer and cold winter. Average annual rainfall ranges between 114 – 120 mm falling mostly in January and February. Mean maximum and minimum temperature during January (coolest month) are 10 and 0.65˚ C, respectively, while for August (warmest month), they are 34 and 17˚ C, respectively.
The topography of the area is undulating with slopes ranging from 1-2 % to 5-8% as maximum. The area of the selected site is 100 ha (1000 *1000 m). Soil depth ranges between 25 and 90 cm, with sandy loamy clayey texture. Theses soils are poor in organic matters (1%), with field capacity of 25.8 %.

2.2. Experiment setup and treatments

Three different micro-catchment water harvesting techniques were tested at the site, which are; 1) manually prepared semi-circular bunds 2) mechanically prepared continuous ridges and 3) mechanically prepared intermittent ridges. These techniques were laid out on the contours with (6 and 12 m) spacing, and three different species of fodder shrubs: *Atriplex halimus*, *Atriplex leucoclada*, and *Salsola vermiculata*. The diameter of each semi-circular bund at both manual and mechanical systems was 2.8 m, with 1.4 m interval between two adjacent bunds. Two shrubs/target area for the 12 m spacing, and one/target for the 6m spacing. The design used was split-plot design with three replicates. The blocks were separated by earthen embankments to prevent runoff effect from neighboring blocks.
Neutron access tubes were installed within each block and treatment to monitor soil moisture variation along the soil profile. Runoff tanks were installed at the lowest point of the plot. The volume of the runoff was measured by pumping the water from the tanks. This was measured after each rainstorm. A recording rain gauge was used to obtain the amount and the intensity of the rainfall. Shrub height, crown length, and crown diameter for measuring shrub volume (SV) were taken quarterly every three months, shrub survival rate (SSR) was done twice a year. Soil moisture was measured every two weeks and after each rainfall.
Shrub survival rate (SSR) and Shrub volume (SV) were used as performance indicators for testing the different water harvesting techniques. Shrub survival rate was measured by counting the number of surviving shrubs twice a year, first observation was taken early in June (the end of rainy season), the

second one in October (the beginning of rainy season), for each species within each treatment, and dividing it by the total number of shrubs as percentage.

The equation used is:

SSR (%) = number of survived shrubs for one species / Total number of same species*100

Shrub volume was measured using the following equation:

$$V = 4/3\ \pi\ (h/2 * LCD/2 * SCD/2)$$

Where:
V: shrub volume (cm^3),
h: shrub height (cm),
LCD: crown diameter (cm) and,
SCD: crown length (cm).

2.3. Community-based approach

Since the community land is located in (*El-Badia),* where land properties are state land and open for grazing and rain-fed cultivation is banned, a community-based approach was introduced as an alternative to better mange their available and degraded resources. Rapid Rural Appraisal (RRA) method was used to characterize the community, where a group of community members together with researchers have discussed the overall objectives of the study and the current degradation of the available and scarce natural resources under the steppe conditions, and how water harvesting techniques with community participation in the study are of use to better manage these scarce and degraded resources. Semi-structured questionnaires were used to characterize the community.

3. Results and discussion:

3.1. Rainfall and runoff characteristics

Annual rainfall at Qaryetein site, given in Table 2, during the 2004-2005 hydrological season was 128 mm. During May, 2005 only one runoff event occurred. This event was a result of 14 mm rainfall during one day. Runoff coefficients for different catchment techniques and sizes are given in Table 3.

Table 2. Monthly rainfall during 2004 – 2005 season at Qaryetein site

Month	Sep	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Total
Rainfall mm	0	2.6	40.4	14.1	21.7	25.6	1	8.2	13.8	0.1	0	0	127.5

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Table.3 Runoff coefficients for different systems and catchment sizes in Qaryetein site

Rainfall			Spacing	Runoff coefficient	
Event	Date	Amount (mm)		Mechanized	Manual
1	4/5/2005	14.4	12m	0.06	0.01
			6m	0.05	0.12

At the mechanical system results of one event show that there is no significant difference in runoff coefficients between the 12 and 6m spacing, while the difference is significant within the manual system (RC at 6m as larger than its value at 12m). This is due to the fact that, the larger the plot length or catchment area, the higher the transmission losses, therefore, less runoff per collected at the outlet.

3.2. Performance of tested water harvesting techniques (WHTs) at Qaryetein site

The shrub survival rate was measured by counting the number of surviving shrubs twice a year. Results of SSR taken in May 2005 showed a higher survival rate at the hand-made system than the mechanized intermittent and continuous ridges. As shown in figures 2, 3.

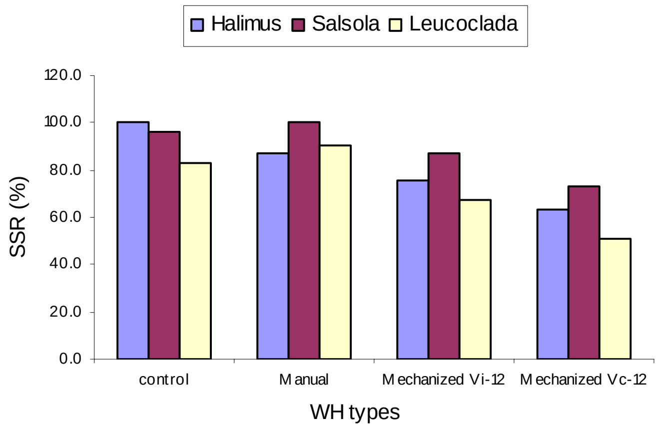

Fig.2. % SSR with different water harvesting techniques and spacing 12m

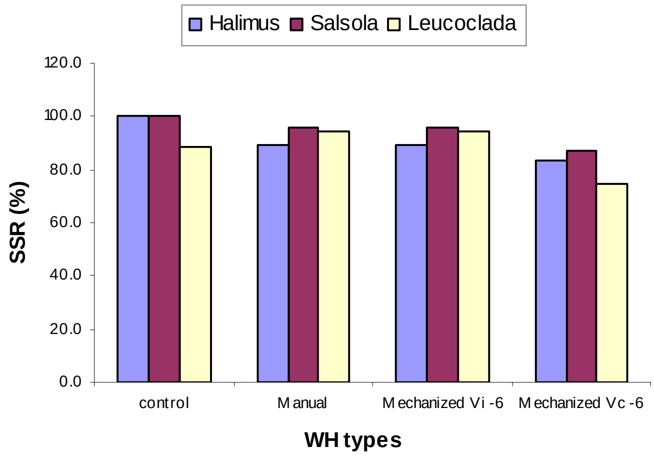

Fig.3. % SSR with different water harvesting techniques and spacing 6m

For shrub growth (SG) results of 3 observations during 2005 showed that at a probability of 0.05, there was significant interaction between shrub volume and water harvesting type (semi-circle, intermittent, and continuous ridges), where the shrub was doing better at the intermittent and semicircular bunds than the continuous ridges. For the spacing, results showed that there was no significant interaction between shrubs volume and spacing between contours. Average over shrubs and spacing showed that *A. halimus* is doing better than the other two shrubs, and at spacing 12 m shrub volume is better than at 6m.

At this stage of the study, it would be difficult to build up general conclusion for interpretation of our hypothesis about water harvesting concepts, means; these results could be associated with other contributing factors rather than water harvesting (topographic factors, slope, planting date, soil disturbances during the establishment of these structures, etc).

Rresults of (RRA) method for characterizing the community in Qaryetein showed that about 80% of the community is doing off-farm business and 14% are farmers, while only 6% are herders. This low percentage refers to the fact that, banning rainfed cultivation has led to decreasing feed resources for the livestock, and increasing supplementary feed and production costs. Therefore, introducing water harvesting systems to this area in participation with farmers will improve the vegetation cover and reduce soil erosion, and reduce production cost and increase income from livestock.

4. Conclusion

The 2004-2005 season is considered as a dry year and only one runoff event was recorded as a result of 14 mm rain during one day. Such harsh climate in the Syrian steppe *(Badia)* constraints water harvesting projects to be implemented and make them risky trials.
What has been done in this site so far could be still considered as a good movement, taking into consideration the degradation status of vegetation, soil and water resources that are dominant under the

arid conditions. The participatory approach has given the community the opportunity to share the researchers their opinions and how they think about water harvesting and managing their lands for grazing. In addition, it helped them to gain additional income from working in the experimental site (establishing WH structures, planting, monitoring, and guarding the site, etc).

References

Atef Abdulal, Research report.. Article in Press. General commission for scientific agricultural research (GCSAR), Damascus, Syria.

Naser, M. 1999. Assessing desertification and water harvesting in the Middle East and North Africa.

Oweis, T., A. Y. Taimeh. (1995). Evaluation of a small basin water-harvesting system in the arid region of Jordan

Oweis, T., D. Prinz and A. Hachum. 2001. Water harvesting: Indigenous knowledge for the future of the drier environment. ICARDA, Aleppo, Syria. 40 pp.