The Economic Evaluation Of Water Harvesting Techniques In Dry Agricultural Areas

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***Abstract*—Rainfall in the dry areas is generally inadequate to meet basic needs for agricultural crop production. As it is poorly and irregular distributed over the growing season and often comes in intense storns and downpour, it usually cannot support economically viable for agriculture farming. Even this water is mostly lost in evaporation and runoff, dry periods during the growing season in dry production areas. İt is necessary to keep this lost water and use it in soil depth.**

Water harvesting is based on the principle of depriving part of the land of its share of rain, which is usually small and non-productive, and adding it to the share of another part. This brings the amount of water available to the latter area closer to crop water requirements and thereby permits economic agricultural production. As long as people have inhabited the drylands and have cultivated crops, they have harvested water. Providing sufficient water for drinking and agricultural production in remote dry areas is one of the most serious challenges for water harvesting research and development, related directly to the poor, so water harvesting practices should be as cheap as farmers can afford.

In this study, Negarim microcatchment water harvesting mulching systems are compared in economic terms in Turkey. In 2009 -2010 years, plastic sheets mulch has been best mulcing application for water harvesting. The cheapest covering material is straw mulch by 32 $. Each of mulching material was found different from economically and benefits for collecting rainwater.

Keywords—Agriculture, water harvesting, drought, economic evaluation.

I. INTRODUCTION

Agriculture in the dry areas depends on the vagaries of weather, especially of the rain. The dry areas are characterized by low annual rainfall, the distribution of which varies in space and time. Without doubt, the greatest climatic risk to sustained agricultural production is rainfall variability, which unfortunately is usually greater in zones of lower mean annual rainfall in these areas [1]. Two distinct zones can be identified within the dry areas. The first zone is relatively wetter, where annual rainfall is sufficient to support continuous and economic cropping systems during the rainy season without irrigation. This zone is usually dominated by rainfed farming. Rainfall in this zone is marginal in relation to water requirement, but its distribution is poor and water stress often occurs during one or more stages of crop growth, lowering the yield. Thus, the productivity of rainfall is low, even though much of it may be utilized by crops. Variations in rainfall from one year to the next create instability in production, and risk-averse farmers are unwilling to invest in fertilizers and other inputs that are needed for high levels of productivity [2].

Water harvesting (WH) is defined as the process of concentrating rainfall as runoff from a larger area for use in a smaller target area. The process is distinguished from irrigation by three key features: first, the “catchment” area is contiguous with the benefiting target area and is relatively small; second, the application to the target area is essentially uncontrolled—the objective is simply to capture as much water as possible and store it within the reach of the plant(s), in the soil profile of a cultivated area or into some type of reservoir; third, water harvesting can be used to concentrate rainfall for purposes other than crop production. Water harvesting is generally feasible increas with an average annual rainfall of at least 100 mm in winter rains and 250 mm in summer rains [3].

While applying water harvesting techniques socio-economic factors are particularly important. Obviously, if the small scale farmer is the "customer" or beneficially, then she/he must understand and be happy with a system which is appropriate, and which she/he is able to manage and maintain. This section looks at some socio-economic factors, and the implications they may have on project management. If the objective of rainwater harvesting projects is to assist resource-poor farmers to improve their production systems, it is important that the farmer's/agropastoralist's priorities are being fulfilled, at least in part. Otherwise success is unlikely. If the local priority is drinking water supply, for example, the response to water harvesting systems for crop production will be poor. After the first season it is the farmers themselves who will often have the best ideas of modifications that could be made to the systems. In this way they are involved in evaluation, and in the evolution of the water harvesting systems. Widespread adoption of water harvesting techniques by the local population is the only way that significant areas of land can be treated at a reasonable cost on a sustainable basis. It is therefore important that the systems proposed are simple enough for the people to implement and to maintain. To encourage adoption, apart from incentives in the form of tools for example, there is a need for motivational campaigns, demonstrations, training and extension work. It is tempting to assume that a system which works in one area will also work in another, superficially similar, zone. However there may be technical dissimilarities such as availability of stone or intensity of rainfall, and distinct socio-economic differences [4].

Commonly two types of runoff harvesting are distinguished by the size of the harvested catchment: Micro and macro catchment runoff harvesting. Runoff harvesting is often accompanied by runoff farming, the characteristic cultivation type [5].

In this study it is observed that fruit can be produced in dry conditions thanks to water harvesting applications. Hence it will increase the welfare of those living who poor farmers in the countryside.

II. MATERIAL AND METHOD

In this study for a good surface to maintain the flow of rainwater in the soil root zone of plants to deliver water by providing micro-basins are covered with a continuous surface covering materials.

P (Plastic Mulch): 0.5 mm thick plastic cover on the inner surface of the micro-basins are covered with black plastic sheeting (Fig 1).

Figure 1. Plastic Mulch for Collect Rain Water

Ss (Straw Mulch): Straw mulch cover the inner surface of the cover of each parcel of land in the micro-watersheds of 10 kg of wheat and barley stalks and straw mixed with 10 kg of wet soil, mulch brought consistency and parcel of paved surface. Straw used in this study about 5 cm in thickness straw mulch (Fig 2).

Figure 2. Straw Mulch for Collect Rain Water

S (Surface Compaction): Surface compaction to compress the inner surface of the wooden mallet used for the micro-watershed. In this application, the soil surface of each micro-watershed was wet compression process (Fig 3).

Figure 3. Surface Compaction for Collect Rain Water

T (Stone Mulch): In stone covering, approximately 20 cm long micro basins are in the area to cover the inner surface of the limestone was used. These stones are in accordance with the inclination of the surface of the parcel, the parcel surface, taking care not to be strung together without spaces (Fig 4).

Figure 4. Stone Mulch for Collect Rain Water

III. RESEARCH FINDINGS

The average of 30 years total rainfall is 344.1 mm in the research area. The lowest rainfall between 1982 and 2011 was 227.3 mm in 2008 and the highest in 1995 was 573.1 mm in meteorological station [6]. Because of climate change and recent droughts, the amount of rainfall has been low in this region. Therefore suggests that need for water harvesting practices in dry agriculture areas [7].

Economic analyzes have been made of the water harvesting mulching system applications. The soil ridges of the microcatchments was made with tractor. The cost of creating a tractor's hounds is 100 $, the daily fee for the worker who performed this operation was calculated as 25 $. The cost of 45 microcatchments is located in the research land is calculated as 125 $. Cost analysis was carried out for the application of the experimental subjects in the survey to the parcels and for the spreading of the covering materials in the parcels.Workers paying 25 $ per day for these transactions. The fee paid is determined by the hours of work the worker has done during the day (hours). According to this; the cost of preparing a parcel of plastic cover is 177.75 $, the cost of preparing a parcel of a stalk cover is 32 $, the cost of making a parcel of a stone cover is 125 $ and the construction of a parcel of surface compression is 32.5 $. The cost table for making a parcel of trial subjects is given in Table 1.

Table 1. Economic Analysis of Research Subjects (2009-2010 water year)

Cost Table of Plastic Covering									
Subject	Used Material	Area (m^2)	Unit Price ($\$/m^2$)	Amount of Used Material (M^2)	**Total Price of Material ($)**	Labor Requirements (Unit Area / Time)	Daily Labor Cost ($ / 8 hours)	**Total Fees Paid for Labor ($)**	**Total Cost ($)**
Plastic Mulch	Plastic Cover	36	3,5	49	**171,5**	2	25	**6,25**	**177,75**
Straw Covering Cost Table									
Subject	Used Material	Area (m^2)	Unit Price ($\$/m^2$)	Amount of Used Material (M^2)	**Total Price of Material ($)**	Labor Requirements (Unit Area / Time)	Daily Labor Cost ($ / 8 hours)	**Total Fees Paid for Labor ($)**	**Total Cost ($)**
Straw Mulch	Straw	36	0,70	10	**7**	8	25	**25**	**32**
Cost Table of Stone Covering									
Subject	Used Material	Area (m^2)	Unit Price (Trailer / $) (Collection of Stones, Loading and Transport)	Material Amount Used (Trailer)	**Total Price of Material ($)**	Labor Requirements (Unit Area / Time)	Daily Labor Cost ($) / 8 hours)	**Total Fees Paid for Labor ($)**	**Total Cost ($)**
Stone Mulch	Stone	36	100	1	**100**	8	25	**25**	**125**
Cost Table of Surface Compaction									
Subject	Used Material	Area (m^2)	Unit Price ($\$/m^2$)	Amount of Materials Used (wooden knocker)	**Total Price of Material ($)**	Labor Requirements (Unit Area / Time)	Daily Labor Cost ($ / 8 hours)	**Total Fees Paid for Labor ($)**	**Total Cost ($)**
Surface Compaction		36	-	1	**20**	4	25	**12,5**	**32,5**

IV. CONCLUSION AND SUGGESTIONS

Rainfall is insufficient, one of the natural resources in the region with semi-arid climate to collect rainwater on the land and use it in a beneficial way for the water plant is of great importance on climate change and the effects of global warming. It will be a great success to promote and apply water harvesting techniques to the local farmers in order to benefit from rain water in the pistachio gardens cultivated in mountainous land where there is no possibility of irrigation in the Southeastern Anatolia Region. In the Negarim type micro basin which is one of the water harvesting techniques, the cover material that provides the most efficient surface flow and the rain water falling in the water year are stored in the root region of the plant by passing to the surface stream.

During the research, the observations and measurements made with data obtained by the statistical analysis; rainwater harvest was determined to be optimal by providing best plant growth and development in the subject micro-watershed soil and water which maintains said plastic sheet. According to the result of economic analysis; the cost of preparing a parcel of plastic cover is calculated as 177.75 TL [7]. In the Southeastern Anatolia region where Pistachio is grown extensively, it is necessary to be renewed every 5 years considering that the plastic cover will be worn over time due to the high temperatures in the summer. Considering the economical situation of the farmers in the region, plastic covering seems to be a costly application. It was the topic of the straw mulch which gave the closest results to the plastic covering, which would compare the test subjects among themselves. Farmer handmade straw mulching is easy to find and apply and the cost of preparing a parcel is calculated as TL 32. Farmers can easily obtain this material from in their area. On the straw mulching, a good runoff flow was provided to the plant root zone and a small amount of sediment loss occurred. As the surface of the micro-basin is covered, the effect of evaporation is also reduced. Surface compression treatment is also not cost as a straw mulching, making a plot of surface pressure was calculated as 32.5 per subject. Straw mulching application more obstacles soil erosion than soil surface compaction application. The one handicap must be renewed when disrupted.

The stone cover is not an economic application like plastic covering can be understood from the economic analysis calculation. The cost of making a parcel of stone cover is 125 TL. However pistachio orchards in the region usually located in stone and sloping terrain. Therefore, the need for workers, especially the manufacturers provide their families can be establih in this treatment for their pistachio orchards thus this application can more economically than their mulching systems. But the most important advantage of this application by preventing the loss of soil cover material as laid stones on the surface micro-watershed, has helped to prevent soil erosion.

According to the findings and observations obtained, the rainwater harvesting applied in this study reveals that the Negarim micro-watershed technique can be economic successfully used in pistachio gardens under drought conditions.

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