IRRIGATION EFFICIENCY IN SELECTED FIELD PLOTS UNDER LOWER SEYHAN IRRIGATION PROJECT

Sermet Onder[1], Sevgi Donma[2], Takanori Nagano[3], Bulent Ozekici[4]
[1]*Mustafa Kemal University, Agricultural Faculty, Department of Irrigation and Drainage Antakya-Hatay, Turkey*
e-mail:sonder@mku.edu.tr
[2]*6th Regional Directorate of State Hydraulic Works(DSI) Adana, Turkey*
[3]*Research Institue for Humanity and Nature(RIHN), Kyoto, Japan*
[4]*Cukurova University, Agricultural Faculty, Department of Irrigation and Drainage Adana, Turkey*

1. Introduction

Water is essential to life on our planet. The availability of sufficient amounts of good quality water is fundamental to all biological processes. Natural ecosystems and agriculture are by far the biggest consumers of the Earth's freshwater.
Accordingly, the new situation of the world economy necessitates irrigated agriculture to be more productive and cost effective. Unfortunately, the results obtained from the irrigated agriculture-in terms of yields and farm income-do not seem to satisfy the expectations (Kanber et al., 2004).
In almost all systems, the whole area can not be irrigated for various reasons; such as, water scarcity, fallow land, socioeconomic reasons, and lack of infrastructure. On the other hand, there are considerable changes in the size of irrigated area and cropping pattern from year to year in all irrigation schemes, referring to all relevant studies. It can also be stated that efficient irrigation scheduling has still not achieved properly and this causes too low water application efficiencies with high water conveyance losses (Kanber et al., 2004).
The performance evaluation of an irrigation project can be examined in two major components, i.e. the on-farm system, and supply and distribution (off-farm) system. It is obvious that, adequacy, efficiency, dependability, and equity parameters are commonly used for controlling an irrigation system performance. The performance of a system can be defined as the measurement of the degree/level of fulfillment of the established objectives (Ait Kadi, 1994). Such a degree/level is expressed by one or several parameters chosen as evaluation criteria or as indicators of the considered objectives. In other words, the definition implies that performance is a relative rather than an absolute concept.

Some Irrigation System Performances in Lower Seyhan Plain.

Some studies on irrigation system performance was carried out in Lower Seyhan Plain. Benli et. al.(1987) showed the results indicated that water amounting to 50 percent of that is taken from reservoir of Seyhan Dam was available to plants grown on the Seyhan Plain. Yavuz (1993) tested furrow, drip and sprinkler irrigation methods in a field condition. Similarly, requirement efficiency (Er) and infiltration (Ei) values changed between 63 and 91%, 61 and 100%, depending on irrigation methods and regimes, respectively. Similar results were obtained by Önder (1994) from his study on surge and continuous furrow flow in the Tarsus Plain. He found out that surge flow increased the tail water runoff losses, while deep percolation losses decreased. A study was carried out by Uçar (1994) on the pressurized system (mini-sprinkler) in the Çukurova plain. Results indicated that distribution coefficient was 67% and storage efficiency varied from 59 to 74.8% during the irrigation season. A study was carried out by Andırınlıoglu (1993) on a linear moving sprinkler irrigation system in Seyhan irrigation areas. According to the results, water application efficiency varied between 95 (min.) and 97% (max.), distribution uniformity was 87.2%
This research was carried out for determination of irrigation efficiency on farm level in Lower Seyhan Plain during the growing season year of 2004.

2.Material and Methods

The research area was Lower Seyah Plain(Figure1). Two water users' associations (WUAs) were selected from the Lower Seyhan Irrigation Project. One was Gazi WUAs and the other was Yesilova WUA. Field plots of first and second crop maize were selected from Gazi WUAs. First and second crop maize fields, and watermelon fields were selected from Yesilova WUAs.

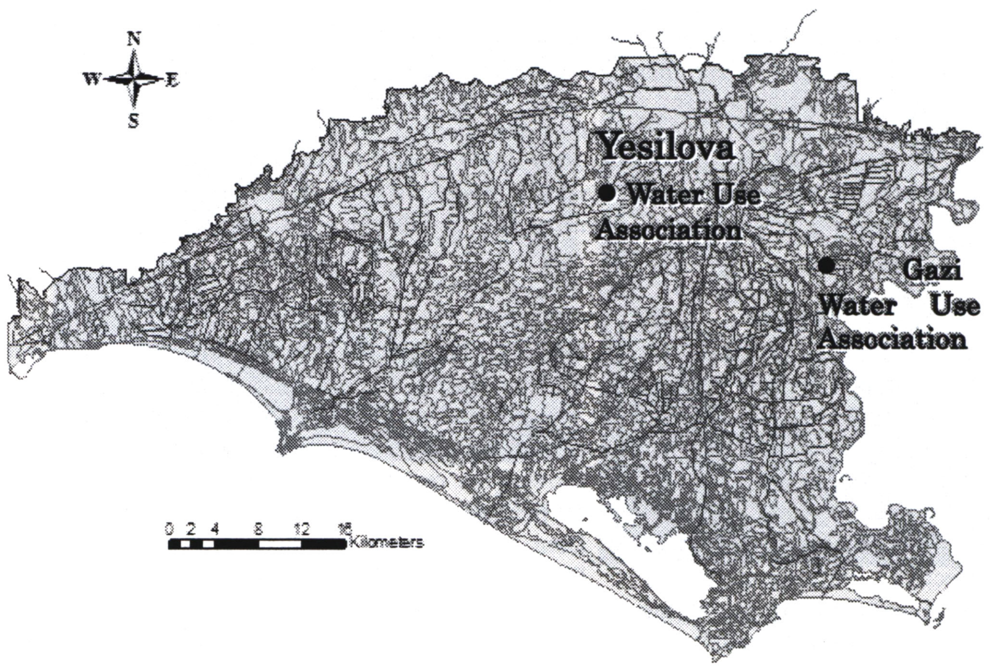

Figure 1. Lower Seyhan Plain and Selected Water Use Associations

The Methodology of Performance Evaluation on Farm Irrigation System Level

Farm irrigation systems are designed to supply the individual irrigation requirements of each field on the farm while controlling for deep percolation, runoff, evaporation, and operational losses. The purposes of evaluating irrigation systems are to determine the efficiency of the system; to determine how effectively the system can be operated and whether it can be improved; to obtain information that will assist engineers in designing other systems; and to obtain information for comparison of various methods, systems, and operating procedures as a basis for economic decision (Merriam et al., 1980, Ait Kadi, 1994).

Various criteria have been developed and used for evaluation of irrigation system performance. It includes mainly social, economical and technical (hydraulic) indicators of performance of irrigation systems. These are known as the performance criteria of a system (Essafi, 1995).

The hydraulic performance of a farm irrigation system is determined by the efficiency with water which is diverted, conveyed, and applied and by the adequacy and uniformity of the application in each field on the farm to evaluate the irrigation system. Three of the most commonly used criteria are efficiency, effectiveness, and uniformity. It has been giving some important hydraulic criteria of performances below.

(a) Application Efficiency (Ea)

In general, efficiency is defined as the ratio of output to input. It is useful to have the concept of efficiency to enable comparison of different management strategies for a particular any type of irrigation systems. The irrigation efficiency of a farm irrigation system is the percentage of water supplied to the farm that is beneficially used for irrigation on the farm. Application efficiency can be thus defined as by Equation 1.

$$Ea = \frac{Water\,Stored\,in\,the\,Root\,Zone}{Water\,Delivered\,to\,the\,Farm} \times 100 \quad (1)$$

The application efficiency is an indicator of the water losses, which occur in the system at the farm level. These irrigation losses may include operational losses from distribution system, seepage and evaporation losses from canals and farm ditches, deep percolation losses below root zone, tail water losses at field end, and evaporation and drift losses resulting from sprinkling.

Soil moisture samples were taken by gravimetric method before and after irrigation applications for calculation of stored water in root zone. Amount of water delivered to the farm was measured by direct and indirect methods. If farmers used siphons, direct (gravimetric) method was used for irrigation amount. But, if the farmers used gates for taking water, direct or indirect method was used for irrigation amount. Velocity of water in canal was measured by velocity measuring device. Also, water depths measuring in canal were measured for water cross area.

(b) Storage Efficiency (Es)
Adequacy is defined as the percentage of the field (farm) receiving the desired amount of water or more. When the desired depth of irrigation fills the soil to the field capacity, a term called the storage efficiency (Es) is often used as an index to adequacy. The Es is computed using Equation 2.

$$Es = 100 \times \left(\frac{Water Stored in the Root Zone}{Soil Moisture Deficit Before Irrigation} \right) (2)$$

Soil moisture deficit before irrigation were calculated by difference of field capacity and initial soil moisture level in root zone.

(c) Irrigation Requirement Percentage (IRP)
This criteria that describes the situation of irrigation. The desired values of irrigation requirement percentage is more than 100%. If applied irrigation water amount is more than irrigation requirement, it is called over irrigation. If applied water is equal to irrigation requirement, it is called full irrigation. If applied water is less than to irrigation requirement, it is called defficient irrigation. The irrigation requirement percentage can be defined as by Equation 3.

$$IRP = 100 \times \left(\frac{Water Delivered to Farm}{Soil Moisture Deficit Before Irrigation} \right) (3)$$

(d) Deep Percolation Percentage (DP)

$$DP = 100 \times \left(\frac{Deep Percolation Amount}{Water Delivered to Farm} \right) (4)$$

Deep percolation amount was calculated by difference of infiltration depth and soil moisture deficit depth before irrigation. Infiltration depth is equal to difference of water delivered amount and runoff amount. Runoff loss amounts were measured by partial flumes.

(e) Runoff Percentage (RP)

$$RP = 100 \times \left(\frac{Runoff Amount}{Water Delivered to Farm} \right) (5)$$

In some conditions, using only application or storage efficiency for evaluation of farm irrigation conditions is not adequate. Irrigations with the highest application of efficiency, and storage are not always desirable, since they do not always maximize net farm profit. Thus, an understanding of the relationship between application and storage efficiency, and irrigation requirement percentage is needed to identify proper irrigation systems.

3.Results

Maize fields were irrigated by border irrigation. The watermelon field was irrigated by sprinkler irrigation method.
Table 1 shows the irrigation performance criterias in Lower Seyhan Plain. In Gazi WUAs, irrigation efficiency was found between 53.8% and 64.6% for surface irrigation. In Yesilova WUAs, maize irrigation efficiency was between 56.3% and 60.2% and 87.7% in sprinkler irrigation. method. The highest Ea was calculated in the water malen plot. The Ea values is almost 60 percent. The lowest Ea values were measured in second crop maize under Yesilova WUAs.

In general, runoff losses of maize plots were little due to farmers' management, because farmers did not let much flow of tail water. The farmers cut off inflow when the water advanced to end of the border. According to this application method, runoff losses were low.

Deep percolation losses were calculated between 12.2% and 38.6% in surface irrigation. The deep percolation losses were high. Because the lenght of border in field plots were 400-500 m. Especially, the longer border was the more deep losses. Only, DP value of first crop maize in Gazi WUAs lower than other plots. The shorter border length decreased deep percolation of this plot..

The other important criterion for performance was storage efficiency. In the irrigation periods of WUAs, the storage efficiencies were found between 46.9% and 59.9% in surface irrigation and 21,2% in sprinkler irrigation. The other mean of this results, irrigations were not adequate.

The other criteria of performance was Irrigation Requirement Percentage(IRP). The IRR describes the situation of irrigation. The desired values of irrigation requirement percentage is more than 100%. According to the results, the IR Percentages for plots changed from 27% in watermalen to 111.3%in second crop maize under Yesilova WUAs. The situation of irrigations were found undesired conditions. In our research, the IRR values showed us the irrigations were applied in defficient irrigation conditions. Only, second crop maize in Yesilova WUAs was over irrigation conditions. The application efficiency (Ea) of this field(Table 1) was 53.8 % that the lowest value.

According to the results referring to all relevant scientific studies, irrigation schemes performance located in different regions of Turkey, overall, is not at acceptable levels. This inadequacy can be highly related to the infrastructure, management (agency, joint, and farmer), allocation and distribution procedures (demand vs. supply), and the climate and socio-economic setting.

4. Required Future Works

The farmers use irrigation water with carefully under water shortage. This means, farmers will be carefull for using of irrigation water in that conditions.

In future, climate will be changed. Because of the water will be much more scare than todays level. In according to this conditions, the farmers will be use efficient irrigation methods which controled irrigation water amount and ground water tables and salinity.

Next year, we will continuou to this research. And, we will chose different crop and different irrigation methods for evaluation of farm irrigation efficiency.

Table 1. Irrigation Performance Criterias in Lower Seyhan Plain

WUAs	Crop	Ea%	Es%	IRP%	DP%	RP%	Irrigation Adequacy
Gazi	1.Crop Maize	60.2	47.7	79.3	12.2	27.6	Defficient
	2.Crop Maize	56.3	46.9	83,2	38,1	5,6	Defficient
Yesilova	1.Crop Maize	64,6	51,6	79,9	34,2	1,2	Defficient
	2.Crop Maize	53,8	59,9	111,3	38,6	7,6	Over
	Watermalen	87,7	21,2	27,0	12,3	0	Defficient

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