Bulgarian Journal of Agricultural Science, 17 (No 4) 2011, 521-530
Agricultural Academy

IRRIGATION PERFORMANCE ASSESSMENT IN TURKEY: THRACE REGION CASE STUDY

M. SENER* and S. ALBUT
University of Namık Kemal, Faculty of Agriculture, Department of Agricultural Construction and Irrigation, 59030 Tekirdag, Turkey

Abstract

SENER, Mehmet and Selcuk ALBUT, 2011. Irrigation performance assessment in Turkey: Thrace region case study. *Bulg. J. Agric. Sci.,* 17: 521-530

Today a large part of the food needs are obtained from irrigated agriculture. However, because of inappropriate, inadequate and wrong management of irrigation systems, farmers cannot obtain desirable outputs. Irrigation systems must have been evaluated by acceptable indicators for expected outputs.

In this study, five comparative indicators which are developed by International Water Management Institute (IWMI) were applied on 10 systems in Thrace region and performance was evaluated. As a result of the study, based on the 2003-2006 years output per unit command area, output per cropped irrigated area, output per unit irrigation supply, output per unit water consumed, and irrigation ratio were determined as 106-7498 US$/ha, 999-3947 US$/ha, 0.06-1.29 US$/m^3, and 0.12-0.63 US$/m^3, 64 % respectively.

According to the results that are obtained, in irrigation schemes such as Altinyazi-Karasaz, Yenikarpuzlu and Kirishane where there is no lack of water, for increasing gross production value which is obtained from per area, plants which have high economic value like rice should be grown. However, in irrigation schemes such as Suleoglu, Kuplu and Hayrabolu where there is inadequate water resources, it is better to plant vegetable and industrial crops which require small amount of water and have a higher economic value instead of planting field crops.

Key words: Irrigation system performance, performance indicator, gross value of production, irrigation ratio

Introduction

Water for agriculture is indispensable component for food security. Irrigated agriculture, in terms of water use, takes on first place in all sectors. Global water consumption between the years 1996-2025 is estimated to increase 16% (Rosegrant and Chai, 2001). Due to high water consumption, by industry and urban sectors, increasing pressure on irrigated agriculture sector is experiencing (Pareira, 2003). The agricultural water users get first place by 64% in European countries, These pressures are felt in Turkey, more severe, due to this ratio for Turkey is 73.8% by the year 2003. Despite the pressures on the irrigated agriculture, many of irrigated agricultural systems cannot provide its expected output (Kanber et al., 2005). It has shown that we need to work intensively on

E-mail: msener@nku.edu.tr

water resources management.

The main reasons behind the irrigation projects not reaching the expected output are administrative errors than lack of project planning and construction. A good irrigation management should provide higher economic output beside water saving and high yield (Pareira, 2003). Nowadays, Project managers, politicians and national planners have been recommending making the rehabilitation of existing projects than establishing new projects.

Project performance assessment has an important role in identifying opportunities in effective water and land use. It can be possible that improve system operation, evaluation of progress towards strategic goals and determine the effects of intervention (Molden et al., 1998).

Sufficient amounts of data base and indicators are needed for performance assessment in irrigation systems (Degirmenci, 2003). International Water Management Institute (IWMI) has been developed a set of performance indicators for evaluation of irrigation systems are under different countries, regions, infrastructure and management (Molden et al., 1998; Kloezen and Garces-Restrepo, 1998).

Many irrigation systems were evaluated with performance indicators have been developed by IWMI, until now. For instance, 18 irrigation schemes in 11 countries (Molden et al., 1998), Coello and Saldana irrigation schemes (Vermillion and Garces-Restrepo, 1996), Alto Rio Lerma WUA (Klozen and Garces-Restrepo, 1998), Alasehir irrigation scheme (Avci et al., 1998), Konya WUA (Cakmak, 2001), Bursa Groundwater irrigation project (Yazgan and Degirmenci, 2002), Southheastern Anatolia Project (Degirmenci, 2003), Lower Seyhan Basin (Yavuz et al., 2006) were assessed by this indicators.

In this study, 10 irrigation schemes performance placed in Thrace (European part of Turkey) has been assessed with using the IWMI's 5 performance indicators between the years of 2003-2006. The purpose of this study, using a minimum set of performance indicators, to determine the current status of the irrigation schemes, compare with other schemes and identify appropriate alternatives to improve available performance.

Materials and Methods

Definition of Research Area

Thrace region is located between 40-42 north parallels and 26-29 East longitudes. It has usually warm and dry summers when winter is cool and rainy. Average annual precipitation ranges between 549-637 mm and generally in the form of rainy. Average temperature is 13.8^{0}C. The biggest water resources are Meric and Ergene rivers. Beside rice, sugar beet, sunflowers, wheat, alfalfa, vegetables, onion, and watermelon are also grown in the region.

Performance indicators

In this study, 10 irrigation schemes which are placed in Thrace region were taken as material (Table 1). Five external indicators developed by International Water Management Institute (IWMI) were used as performance indicators (Molden et al., 1998). The first four indicators were developed for agricultural performance evaluation on unit land and water. Areas where the water scarcity is exist; output per unit of water consumed is especially significant, whereas areas in which the land has limited source, output per unit of command or cropped area are more important (Molden et al, 1998; Kloezen and Garces-Restrepo, 1998). Output per unit command area, output per unit cropped area, output per unit irrigation supply and output per unit water consumed were calculated by using the following equations.

Output per unit of land cropped (US$/ha) =Production/irrigated cropped area (1)

Output per unit command area (US$/ha) = Production/Command area (2)

Output per unit of irrigation supply (US$/m^3) =Production / Diverted irrigation supply (3)

Output per unit of water consumed (US$/m^3) = Production / Volume of water consumed by ET (4)

Where, production is the output of the irrigated

Table 1
The data used related to Thrace Region Irrigation Schemes

Scheme Name	Years	Command area, ha	Irrigated area, ha	Irrigation supply, m^3/ year	Irrigation water requirement, m^3/ha
Kirishane	2003	1188	371	14992000	11952
	2004	1188	377	7921000	11355
	2005	1188	424	6794000	9503
	2006	1188	609	12807000	9388
Kuplu	2003	1300	228	700000	4783
	2004	1300	217	729000	4039
	2005	1300	520	7227000	11110
	2006	1300	446	12574000	10530
Altinyazi-Karasaz	2003	6550	4384	61283000	12260
	2004	6550	4348	74657000	11925
	2005	6550	4756	86077000	10709
	2006	6550	5992	76253000	10208
Yenikarpuzlu	2003	2426	5030	36942000	13210
	2004	2426	5492	56962000	12480
	2005	2426	6991	63988000	11110
	2006	2426	6500	79362000	10530
Kesan	2003	3850	3388	30456000	11126
	2004	3850	2070	14890000	9870
	2005	3850	1931	13640000	8840
	2006	3850	3181.1	31480000	9095
Suleoglu	2003	3500	412	4662000	4886
	2004	3500	--*	--	--
	2005	3500	329	4033000	4398
	2006	3500	610	5897000	3188
Sultankoy	2003	1500	520	11938000	11802
	2004	1500	565	7267000	7962
	2005	1500	915	12010000	11103
	2006	1725	1316	14938000	10530
Kayalikoy	2003	13500	5572	51193000	4392
	2004	13500	3700	33365000	3876
	2005	13500	5278	42300000	3796
	2006	13500	5278	46360000	3417
Kirklareli	2003	8500	2170	--**	4197
	2004	8500	1905	24903000	4540
	2005	10850	5463	42005000	5770
	2006	10850	4973	50180000	5602
Hayrabolu	2003	7720	2221	22038000	6999
	2004	7720	2780	26461000	6959
	2005	7720	4206	31978572	9091
	2006	7720	4884	36369181	9158

*Farmers didn't irrigation due to sufficient precipitation
**Flow measurment had not been made.

area (US$) in terms of gross or net value of production measured at local or world prices. Irrigated copped area (ha) is the sum of areas under crops during the time period of analysis. Command area (ha) is designed area for irrigation. Diverted irrigation supply (m^3) is the volume of surface irrigation water diverted to the command area, plus net removals from groundwater. In our case, groundwater contribution was not taken into account. Cropped area, command area and diverted irrigation supplies were taken from State Hydraulic Works General Directorate (DSI, 2003-2006a). Volume of water consumed by ET (m^3) is the actual evapotranspiration of crops. ET was calculated with Cropwat program for every irrigation system and years (FAO, 1992). Crop pattern was taken from yield count reports for calculation of ET (DSI, 2003-2006b).

The standardized Gross Value of Production (SGVP) was developed for cross-system comparison as obviously there are differences in local prices at different location through the world (Molden et al., 1998).

$$SGVP = \left(\sum_{crops} A_i Y_i P_i / P_b \right) P_{world} \quad (5)$$

Where;

A_i: the area cropped with crop i (ha),

Y_i: the yield of crop i (kg/ha),

P_i: the local price of crop i (US$/kg)

P_b : the local price of the base crop (US$/kg), and

P_{world}: the values of the base crop traded at world prices (US$/kg).

Rice was considered as the base crop because it was predominantly locally grown and internationally traded.

Last Irrigation ratio which is the last indicator is related with the changing irrigated land in the command area by different reasons.

Irrigation ratio= irrigated land / irrigable land (6)

Irrigated land (ha) refers to the portion of the actually irrigated land (ha) in any given irrigation season. Irrigable land (ha) is the potential scheme command area (Vermillion, 2000). It is expected that irrigation ratio must be near or above 100 % in good managed and intensive farming schemes.

Results and Discussion

Output per unit command area

Output per unit command area between years of 2003-2006 for 10 irrigation schemes is presented in Figure 1. Output per unit command area varied 106-7498 US$/ha between the years 2003-2006. As it is shown in figure, the highest and lowest output per unit command area were observed at the Yenikarpuzlu and Suleoglu schemes in 2005. The main factor which changes output per unit command area is cropping intensity Irrigation ratio was seen as 288% in Yenikarpuzlu scheme, but it was only 9% in Suleoglu scheme in the same year 2005. In fact, this irrigation ratio values were the lowest and the highest values for the years 2003-2006. Similarly, it is determined that schemes have high irrigation ratios as Altinyazi-Karasaz and Kesan have also higher output per unit command area than the other schemes.

Yenikarpuzlu irrigation scheme has been highest output per unit command area because of high irrigation ratio and the total irrigation area is cultivated with rice which is having high economic value. It has shown that economic value of cultivated plants is another influential factor.

Output per unit command area were founded 677 and 3105 US$/ha in Tayland-Lam Pao and Iran Dez schemes (Burt and Styles, 1998), 6233 US$ / ha for Bergama Kestel Irrigation 1469 US$/ha in Gediz Basin (Avcı et al., 1998; Girgin et al., 1999), 2629 US$ /ha in Bursa Groundwater irrigation scheme (Yazgan and Degirmenci, 2002), 144-8349 US$ /ha in 158 irrigation projects (Degirmenci, 2001), 1689-5030 US$ /ha in Lower Seyhan Basin (Yavuz et al., 2006).

Output per unit cropped area

Output per unit cropped area over time period

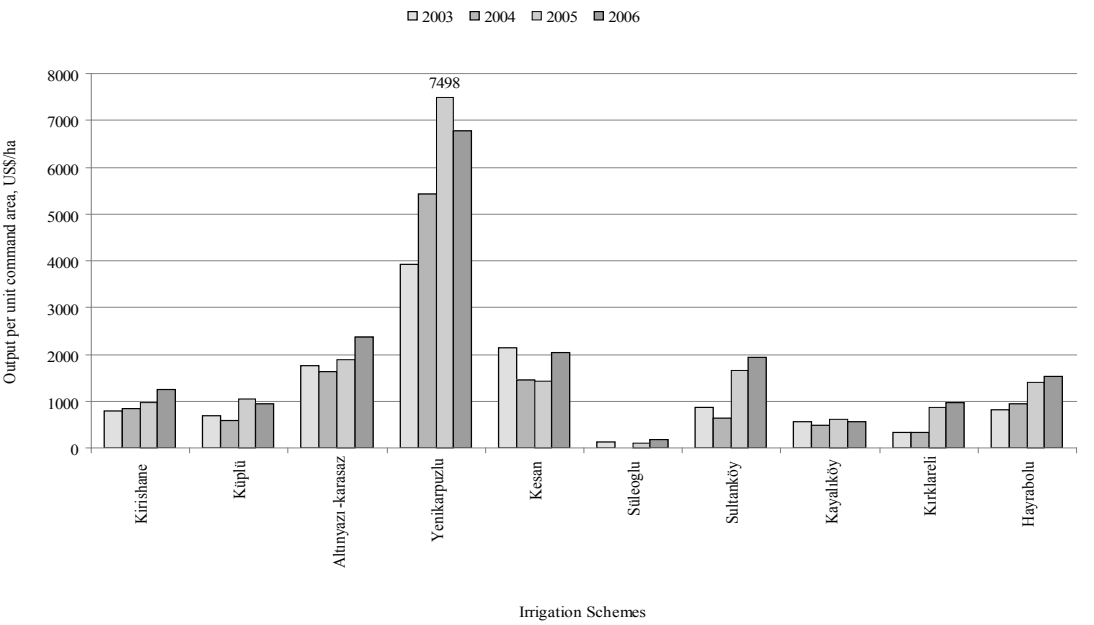

Fig. 1. Output per unit command

for 10 irrigation schemes have been given in Figure 2. The lowest and highest Output per unit cropped area was determined as 999 and 3947 US$/ha respectively in Suleoglu and Kuplu schemes in 2003. Output per unit cropped area is affected by cropping pattern and cropping intensity, yield and local price. Sunflower was cultivated in 46 % of Suleoglu schemes area though sunflower has lower economic value than rice and watermelon etc. Hence, Output per unit cropped has been stayed lower than the other schemes. On the other hand, watermelon was the dominant crop as 38% in Kuplu scheme.

As it is seen, Output per unit cropped area was determined above 2000 US$/ha in 70 % of the irrigation schemes between research years. Output per unit cropped area was determined to be 2780, 398-842, 359-6197 and 4551-6981 US$/ha in the studies conducted by Klozen and Restrepo (1998), Molden et al. (2001), and Cakmak (2001 and 2003) respectively.

Output per unit irrigation supply

Output per unit irrigation supply over 4 year period for 10 irrigation schemes has been given in Figure 3. The highest output per unit irrigation supply was 1.29 $/ m^3 in 2003 in the Kuplu scheme while the lowest output per unit irrigation supply was 0.06 US$/$m^3$ in 2003 in Kirishane scheme. This indicator shows the output against unit water supply. Hence, the value of output per unit irrigation supply is directly affected by crop pattern and the amount of water given to scheme.

Watermelon which was widely grown with a ratio of 38% was followed by sunflower and maize in Kuplu scheme in the year 2003. Output per unit irrigation supply was found higher because watermelon and maize require lower irrigation requirement but high prices. While 3070 m^3/ha irrigation water was being provided to Kuplu irrigation scheme in the year 2003. On the other hand, 35018 m^3/ha irrigation water had been applied to Kirishane irrigation scheme in the same year. As you can see, between two networks, there has been a huge difference in terms of the water given to the unit area. 11.4 percent of the Kuplu irrigation scheme water has been applied to Kirishane scheme.

In the irrigation scheme area, orchards, vegetables and industrial plants should be highly

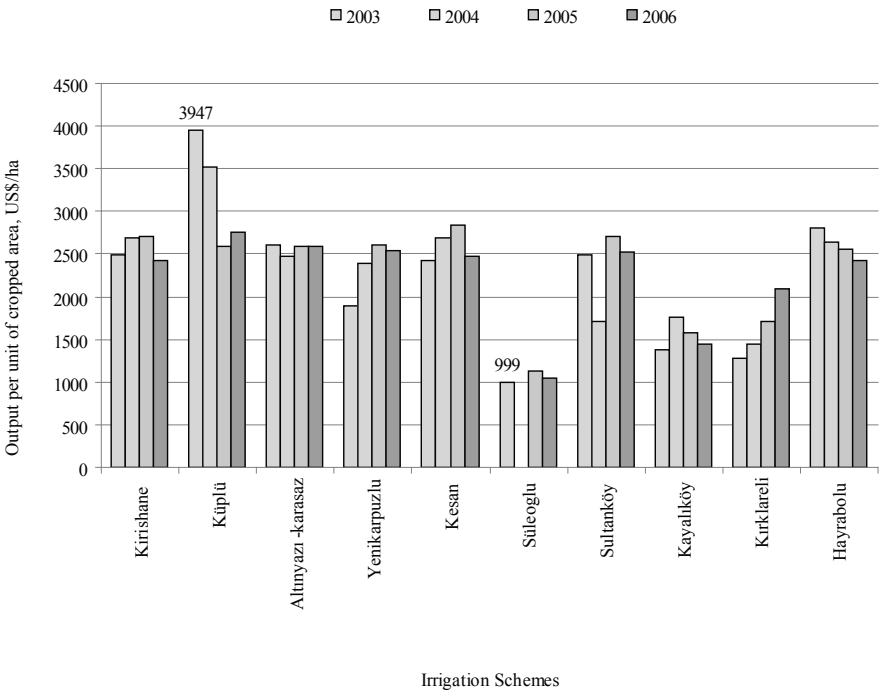

Fig. 2. Output per unit cropped area

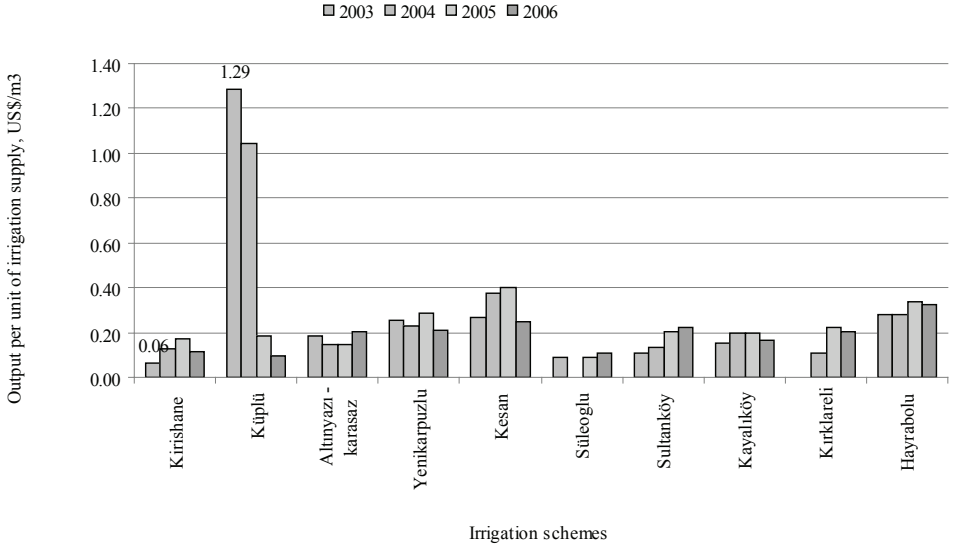

Fig. 3. Output per unit irrigation supply

included for increasing the value of output per unit irrigation supply. Molden et al. (1998) found output per unit irrigation supply as 0.21 (US$/m^3). Avci et al. (1998) determined output per unit irrigation supply as 0.9 US$/m^3 in Bergama-Kestel irrigation scheme. Yazgan and Degirmenci (2002) assessed irrigation performance of Bursa Goundwater irrigation schemes and determined as 0.8 US$/m^3. Degirmenci (2003) assessed irrigation system performance of 12 irrigation schemes in

Southeastern Anatolia Project (GAP) for 1997-2001 years and found output per unit irrigation supply as 0.12-2.16 US$/m^3.

Output per unit of water consumed

Output per unit of water consumed between years of 2003-2006 is given in Figure 4. Output per unit of water consumed varied between 0.12 US$/m^3 and 0.63 US$/m^3 respectively in Yenikarpuzlu and Kuplu irrigation scheme. Output per unit of water consumed is being affected by ET. If crop which has high ET like rice, is grown in irrigation scheme, even if the increased production value, output per unit of water consumed value is reduced as Yenikarpuzlu irrigation scheme. As the years taken into account, Yenikarpuzlu scheme had been the lowest output per unit of water consumed value because of rice is widely grown (100%) in scheme.

Watermelon is widely grown which was followed by sunflower, wheat, vegetables and maize in Kuplu irrigation scheme, in 2003 and 2004. Output per unit water consumed in Kuplu irrigation has been in the maximum level in the years 2003 and 2004. On the other hand, only rice cultivation was made in Kuplu irrigation scheme in the years 2005 and 2006. There has been a dramatic decrease in 2005 and 2006. This is because, in these years, rice which require high amount of water has been very effective. It has been clearly shown that how the water consumption affects the values of output per unit of water consumed.

Output per unit of water consumed founded as 0.19 US$ /m^3 in Seyhan irrigation scheme in the years 1996 and 1997 (Molden et al., 1998). Perez et al. (2004) assessed irrigation performance in south of Spain in the years 1995-2000 and Output per unit of water consumed founded as between 0.41-0.51 US$ /m^3. Rodriguez-Díaz et al. (2008) calculated Output per unit of water consumed as 0.43-1.44 US$ /m^3.

Irrigation ratio

Irrigation ratio over time period for 10 irriga-

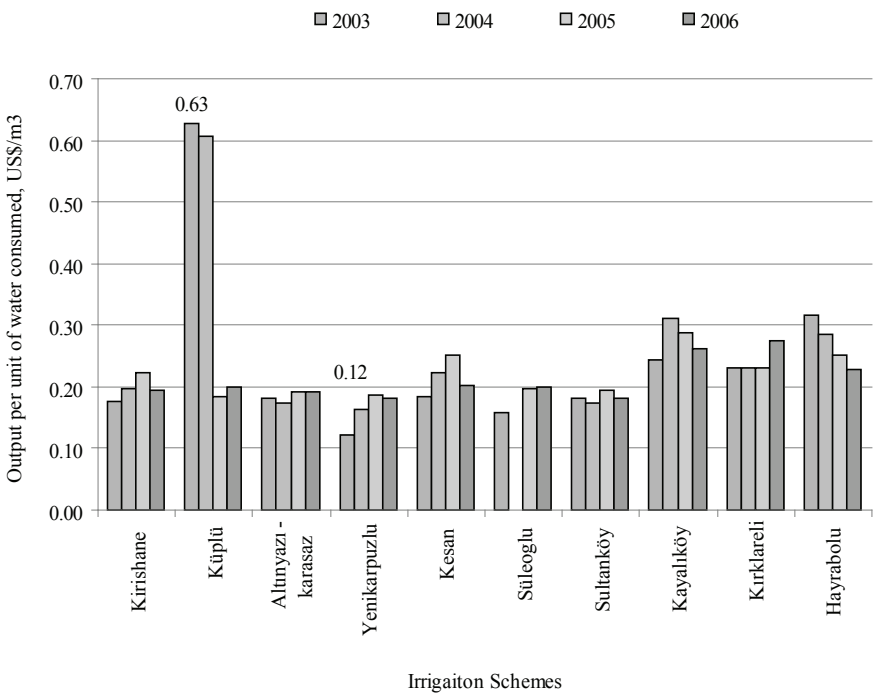

Fig. 4. Output per unit water consumed

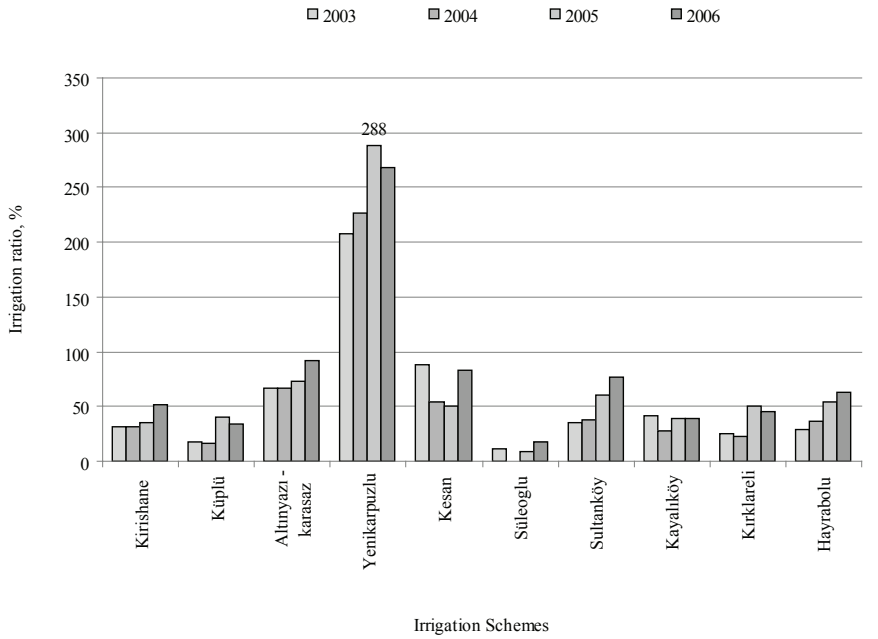

Fig. 5. Irrigation ratio

tion schemes has been given in Figure 5. Average irrigation ratio was found 64 %. Irrigation ratios was set below 50 % in more than half (55%) of the irrigation schemes. However, just a portion of 10% was seen over 100% over time period. In all time periods, Irrigation rate has always been above 100% in Yenikarpuzlu scheme. Yenikarpuzlu irrigation scheme which was constructed by World Bank did not experience any trouble for water supply. Although Yenikarpuzlu scheme area which was separated the entire area for rice production was 2426 ha, it was seen that it reached 6991 ha in 2005. On the other hand, the lowest irrigation ratio was as 0% on Suleoglu irrigation scheme in the year 2004. Farmers didn't need irrigation because of excessive rainfall in that year. It was determined that irrigation ratio has risen as parallel to the rice production area. Irrigation ratio was, 88% for Menemen irrigation (Kuklu et al., 2008), 70% for transferred irrigation schemes in Turkey (Yazgan and Degirmenci, 2002), 24-105% for 21 irrigation schemes for the years 1984-1993 (Beyribey et al., 1997), 17-92% for 239 irrigation schemes for the year 2001 (Merdun, 2004).

Conclusion

Comparative indicators are powerful tools to evaluate performance of irrigation schemes. These indicators allow comparison of irrigation schemes which are in different regions or country, managed differently and have different infrastructure.

The gross production values have been identified for 10 irrigation schemes with different input in Thrace Region. Output per unit command area, Output per unit cropped area, Output per unit irrigation supply, Output per unit of water consumed determined respectively 106-7498 US$/ha, 999-3947 US$/ha, 0.06-1.29 US$/$m^3$, and 0.12-0.63 US$/m^3 for the years 2003-2006. Output per unit command area found approximately the same with the average of Turkey. Output per unit cropped area found higher on widely cultivated rice schemes than the wheat or sunflower cultivated schemes. Industrial and vegetables should be given more space in irrigation scheme due to having less water consumption and the higher economic returns.

Irrigation ratio was founded between 0 and 288% and average 64% for the years 2003-2006.

This irrigation ratio value must be increased to above 100% and so areas that aren't irrigated should be eliminated. It was seen that irrigation ratio was affected from technical and socio-economic factors. When Irrigation schemes was projecting, socio-economic status of farmers' groups should be taken into account and technical specifications should be appropriate to create a scheme. To enable farmers to sell their crops for high price, long-term national agricultural policies should be developed by politicians and crop pattern should be established according to these needs.

References

Avci, M., E. Akkuzu, H. B. Unal and S. Asik, 1998. Performance assessment of Bergama-Kestel Dam Irrigation. Aegean Region I. Agriculture Congress, Aydin, pp. 62-69.

Beyribey, M., F. K. Sonmez, B. Cakmak and M. Oguz, 1997. Evaluation of System Performance in irrigation scheme *6. Kulturteknik* Congress Book, Bursa, pp. 162-171.

Burt, C. M. and S. W. Styles, 1998. Modern management practice in irrigation: impact on performance. *AGR, IPTR and ITRC Research Report*. Prepared for the World Bank Research Committee.

Cakmak, B., 2001. Evaluation of irrigation system performance in Irrigation Associations, Konya . Ankara University Faculty of Agriculture, *Journal of Agricultural Sciences*, **7**(3): 111-117.

Cakmak, B., 2003. Evaluation of system performance in Ceylanpinar Ikicircip Irrigation Association. Harran University, *Journal of the Faculty of Agriculture*, **7:** 1-9.

Cakmak, B. and M. Beyribey, 2003. Evaluation of system performance in Sakarya basin irrigation. *A. U.* Agriculture Faculty, *Journal of Agricultural Sciences,* **9**: 116-124.

Degirmenci, H., 2001. Assessment of transferred irrigation scheme with comparative indicators *Uludag University. Journal of Agricultural Faculty*, **15**: 31-42.

Degirmenci, H., 2003. Assessment of irrigation schemes with comparative indicators in the Southeastern Anatolia Project. *Turkish Journal of Agriculture and Forestry*, **27**: 293-303.

DSI, 2003-2006a. Evaluation report of irrigation schemes of operated and transferred by DSI General Directorate of *DSI,* The head of the Department of operation and maintenance, Ankara.

DSI, 2003-2006b. Result of product counting of irrigation and drying schemes are opened by DSI. DSI General Directorate, The head of the Department of operation and maintenance, Ankara.

Girgin, A., G. Gecgel and S. **Gul,** 1999. Performance of Gediz basin irrigation in terms of water management,Izmir Water Congress Proceedings Book, TMMOB Izmir Provincial Coordination Committee. Izmir, pp. 317-334.

FAO, 1992. CROPWAT, A computer program for irrigation planning and management, *Irrigation and Drainage Paper* **46**. Food and Agriculture Organization, Rome, Italy.

Kanber, R., M. Unlu, E. H. Çakmak and M. Tuzun, 2005. Irrigation system performances in Turkey. Use of Water and Land for Food Security and Environmental Sustainability. International commission on irrigation and drainage. *The 19th international congress and 56th International executive council meeting*. Beijing, China September 10 – 18.

Klozen, W. H. and C. Garces-Restrepo, 1998. Assessing irrigation performance with assesing irrigation system performance of water user associations in the Lower Seyhan Plain irrigation area. *II. Ulusal Sulama Kongresi*, 16-19 Ekim, Aydin, pp. 56-65.

Kukul, Y. S, S. Akcay, S. Anac and E. Yesilirmak, 2008. Temporal irrigation performance assessment in Turkey: Menemen case study. *Agricultural Water Management*, **95:** 1090–1098.

Merdun, H., 2004. Comparison of irrigation performance based on the basin, crop pattern, and scheme sizes using external indicators. *Turkish Journal of Agriculture and Forestry,* **28**: 321-331.

Molden, D. J., R. Sakthivadivel, J. P. Christopher, F. Charlotte and W. H. Kloezen, 1998. Indicators for comparing performance of irrigated agricultural

systems. *Research Report 20*, Colombo, Sri Lanka, IWMI.

Molden, D. J., R. R. Sakthivadival and H. Habib, 2001. Basin level use and productivity of water; examples from South Asia. *International Water Mangement Inst., Research Report 49*, Colombo, Sri Lanka.

Pareira, L., 2003. Proceeding of the international workshop on participatory management of irrigation systems, *water utilization techniques hydrology*, A session of the 3rd world water forum, Theme: Agriculture, Food & Water, March 2003.

Perez, L., J. A. Rodríguez, E. Camacho, R. Lopez, J. Roldan, M. Alcaide, J. Ortiz and R. Segura, 2004. IGRA: an approach for the Application of the benchmarking Initiative to irrigation areas.

Rodriguez-Díaz, J. A., E. Camacho-Poyato, R. Lopez-Luque and L. Perez-Urrestarazu, 2007. Benchmarking and multivariate data analysis techniques for improving the efficiency of irrigation districts: An application in Spain. *Agricultural Systems,* **96 (1-3):** 250-259.

Rosegrant, M. W. and X. Cai, 2001. Water for Food Production. 2020 Focus 9 (Overcoming Water Scarcity and Quality Constraints), Brief 2of 14. The International Food Policy Research Institute (IFPRI). October 2001, http://www.ifpri.org/2020/focus/focus09/focus09_02.htm

Vermillion, D. L. and C. Garces-Restrepo, 1996. Results of management turnover in two irrigation district in Columbia. *Research Report 4*. *Colombia, Sri Lanka: International Irrigatation Management Institute.*

Vermillion, D. L., 2000. Guide to monitoring and evaluation of irrigation management transfer. http://www.impim.org/library.html.

Yavuz, M. Y., I. Kavdir and N. Y. Delice, 2006. Performance evaluation of water user associations: A case study of the Lower Seyhan Basin. *Harran University, Journal of Agricultural Faculty,* **10** (3/4): 35-45.

Yazgan, S. and H. Degirmenci, 2002. Efficiency Indicators in Irrigation Projects' Performance Evaluation: A Case Study on the Bursa Groundwater Irrigation Project. *Turkish Journal of Agriculture and Forestry*, **26**:93-99.

Received December, 2009; accepted for printing May, 2, 2011.