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Abstract: In this study, 6 comparative indicators for the assessment of irrigation system performance were applied to 12 irrigation schemes, which were components of the Southeastern Anatolian Project, for the period 1997-2001. The output per unit cropped area, output per unit command, output per unit irrigation supply, output per unit water consumed, relative water supply and irrigation ratio were calculated as 1223-9436 $ ha^{-1}, 308-5771 $ ha^{-1}, 0.12-2.16 $ m^{-3}, 0.45-2.92 $ m^{-3}, 1.00-5.90, and 7-100%, respectively. ANOVA test results indicated that among the schemes the differences in the output per unit cropped area, output per unit irrigation supply, output per unit water consumed and relative water supply were not statistically significant but that the differences in output per unit command and irrigation ratio were statistically significant. For efficient and rational irrigation management, an information system for monitoring and evaluation which encompasses all stakeholders, should be set up and irrigation scheduling should be designed.

Key Words: Irrigation scheme, comparative indicators, standardized gross value of production, relative water supply, irrigation ratio

Güneydoğu Anadolu Projesinde Karşılaştırma Göstergeleri ile Sulama Şebekelerinin Değerlendirilmesi

Özet: Bu çalışmada; sulama şebekelerinin sistem başarılarının değerlendirilmesinde altı karşılaştırma göstergesi, 1997-2001 yılları sulama sonuçlarına göre, Güneydoğu Anadolu Projesi (GAP) içinde yer alan 12 sulama şebekesine uygulanmış ve sulama sistem performansı değerlendirilmiştir. Çalışma sonucunda, fiilen sulanan alan eşdeğer brüt üretim değeri 1223-9436 $ ha^{-1}, proje alanı eşdeğer brüt üretim değeri 308-5771 $ ha^{-1}, saptırılan suya karşılık eşdeğer brüt üretim değeri 0.12-2.16 $ m^{-3}, bitki su gereksinimine karşılık eşdeğer brüt üretim değeri 0.45-2.92 $ m^{-3}, su temin oranı 1.00-5.90 ve sulama oranı % 7-100 olarak bulunmuştur. Yapılan varyans analizleri sonucunda, fiilen sulanan alan eşdeğer brüt üretim değeri, saptırılan suya karşılık eşdeğer brüt üretim değeri, bitki su gereksinimine karşılık eşdeğer brüt üretim değeri, su temin oranı bakımından projeler arasında istatistiksel açıdan fark önemsiz, proje alanı eşdeğer brüt üretim değeri ve sulama oranı bakımından ise fark önemli bulunmuştur. Etkin ve verimli bir sulama yönetimi için, tüm ilgi gruplarını içine alan bir izleme ve değerlendirme bilgi sisteminin oluşturulması ve sulama planlamasının yapılması gerekmektedir.

Anahtar Sözcükler: Sulama şebekesi, karşılaştırma göstergeleri, eşdeğer brüt üretim değeri, su temin oranı, sulama oranı

Introduction

Water is a valuable resource for agricultural production. Scarcity and misuse of water pose a serious and growing threat to life and sustainable development. As water is the limiting factor in most of the world, increasing yields and sustaining food production depend mainly on irrigation. Therefore, protection and development of water resources are crucial for irrigation facilities. The performance of many irrigation systems is significantly below their potential due to a number of shortcomings, including poor design, construction, operation and maintenance. More than 2/3 of the total area under irrigation in Turkey has been developed by the public sector. However, the anticipated development in irrigation planning, operation and maintenance has not been achieved to the same extent as in developed countries.

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Considering the total budget investment for the last 4 years, agricultural activities share of investment decreased from 11.48% in 1997 to 6.72% in 2000 (Şengün, 2002). According to these data, the agricultural infrastructure has not been established as sufficiently as expected and existing facilities have not been operated appropriately due to the lack of allowable funds.

In the framework of the accelerated transfer program started in 1993, the responsibility for the management, operation and maintenance of irrigation systems has mainly been transferred to users. Participatory irrigation management has been established for 3 main reasons: user participation, self-control of the irrigation management and decreasing operation and maintenance costs. The number and corresponding percentage distribution of the transferred area (in parentheses) from the State Hydraulic Works (DSİ) to Water User Associations (WUAs), Water User Groups (WUGs), municipalities, cooperatives and others are: 336 (1,518,118 ha), 215 (33,643 ha), 136 (56,619 ha), 44 (54,318 ha) and 4 (1000 ha), respectively, with a total area of 1,663,698 ha (Tekinel, 2001).

A sufficient database and comparative indicators for the assessment of irrigation system performance are needed. Therefore, many researchers have offered and applied a great many comparative indicators for such an assessment.

Molden et al. (1998) tested comparative performance indicators using the water input-yield relationship in 18 irrigation schemes in 11 different countries. The Coello and Saldana irrigation schemes in Colombia (Vermillion and Garces-Restrepo, 1996), Alto Rio Lerma WUA (Kloezen and Garces-Restrepo, 1998), Bergama-Kestel Dam Irrigation (Geçgel et al., 1998), Alaşehir irrigation scheme (Avcı et al., 1998), Konya WUA (Çakmak, 2001) and 158 DSİ-transferred irrigation schemes (Değirmenci, 2001a) were assessed by comparative indicators developed by the International Water Management Institute (IWMI).

The objectives of this study were: a) to make recommendations for the improvement of irrigation system operation, b) define the existing conditions and the impacts of interventions on the system, and c) make across-system comparison. For this purpose, the performances of 12 transferred schemes; Derik-Dumluca, Nusaybin, Ş.Urfa-Harran, Akçakale, Ceylanpınar, Hacıhıdır and Hancağız in the Euphrates Basin and the Garzan-Kozluk, Gözegöl, Devegeçidi, Çınar-Göksu and Batman irrigation schemes in the Tigris Basin were assessed using the appropriate indicators developed by the IWMI.

Materials and Method

In this study, 12 transferred irrigation schemes were taken as material. Data for the irrigation schemes were compiled from the irrigation project evaluation reports (Table 1) (DSİ, 1997-2001a). The data regarding crop patterns, unit yields and prices for 1997-2001 were obtained from the product count results. Table 2 shows the evaluated data for 2001 as an example (DSİ, 1997-2001b).

A set of comparative performance indicators related to economic, agricultural, and water use efficiency, developed by the IWMI, were used for the assessment of irrigation system performance (Molden et al., 1998). The first 4 basic comparative indicators relate agricultural production to unit land and water. These indicators allow a comparison of the performance of fundamentally different systems by standardizing the gross value of agricultural production. In areas where water is scarce, the standardized gross value of production (SGVP) per unit of water consumed is especially significant, whereas in areas in which the land is the limited source, output per unit of command or cropped area are more important. These external indicators are output per unit cropped area, output per unit command, output unit irrigation supply and output per unit water consumed. In addition to the aforementioned indicators, 2 other indicators, relative water supply and the irrigation ratio, were considered for the assessment study.

According to Molden et al. (1998) and Perry (1996), these indicators can be calculated as:

$$\text{Output per cropped area}\left(\frac{\$}{\text{ha}}\right) = \frac{\text{SGVP}}{\text{Irrigated cropped area}} \qquad (1)$$

$$\text{Output per unit command}\left(\frac{\$}{\text{ha}}\right) = \frac{\text{SGVP}}{\text{Command area}} \qquad (2)$$

Table 1. Assessed irrigation schemes and data used in the GAP region (continued).

Name of Scheme	Name of Project	Water Resource	Years	Command Area (ha)	Irrigated Cropped Area (ha)	Diverted Irrigation Supply (hm^3)	Volume of Water Consumed by ET (m^3/ha)
GAP Tigris Basin Irrigation Schemes							
			1997				
			1998	3700	2590	20,720	6582
Garzan-Kozluk	Garzan	Garzan	1999	3700	1702	23,500	6581
			2000	3700	1147	13,850	6482
			2001	3700	1998	13,100	6276
			1997	550	539	6001	5701
			1998	1003	451	14,057	5516
Gözegöl	Dicle-Kralkızı	Çağıtran	1999	1003	201	2177	4501
			2000	1003	181	641	2629
			2001	1003	221	4075	6146
			1997	6900	6003	86,999	5741
			1998	6900	6417	96,493	5590
Devegeçidi	Devegeçidi	Devegeçidi Creek	1999	6900	5658	87,132	5667
			2000	6900	6072	66,724	5144
			2001	6900	6348	82,930	4420
			1997	3582	2651	33,049	5254
			1998	3582	2901	34,714	4978
Çınar-Göksu	Göksu-Çınar	Göksu Creek	1999	3582	2579	20,600	4298
			2000	3582	2472	16,933	3020
			2001	3582	1361	17,729	5700
			1997	7590	5844	62,032	4239
			1998	7590	5617	43,780	5753
Batman	Batman	Batman Creek	1999	7590	5313	78,230	5230
			2000	7590	4934	67,100	5129
			2001	7590	4934	70,000	5784

$$\text{Output per unit irrigation supply}\left(\frac{\$}{m^3}\right) = \frac{\text{SGVP}}{\text{Diverted irrigation supply}} \tag{3}$$

$$\text{Output per unit water consumed}\left(\frac{\$}{m^3}\right) = \frac{\text{SGVP}}{\text{Volume of water consumed by ET}} \tag{4}$$

$$\text{Relative water supply} = \frac{\text{Total water supply}}{\text{Crop - water demand (ET)}} \tag{5}$$

$$\text{Irrigation Ratio} = \frac{\text{Irrigated cropped area}}{\text{Command area}} \tag{6}$$

Table 2. Data for crops in the GAP region.

Name of Scheme	Name of Crop	Percentage (%)	Average Yield (kg/ha) (m^3/ha)	Unit Price (TL/kg) (TL/m^3)
GAP Euphrates Basin Irrigation Schemes				
Derik-Dumluca	Grain	80.2	400	210,000
	Cotton	19.8	299	443,666
Nusaybin	Grain	26.4	766	115,700
	Cotton	72.4	292	513,669
	Vegetables	0.8	2709	347,571
	Poplar	0.4	3	45,000,000
Ş.Urfa-Harran	Grain	9.7	380	200,000
	Melon-Watermelon	0.1	3930	200,000
	Cotton	88.7	375	700,000
	Maize	0.2	780	180,000
	Grapevine	0.1	1600	260,000
	Fruits	0.1	1500	225,000
	Vegetables	0.7	2470	400,000
	Fodder Crops	0.2	650	110,000
	II. Product Cotton	0.2	360	725,000
	II. Product Maize	0.3	750	190,000
Akçakale P	Grain	29.6	390	190,000
	Cotton	70.1	370	700,000
	Maize	0.1	750	175,000
	Vegetables	0.2	2900	390,000
Ceylanpınar P	Grain	42.9	380	190,000
	Melon-Watermelon	14.3	3500	210,000
	Cotton	42.9	300	700,000
	II. Product Vegetables	7.1	2400	375,000
Hacıhıdır	Cotton	100	370	700,000
Hancağız	Grain	95.2	400	130,000
	Cotton	2	380	480,000
	Fruits	0.7	450	250,000
	Vegetables	2	2000	200,000
	II. Product Maize	2	700	200,000
GAP Tigris Basin Irrigation Schemes				
Garzan-Kozluk	Grain	5	390	212,343
	Cotton	80	299	481,558
	Tobacco	15	200	761,000
Gözegöl	Cotton	97.1	325	450,000
	Paddy	2.9	180	425,000
Devegeçidi	Grain	22.9	398	137,908
	Cotton	71.7	364	443,111
	Maize	3.4	450	225,000
	Vegetables	2	4341	200,000
Çınar-Göksu	Cotton	100	326	450,000
Batman	Melon-Watermelon	0.5	2200	125,000
	Cotton	98.5	374	463,080
	Tobacco	1	250	900,000

where the SGVP is the output of the irrigated area in terms of the gross or net value of production measured at local or world prices (see below), the irrigated cropped area is the sum of areas under crop during the period of analysis, the command area is the nominal or design area to be irrigated, the diverted irrigation supply is the volume of the surface irrigation water diverted to the command area plus net removals from groundwater, the volume of water consumed by evapotranspiration (ET) is the actual ET of crops, irrigation supply is only the surface diversions and net groundwater draft for irrigation, and irrigation demand is the crop ET less effective rainfall. In transferred irrigation schemes, the water consumption or ET of the all crops planted in the irrigation season is determined by the Blaney-Criddle method. The reason for using this method is that it requires fewer climatic parameters but produces acceptably reliable results.

The SGVP was used for the cross-system comparison, as obviously there are differences in local prices at different locations throughout the world (Molden et al., 1998). Cotton was chosen as the base crop due to its cropping intensity in the study area and its importance in international markets. International exchange prices for cotton were 1.72, 1.62, 1.33, 1.38, and 0.96 $ kg^{-1} in 1997, 1998, 1999, 2000 and 2001, respectively (ICAC, 2001). The SGVP can be calculated as

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

where A_i is the area cropped with crop i (ha), Y_i is the yield of crop i (t ha^{-1}), P_b is the local price of the base crop ($ t^{-1}), P_i is the local price of crop i ($ t^{-1}), and P_{world} is the value of the base crop traded at world prices ($ t^{-1}).

The indicators were calculated by the above equations using Microsoft EXCEL calculating tables. The calculation steps are summarized in Figure 1.

Results and Discussion

Output per unit cropped area

The output per unit cropped area over time for the 12 irrigation schemes is presented in Figure 2. The output per unit cropped area varied between 1223 and 9436 $ ha^{-1} for the period 1997-2001. The highest and lowest values of the output per unit cropped area were observed at the Ceylanpınar and Hancağız irrigation schemes 9436 $ ha^{-1} in 1999 and 1223 $ ha^{-1} in 2000. In conclusion, cotton, which is the dominant crop in the Ceylanpınar irrigation scheme, produced more value than grain. Grain was the predominant crop (97.9%) in the Hancağız scheme for 2000. The output per unit cropped area varied from one project to another due to fluctuations in the crop pattern and world prices of the base crop.

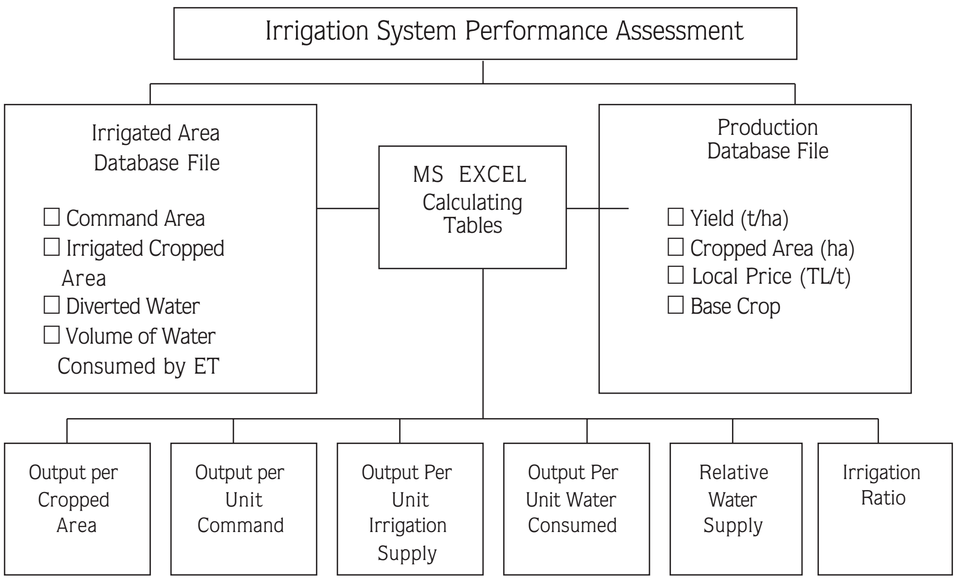

Figure 1. Steps for assessment of irrigation system performance.

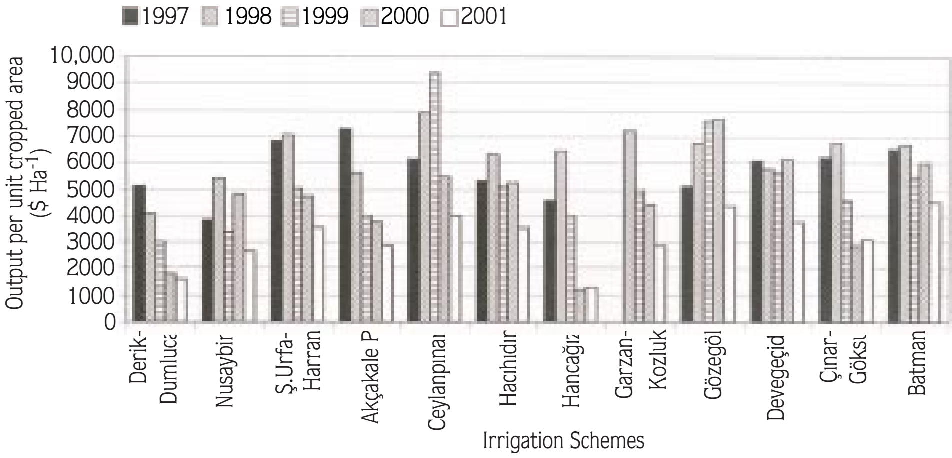

Figure 2. Output per unit cropped area.

ANOVA test results indicated that the differences in the output per unit cropped area among the schemes were not statistically significant [F(11.47) = 2.285; P = 0.025 > P = 0.001].

In similar studies, output per unit cropped area was calculated as 676-5430 $ ha^{-1} for 1999 and 354-8659 $ ha^{-1} for 2000 in the Sakarya Basin irrigation schemes by Çakmak and Beyribey (2003), 2857-4415 $ ha^{-1} in the Uluabat irrigation scheme between 1992 and 1998 by Değirmenci (2001b), and 2900-4000 $ ha^{-1} in 18 irrigation schemes for 1998 by Molden et al. (1998).

Output per unit command

The output per unit command varied between 308 and 5771 $ ha^{-1} (Figure 3). The highest and lowest values of the output per unit command were observed at Ş.Urfa-Harran in 1997 and the Hancağız irrigation scheme in 2001, respectively. For 2001, the irrigation ratio was highest (84%) in Ş.Urfa-Harran and lowest (24%) in the Hancağız irrigation scheme. These initial results indicate that the important factors contributing to higher output per unit command are the cropping intensity and the type of crop grown. ANOVA test results indicated that the differences in the output per unit command among the schemes were statistically significant [F(11.47) = 0.001, P = 0.000 < P = 0.001]. According to least squares difference (LSD) test results, the differences in output per unit command occurred due to the Ş.Urfa-Harran-Hacıhıdır (P = 0.001), Hancağız-Devegeçidi (P = 0.000), Devegeçidi-Akçakale (P = 0.000) and Devegeçidi-Hacıhıdır (P = 0.000) irrigation schemes.

Many researchers have studied the calculation of output per unit command in parallel studies carried out in different regions of the world. For example, output per unit command values were calculated as 6233 $ ha^{-1} in the Bergama-Kestel project, 2167 $ ha^{-1} in the Lower Seyhan project, 105-1800 $ ha^{-1} in the Alto-Rio Lerma project in Mexico and 195-5391 $ ha^{-1} in the Konya irrigation schemes (Avcı et al., 1998; Molden et al., 1998; Kloezen and Garces-Restrepo, 1998; Çakmak, 2001).

Output per unit irrigation supply

The values of output per unit irrigation supply for the period 1997-2001 are presented in Figure 4. The highest and lowest values were 2.16 $ m^{-3} in 2000 and 0.13 $ m^{-3} in 2001 in the Gözegöl and Hancağız and Derik-Dumluca irrigation schemes, respectively. The output per unit irrigation supply tends to be higher in humid regions where irrigation needs are generally lower. Due to irrigation water scarcity in the Gözegöl and Hancağız irrigation schemes, 44 and 54% of the command areas were not irrigated, respectively. ANOVA test results indicated that the differences in the output per unit irrigation supply among the schemes were not statistically significant [F(11.47) = 1.011; P = 0.452 > P = 0.001].

Vermillion and Garces-Restrepo (1996) calculated output per unit irrigation supply as 0.12 $ m^{-3} in the Coello project in Colombia. In similar studies, output per unit irrigation supply was calculated as 0.31-0.50 $ m^{-3} in the Bursa-Uluabat project by Değirmenci (2001b) for the period 1992-1998, as 0.23-0.81 $ m^{-3} and 0.26-0.77 $ m^{-3} in the Karacabey and Mustafakemalpasa projects by Değirmenci and Kuşçu (2002) for 1996-

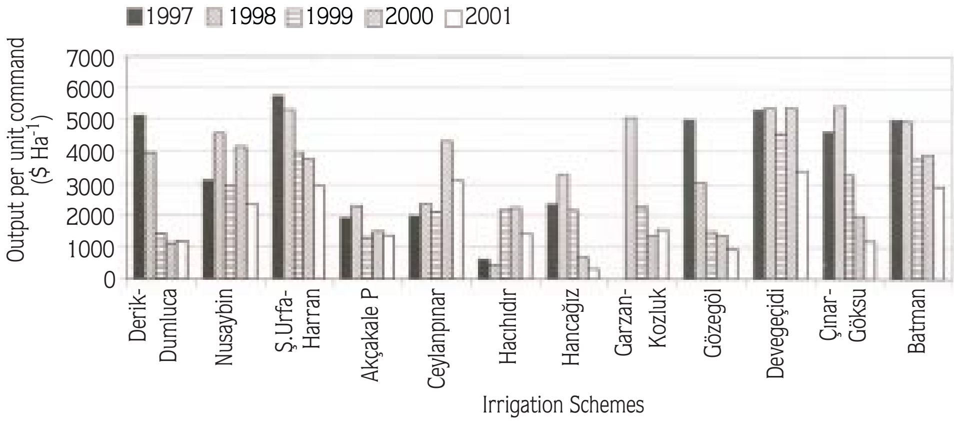

Figure 3. Output per unit command.

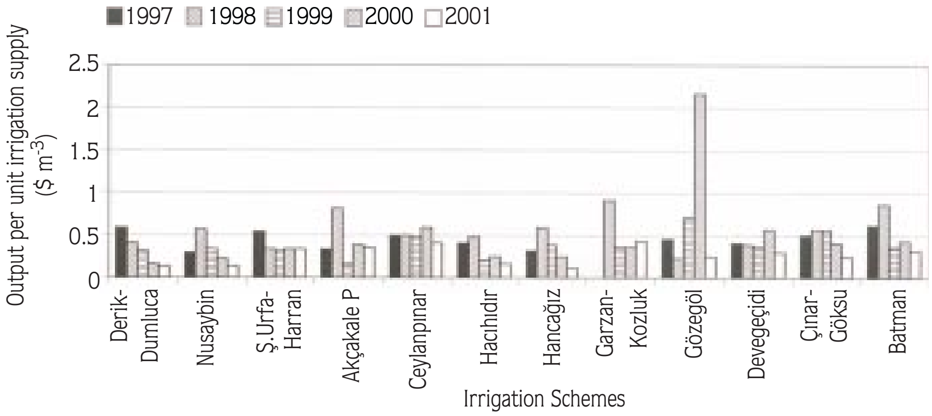

Figure 4. Output per unit irrigation supply.

2000, and 0.63 and 0.04 $ m^{-3} at Samaka in Colombia and Mahi-Kadana in India by Molden et al. (1998).

Output per unit water consumed

Consumed water is the actual ET from irrigated crops. The output per unit water consumed in Figure 5 shows variations of 0.45 to 2.92 $ m^{-3}. The highest (2.92 $ m^{-3}) and the lowest (0.45 $ m^{-3}) values were obtained in Gözegöl in 2000, and in Garzan-Kozluk in 2001, respectively. The difference depends on cropping patterns and the abilities of farmers and system managers. ANOVA test results indicated that the differences in the output per unit irrigation supply among the schemes were not statistically significant [$F(11.47) = 1.712$; $P = 0.100 > P = 0.001$].

The output per unit water consumed was determined as 0.15-1.55 $ m^{-3} by Çakmak (2002) in the Kızılırmak Basin irrigation schemes for 1999-2000, and 0.18-0.41 $ m^{-3} by Girgin et al. (1999) in the Salihli project. Kloezen and Garces-Restrepo (1998) have calculated output per unit water consumed as 0.38, 0.41 and 0.41 $ m^{-3} for the Alto-Rio Lerma, Cortazar and Salvatierra irrigation projects in Mexico, respectively.

Relative water supply

The variation of relative water supply for the period 1997-2001 is presented in Figure 6. It varied between 1.0 and 5.9. Since relative water supply indicates how well irrigation supply and demand are matched, a value higher than 1 would suggest too much water is being supplied, possibly causing waterlogging and negatively impacting on yields; a value lower than 1 indicates that crops are not getting enough water. Considering all the projects that have been studied in Figure 6, more water was diverted than demanded in all irrigation schemes. Exceptionally, demand and supply were only matched in the Garzan-Kozluk irrigation scheme in 2001. According to Levine (1982), water supply that is more than 2.5

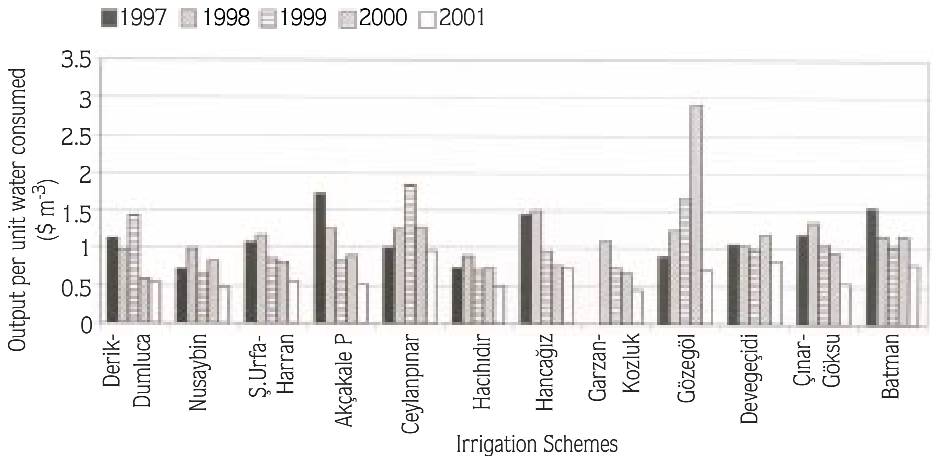

Figure 5. Output per unit water consumed.

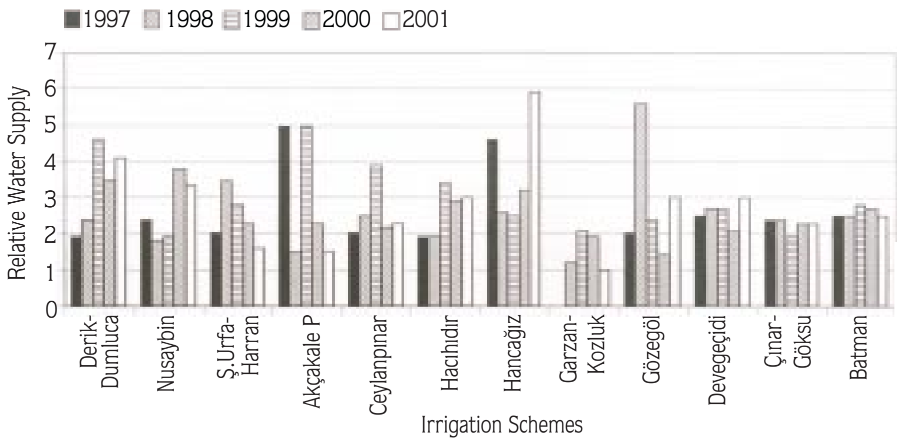

Figure 6. Relative water supply.

times greater than water demand is an inappropriate water management indicator. ANOVA test results indicated that the differences in relative water supplies among the schemes were not statistically significant [F(11.47) = 1.332; P = 0.237 > P = 0.001].

In similar studies, Beyribey et al. (1997) determined the relative water supply as 0.29-1.67 for June, 0.44-1.49 for July and 0.40-1.71 for August. In another study, relative water supply was observed as 0.91-7.15 by Değirmenci (2001a) in 158 irrigation schemes transferred to WUAs for 1999. The highest and the lowest values for relative water supply were found in the Mexico-Salvatierra (4.1) and Malaysia-Muda (0.8) irrigation schemes (Molden et al., 1998). Yazgan and Değirmenci (2002) have determined the RIS as 0.60-1.09 in the Bursa groundwater irrigation scheme.

Irrigation ratio

The highest and the lowest values of irrigation ratio were observed in the Derik-Dumluca (100%) in 1997 and Hacıhıdır (7%) irrigation schemes in 1997, respectively. The variation of irrigation ratio for the period 1997-2001 is presented in Figure 7. ANOVA test results indicated that the differences in irrigation ratio among the schemes were statistically significant [F(11.47) = 6.592; P = 0.000 < P = 0.001]. According to LSD test results, the differences in output per unit command occurred in the Derik-Dumluca-Hacıhıdır (P = 0.000), Nusaybin-Akçakale (P = 0.000), Nusaybin-Hacıhıdır (P = 0.000), Nusaybin-Gözegöl (P = 0.000), Ş.Urfa-Harran-Akçakale (P = 0.000), Ş.Urfa-Harran-Hacıhıdır (P = 0.000), Ş.Urfa-Harran-Gözegöl (P = 0.001), Akçakale-Devegeçidi (P = 0.000), Ceylanpınar-Devegeçidi (P = 0.001), Hacıhıdır-Devegeçidi (P =

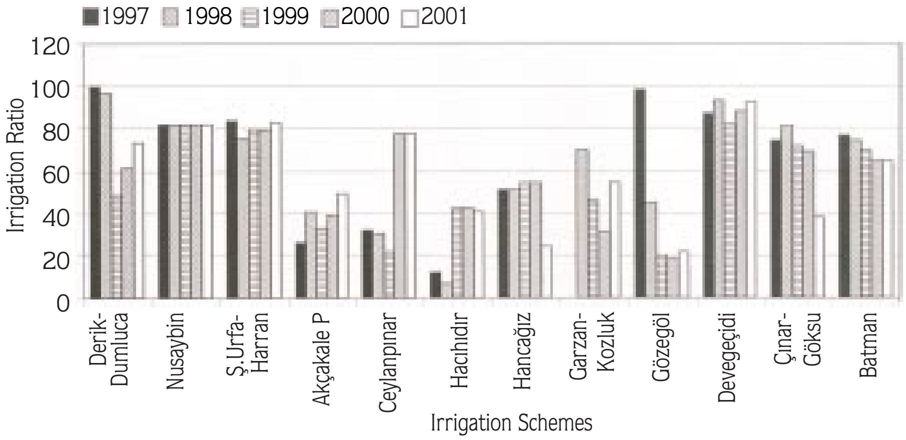

Figure 7. Irrigation ratio.

0.000), Hacıhıdır-Batman (P = 0.000), Hancağız-Devegeçidi (P = 0.000) and Gözegöl-Devegeçidi (P = 0.000) irrigation schemes.

From a total of 199 irrigation schemes, Beyribey (1997) determined the irrigation ratio as lower than 30% in 74 schemes, between 30% and 60% in 72 schemes, and higher than 60% in 53 schemes for the period 1984-1993. The 0-30% group constituted 18% of the total area, the 30-60% group constituted 31.8% of the total area and the 60-100% group constituted 50.2% of the total area. Gündoğmuş et al. (2001) determined the irrigation ratio as 41 and 70% in DSİ and transferred irrigation schemes.

The irrigation ratio is one of the main indicators of farmers willingness or unwillingness to engage in irrigation. A decrease in the irrigation ratio depends mostly upon factors such as national agricultural policy, increases in input prices, the landownership situation, poor farmer training, irrigation water fees and insufficient water resources.

Conclusions

The comparative indicators used in this study are suitable for the comparison of performances among different irrigation schemes. The objective of this study was to apply the comparative performance indicators developed by the IWMI to 12 transferred irrigation schemes to evaluate the management interventions and to determine the impacts of network infrastructure on production value. When considering output per unit cropped area, output per unit command, output unit irrigation supply and output per unit water consumed of 12 irrigation schemes, the SGVP was higher for land cultivated with cotton. The variability among output per unit cropped area, output per unit irrigation supply, and output per unit water consumed might be due to the variations in diverted water supply and predicted cropping patterns. These values are similar to the results obtained by Molden et al. (1998) in 18 irrigation schemes in 11 countries. In this study, the incomes were much higher in areas where fruits, vegetables and industrial crops are mostly cultivated.

Where land is limiting relative to water, output per unit land may be more important. Where water is a limiting factor on production, output per unit water may be more important. Performance of an irrigation scheme is related to infrastructure (fixed, flexible), management (agency, joint, farmer), allocation and distribution procedures (demand versus supply), climate and socioeconomic setting. In this study, the whole area cannot be irrigated for various reasons, such as water scarcity, fallowland, socioeconomic reasons and lack of irrigation infrastructure. There are considerable changes in irrigated area size and crop pattern in the same schemes on a year-to-year basis and efficient irrigation scheduling was not achieved in the pre-irrigation season. When these problems are solved in the study area, SGVP might increase considerably.

The relative water supply as an important water use efficiency parameter varied between 1.0 and 5.9. Common practice in irrigation supply is to apply water to the root zone at the required time, amount and quality. Although more water was used than required in the

Southeastern Anatolian Project (GAP), the SGVP obtained from unit land and water remained low, contrary expectations. There is a great need to develop and practice efficient water management.

The irrigation ratio as a percentage failed to achieve its potential and varied from 7% to 100%. In order to raise irrigation efficiency and the irrigation ratio, on-farm developments and practices should carefully be monitored and evaluated. Training and extension of farmers and irrigation managers in technical and economical considerations are also vital to the augmentation of the irrigation ratio.

Recommendations

The performance study will allow a comparison of how well one system is performing relative to others in similar settings. This is an important tool for policy makers who want to know where, how and how much to invest in irrigation. The comparative assessment will give gross indications of where improvements can be made in types of management, infrastructure or water allocation.

Sustainable irrigation is at risk due to excessive flooding of lands with inappropriate irrigation methods. Therefore, cultivation plans and patterns should be followed and water must be supplied to the root zone after efficient measurement on a volume basis. For efficient irrigation management, all activities in the irrigation network should be monitored and checked, technical requirements should be met, training and extension should be enhanced, evaluations should be performed on a daily and seasonal basis and the results should be delivered to the relevant individual and institutions with an efficient monitoring and evaluation system (M&E). WUAs, municipal organizations, village organizations and cooperatives that undertake the operation and management of irrigation schemes should be empowered as legal entities. The vitality of the M&E system should be well understood by all relevant individuals, from farmers to managers. When this is achieved, problems and solutions in project management can be easily and rapidly defined.

In conclusion, a permanent and reliable database should be set up to carry out an efficient performance assessment among irrigation schemes for better irrigation management. For an efficient and reasonable irrigation management, an information system for M&E, which encompasses all stakeholders, should be set up and irrigation scheduling should be properly designed. In addition, irrigation scheduling and predicted cropping patterns should be followed by farmers and irrigation managers.

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