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The Performance Assessment in Irrigation Systems: The Case of Turkey

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Abstract

Water is an essential resource for human's live maintaining. Alongside it supplies people with daily needs, water is used for the purpose of agriculture, energy production, industry and tourism. The increase of population and industrialisation have caused both rise of present water consumption and contamination of present water resources. For this reason, water is among the resources should be used efficiently in the world. Water used in agriculture is considerably more than the other sectors use. Comparing with the developed and European countries, water percentage used in agriculture in Turkey is much more. It is known that water resources decreased and would decrease even more due to population increase, climate changes and unconscious uses. It is known that due to population increase, climate changes and unconscious uses, water resources decreased and will decrease even more. While Turkey is not among the countries suffered from water shortages, present water resources should be carefully used due to rapid population growth, pollution and the average annual precipitation lower than the world average and should be immediately taken the necessary precautions against contamination. Therefore, especially in agriculture, water must be used economical, conscious and in a planned way. Regarding this issue, one of the applications should be performed is performance assessments of irrigation. Studies about performance assessments of irrigation are carried out by the Irrigation Association to determine and take necessary measures the inabilities and problems on irrigation by evaluating of the present water potential in any area. In this review, performance assessments of irrigation studies carried out by Irrigation Associations were summarised.

Keywords: Assessment criteria, irrigation, irrigation associations, irrigation performance assessment, use of water, water resources

INTRODUCTION

Water is an essential source for living creatures and it is important for plant development. Thus, importance of water in sense of agriculture is pretty much. The amount of freshwater bodies containing the large part of water use is 35 million km^3 which is 2,5 percent of total water presence. This water has been used 67-70 percent in agriculture, 22-23 percent in industry, 8-10 percent in water intended for human consumption. These rates in Turkey are as below; 72-75 percent in agriculture, 15-16 percent in water intended for human consumption, 10-12 percent in industry.

The average water consumption per human in the world is 800 m^3 in a year. About 20 percent of world population lack of adequate drinking water and 2,3 billion people can't reach the healthy water. The world average of the ratio of the population reaching healthy water to total population is about 82 percent. This ratio in Turkey is 93 percent. Average daily urban water consumption standard per human is 150 liter in the world, 111 liter in Turkey (DPT, 2007).

In consideration of above information, it is seen that in large of water has been used in agriculture. For this reason, planning and programming of water use in agriculture are crucial.

Because of population growth, climate change etc., the decrease of present water resources makes economical and convenient water use a current issue. Therefore, organizations providing control of the water fall is responsible on this subject. Organizations providing agricultural lands with water must make performance assessment of irrigation system and take some precautions.
When the performance level of irrigation and drainage projects is taken into consideration, increase of irrigated agricultural areas is expected to increase world's food production. But, the performance improvement on irrigation networks is needed because usable water and land sources are limited (Murry-Rust & Snellen, 1993)

In consequence of soil salinity and giving excessive water resulting from insensible irrigations, some areas become arid every year. In this respect, effective use of water and land sources and performance assessment in irrigation systems are of capital importance (Çakmak, 2002).

PERFORMANCE ASSESSMENT and INDICATORS

The performance of a system is its measured levels of achievement according to one or more parameters which are chosen as indicators (Bos et al., 2005). As to performance assessment in irrigation and drainage can be defined as the systematic observation, documentation and interpretation of activities related to irrigated agriculture with the objective of continuous improvement (Molden et al., 1998). Performance assessments have been made in the direction of various purposes. For example; developing system operation, evaluating processes intended strategic purposes, general situation of the system and interventions to system, comprehending better the factor determining the performance better, diagnosing the problems, comparing between system performance and others etc. Determination of performance assessment method depends on the purpose of assessed case (Abernethy, 1989). Performance assessments consist of some steps; Identification and planning, data collection, analysis, integration, action, monitoring and evaluation stages, respectively. Identification and planning stage is important and specifies the success of assessment in large measure. Content and characteristics of the data need for assessment is identified on this stage. Data collection stage is the core of assessment. Data need for assessment must be supplied from a confidential source and be complete. After analysis stage, to facilitate the integration and action stages, it is important to involve key players in the assessment process at the outset (Malano & Burton, 2001). Performance indicators are needed when irrigation performance has been assessed. These indicators have been identified by many researchers and give us information about effectiveness of performance. Performance indicators are a quantitative measure of irrigation situation which helps observing and assessing irrigation effectiveness (Alegre et al., 2000).

Malano and Burton (2001) revealed some performance indicators which recommended by IPTRID (International Programme for Technology and Research in Irrigation and Drainage). These indicators were showed under the titles of service delivery performance, financial, productive efficiency, environmental performance. Indicators are given in Table 1.

Table 1. Indicators of performance assessment

Service Delivery Performance	annual volume of irrigation water delivery (m^3 $year^{-1}$) al irrigation water delivery per unit command area (m^3 ha^{-1}) al irrigation water delivery per unit irrigated area (m^3 ha^{-1}) system water delivery efficiency al relative water supply al relative irrigation supply delivery capacity ity of entitlement supply
Financial	ity of entitlement supply ecovery ratio enance cost to revenue ratio MOM cost per unit area (US$ ha^{-1}) cost per person employed on water delivery (US$ $person^{-1}$) ıue collection performance ng numbers per unit area (persons ha^{-1}) ıge revenue per cubic metre of irrigation water supplied (US$ m^{-3})
Productive Efficiency	gross annual agricultural production (tonnes) annual value of agricultural production (US$) ıt per unit serviced area (US$ ha^{-1}) ıt per unit irrigated area (US$ ha^{-1}) ıt per unit irrigation supply (US$ m^{-3}) ıt per unit water consumed (US$ m^{-3})
Environmental Performance	quality: Salinity (mmhos cm^{-1}) quality: Biological (mg $litre^{-1}$) quality: Chemical (mg $litre^{-1}$) ıge depth to watertable (m) ge in watertable depth over time (m) alance (tonnes)

Some studies concerned the performance assessment of Irrigation Associations and other irrigaton organizations in Turkey made by being used these performance indicators are in below;

Kapan (2010) aimed to assess the irrigation system performance of Asartepe irrigation put into operation in 1993 and assigned to Irrigation Association later between 2005 and 2008 years. The results related to this study are showed in Table 2. In consequence of this assessment, it was determined that annual irrigation water delivery per unit command area was 2181 - 6312 m^3 ha^{-1}, annual irrigation water delivery per unit irrigated area was 9546 – 14043 m^3 ha^{-1}, annual relative water supply was 0,25 – 1,17, cost recovery ratio was 7 - 73,9 percent and total annual value of agricultural production was 3163539 - 7217335 TL.

Eliçabuk (2016) carried out an irrigation performance assessment in Konya Gevrekli Irrigation Association between 2006 and 2012 years. The results related to this study are showed in Table 3. In consequence of this assessment, it was determined that annual irrigation water delivery per unit command area was 665 - 1301 m^3 ha^{-1}, annual irrigation water delivery per unit irrigated area was 2577 – 5273 m^3 ha^{-1}, annual relative water supply was 0,51 – 1,04, cost recovery ratio was 82,3 – 120,1 percent and total annual value of agricultural production was 21225000 – 38898000 TL.

Sönmezyıldız ve Çakmak (2013) aimed to assess irrigation performance of village of Beyazaltın in Eskişehir for the land consolidation. Results related to this study are showed in Table 4. In consequence of this assessment, it was determined that annual irrigation water delivery per unit command area was 4311,02 m^3 ha^{-1}, annual irrigation water delivery per unit irrigated area was

4311,02 m^3 ha^{-1}, annual relative water supply was 1,60, cost recovery ratio was 530 percent and total annual value of agricultural production was 9030000 TL.

Cin (2017) carried out an irrigation performance evaluation in Ankara Beypazarı Başören Irrigation Cooperative. Results related to this study are showed in Table 5. In consequence of this assessment, it was determined that annual irrigation water delivery per unit command area was 10542,8 m^3 ha^{-1}, annual irrigation water delivery per unit irrigated area was 14760 m^3 ha^{-1}, annual relative water supply was 1,98, cost recovery ratio was 50 percent and total annual value of agricultural production was 2378953 TL.

Nalbantoğlu (2016) aimed to benchmarking and assessment of irrigation performance of Akıncı Irrigation. Results related to this study are showed in Table 6. In consequence of this assessment, it was determined that annual irrigation water delivery per unit command area was 7,23 – 10,54 m^3 ha^{-1}, annual irrigation water delivery per unit irrigated area was 7,68 – 16,15 m^3 ha^{-1}, annual relative water supply was 1,55 – 1,98, cost recovery ratio was 56 – 172 percent and total annual value of agricultural production was 1021460 - 1561868 $.

Table 2. Performance indicators and results of study

	Performance Indicators	Result
Service Delivery Performance	Annual irrigation water delivery per unit command area (m^3 ha^{-1})	2181 - 6312
	Annual irrigation water delivery per unit irrigated area (m^3 ha^{-1})	9546 - 14043
	Annual relative water supply	0,25 – 1,17
Financial	Cost recovery ratio (%)	7 – 73,9
	Maintenance cost to revenue ratio (%)	31,6 – 543,2
	Total MOM cost per unit area (TL ha^{-1})	60,97 – 91,56
	Total cost per person employed on water delivery (TL $person^{-1}$)	3531,25 – 9487,50
	Revenue collection performance (%)	23 – 47
	Staffing numbers per unit area (persons ha^{-1})	0,0053
	Average revenue per cubic metre of irrigation water supplied (TL m^{-3})	0,004 – 0,009
Productive Efficiency	Total annual value of agricultural production (TL)	3163539 - 7217335
	Output per unit serviced area (TL ha^{-1})	2108,96 – 4823,60
	Output per unit irrigated area (TL ha^{-1})	7682,36 – 15839,25
	Output per unit irrigation supply (TL m^{-3})	0,6118 – 1,5342
	Output per unit water consumed (TL m^{-3})	5804 – 13951

Table 3. Performance indicators and results of study

	Performance Indicators	Result
Service Delivery Performance	Annual irrigation water delivery per unit command area (m^3 ha^{-1})	665 – 1301
	Annual irrigation water delivery per unit irrigated area (m^3 ha^{-1})	2577 – 5273
	Annual relative water supply	0,51 – 1,04
Financial	Cost recovery ratio (%)	82,3 – 120,1
	Maintenance cost to revenue ratio (%)	32 – 51,8
	Total MOM cost per unit area (TL ha^{-1})	89,93 – 165,31
	Total cost per person employed on water delivery (TL $person^{-1}$)	20975,68– 42296,78
	Revenue collection performance (%)	66,7 – 99,9
	Staffing numbers per unit area (persons ha^{-1})	0,0018 – 0,0025
Productive Efficiency	Total annual value of agricultural production (TL)	21225000– 38898000
	Output per unit serviced area (TL ha^{-1})	1679,2 – 3077,4
	Output per unit irrigated area (TL ha^{-1})	6451,4– 11501,8
	Output per unit irrigation supply (TL m^{-3})	1,474 – 3,814

Table 4. Performance indicators and results of study

	Performance Indicators	Result
Service Delivery Performance	Annual irrigation water delivery per unit command area (m^3 ha^{-1})	4311,02
	Annual irrigation water delivery per unit irrigated area (m^3 ha^{-1})	4311,02
	Annual relative water supply	1,60
Financial	Cost recovery ratio (%)	530
	Maintenance cost to revenue ratio (%)	8
	Total MOM cost per unit area (TL ha^{-1})	51,98
	Total cost per person employed on water delivery (TL $person^{-1}$)	10000
	Revenue collection performance (%)	100
	Staffing numbers per unit area (persons ha^{-1})	0,002
Productive Efficiency	Total annual value of agricultural production (TL)	9030000
	Output per unit serviced area (TL ha^{-1})	9386,69
	Output per unit irrigated area (TL ha^{-1})	9386,69
	Output per unit irrigation supply (TL m^{-3})	2,18
	Output per unit water consumed (TL ha^{-1})	9236,65

Table 5. Performance indicators and results of study

	Performance Indicators	Result
Service Delivery Performance	Annual irrigation water delivery per unit command area (m^3 ha^{-1})	10542,8
	Annual irrigation water delivery per unit irrigated area (m^3 ha^{-1})	14760
	Annual relative water supply	1,98
Financial	Cost recovery ratio (%)	50
	Maintenance cost to revenue ratio (%)	14
	Total MOM cost per unit area (TL ha^{-1})	10
	Revenue collection performance (%)	100
Productive Efficiency	Total annual value of agricultural production (TL)	2378953
	Output per unit serviced area (TL ha^{-1})	33985,04
	Output per unit irrigated area (TL ha^{-1})	47579,06
	Output per unit irrigation supply (TL m^{-3})	3,22
	Output per unit water consumed (TL ha^{-1})	7,28

Table 6. Performance indicators and results of study

	Performance Indicators	Result
Service Delivery Performance	Annual irrigation water delivery per unit command area (m^3 ha^{-1})	7,23 – 10,54
	Annual irrigation water delivery per unit irrigated area (m^3 ha^{-1})	7,68 – 16,15
	Annual relative water supply	1,55 – 1,98
Financial	Cost recovery ratio (%)	56 – 172
	Maintenance cost to revenue ratio (%)	2,51 – 10,82
	Total MOM cost per unit area (TL ha^{-1})	22,53 – 108,61
	Total cost per person employed on water delivery (TL $person^{-1}$)	1091,09 – 8658,84
	Revenue collection performance (%)	70 – 93
	Staffing numbers per unit area (persons ha^{-1})	0,006 – 0,012
	Average revenue per cubic metre of irrigation water supplied (TL m^{-3})	0,004 – 0,008
Productive Efficiency	Total annual value of agricultural production (TL)	1021460 - 1561868
	Output per unit serviced area (TL ha^{-1})	364,81 – 557,81
	Output per unit irrigated area (TL ha^{-1})	1454,29 – 2970,46
	Output per unit irrigation supply (TL m^{-3})	0,107 – 0,110
	Output per unit water consumed (TL m^{-3})	1350,69 – 2071,26

CONCLUSIONS

As mentioned above, some case studies have been showing performances of some irrigation systems in Turkey. According to these studies, annual relative water supply has been generally high. That is to say, the water which is more than needed has entered to irrigation systems. Hereat, protection and using optimum of present water are essential.

Due to the fact that some irrigation organizations have an important position on irrigation management in Turkey, studies must be carried to use water properly and not to make farmers sufferer. Before water use directly, irrigation system performance must carried out and current situation analysis can be made. In this way, reasons of problems can be found and some precautions can be took.

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