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DETERMINATION THE EFFECT OF LAND LEVELING ON SOIL LOSES IN RICE (*ORYZA SATIVA* L.) PRODUCTION AREAS

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Abstract

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In this study, loses stemming from basin ditches were calculated through satellite photographs in rice production areas of Bafra plain having insufficient land leveling and irrigated with mainly basin irrigation methods. Within the 39000 da of cultivated areas on the right coast of Bafra plain, selected as the experimental area, 102 parcels of 4535 da of rice lands were examined and soil loses stemming from basin numbers and ditches were determined. Based on the results, some practical suggestions were concluded by comparing the losses in production areas where land leveling was performed or not.

Key words: Bafra plain, rice, *Oryza sativa* L., basin irrigation, land leveling.

Introduction

Environmental factors such as climate and soil factors affect plant growth and development (Caliskan et al., 2009; Celik and Odabas, 2009). But, there are biological limitations as to how the temperature can be raised. These factors determine plant species, which will be grown productively in a region (Odabas et al., 2008; Odabas et al., 2010).

Approximately 150 million hectares areas all around the world are used for rice cultivation and an average of 4.9 t/ha yield is acquired. Most of the rice cultivated is grown in tropical and sub-tropical areas (Anonymous, 2003). While rice cultivation areas were about 20.000 hectares in the first years of our country, it arose up to 70.000 hectares in 1980s.

On the other hand, almost 60.000 hectares areas were used for rice cultivation in 2000s (Table 1). Rice cultivation is carried out in all geographic regions of our country.

However, 56.0% of the total rice areas are cultivated in Trachea-Marmara, 36.5% in the Black Sea Region and 7.5% in the other regions (Surek, 2002).

Basin irrigation method is mostly used in the irrigation of plants, which are not susceptible to diseases deriving from mainly dampening of root strait (Gungor et al., 2004).

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Table 1
In Turkey, rice acreage , production and yield values (Anonymous, 2003)

Year	Field, X100 ha	Production, megaton	Yield, ton/ha	Year	Field, X100 ha	Production, megaton	Yield, ton/ha
1961	59	0.23	3.95	1982	77	0.35	4.52
1962	81	0.28	3.40	1983	70	0.32	4.50
1963	55	0.22	3.94	1984	64	0.28	4.38
1964	35	0.17	4.76	1985	60	0.27	4.52
1965	50	0.22	4.33	1986	55	0.28	5.00
1966	65	0.25	3.85	1987	53	0.28	5.19
1967	60	0.23	3.89	1988	51	0.26	5.15
1968	45	0.21	4.56	1989	66	0.33	5.00
1969	57	0.21	3.74	1990	46	0.23	4.96
1970	66	0.27	4.04	1991	40	0.20	4.95
1971	65	0.29	4.49	1992	43	0.22	5.00
1972	51	0.20	3.99	1993	45	0.22	5.02
1973	60	0.27	4.45	1994	41	0.20	4.94
1974	58	0.25	4.31	1995	50	0.20	4.00
1975	55	0.25	4.57	1996	55	0.28	5.10
1976	54	0.26	4.88	1997	55	0.28	5.00
1977	58	0.28	4.75	1998	60	0.32	5.25
1978	70	0.32	4.52	1999	65	0.34	5.23
1979	75	0.38	5.00	2000	58	0.35	6.03
1980	52	0.24	4.58	2001	59	0.36	6.10
1981	73	0.33	4.54	**Mean**	**58**	**0.27**	**4.64**

Irrigation of the rice plant is more important than the other plants due to the fact that it is cultivated under water or in saturated conditions throughout the season. The important issue on which has to be focused is land leveling in choosing or preparing the land on which rice cultivation shall be carried. The land should be leveled well or the leveled lands should be preferred. When the rice is irrigated by leaving under water, the importance of leveling increases more. Slope of the land should be less than 1% for irrigation. Benefits of good leveling can be summarized as follows:

1. Basins can be formed in demanded sizes. Keeping basins small in unleveled lands will prevent land soil lose which is caused by unnecessarily made ditches.

2. Water is distributed homogeneously to the basins. Therefore, using efficiency of the present water will increase.

3. It will be easier to control water and as a result surface and deep drainages will be easier.

4. Uniform vegetation cover is provided (Meral and Temizel, 2006).

5. Crop yields increase by 10-25%.

6. Water lost during the application of water is reducing by 25%.

7. Saving in irrigation water by 35-45% (Singh et al., 2008 and Chhatwal, 1999).

8. Business need for irrigation is reduced by 35% (Farooq, 2003).

9. This technology reduces weed problems and increases cultivable area by 3-6% (Jat et al., 2004).

Control of water depth in rice plant is pretty important. While in some periods deep ponding is applied, in other periods little ponding can be applied. Land leveling can become so important in order to carry out these practices sensitively (Tulucu, 2003).

Laser leveling systems are generally used in Australia, Japan and the USA for agricultural practices. Laser leveling systems are increasingly being used in developing countries. Laser leveling systems make the lands much more flat. They can increase the accuracy to more than 50%. Their advantages compared to other land leveling methods are: smoother and flatter soil surface; saving of time and water needed for irrigating the land; more uniform water distribution on the land; more uniform humidity environment for plants; more uniform germination and growing in plants; saving of seeds, fertilizer chemicals and fuel. On the other hand, their disadvantages are: high cost of lasers leveling devices and equipments; the need of qualified operators for installing, setting up lasers leveling devices and using the tractor. This method can be more efficient on lands whose forms and sizes are regular. The purpose in laser leveling is sliding the soil from the highest to the lowest points with the best possible cost. Practice of leveling consists of plowing the field, topographical measurements and flattening of the land (Rickman, 2002).

In small established basins due to the insufficient land leveling, length of ditch/area rate is huge resulting in significant loses in production area.

The easy use of laser leveling devices in recent years has attracted significant interest as the beneficial practices, as the devices widen basin sizes and decrease soil loses. However, there are still rice fields on which basins are formed with traditional methods and which are exposed to soil loses. In this study, it was aimed to produce some practical suggestions for planners and designers by showing the significant loses in rice production areas due to the small basin size.

Material and Method

The simulation software may be general-purpose, intended to capture a variety of developmental processes depending on the input files, or special-purpose, intended to capture a specific phenomenon (Caliskan et al., 2010a; 2010b). Input data range from a few parameters in models capturing a fundamental mechanism to thousands of measurements in calibrated descriptive models of specific plants (species or individuals). Standard numerical outputs (i.e. numbers or plots) may be complemented by computer-generated images and animations (Odabas et al., 2009a, 2009b, 2009c).

Rice parcels which were planted on an area of 6824 ha on Bafra plain between 41°35’21” and 41°41’19 N latitudes and 35º54’10” and 36º02’00” E longitudes were used as experimental area. Rice plantation areas were determined by examining the photographs in relation to this area and the location of the parcel; number of basins within the parcel and losses deriving from basin ditches were calculated. Locations of rice parcels within the determined area are shown in Figure 1. Rice production areas were determined through aerial photographs and these photographs were taken into CAD program with scale correction and digitization; each rice planted parcel was determined

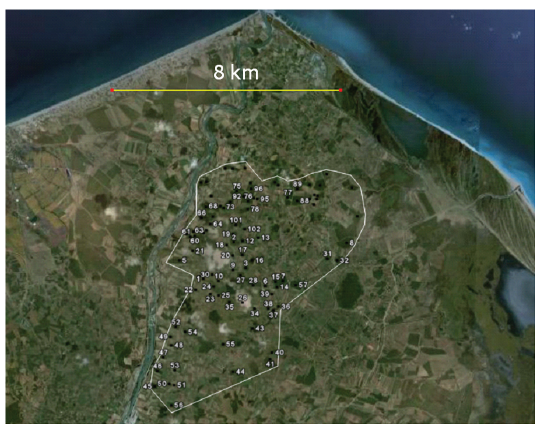


Fig. 1. Rice parcels which were selected within the field of study

on this program by counting basin numbers and ditch lengths were found by measuring one by one with the help of this program. Basin ditches were taken as 0.80m in single ditches and 1.70m in couple ditches (water transmitting channels within the field) (Figure 3) by examining plowing tool which made ditches (Figure 2) and by measuring the ditches formed and used on the field in the present situation, and all loses were calculated. For this purpose, CAD programs, which are suitable for accessing aerial photographs, were used; it was benefited from these programs in calculating defined area and lengths.

Upon development of the devices, which are operated with laser leveling method (Figure 4) in recent years, it is seen that basin areas have been established as average of 10 da. Size of rice basins in the countries, which benefit from laser technology in land leveling, can reach up to 40-50 da (Surek, 2009).

In the study, ditch loses were determined in laser leveling performed areas by assuming that one basin is 10 da in area.

Fig. 2. The plow that was used for forming basin bars

Fig. 3. Couple Ditch width in field

Results and Discussion

Parameters in relation to calculating land losses concerning 102 parcels with a total of 6824 da rice sowed areas; flat or near-flat in level which was selected on the right coast of Bafra plain are shown in Table 2. Losses concerning each leveled parcel (a total of 10 da basin area) are also shown in the same table.

It was found that the smallest parcel was 2.3 da, the biggest parcel was 226.7 da, the average size was 44.5 da and standard deviation value of the parcels was calculated as 40.9 da. It was also found that basin number per parcel changed with 6-373 and 6622 basins were evaluated in this study. Basin number per parcel increased with growing the parcel area and the relationship between parcel area and basin number per parcel was formulized as Y=0.001x + 5.750 (R^2=0.76) (Figure 5). As shown in Figure 5, there were 70 basins in a rice parcel without leveling, 50 da in area. The relationship between parcel area and basin number per parcel was found to be significant in 1% level ($p=0.872^{**}$).

Fig. 4. Laser leveling tool

The total land lose deriving from the experimental basin ditches was found to be 0.3-13.8 da (average 3.6 da, the total 367 da). The rate for the areas with land lose/total experimental area was found to be 4.9-16.3% (as average 8.94%). Standard deviation value of the lost areas was found to be 2946m^2. Lose amount for each parcel in case of the production areas with or without leveling is shown in Figure 6. Ditch losses for each basin on the experimental field ranged between 28-107m^2 (as average 60.6m^2, σ=14.96m^2). In case of performing leveling on the same experimental area, basin number per parcel shifted as 1-23 for basin, 10 da in area. Thus, the probable lost was found to be 156-6009 m^2 (as average 1428 m^2). On the other hand, the total lost was found to be 145.6 for the same parcels. Rational loss amounts were between 1.6%-6.7 and the average was determined as 3.55% (σ=0.88).

Aerial photographs concerning the parcels, chosen to represent the basin number per parcel are shown in Figure 7. As parcel area increases, decreases were observed in the percentage of lost area (Figure 8). The relationship between parcel area and percentage of lost area was found to be significant at the level of 1% (p=-0.492**). Performing the laser leveling resulted in decreasing

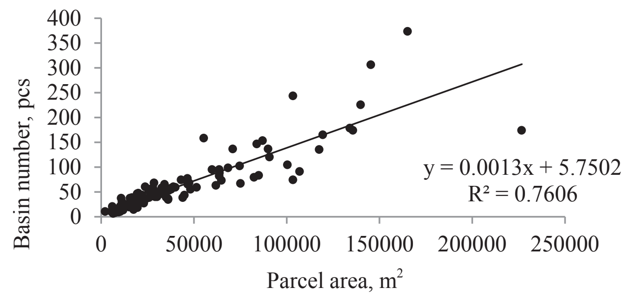


Fig. 5. Basin numbers according to parcel sizes

Table 2
Some data acquired from the evaluation of aerial photographs

A	B	C	D	E	F	G	H	I	K	L	M
1	41°38'49.41"K	35°56'02.95"D	22487.0	33	681.4	2064.3	9.18	62.6	3	689.0	3.1
6	41°38'42.42"K	35°57'37.19"D	16760.2	38	441.1	1869.7	11.16	49.2	2	533.8	3.2
12	41°39'34.65"K	35°57'01.21"D	39047.7	60	650.8	3508.6	8.99	58.5	4	943.8	2.4
22	41°38'36.04"K	35°55'51.80"D	11411.0	30	380.4	1440.2	12.62	48.0	2	559.5	4.9
32	41°39'14.44"K	35°59'24.90"D	23787.3	60	396.5	2627.1	11.04	43.8	3	759.9	3.2
42	41°37'10.48"K	35°57'47.11"D	71006.3	136	522.1	5921.8	8.34	43.5	7	2013.5	2.8
52	41°37'52.10"K	35°55'23.31"D	43146.7	74	583.1	3732.0	8.65	50.4	5	1427.2	3.3
62	41°39'43.09"K	35°56'01.99"D	28629.0	68	421.0	3067.9	10.72	45.1	3	977.4	3.4
72	41°40'26.79"K	35°56'11.94"D	18727.0	21	891.8	1453.3	7.76	69.2	2	696.5	3.7
82	41°40'55.50"K	35°59'06.12"D	103544.6	243	426.1	10910.7	10.54	44.9	2	3211.1	3.1
92	41°40'27.14"K	35°57'01.21"D	82458.0	79	1043.8	4734.7	5.74	59.9	9	2761.9	3.3
102	41°39'48.75"K	35°57'03.59"D	18320.5	28	654.3	1694.7	9.25	60.5	2	552.0	3.0
Total			4535515.0	6622	367866.8				464	145653	
Ave.			44465	64.9	709.0	3603.5	8.94	60.6	4.5	1428	3.55
Std. Dev.			40937			2946.4	1.85	15			0.88

A: Parcel Number
B: Degree of latitude of parcel (°, ', ", North)
C: Degree of longitude of parcel (°, ', ", East)
D: Parcel Area (m^2)
E: Number of Basin of Parcel (piece)
F: Average Basin Area (m^2)
G: Ditch Loses on Parcel (m^2)
H: Rational Loss (lost area/parcel area, %)
I: Loss per Basin (lost area / basin number, m^2)
K: New basin number (10 decares of basins on average, piece)
L: New lost area (m^2)
M: New lost rate (lost area /total parcel area, %)

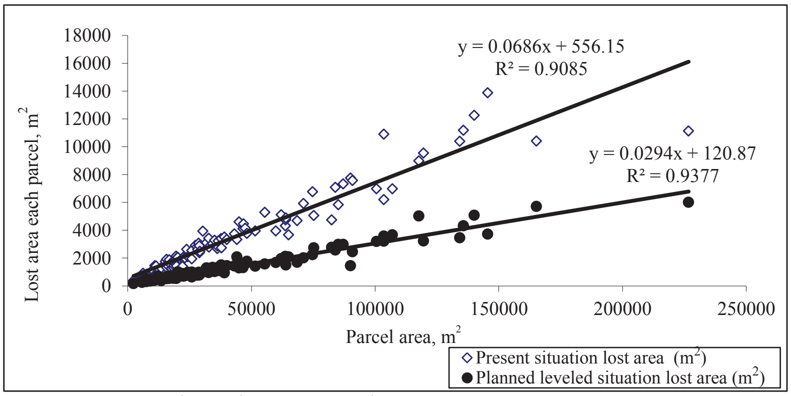
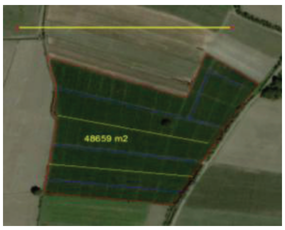


Fig. 6. The present situation according to parcel areas and loss amounts for the planned leveled situation



(a) # 1 parcel

(b) # 6 parcel

(c) # 12 parcel

(d) # 22 parcel

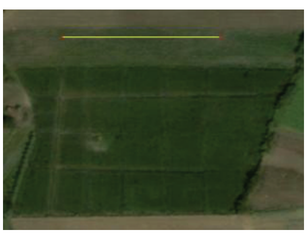
(e) # 32 parcel

(f) # 42 parcel

(g) # 52 parcel

(h) # 62 parcel

(k) # 72 parcel



(l) # 82 parcel

(m) # 92 parcel

(n) # 102 parcel

Fig. 7. Aerial photographs and measurements of some of the rice parcels which were on the chosen area

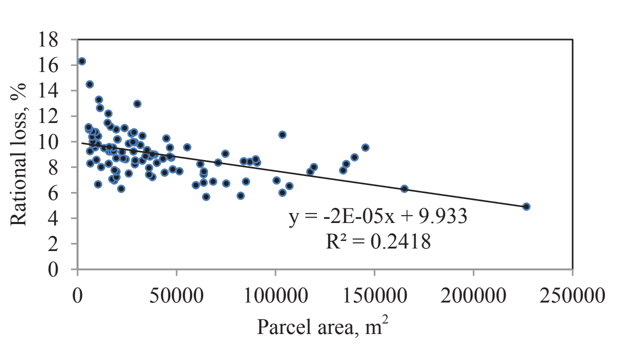


Fig. 8. Rational loss amounts according to parcel areas

of 93% in basin number and the new total basin number was 464.

Similarly, lost rates in parcel area were found to be 3.55% in case of laser leveling. It was observed an increase of 5.4% in parcel area in response to laser leveling. The difference between the lost area in parcels with/without laser leveling was found to be significant ($p<0.001$).

Conclusion

It is possible to increase the yield in case of continuing positive environmental conditions and by using high yielding varieties. But this increase is possible to a self-determined point, and then new possibilities should be tried to utilize the fields in which agricultural production performed. Present form of rice production in Bafra plain can be drawn that rice are produced in 102 parcels corresponding 6622 basins by considering surface conditions of the plain. The basin area can be considered as "small". The reason why the basin area is small is to perform a uniform irrigation by supplying a homogenous water distribution with similar dept. Basin area can be enlarged by land leveling. Laser leveling is a new agricultural practice for the rice producers in Bafra. Laser leveling has many of advantages such as practiced fast and precisely and being the most preferred method, compared to the other leveling methods.

In the present study, an increase of 5.4% in parcel area in response to laser leveling was determined. The result indicated that the total 367 da field lost due not to perform the leveling in Bafra plain. The lost in production area correspond to approximately 330 ton rice for only the Bafra plain (rice yield is 900 kg/da in Bafra conditions). Considering the rice production area without leveling of Turkey, 58.000 ha, the total lost in both production area and amount is much higher. It is possible to increase the rice production significantly by a simple leveling application. But further studies are needed on land leveling in rice production areas to make more substantial conclusions.

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