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THE EFFECT OF PRECISION LAND LEVELING ON WATER USE EFFICIENCY AND PERFORMANCE FOR SOME FARM MACHINARY

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Abstract

The present work was carried out to study the effect of land leveling by laser technique, leveling slope (0.03%, 0.05%) and strip length on water application efficiency and the performance of chisel plough and seed-drill. The field experiments were conducted at Sids Agricultural Research Station in clay soil, planting (Sids -1) wheat variety. Using Nordsten seed drill, Dainish make and a local manufactured chisel plough. The results indicated that, the highest water use efficiency and yield were obtained when field plot length was of 150 m and slop 0.05 % while the lowest water use efficiency and yield were obtained at zero level and plot length of 150 m. The operating tractor slip and actual field capacity were not affected by slope % but were affected by plot length. The average tractor forward speed increased by 19 %and 4% for chisel plough and seed drill respectively when the plot length increased from 50 m to 150m. Also the tractor fuel consumption was not affected by surface slope but were affected by plot length The tractor fuel consumption lit/h. increased by 4% and 19% when using chisel plough and seed drill respectively when the strip length increased from 50m to 150m. Field capacity increased by 38 % and 27 % for chisel plough and seed drill respectively when the plot length increased from 50 m to 150m.

INTRODUCTION

Adoption of laser land leveling practices has gained considerable attention in the last two decades due to irrigation water saving, and optimize productivity. Laser Land leveling practices are also considered to be among methods that save some of the machinery energy consumption. Frank, (1974), indicated that, increasing farm efficiency was adversely affected if the ground is leveled and operational problem Rumble and Joseph (1982) concluded that, the field can be irrigated with very little labor using large flows of water and designed water control structures. Irrigation farming is again becoming competitive in its ability to produce high yields of a large variety of products. Elhaddad *et al.*, (1984), mentioned that preliminary studies indicated that leveled agriculture land saved field irrigation times. An extension effort coupled with a basin rehabili-

tation program would allow to change on-farm irrigation practices to long furrow basin system. This in turn would open the door for mechanized agriculture practices. For affecting on water saving, productivity El-Yazal and Ismail. (1986) found that precision land leveling has increased irrigation efficiency and yield in large basin irrigation for fields of wheat also El-Sahrigi (1988) reported that, using laser beam as a control system in land leveling increased yield of crops and saved water used for irrigation. On other hand Hamada, (1990), found that, seeding rate slightly decreased by appropriate land leveling accuracy and planting costs decreased as result of machine planting speed.

Michael, (1990), stated that, field leveling resulted in increasing the coefficient of useful time, field capacity and germination ratio as compared with field unleveled field. Abdel-Dayem *et al.*, (1991), indicated that the high accuracy of land leveling and drain lines improved the machines efficiency and helped in increased tractor speed in field operations. EL-khatib, (1992), concluded that, the effectiveness of different land leveling methods on the performance, showed that, there are relation between precision land leveling index and tractor operational speed, hence increase the actual working speed by decreasing the precision land index value. Abdel-Rahman, (1994) concluded that water requirement m^3/fed, was highly affected by the precision of land leveling index value which decreased with low (index) values.

The present work mainly highlighted the effectiveness of different land leveling technique and field strip length on the operation of chisel plough and seed-drill performances. resulted by increasing width and effectively leveled.

MATERIALS AND METHODS

The field experiments were conducted at Sids Agricultural Research Station - Bani Suief Governorate during 1998, 1999 seasons to study the effect of field strip length and laser land leveling techniques on water application efficiency and the performance of chisel plough and seed-drill field efficiency. The experimental area was divided into four equal plots. The control field was leveled depending on traditional method, the first plot was zero leveling, the second plot was 0.03%, and the last plot was 0.05% field slopes by the effect of laser equipment. Each plot was divided into three length wise sections 50, 100, and 150m, having 15 m width per each. Mechanical soil analysis indicated that soil type was 29.73% silt, 53.91% clay and 2.43% $CaCo_3$, and the soil texture was clay. Bulk density was about 1.2 g/cm^3 in the first 5 cm (layer) and increased with soil depth. Values of available water, field capacity and wilting point were

31 % 19 % and 11 % respectively.

The plots were irrigated with surface irrigation, and a four inch flow meter was used to measure the water discharge in each plot. The following implements were used :

1. Belaruse tractor 80 hp.
2. Chisel plough local made 7 tines.
3. Seed-drill width 2.5m Nordsten-Danish made.

Measuring instruments were used during the field experiments such as stop watch, measuring tape (50m) and speedometer.

Methods of Calculations :

WUE = [yield (kg/fed)/total applied water (m^3/fed).]

Where : WUE = water use efficiency kg/m^3.

slip percentage of wheels tractor

$$\text{Slip \%} = \frac{L_1 - L_2}{L_1} \times 100$$

where : L_1 = advance per 10 wheel revolutions with no load, m.

L_2 = advance per 10 wheel revolution with load, m.

The theoretical field capacity (TFC) was calculated by the following formula :

TFC = W X S Fed/h.

where : W = width of machine, m.

S = travel speed, km/h.

The actual field capacity (AFC) was calculated as follows :

$$\text{AFC} = \frac{1}{\text{total time required}} \quad \text{Fed/h.}$$

RESULTS AND DISCUSSION

The main goal of the present work is to use the laser land leveling technique to study the effect of plot length and slope on irrigation application efficiency and to determine the most pertinent performance for some farm machinery operation under different field plot length.

Irrigation characteristics:

The data listed in table (1) and fig (1) show that the water use efficiency decreased by increasing the plot length in the traditional leveled plot. Also, it is noticed that, in the zero leveled plot, the water use efficiency reduced from 1.81 kg/m^3 to 1.69 kg/m^3 when the plot length increased from 50m to 150 m. The plot leveled with slope of 0.03% recorded of increased water use efficiency by 27.7 % more than the plot leveled at zero having plot length 150m. Also the plot leveled at slope of 0.05% had the same trend of the water use efficiency recording an increase of 31.8 % and 5.6 % more than the plots were leveled at zero level and 0.03% slope under plot length 150m, respectively. Results show that, the plot length of 150m and slope 0.05 % may help in obtaining higher yield and more water use efficiency. This finding was due to the long strip with no borders, no bends or cross channels and the slope had improved the water distribution. Also fig (1) indicates that the WUE started to decrease by increasing the value of slope. Table (2) indicates that under chisal plough, the plot length of 50 m and at zero level was not less than plots leveled at slope 0.03 % or 0.05%.The effectiveness of different land leveling techniques and strip length on the performance of the chisel plough is presented in table (2). It is noticed that, there was relationship between field strip length, tractor operational speed, and actual field capacity. The tractor operational speed was increased when the field strip length increased from 50 m to 150 m for all slope values. Tractor operational speed increased from 3 to 4.3 km/h when the strip length increased from 50 to 150 m at field slope of 0.05 %. The data in table (2) indicated that, tractor fuel consumption was not affected by soil surface slope but was affected by plot length. The tractor fuel consumption increased from 11.9lit/h to 12.5 lit/h when strip length increased from 50m to 150 m. This finding was due to the increase in speed. Also, the actual field capacity increased from 1.17 Fed/h to 1.62 Fed/h when the strip length increased from 50 m to 150 m for all slope values. For the seed drill, table (3) shows that, the average operational speed increased from 3 to 3.9 km/h when the field strip length increased from 50 to 150 m, at slope value of 0.05 %. The tractor fuel consumption was not affected by soil surface slope but was affected by plot length. The tractor fuel consumption increased from 3.96 lit/ h to 4.50 lit/ h when the strip length increased from 50m to 150m. This finding was due to the increased in speed. Also, the actual field capacity increased from 1.67 Fed/h to 2.13 Fed/h when strip length increased from 50 to 150 m at slope value of 0.05 %. This finding was due to, higher tractor speed and less turning time when the strip length increased. The data presented in table (1) indicated that, the yield in the first 50 meters in laser leveling were not significant. The effect of slope was clear

for long strips. In the first 50 m the yield was 2690 kg/fed for all values of slope. After the first 50 m the yield started to decrease for zero leveled but for the strips which were leveled with slope 0.03, 0.05 %, the yield increased. In plot length 100 m the yield was 2680, 2685 and 2690 kg/fed for plots zero leveled, 0.03 and 0.05 %, respectively. In the plot which was leveled with slope 0.05% at length150 meter The yield increased by 0.75% and 3% for zero level plot, and 0.03% slope plot, respectively.

CONCLUSIONS

Water application efficiency :

The highest water use efficiency and the highest yield were obtained when the plot length was 150 m and field slope 0.05 %. The lowest water use efficiency and lowest yield were obtained when field was zero level and plot length was 150 m. The average tractor operational speed increased while the field strip length increased from 50 to 150 m for both chisel plough and seed drill operations when values of slope were (zero, 0.03%, and 0.05%). The actual field capacity increased from 38.46 % to 27% when the strip length increased from 50 to 150 m for both chisel plough and seed drill operations when values of slope (zero, 0.03% and 0.05%). Data concluded that, the tractor operation performance was not affected by slope values of slope but rather affected by plot length.

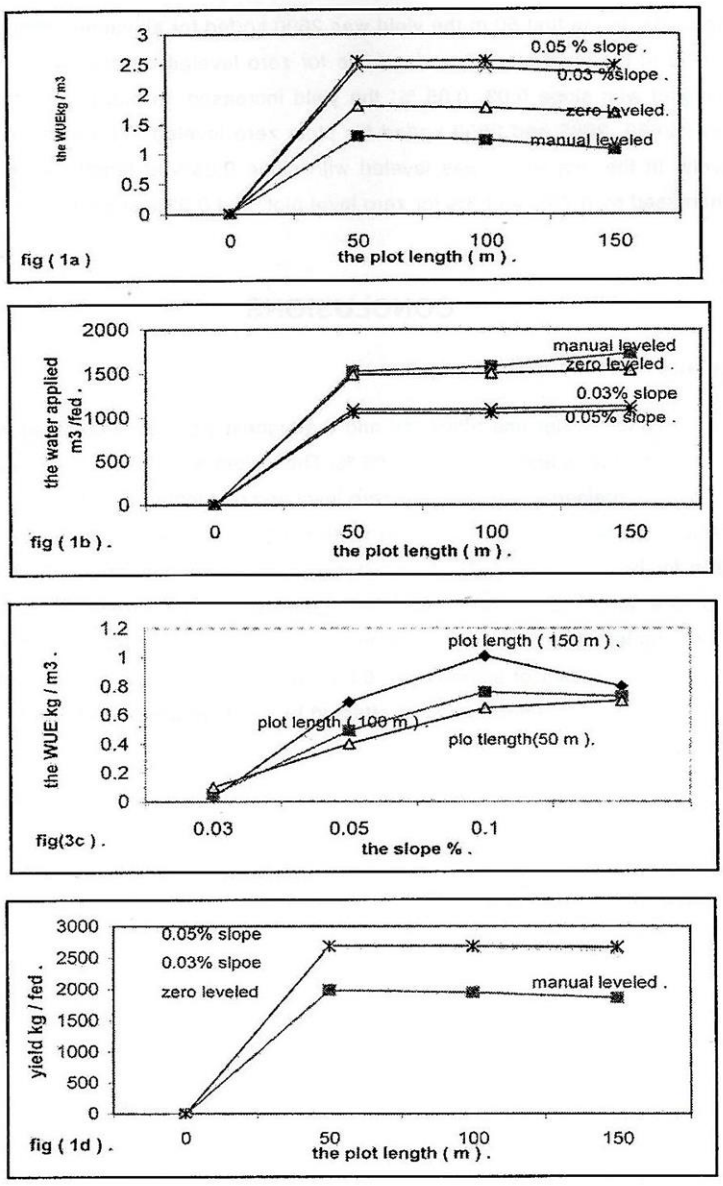

Fig. 1a, 1b, 1c and 1d. The effect of plot length and land surface slope on the WUE, water applied and yield of wheat crop.

Table 1. The effect of plot length and laser leveling on water use efficiency and yield of wheat crop.

Treatment		Plot length m	Plot area (fed)	Irrigation time h/fed	Water applied m^3/fed	Yield Kg/fed	WUE Kg/m^3
Traditional leveling (control)		50m	0.18	11.28	1525	1986	1.30
		100m	0.36	11.30	1580	1950	1.23
		150m	0.54	12.35	1730	1865	1.07
Laser Leveling	Zero level	50m	0.18	10.40	1486	2690	1.81
		100m	0.36	10.50	1505	2680	1.78
		150m	0.54	11.00	1540	2600	1.69
	0.03% slope	50m	0.18	8.00	1097	2690	2.45
		100m	0.36	8.05	1100	2685	2.44
		150m	0.54	8.50	1135	2660	2.34
	0.05% slope	50m	0.18	7.50	1050	2690	2.56
		100m	0.36	7.55	1050	2690	2.56
		150m	0.54	8.30	1080	2680	2.48

Table 2. Effect of Strip Length and Laser Leveling Techniques on Chisel plough Efficiency.

Agric. operation		plot length m	average operational speed km/h	operation time min/fed	Turning time min/fed	total time min/fed	Tractor wheel slip %	Tractor fuel consumption lit/h	actual field capacity Fed/h
Traditional leveling (control)		50	2.65	54.55	6.75	61.30	9.30	12.50	0.98
		100	3.00	48.00		54.75	9.65	12.85	1.10
		150	3.30	43.48		50.23	10.10	13.15	1.19
Laser Leveling	zero level	50	3.00	48.00	3.90	51.90	8.50	11.90	1.16
		100	3.50	41.10		45.00	8.80	12.35	1.33
		150	4.05	35.50		39.40	9.10	12.50	1.52
	0.03% slope	50	3.00	48.00	3.90	51.90	8.50	11.85	1.16
		100	3.50	41.10		45.00	8.65	12.00	1.33
		150	4.05	35.50		39.40	8.90	12.35	1.52
	0.05% slope	50	3.00	48.00	3.90	51.45	8.40	11.85	1.17
		100	3.50	41.10		45.50	8.55	12.00	1.33
		150	4.10	35.50		39.40	8.70	12.15	1.52

Table 3. Effect of Strip Length and Laser Leveling Techniques on Seed-Drill Efficiency.

Agric. operation		plot length m	average operational speed km/h	operation time min/fed	Turning time min/fed	total time h/fed	Tractor wheel slip %	Tractor fuel consumption lit/h	actual field capacity Fed/h
Traditional leveling (control)		50	2.30	43.79	4.73	0.80	5.60	4.63	1.25
		100	2.90	34.68		0.66	7.00	3.83	1.52
		150	3.35	30.15		0.58	7.80	5.00	1.72
Laser Leveling	zero level	50	2.65	37.97	2.90	0.68	5.00	3.96	1.47
		100	3.35	28.85		0.53	5.80	4.10	1.89
		150	3.80	26.55		0.49	6.30	4.50	2.04
	0.03 % slope	50	2.65	37.97	2.90	0.68	4.60	3.15	1.47
		100	3.35	28.85		0.53	5.00	3.65	1.89
		150	3.80	26.55		0.49	5.50	3.90	2.04
	0.05 % slope	50	2.65	37.97	2.90	0.68	4.60	3.00	1.47
		100	3.35	28.85		0.53	4.85	3.50	1.89
		150	3.80	26.55		0.49	5.10	3.70	2.13

REFERENCES

1. Abdel-Dayem, M. S., M. Abuzeid and M. M. H. Amer. 1991. Laser Technology in Irrigation and Drainage. Conference on improvement. Water research center, Cairo, Egypt.

2. Abdel-Rahman, M. 1994. Effect of Different Leveling Systems on The Performance of Some Farm Machines. M.Sc. Thesis Fac. of Agric. Mansoura Univ.

3. El-Haddad, Z., A. Araby and J. A. Mc-Clung. 1984. A Preliminary Study of a Precision Land Leveling Service. Agric. Mech. Project. Agric. Res. Cent, Ministry of Agriculture and USAID. Egypt, Cairo, Activity report No. 12.

4. El-Khatib, S. I. 1992. Effect of Degree of Accuracy of Land Leveling on Performance and Efficiency of Some Farm Machinery. M. Sc. Thesis Fac. of Agric. Ain Shams Univ.

5. El-Sahrigi, A.F. 1988. Using Laser Technique In Land Leveling. Agric. Conference on improvement to study irrigation and drainage problems. In Fayum Governorate.

6. El-Yazal, M.N. and M. Ismail. 1986. An Economic Evaluation of Land Leveling Effects on Maize Production. Agric. Mech. Proj. Agric. Res. Cent, Ministry of Agriculture and USAID. Egypt, Cairo, Activity report No. 12.

7. Frank, M. Z. 1974. Optimum Width and Speed for Least Coast Tillage. Transaction of the ASAE, (17):845-850.

8. Hemada, M. B. 1990. The Efficiency of Mounted Type Drills Under Small Holdings. M. Sc. Thesis Fac. of Agric., Cairo Univ.

9. Michael, K. M. 1990. Effect of Leveling on Performance of Some Farm Machinery. Ph. D. Thesis, Fac. of Agric., Moshtohor, Zagazig Univ.

10. Rumble, B. and T. Joseph. 1982. Whole Farm Ploughing Using Laser Leveling. ICID. Bulletin, vol.31.no.2

تأثير دقة التسوية على كفاءة استخدام مياه الرى وكفاءة بعض الآلات الزراعية

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يتناول البحث تأثير طول الشريحة ونسبة ميل التسوية في التسوية باستخدام أشعة الليزر وكذلك سرعة الجرار على الكفاءة الحقلية للمحراث الحفار وآلة التسطير وكفاءة استخدام مياه الري.

أجريت التجربة في محطة بحوث سدس – محافظة بنى تسويف في أرض طينية . تم تقسيم مساحة التجربة إلى ٤ أجزاء . جزء تم تسويته تسوية عادية و جزء تم تسويته باستخدام أشعة الليزر بدون ميول و جزء بميول ٣ سم/١٠٠متر و الجزء الأخير تم تسويته باستخدام ميول ٥ سم/١٠٠متر. و المحصول المنزرع قمح صنف سدس١ و تم إجراء المعاملات المعتادة آلتي تتم على محصول القمح من تسميد و مواعيد الرى وقد تم حساب كفاءة استخدام مياه الرى .كذلك تم حساب السرعة الفعلية و استهلاك الوقود و نسبة الانزلاق و السعة الحقلية لكل من آلة التسطير المستخدمة ماركة Nordsten دنماركية الصنع و كذلك المحراث الحفار سبعة أسلحة محلى الصنع.

وكانت النتائج كما يلى :

- أعلى كفاءه لأستخدام كانت عند طول شريحة ١٥٠متر وميول ٥سم /١٠٠متر .كما كانت أقل كفاءة لأستخدام مياه الرى عند طول شريحة ١٥٠متر والتسوية بدون ميول (تسويه أفقيه).
- تزداد قيمة WUS بزيادة نسبة الميل حتى قيمة ١٠ سم /١٠٠ متر ثم تبدأ فى الأنخفاض بزيادة نسبة الميل .
- لم تتأثر كفاءة المحراث الحفار أو آلة التسطير بنسبة الميل فى التسويه باستخدام اشعة الليزر .وقد زادت سرعة التقدم بنسبة ١٩,٤٤ ٪ و ٤ ٪ بالنسبه للمحراث الحفار وآلة التسطير على التوالى بزيادة طول الشريحة من ٥٠ إلى ١٥٠ متر.
- لم يتأثر استهلاك الوقود لتر/ساعة باستخدام الميول فى التسويه ولكن تأثر بزيادة طول الشريحه من ٥٠ متر الى ١٥٠ متر ويرجع ذلك لزيادة سرعة تقدم الجرار .
- زادت السعة الحقلية بنسبة ٣٨,٤٦٪ و ٥٤,٢٧ ٪ بالنسبه للمحراث الحفار وآلة التسطير على التوالى عندما زاد طول الشرائح من ٥٠ إلى ١٥٠ متر.