Tarım Makinaları Bilimi Dergisi (Journal of Agricultural Machinery Science)
2009, 5 (1), 53 - 59

Comparison Study Between Some Land Reclamation Machinery to Evaluate the Performance in the New Reclaimed Areas of Egypt

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Abstract : Earthmoving machinery strongly affects on the land reclamation projects, mainly in terms of soil movement and leveling which were more critical because of machine performance and energy consumed. Hence, the aims of this study were to investigate the performance of some most widely spread earthmoving machinery in Egypt using motor grader and landleveller to investigate operating parameters of forward speeds and stroke lengths. The obtained results showed that the machine productivity increased with increasing both the forward speed and stroke length**.** The motor grader was more effective in productivity than landleveller. The energy consumed increased with increasing the forward speed and the stroke length for both motor grader and landleveller.

Keywords: Motor grader, Landleveller, Machine productivity, Energy.

INTRODUCTION

Egypt adapted many land reclamation projects to establish new urban settlements in the desert areas. Despite the fact that the land reclamation activities in South Qantara - Egypt is heavily mechanized and supported from the governmental sector, but still therefore a less number of studies conducted to assess the whole-body to mechanize the land reclamation projects. Meanwhile land leveling and smoothing may be considered the hardest operations during the reclamation processes; the optimum performance of these equipments is not yet achieved. An important aspect of the reclamation unit operation is topsoil spreading and revegetation. (Rue and Hunt, 1981) predicted a method for estimating the earthmoving performance by a self-loading scraper which can be developed based on scraper travel for balanced cut and fill terraces. One of the limitations to successful reclamation is topsoil compaction caused during the respreading of the soil. Excessive compaction can hinder plant growth and therefore impede the revegetation process (Barry and Lysa, 1987). (Adlaka and Kalra, 1988) stated that the power, speed and fuel consumption are related and the performance curve of the torque is not flat. On the other hand (El-Khatib, 1992) pointed out that the power required for land leveling was 60.15 hp (44.27 kW), while the manual leveling consumed 58.9 hp (43.35 kW) under the conditions. (Hassan, 1996) found that, the optimum speed for machine productivity was ranged between 1.35-2.5 km/h, the machine productivity increase with lower rubber wheel pressure when the cut stroke length was short. (Alexandr, 2003) reported that heavily loaded wheels of agricultural transport vehicles and heavy machinery may cause severe damage to the farmland. A remedy consists of reducing both the wheel load and the contact pressure. A physical modeling under controlled conditions was complemented by an adequate evaluation procedure and promising potential to predict full-scale ground compaction and become a sound basis for practical measures based on tire strength and wear. (Luquan et al., 2003) Clarified that bionic bulldozer blades were affected on resistance reduction against soil. The draft forces of different samples were obtained. The largest convex base diameter of the bulldozer had the lowest draft force. A minimum amount of soil adhered to the soil surface, and the draft force varied smoothly. (Thomas et al., 2005) tested a radial-ply tractor drive tire operating at 10% travel reduction. Strain was determined in the vertical, longitudinal, and lateral directions. Initial lengths of strain were approximately 118 mm for both longitudinal and lateral, and 136 mm for vertical strain. The tire dynamic load was 25 kN and the inflation pressure was 110 kPa, which was a recommended pressure corresponding to the load.

The mean final volumetric natural strain from the strain transducer data was 0.099, which was only 35% of the mean change in natural volumetric strain calculated. (Kaiming, 2008) modified a combination of analytical and numerical methods utilized to calculate a three-dimensional model which can effectively predict the earthmoving productivity, forces and moments acting on the blade not only for level terrain dozing but also for irregular terrain dozing. The blade can be operated as tilted and angled. The model was then integrated in multi-body dynamics code for machine dynamics analysis and representative simulation provided to further demonstrate the capability as means to identify the important factors for ways in which the machine generally is operated under different complex conditions and help in designing earthmoving systems.

The objectives of this study were:

1. Evaluate the performance of most used earthmoving machinery in Egypt (Hydraulic Landleveller and Grader).

2. Studying the operation parameters which affect the performance under new reclaimed areas.

MATERIALS AND METHODS

This study was performed at South Qantara on sandy loam soil as clarified in table (1), and divided into two main experiments.

Experiment (1): On area of 2.76 ha using a motor grader (Caterpillar 120 M) under three forward speeds (1.12, 1.35 and 1.84 km/h) and four stroke length of (5, 10, 15 and 20 m).

Experiment (2): On area of 3.95 ha using a tractor (Belaruss MTZ-80) and Hydraulic Landleveller (El-Behera) under three forward speeds (2.6, 3.1 and 3.7 km/h) and four stroke length of (40, 50, 60 and 70 m).

The specifications of tractor, hydraulic landleveller and motor grader used were illustrated in tables (2), (3), (4) and figure (1).

Table 1. Some properties of soil profile representing the experimental site.

Soil Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture class.	Organic Matter (%)
0 – 50	8.26	29.94	61.80	Sandy Loam	0.42

Table 2. The used tractor.

Type	Belaruss MTZ-80
Source	Russia
Engine Type	4 Stroke- Diesel
Power	66.2 kW
P.T.O	540- 1000 rpm
Ground Clearance	350 mm
Mass	3500 kg

Table 3. Hydraulic Landleveller.

Model	El-Behera
Source	Egypt
Cutting edge	360 cm
Cutting depth	10 cm
Capacity	1.53 m^3
Weight	770 kg
Control	Tractor hydraulic

Table 4. The motor grader.

Type	Caterpillar 120 M
Source	USA
Engine Type	4 Stroke- Diesel, 6 cylinder
Power	103 kW
Mass	14093 kg
Blade width	370 cm
Blade height	61 cm
Forward speeds	8 speeds (0- 44.5 km/h)
Rear speeds	6 speeds (0- 37.8 km/h)

Three main measurements were included through the previous tested experiments to find out the following :

1- Machine productivity: which represent the capacity of the blade and size volume pushed by the machine used. The machine productivity can be calculated as following:

Machine productivity (m^3/h) = V* 3600 \ T

Where: V= volume pushed of cutting soil by blade (m^3), 3600= a converter factor from seconds into hours and T= time consumed through the operation (h). The volume pushed of cutting soil by blade (V) can be calculated as :

$V = V_w . * K_{Los}$,and $V_w = LH_2 / 2 \tan \Phi$,

Where: V_w = Estimated volume of cutting soil (m^3), L= Blade width (m), H = Blade height (m), Φ= Angle of soil repose on the blade, K_{Los} = Coefficient accounty.

2- Machine energy: which indicate directly the fuel consumption and power used by the machine through the earthmoving operation. The machine energy can be calculated as following by the following formula of (Hunt, 1983):

Machine energy (kW) = F.C (1/3600) * PE * LCV * 427 * ξ_{th} * ξ_m * 1/75 * 1/36

where: F.C= Fuel consumption, (lit/h), P.E= Fuel density (for solar 0.85 kg/m^3), LCV= Calorific value of fuel (11000 k.cal/kg), ξ_{th} = Thermal efficiency of engine (35% for diesel engine), ξ_m = Mechanical efficiency of the engine (85%).

3- Grid lines topography: which were registered as clarified in fig.(1 and 2)before all experimental earthmoving operations by tedolite and using the software program (Surfer(R) Version 8.0 , Golden Software, 2002) working under XP windows.

4- The previous data collected from both hydraulic landleveller and motor grader were analyzed statistically using analysis of variance.

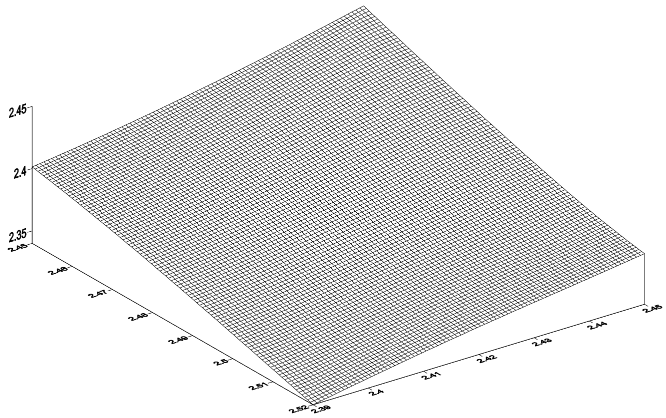


Fig. 1. Grid lines topography for Motor grader experiment before leveling

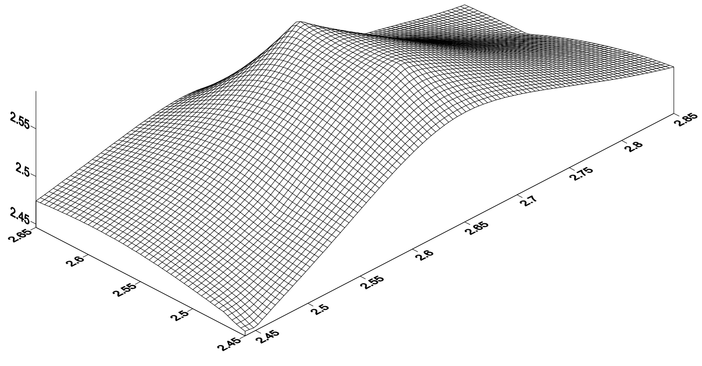
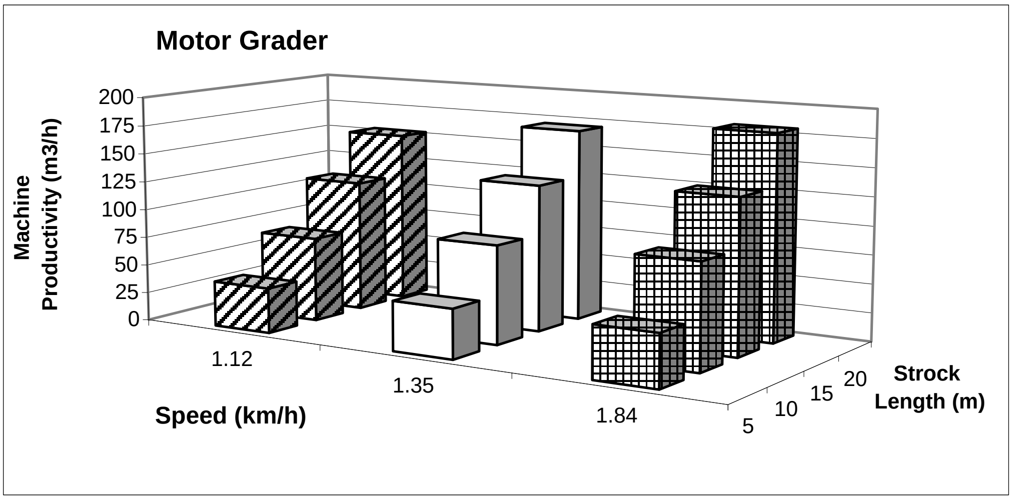


Fig. 2. Grid lines topography for Landleveller experiment before leveling

RESULTS

Effect of forward speed and stroke length on machine productivity:

The obtained results from both motor grader and landleveller experiments through earthmoving operations were affecting on the machine productivity. Fig (3) showed that four different stroke lengths which were tested 5, 10, 15 and 20 m, and 40, 50, 60 and 70 m for both motor grader and landleveller respectively. The collected data indicated a clear increase in the machine productivity as the forward speed increased from 1.12 to 1.84 km/h and 2.6 to 3.7 km/h for motor grader and landleveller respectively. It was attributed to the accumulated quantities of soil moved through each operation. It can be concluded that the machine productivity was highly affected by forward speed. Hence, it's clear that increasing the stroke length also increase the productivity of the machine itself.



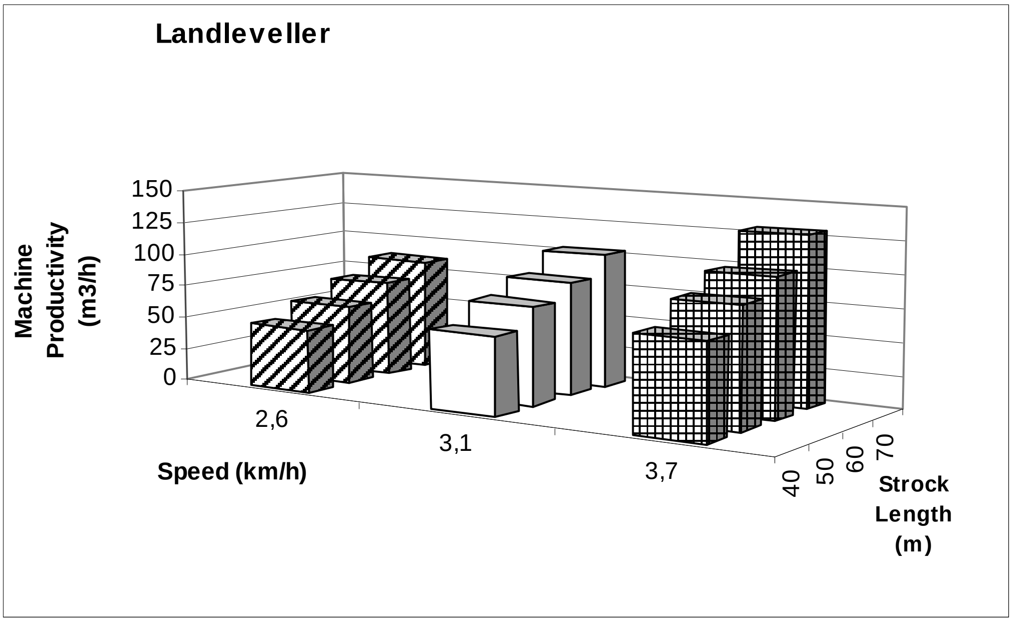


Fig 3. Effect of forward speed and stroke length on machine productivity

Effect of forward speed and stroke length on machine Energy:

The energy consumed through each earthmoving operation was affected by both forward speed of machine used and stroke length. Fig (4) showed that increasing both forward speed from 1.12 to 1.84 km/h and 2.6 to 3.7 km/h for motor grader and landleveller respectively, increases the energy consumed from 6.56 to 29.27 and from 1.66 to 3.26 kW.h/ha for both motor grader and landleveller respectively. The increase in energy consumed was attributed to increasing in forward operational speeds and also the stroke length which consumed more fuel through the soil movement. The highest values of energy consumed were observed by using the motor grader as compared with the landleveller.

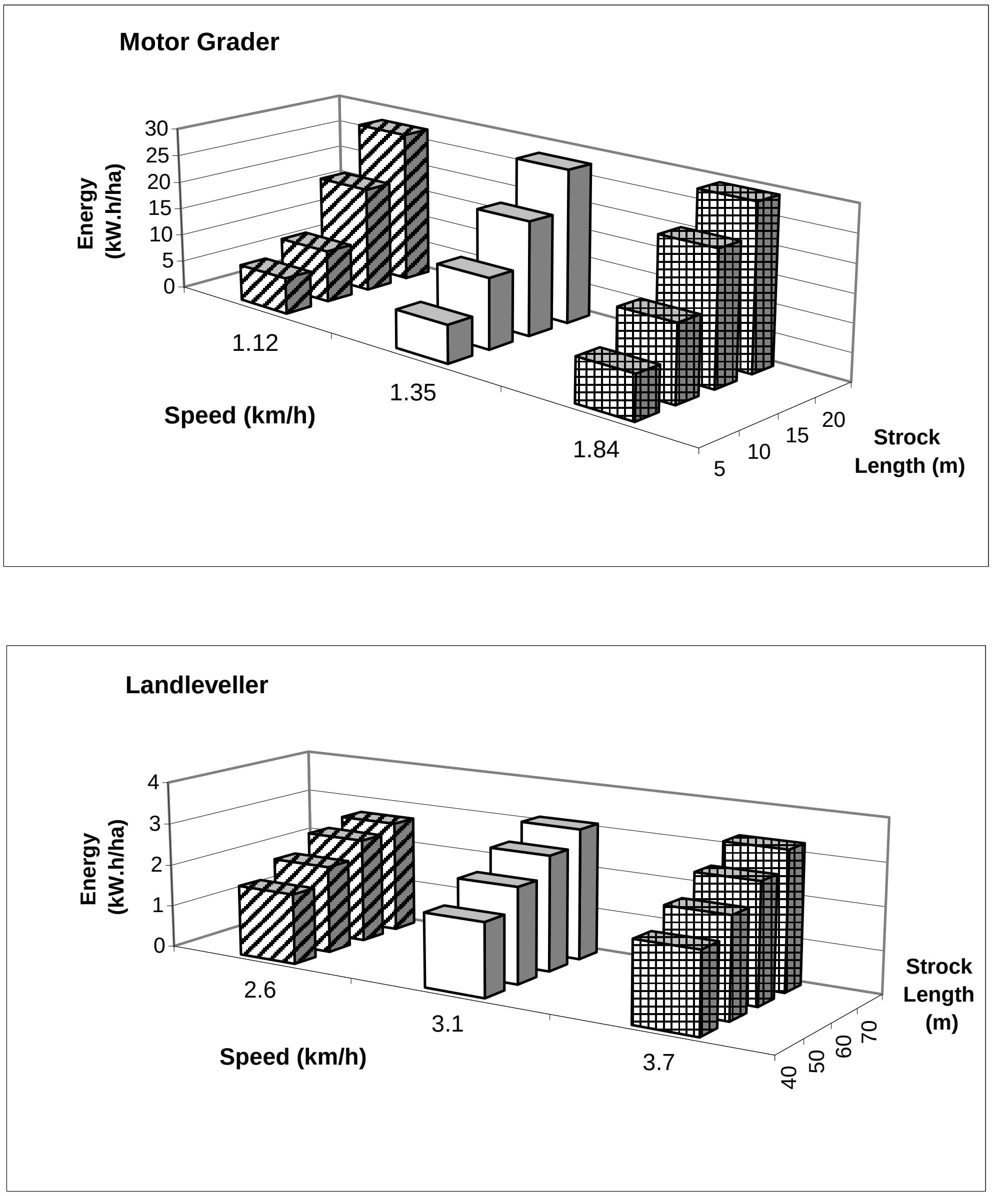


Fig. 4. Effect of forward speed and stroke length on machine Energy

Data analysis:

Data in Table (3) represented the effect of stroke length and forward speed on productivity and energy at motor grader and landleveller. Data analysis showed that the effect of stroke length was significant on both the machine productivity and energy consumed at motor grader and landleveller. Statistical analysis, showed a highly significant effect of interaction forward speeds and machine productivity and energy consumed at motor grader and landleveller. Such interaction is more pronounced in the length stroke treatments than in forward speeds regardless machine type.

Table 5. Effect of stroke length (m) and forward speed (km/h) on productivity (m^3/h) and energy (kW.h) at Motor Grader and Landleveller.

Type	Length (m)	Speed (km/h)	Productivity (m^3/h)	Energy (kW.h/ha)
(Motor Grader)	L1 (5)	S1(1.1)	39.31	6.57
		S2(1.4)	42.93	6.81
		S3(1.8)	45.02	7.85
	L2 (10)	S1(1.1)	73.83	9.42
		S2(1.4)	85.86	12.69
		S3(1.8)	91.11	13.64
	L3 (15)	S1(1.1)	115.79	19.04
		S2(1.4)	128.8	20.47
		S3(1.8)	134.72	23.56
	L4 (20)	S1(1.1)	152.67	27.61
		S2(1.4)	169.71	27.7
		S3(1.8)	180.52	29.27
LSD (0.05)		"S"	**0.37**	**0.3**
		"L"	**0.43**	**0.34**
		"SXL"	**0.74**	**0.59**
(Landleveller)	L5 (40)	S4(2.6)	48.21	1.67
		S5(3.1)	59.26	1.74
		S6(3.7)	72.16	1.88
	L6 (50)	S4(2.6)	60.26	2.07
		S5(3.1)	74.7	2.26
		S6(3.7)	90.2	2.33
	L7 (60)	S4(2.6)	73.12	2.48
		S5(3.1)	86.94	2.74
		S6(3.7)	104.82	2.81
	L8 (70)	S4(2.6)	85.36	2.67
		S5(3.1)	103.14	3.12
		S6(3.7)	129.22	3.26
LSD (0.05)		"S"	**0.34**	**0.15**
		"L"	**0.39**	**0.22**
		"SXL"	**0.72**	**0.29**

CONCLUSION

Still therefore a less number of studies conducted to assess the whole-body to mechanize the land reclamation projects in Egypt. Using a motor grader (Caterpillar 120 M) under three forward speeds (1.12, 1.35 and 1.84 km/h) and four stroke length of (5, 10, 15 and 20 m), and Hydraulic Landleveller under three forward speeds (2.6, 3.1 and 3.7 km/h) and four stroke length of (40, 50, 60 and 70 m) were tested on sandy loam soil. It can be concluded that the machine productivity was highly affected by forward speed. Hence, it's clear that increasing the stroke length also increase the productivity of the machine itself. The increase in energy consumed was noticed with increasing in forward operational speeds and also the stroke length. The highest values of energy consumed were observed by using the motor grader as compared with the landleveller.

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