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Zero-Tillage Performance Of Comparing With Conventional Cultivation In The Economic Study

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Abstract

This study was carried out at the Agricultural Research and Experiments Station (Bani Maqan) in Chamchamal district (2019-2020) and (2020-2021), and it is within an area that is almost guaranteed rain and has a silty clay texture. Two types of cultivation systems are used in this study, which is (the traditional planter system and the zero tillage system) with two levels of forward speed (3 and 5) km/h and two depths of tillage (3 and 6) cm to study some of the mechanical characteristics of agriculture (draw bar power, lost power due to slippage, and Effective field capacity) and some of economical characteristics (operation time, and fuel consumption) and their effect of net profit. The experiment field was divided according to the design of (RCBD). The indicators were randomly distributed among the experimental units within the sector. The experiment field was divided into three sectors. The range is below the level (0.05). The results showed, the zero-tillage system achieved the lowest value required for a time and fuel consumption during the process of agriculture, draw bar power and losses power from slippage were increased by increasing tractor speed, while effective field capacity and fuel consumption were decreased., draw bar power, power losses due to slippage, and fuel consumption were increased by increasing the depth.

Key words: Zero-Tillage, draw bar power, Losses power due to slippage, fuel consumption, Effective field capacity

Introduction

The main goal of most agricultural researchers is to reduce the costs of agricultural production in order to obtain a higher net profit, and the past few years have witnessed various and serious attempts in the world to find cheap, economical, efficient and high-productivity machines and machines for use in agricultural operations while reducing their passage in the field to a minimum, and preserving On soil and acceptable agricultural production (Mosad and Foudy, 2003). Zero-tillage enables the control of soil erosion, as it reduces environmental damage, reduces surface runoff, and better harvesting of water, as well as improves the cultivation without tillage of soil biology (microorganisms) and the composition of the soil and organic matter in the soil, and the stability of their groups and distances soil microelement, increase soil resistance to pests (Hargrove, 1990). Grissso, (2000) reported that fuel and oil costs typically cost from 16% to 45% of the total machine operating costs. Leghari et al. (2014), while studying three farming systems, indicated that the minimum-tillage showed the lowest significant value of the actual production capacity as it reached 0.32 ha/h. As for the conventional cultivation and zero-tillage, no significant differences were found between them, as their results were 0.49 and 0.47 ha/h respectively. Costs are a major determinant of the extent of profit and economic feasibility of the overall agricultural process, of which the most important paragraphs fall are the cultivation and soil preparation operations because of their important effects that may be positive or negative on the physical and chemical properties of the soil and the extent of the reflection of the effects on the growth characteristics of the crop and its productivity (Tahir et al, 2018). Younis et al. (2020a) mentioned that The fuel consumption tended to decrease with an increasing the travel forward speed. It tended to increase with an increase in the seeding depth. The main objective of this study is to find out the comparison of zero-tillage performance with conventional cultivation

Material and Methods:

Field of Experience:

The experiment was conducted at the Agricultural Research and Experiments Station (Bani Maqan) in Chamchamal district of the Directorate of Agricultural Research and Experiments in the Sulaymaniyah Governorate, which is 40 km north of Kirkuk governorate for the years (2019-2020) and (2020-2021). One dunum is in a technical and economic study to compare the performance of different seeding techniques to grow bread wheat. The experiment field, which has an area of 2500 m^2, was contained three factors; cultivation systems, depths and speed, and applied to randomized complete plots design (RCBD).

The studied factors:

First: two types of cultivation systems:

1- No-till planting system using no-till planting seed only.
2- The conventional cultivation system, which includes tillage, smoothing, leveling, and seeding operations.

Second: seeding techniques depths (3 and 6) cm.

Third: Ground forward speed include (3 and 5) km/h.

Thus, the experiment included treatments (2 × 2 × 2), and with three replicates by (24) experimental units, the length of one sector is (20) m and the width is (40) m while leaving the distance (2.5) m between the repeaters for the drawer gaining its forward speed. During which the studied traits were calculated, and the averages of the transactions were tested using (Duncan's Multiple Range Test) at a probability level (5%).

Tractors and machines used:

1- The Tractor MF-435 and MF-285 with both 75 hp.
2- Disc plough with number of discs: (3).
3- Sprig-tooth harrows with Number of shears: (15) shears.
4- Grain Drill, (Sun Flower).
5- The planting process was carried out using the 9312 end-wheel grain drill of the Massey Ferguson type (Sun Flower), fig. (1) in the zero-tillage and traditional planting system, and they have the same characteristics.

Fig. 1 ; 9312 End-Wheel Grain Drill, MF Sunflower Zero-Tillage

6- The studied qualities and methods:

The indicators of seed mechanization:

a- Draw bar power (hp):

It was calculated by the following law (Tahir, 2004):

Draw bar power (hp) = $\mathrm{Pf(kg)} \times \mathrm{Vp}(\frac{\mathrm{km}}{\mathrm{h}})/270$

Dhp = Draw bar power (hp).

Pf = draft force (kg).

Vp = practical forward speed (km/h).

b- Power losses due to slippage (hp):

Calculate the power lost by slippage from the following formula; (Tahir, 2004):

$$Ps = \frac{\mathrm{Pf(Vt-Vp)}}{270}$$

Ps= power losses due to slippage (hp) converted to (hp).

Pf = machine pulling force (kg).

Vt =The theoretical forward speed without loading (Vt) m/s was calculated by dividing the distance specified by signs by the time it takes for the tug to travel that distance (km/h).

Vp =The practical forward speed of the tractor during the tillage process (Vp) m/s was calculated by dividing the distance covered by the tractor during the sowing process by the time taken to cover that distance (km/h).

c- Effective field capacity (ha/h):

It was calculated according to the following equation, (Jajo, 2016)

$$\text{Effective field capacity } (\frac{\mathrm{ha}}{\mathrm{h}}) = \frac{\mathrm{Vp}\ (\frac{\mathrm{km}}{\mathrm{h}}) \times \mathrm{Wp\ (m)} \times \mathrm{E}}{\text{unit area (ha)}}$$

as that:

Ec = Effective field capacity (ha/h).

Wp = Actual working width (m).

Vp = practical forward speed (km/h).

E = Field efficiency (80% seeding value).

Economic study indicators:

1- Operation time (h): Which computed as a planting time for zero- tillage system and disk plow, harrowing, and planting for traditional system.
2- Fuel consumption (liters/ha):
It was measured by the method of addition using a graduated cylinder, where a tank is filled and then the tractor is started and it starts working immediately, and during the end of the working line the tractor is extinguished immediately, then the fuel is added to the drawer using the inserted cylinder and the amount of this addition is the fuel consumed (AL-Hashem et al., 2000) According to the following equation:

$$\text{Fuel Consumed} = \frac{\text{The amount of fuel consumed during the transaction}(ml) * 10}{\text{the length of the transaction }(m) * \text{actual display }(m)}$$

Results and Discussion

Mechanical properties in the planting seeds process:

We note from the statistical analysis that there is a significant effect for the cultivation systems at a probability level (0.01) of both lost slippage ability, and fuel consumption.

1. Draw bar power (hp):

Table No. (1) shows that there are significant differences in the indicator of the draw bar power, as the conventional cultivation system achieved the lowest draw bar power of (7,5668) hp compared to the zero-tillage system, which recorded (7.8735) hp and the reason may be that the dismantled soils need the pulling force is less in a conventional cultivation system compared to a zero-tillage system, and this is consistent with what he mentioned (Johnston et al., 2000), As shown in Table No. (1) the interaction between the conventional cultivation system and the depths, where the conventional cultivation system and depths (3 and 6) cm recorded the draw bar power (6.8680 and 8.2657) hp, respectively, compared to the achieved the lowest draw bar power of (7,5668) hp compared to the zero- tillage system and the depths (3 and 6) cm were recorded. Draw bar power (7.0230 and 8.7241) hp respectively, and here it becomes evident with the increase in the depth of tillage, the draw bar power increases and also the draw bar power in the achieved the lowest draw bar power of (7,5668) hp compared to the zero- tillage system increases and this is due to the resistance of the soil to the shear of the seeders and it needs a greater capacity and this is consistent with (Tahir, 2020), It can be seen from Table No. (1) that the draw bar power increased with the increase in the practical forward speed in the conventional cultivation system and the forward speed (3 and 5) km/h, as the draw bar power was recorded (5.2745 and 9.8592) hp, respectively, and in a achieved the lowest draw bar power of (7,5668) hp compared to the zero-tillage system and forward speed (3 and 3). 5 km/h The draw bar power was recorded (5.6090 and 10.1381) hp, respectively, and the reason for this is that increasing the forward speed leads to a decrease in the time required to accomplish the same amount of work that the shear accomplish in the process of demolishing and forming soil, which increases the power needed to pull the machine Likewise, increasing the forward speed leads to an increase in the acceleration of the soil compounds and an increase in the energy of movement given to the soil, and this is consistent with what was stated (Al-Khafaji, 2006), Table No. (1) also shows the interaction between depths and forward speed, as the draw bar power at depth (3) cm and forward speed (3 and 5) km/h reached

(4.8573 and 9.0336) hp, compared with depth (6) cm and forward speed (3 and 5) km/h, reaching (6.0261 and 10.9637) hp, and from this, it becomes clear that with increasing depth and forward speed, the draw bar power increases, and this is consistent with (Hamida and Muhammad, 2015). It was observed in Table No. (1) the interaction between cultivation systems, depths and forward speed in the conventional cultivation system, depths (3 and 6) cm, and forward speed (3 and 5) km/h, achieved a draw bar power of (4.7726, 8.9614, 5.7743 and 10.7570) hp, respectively, compared to With the zero-tillage system and the depths (3 and 6) cm and the forward speed (3 and 5) km/h, the draw bar power was recorded (4.9401, 9.1058, 6.2779 and 11.8348) and it is also clear that the greater the depth and forward speed, the more the machine needs a greater traction capacity, and this is consistent with (Johnston et al., 2000).

Table (1) the effect of average Agriculture systems, depths, and forward speed on the draw bar power indicator.

Cultivation systems	Depths of tillage (cm)		Average cultivation systems
	(3 cm)	(6 cm)	
conventional	6.8680 B	8.2657 A	7.5668 A
Zero-Tillage	7.0230 B	8.7241 A	8.7241 A
Cultivation systems	Types of forward speed (km / h)		
	(3 km/h)	(5 km/h)	
conventional	5.2745 B	9.8592 A	
Zero-Tillage	5.6090 B	10.1381 A	
Depths of tillage (cm)	Types of forward speed (km / h)		Average plowing depths(cm)
	(3 km/h)	(5 km/h)	
3 cm	4.8573 D	9.0336 B	6.9455 B
6 cm	6.0261 C	10.9637 A	8.4949 A
Average forward speed	5.4417 B	9.9986 A	
Cultivation systems	Depths of tillage (cm)	(3 km/h)	(5 km/h)
conventional	3 cm	4.7746 D	8.9614 B
	6 cm	5.7743 CD	10.7570 A
Zero-Tillage	3 cm	4.9401 D	9.1058 B
	cm 6	6.2779 C	11.1703 A

2- Power losses due to slippage (hp):

Table No. (2) shows that the conventional cultivation system achieved the lowest significant value for the power losses due to slippage (0.5253) hp, while the zero-tillage system recorded the highest value of (0.8776) hp. The characteristic of the power losses due to slippage was the lost power by sliding in the conventional cultivation system with depth (3 and 6) cm to (0.4094 and 0.6412) hp respectively, compared to the zero-tillage system with depth (3 and 6) cm, where the power losses due to slippage was (0.6837). And 1.0114) hp respectively, and it is evident that the power losses due to slippage increases with the depth of tillage and also increase in the zero-tillage system The reason is due to the influence of this trait and its dependence on the characteristic of slippage more, and this is consistent with both (Tahir, 2004), It was shown in Table No. (2) and in the conventional cultivation system with the forward speed (3 and 5) km/h the power losses due to slippage was (0.2872 and 0.7635) hp, respectively. The zero-tillage system recorded an ability lost by slippage (0.2872 and 0.7635) hp. The zero-tillage system and forward speed (3 and 5) km/h recorded the power losses due to slippage (0.4394 and 1.2557) hp respectively, and the reason is due to the increase in the movement resistance due to the increase in forward speed, which leads to an increase in the energy spent to overcome the resistances, causing an increase in the power losses due to slippage , this is consistent with what was stated by both (Tahir and jeejo, 2019), In Table No. (2) the average forward speed with a depth of the ability lost by slippage for (3) cm and (3) km/h, which amounted to (0.3633 and 0.5466) hp, respectively, and the average ability lost by slippage for the forward speed of (5) km/h with depth (6) cm amounted to (1.0095 and 0.8263) respectively when the interactions between depth and forward speed reached the power losses due to slippage for depth (3) cm with forward speed (3) and 5 km/h (0.2969 and 0.7969) hp, respectively compared with depth (6) cm and the forward speed (3 and 5) km/h amounted to (0.4279 and 1.2230) hp respectively, and an increase in the lost ability was observed by slippage with an increase in depth and forward speed. Resistors increase the lost ability causing slippage, and this is consistent with both (Younis et al, 2020b), Table No. (4) shows the interactions between cultivation systems with planting depth and cultivation forward speed. The power losses due to slippage of the conventional cultivation system with depths (3 and 6) cm and forward speed (3 and 5) km/h reached (0.2381, 0.5808, 0.3362, and 0.9463). hp respectively compared to the zero-tillage system with depths (3 and 6) cm forward speed (3 and 5) km/h, where the power losses due to slippage was (0.3557, 1.0117, 0.5231, and 1.4997) hp, and an increase in the lost ability was observed by slippage with the increase in depth and forward speed at the zero-tillage, the reason may be due to the increase in movement resistance due to the increase in depth and forward speed, which leads to an increase in the energy spent to overcome these resistances, causing an increase in the power losses due to slippage .

Table (2) The effect of average cultivation systems, depths, and forward speed on the characteristic of power losses due to slippage (hp).

Cultivation systems	Depths of tillage (cm)		Average cultivation systems
	(3 cm)	(6 cm)	
conventional	0.4094 C	0.6412 B	0.5253 B
Zero-Tillage	0.6837	1.0114	0.8473

	B	A	A
Cultivation systems	Types of forward speed (km / h)		
	(3 km/h)	(5 km/h)	
conventional	0.2872 D	0.7635 B	
Zero-Tillage	0.4394 C	1.2557 A	
Depths of tillage (cm)	Types of forward speed (km / h)		Average plowing depths(cm)
	(3 km/h)	(5 km/h)	
3 cm	0.2969 D	0.7964 B	0.5466 B
6 cm	0.4297 C	1.2230 A	0.8263 A
Average forward speed	0.3633 B	1.0096 A	
Cultivation systems	Depths of tillage (cm)	(3 km/h)	(5 km/h)
conventional	3 cm	0.2381 D	0.5808 C
	6 cm	0.3362 D	0.9463 B
Zero-Tillage	3 cm	0.3557 D	1.0117 B
	cm 6	0.5331 C	1.4997 A

3-Effective field capacity (ha/h):

Table No. (3) shows the significant superiority of the conventional cultivation system, as it achieved the highest value in the characteristic of actual productivity, which amounted to (0.3402) ha/h, followed by a system of cultivation without tillage, which amounted to (0.3072) ha/h this is consistent with both (Leghari et al., 2014) and (Younis et al, 2020a), It can be seen in Table No. (3) also and when the depths have an effect of (0.3238) ha/h at depth (3) cm compared with the depth (6) cm, which recorded the actual productivity of (0.3237) ha/h, and it is also found that the actual productivity at forward speed (3) km/h amounted to (0.2489) ha/h compared to the forward speed (5) km/h, which achieved (0.3985) ha/h, and it is noted in Table No. (3) the effect of the overlap between the cultivation system and the depth as it is, in the cultivation system Traditional yields with depths (3 and 6) cm give the actual productivity (0.3394 and 0.3310) ha/h compared to a zero-tillage system with depths (3 and 6) cm. The Effective field capacity is (0.3081 and 0.3063) ha/h and here it becomes clear that the greater the depth Effective field capacity decreases and the reason for this is increased soil resistance as the depth of tillage increases and In Table No. (3) it was noticed that the Effective field capacity increases with the increase in forward speed this is consistent with what was stated by,(Tahir, 2020), for example in the conventional cultivation system with two forward speeds (3 and 5) km/h, the Effective field capacity was recorded (0.2556 and 0.4248) ha/h respectively, and in a zero-tillage system with two forward speed 3 and 5 km/h recorded Effective field capacity (0.2422 and 0.3722) ha/h, and Table No. (3) also shows the overlap between depth and forward speed, so the depth (3 cm) recorded the Effective field capacity of (3 and 5 km/h) 0.2492 and 0.3984 (ha/h) compared to the depth (6) cm and the forward speed (3 and 5) km/h. The Effective field capacity was recorded (0.2486 and 0.3987) ha/h this is in agreement with both (Leghari et al., 2014) and (Younis et al, 2020a) and, We note from Table No. (3) the interaction between cultivation systems, depths, and forward speed, that the conventional cultivation system and depth (3 and 6) cm and forward speed (3 and 5) cm achieved Effective field capacity (0.2529, 0.4229, 0.2583 and 0.4238) ha/h, respectively, compared to With a zero-tillage system and the depth (3 and 6) cm and the forward speed (3 and 5) km/h, where it recorded (0.2454, 0.3709, 0.2390 and 0.3736) ha/h, respectively, as it is clear that the conventional cultivation system is superior to the zero-tillage system.

Table (3) The effect of average cultivation systems, plowing depths, and forward speed on the actual productivity characteristic.

Cultivation systems	Depths of tillage (cm)		Average cultivation systems
	(3 cm)	(6 cm)	
conventional	0.3394 A	0.3410 A	0.3402 A
Zero-Tillage	0.3081 B	0.3063 B	0.3072 B
Cultivation systems	Types of forward speed (km / h)		
	(3 km/h)	(5 km/h)	
conventional	0.2556 C	0.4248 A	
Zero-Tillage	0.2422 D	0.3722 B	
Depths of tillage (cm)	Types of forward speed (km / h)		Average plowing depths(cm)
	(3 km/h)	(5 km/h)	
3 cm	0.2492 B	0.3984 A	0.3238 A
6 cm	0.2486 B	0.3987 A	0.3237 A
Average forward speed	0.2489 B	0.3985 A	
Cultivation systems	Depths of tillage (cm)	(3 km/h)	(5 km/h)
conventional	3 cm	0.2529 CD	0.4259 A
	6 cm	0.2583 C	0.4238 A

Zero-Tillage	3 cm	0.2454 CD	0.3709 B
	6 cm	0.2390 D	0.3736 B

4- Economic study indicators:

a- Impact of cultivation systems, depth, and forward speed in the required time:

Figure No. (3) shows that the zero-tillage system achieved the lowest value of time required during the cultivation process at forward speed (5) km/h with depth (3) cm, as it gave (0.666) h/ha compared to the forward speed (3 km/h) which gave (1.083) h/ha and the reason for this is that no plow was used in these transactions and no plowing or smoothing process was carried out, and thus there was no wasted time during the plowing or smoothing process, as only the planting process is considered in this aspect.

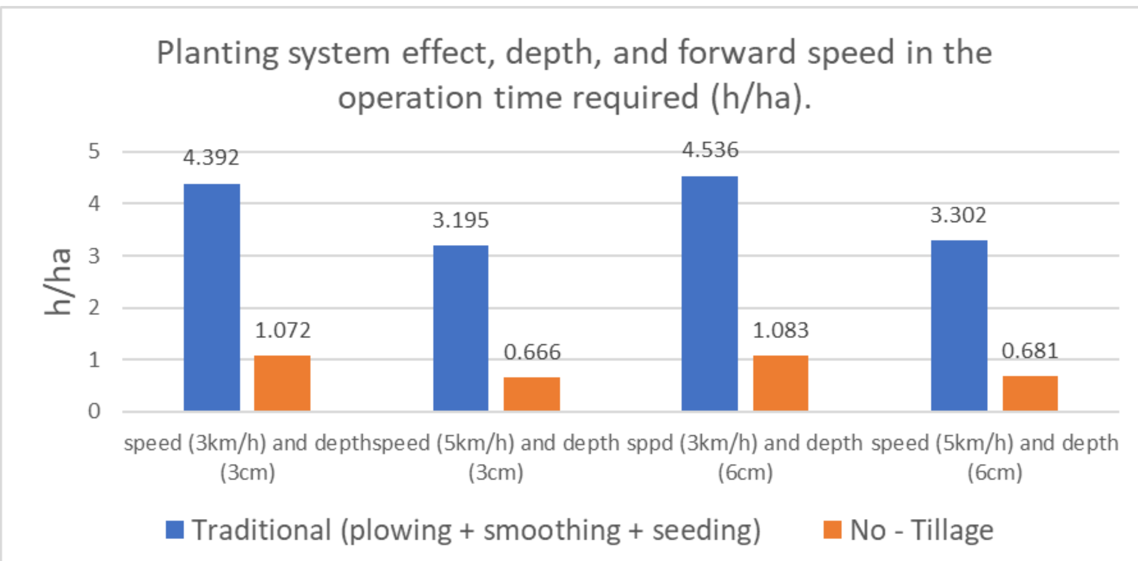
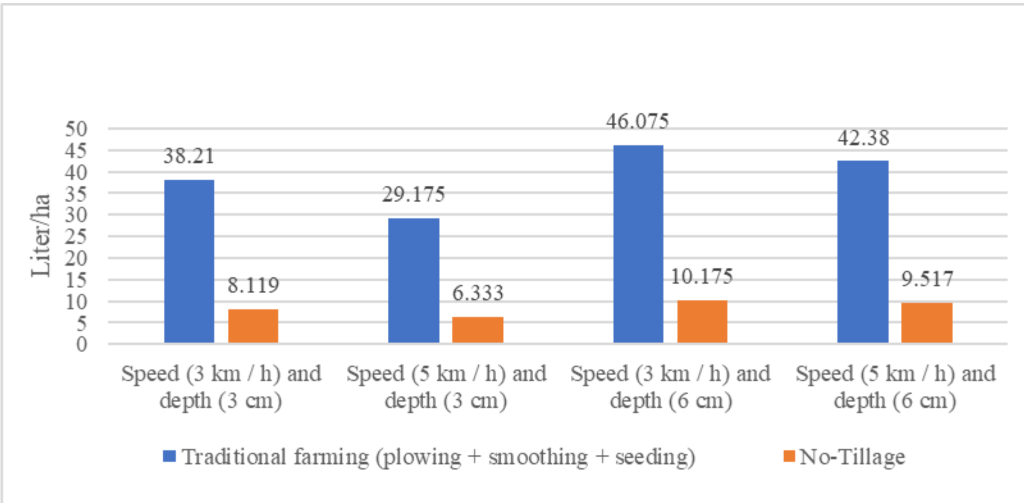


Figure No. (3) shows the effect of cultivation systems on the forward speed, depth in the required time.

While the conventional cultivation system (plowing + harrowing+ planting) at a forward speed of 3 km/h with a depth of (6) cm recorded the highest value of time required during the cultivation process amounted to (4.536) h/ha, and this is due to the use of three agricultural operations in this system, which is the process of (plowing + harrowing+ planting) which led to the consumption of additional time during the cultivation process, and on the other hand, the disc plow is relatively small in width and its working forward speed is low and therefore it requires more effort and time in the completion of the work, and this is consistent with what each of the (Bolliger et al., 2006), (Jajo, 2016) and (Tahir et al, 2018).

b- The effect of cultivation systems, depth, and forward speed on fuel consumption:

Figure (4) indicates the superiority of the zero-tillage system by achieving the lowest value for fuel consumption compared to the conventional cultivation system, as the zero-tillage system recorded the lowest value at forward speed (5) km / h and depth (3) cm amounting to (6.333) liters/ha.



The reason for this is that the plowing and smoothing operations do not need to be performed in the first place, and thus there was no fuel consumption for these two processes, while the highest value of fuel consumption in the conventional cultivation system was at forward speed (3) km/h and depth (6 cm), as it gave (46.075) L/ha and the reason for this is due to the use of the plowing and smoothing processes, as the disc plow, which is one of the plows used for primary plowing, needs more pulling force than the rest of the farming operations, and this, in turn, requires the consumption of more fuel and this is consistent with what each of (Kumar et al., 2013), (Akbarnia and Farhani, 2014) and (Younis et al, 2020b).

Conclusions:

1- Zero-Tillage achived less time and fuel consumption compared with the conventional cultivation system (plowing + harrowing+ planting).
2- Draw bar power and losses power from slippage were increased by increasing tractor speed, while effective field capacity and fuel consumption were decreased.
3- Draw bar power, power losses due to slippage, and fuel consumption were increased by increasing the depth.

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