

## **Developing A Double Purpose Machine Prototype For Rice Transplanting**

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### **ABSTRACT**

A double purpose machine prototype for rice transplanting was developed, locally manufactured, and evaluated in order to overcome numerous problems which restrict the mechanization of rice transplanting in Egypt. The proposed transplanter is 4 rows planting machine, and propelled on three ground wheels to suit small scale farms. It suits both traditional rice seedlings method, and in trays seedling method. To achieve these machine functions, the developed prototype included two seedling platforms: - one of them is fixed to accomplish the traditional seedlings method, while the other is movable to accomplish the in trays seedling method. The developed prototype was provided with two groups of finger nails to suit both tested transplanting methods. Transplanting performances the machine prototype was tested and evaluated versus of the two seedling platform types, and the two nail finger types, it was also tested versus four transplanting depth levels of (2 – 3 – 5 – 7 cm), and three provided human power levels. These performances were determined, and evaluated in terms of: -machine field capacity, machine transplanting efficiency, longitudinal seedlings spacing and total machinery costs. The gained results revealed that: - the maximum field capacity values were 0.29, and 0.283 fed/h, and the highest transplanting efficiency values were 72 and 68 % as the developed prototype was accomplishing the traditional, and in trays seedling methods respectively. The optimum transplanting depth for operating the locally manufactured transplanter was determined as 5 cm for both seedling methods. The cost of rice transplanting operation using the locally manufactured transplanter under the study is estimated about 101.82 L. E/fed compared with 600 L.E/fed for manual transplanting and 247.96 LE/fed for the imported transplanter.

### **INTRODUCTION**

Rice is one of the most important crop in Egypt, it has a great effect on human food. The cultivated rice area in Egypt is reached about 1.42 million feddan with a total production of about 5.72 million Mg of rough rice. At Kafr El-Sheikh Governorate the total cultivated area is about 292840 fed per year with average yield of 4.03 Mg/fed. Abdel-Fatah and Mansour, (2015) Rice is largely grown traditionally by manual transplanting. Manual transplanting requires a lot of labours besides involving drudgery and is also very expensive. Scarcity of labours is another major problem in some paddy growing area of the country. Hence, less expensive, farmer friendly and labour saving method of paddy transplanting is urgently needed. The mechanical transplanting of paddy has been considered the most promising option, as it saves labour, ensures timely transplanting and attains optimum plant density that contributes to high productivity. Keeping this in view, the study was conducted to manufacturing and evaluate a manual rice transplanter to minimize the cost of transplanting of paddy crop through farm mechanization. Sang-Su et al. (1999) transplanted three rice cultivars with 3 different seedling age to investigate their growth habits and observed that the 10 days old seedlings had more vigorous elongation of plant height and higher till ring ability but lower effective tiller rate, when compared with 35-day or 40-day old seedlings. Younis *et al.*, (2004) developed sugar beet transplanter to suit cotton and other vegetable crops seedlings. He found that a sugar beet transplanter failed to transplant cotton seedlings, the highest actual performance rates of the developed transplanter were 0.77, 0.84 and 0.88 fed/h at forward speed 3.22 km/h for cottons eggplant and tomato seedlings respectively. And he found that the percentage of damaged and floated seedlings for all treatments ranged between 1.2 and 7.3 %. Genaidy, M.A.I. (2008) carried out a study on performance of a small cotton transplanted under Egyptian condition. He found that the increase of forward speed from 0.5 to 1.5

km/h leads to increase the field capacity, fuel consumption, slippage percent and deviation coefficient and decrease the field efficiency, the energy required transplanting efficiency and total cost of transplanting. and the mechanical transplanting increase the field capacity, efficiency and cotton yield compared with manual transplanting. Global, B. (2012). reported that the mechanical transplanting method would be economically covered an area of 28 ha and above in every year as well as grain yield in both manual and mechanical transplanting remained on par with mean grain yield of 53.77 and 54.01 q/ha, respectively. Pateriya and Datta, (2012) design modifications of mat type rice transplanter. The results indicated that the performance of the modified rice transplanter was better compared to the unmodified rice transplanter. The machine was capable of transplanting 2-4 seedlings per hill The percentage of missing hills was limited to 8.06 to 9.75 per cent. The total number of plants ranged from 35-42/m<sup>2</sup>. The row to row distance was also maintained uniform. The planting depth was 5.4 cm and there is no mechanical injury to the seedlings. The field capacity of the machine was 1.05 ha/day when operated at low gear (1.03 km/h) in the side to side method. Murumkar et al. (2014) found that by using self-propelled four row paddy transplanter. The labour requirement was 2 man days per hectare compared to 32 man days of labour per hectare in manual transplanting of paddy. Thus, it saved 30 man days of labour per hectare. Munnof et al. (2014) in their research on the techno-economic performance of imported kukje self-propelled rice transplanter. They found in the experiment was conducted to study. The field efficiency and planting efficiency of the transplanter were 83.33% and 95%, respectively. Percent damaged (3.33%) and missing (5.33%) hills were higher in mechanical transplanting method and percent floating (4.33%) hill was higher in case of manual transplanting method. The average labor input in mechanical transplanting was 1.4 man-day/ha where 25 man-day/ha was in case of manual transplanting. Uttam and Thomas (2015) studied

the force acting on the rice transplanter finger and found magnitude of force acting on seedling finger was influenced by age of seedlings, seed rate and planting speed. The energy required at the crank increased with age of seedlings and seed rate but transplanting velocity had negligible influence for the 15 mm size mat. The energy required has initially decreased and then increased with the increase in each of the variables, age of seedlings, seed rate and planting speed for the 20 mm size mat.

From the above mentioned the aim of the present study was to develop, locally manufacture, and evaluate a double purpose machine prototype for rice transplanting in order to overcome numerous problems which restrict the mechanization of rice transplanting in Egypt.

The proposed transplanter is 4 rows transplanting machine, and propelled on three ground wheels to suit small scale farms. It suits both traditional rice seedlings method, and in trays seedling method.

### MATERIALS AND METHODS

The present work was carried out during summer season 2016 at Rice mechanization center, Meet El-Deeba, Kafrelsheikh Governorate. The experimental field was prepared by using chisel plow two passes. To achieve the objectives of the present study two sequences stages were accomplished. The first stage is to locally manufacturing a small machine for rice transplanter to suit small farms. The transplanter machine was fabricated with locally available materials at the manufacture Center of Kafr El-Sheikh. The developed rice transplanter was opeveted by engine fixed it, his power 6.0 hp model Firman. While the second stage was to carry out the experimental work

that aimed to determine and evaluate the effects of the processing variables on the manufacturing machine for rice transplanter performance. In this experiment, rice crop of Sakha 78 variety was used.

### Materials.

The materials used in the present study are described as follows:

### The manufactured transplanting machine prototype

It's having the frame was made of iron rectangle with dimension of 2500,1800 and 1900 mm length, width and height respectively, two seedling platforms one of them is fixed to accomplish the traditional seedlings method. While the other is movable to accomplish the in trays seedling method, 4 rows transplanting, three ground wheels two rear and one front rubber wheels with diameter of 600 mm and width of 130 mm. The front wheel is used for steering, two group of finger nails to suit both tested transplanting traditional seedlings and seedlings Trays. The transport system consists of a Gasoline engine 6 hp, engine shaft, and steering, a driver's seat. These machine small enough to operate manually to targeting small scale farmers in the country. This machine takes the movement from the ground wheel through the gasoline engine. when moving from one place to another. The engine is only used during the transplanting process to increase the speed of transplanting group in order to get the longitudinal distance between the appropriate seedlings. This is due to the low engine's power to draft the machine during the transplanting process. Moving machine by people during the transplanting process. Transplanting machine manufacturer are sketched in Fig.1 and 2

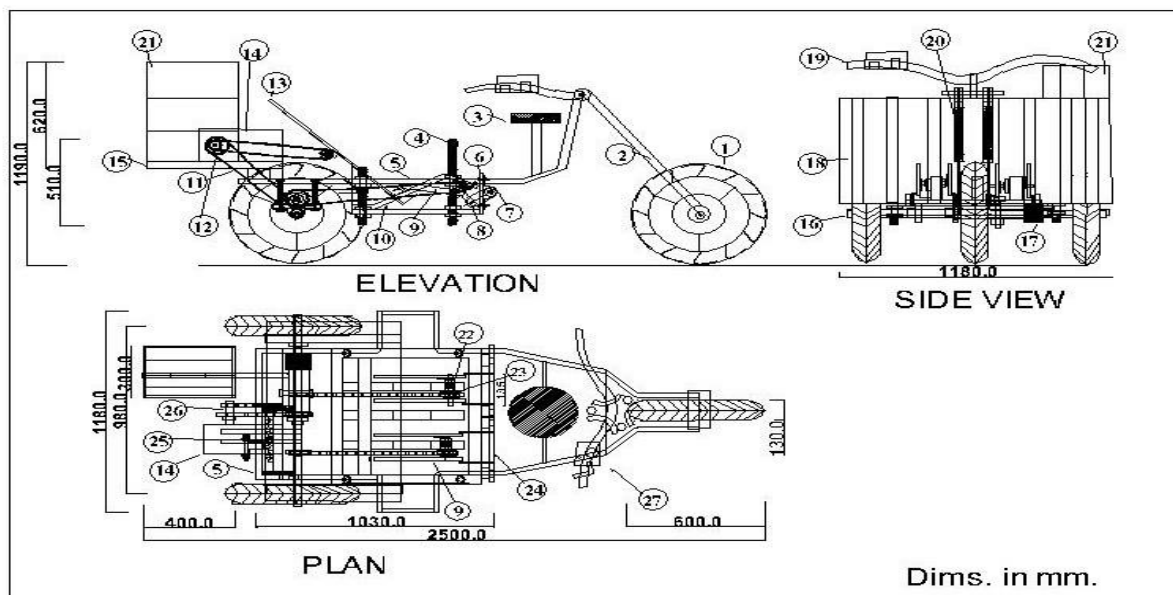


Fig. 1. Elevation, side, and plane views of the developed rice transplanting machine prototype.

1-Wheel 2- Cadre 3- Drivers seat 4- Spiral shaft 5- Chassis machine 6- Stand 7- Ball bearing 8-Connecting rod 9- Finger nails seedling 10- Finger nails stand 11- Chain 12- Gear 13- Seedling platform 14- Engine 15- Seedling seat stand 17- Reverse gear movement 18- Barrier seedlings 19- hand steering system 20-Assistant 21- Seedling trays stand 22- Bearings 23- Gear finger nails 24- Movement shaft 25- Reciprocating movement shaft 26- Engine shaft 27- Speed change handle.



**General technical specifications of transplanter machine:**

The general specifications of the transplanting machine manufacturer under investigation are presented in Table 1.

**Table 1. The technical specifications of the developed transplanter.**

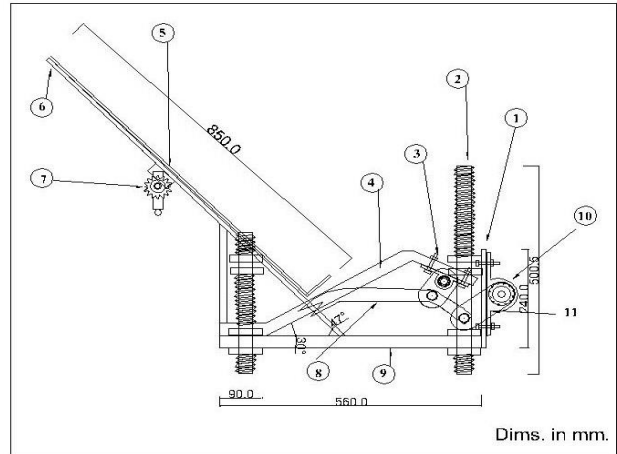
Specification	Value
<i>Main dimensions:</i>	
Total length, mm	2500
Total width, mm	1180
Total height, mm	1250
Total mass, kg	122
Source of power:	Gasoline engine (6 hp)
r.p.m	3600
Max torque	10.5 N.m/2500 rpm
Fuel type	Gasoline
Fuel tank capacity, Lit.	4.5
No. of transplanting fingers	4
No. of wheels,	3
No. of seedling platform,	2
No. of planted rows	4



**Fig. 2. Photograph of the developed rice transplanting machine prototype**

**Transplanting unit compositions**

Figs 3 and 4 shows the composition of the manufactured transplanting unit. It can be seen that this unit is mainly consisting of two groups and each group has two finger nails seedlings. They are assembled with two iron shafts, one fixed and the other is movable. There is four iron curved end shape joints to link the finger nails seedlings with two shafts, in order to move the given crank. This group is equipped on the two shafts and carried out by means of ball bearing. Each group is operated by means of a sprocket gear- chain transmission drive. There is in return finger nails seedlings a chassis fixed above it proves two seedling platform the first one is fixed and the other is moving. Units transplanter installed in chassis transplanting machine by four shafts, spiral to control the lifting and lowering unit transplanting and adjust the depth of transplanting from which. The optimum depth of planting of the seedlings is very important because shallower depth will result in the uprooting of seedlings even with mild flow of water or wind. A deeper depth will result in submergence of the planted seedlings, thereby creating the risk of rotting.



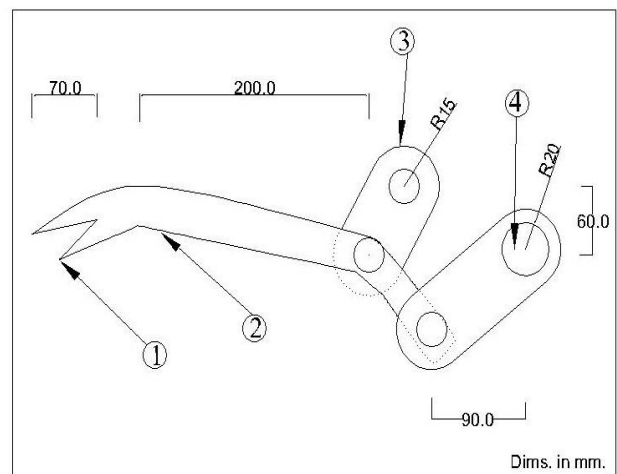
**Fig. 3. sketched view of the unit planting seedlings.**  
 1- Stand of ball bearing 2- Spiral shaft 3- Nail linking 4- Stand  
 5-Seedling platform 6-Stand of seedling platform 7- Reciprocating  
 movement shaft 8- Finger nails seedlings 9-Chassis of  
 transplanting unit 10-Ball bearing 11- Connecting rod.



**Fig 4. Photograph of the unit planting seedlings.**

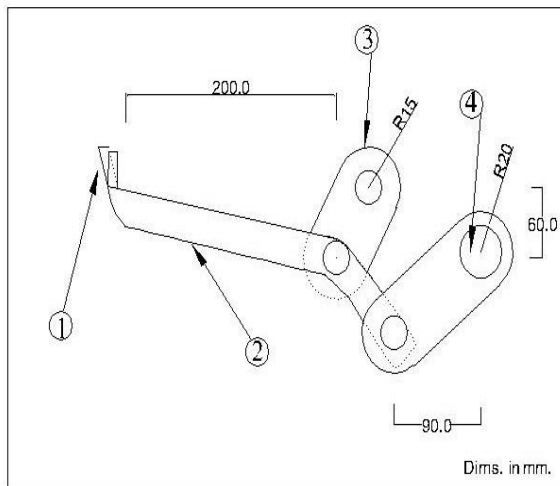
**Types of finger nails seedlings**

Figs. 5 and 6: Shows two types of finger nails seedlings. The first one used with fixed seedling platform and the other used with movable seedling platform. A planting finger, which is a part of the coupler link of the mechanism, separates the seedlings from the seedling tray and places them in the soil. The curve traced by the planting finger may have an influence on the stability of the planted seedlings.



**Fig. 5.Finger nails who manufactured to use with fixed seedling platform.**

1-Slot nails transplanting 2- Finger nails seedlings  
 3- Small connecting rod 4- Contact a fixed shaft by this point

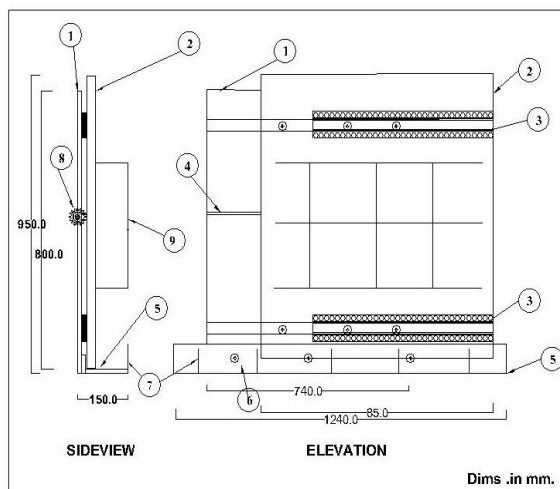


**Fig. 6. Finger nails seedlings who manufactured to use with movable seedling platform.**

1-1-Slot nails transplanting 2- Finger nails seedlings 3- Small connecting rod 4- Contact a fixed shaft by this point.

**Seedling platform**

Two manufacturing seedling platform to suit the traditional seedling and seedlings trays. Fig. 2 shows the traditional seedling platform. The platform was made of a steel sheet thickness of 3 mm with width of 100 cm and height of 85 cm. It has a five-iron wicker with width of 2 cm to prevent a seedling from falling. Describes the traditional seedling roots after washing a half-laundering in the form of elongated behind the barrier and be rooted in one direction when the corresponding aperture to finger nails seedlings. Seedlings are dropped to the bottom by gravity with the machine movement of water behind her workshops to help to slide down. Figs.7 and 8 shows trays seedling platform has width of 85 cm and a height of 95 cm.



**Fig. 7. Seedling platform who manufactured to use with seedlings trays.**

1- Stand of seedling platform 2- Seedling platform 3- Moving plate 4-Bar of stand seedling platform 5- Bar to moving the seedling platform 6- Nail linking 7- Seedlings barrier from the bottom of 8- Connection point and motion the seedling platform. 9- Barrier seedlings from the top

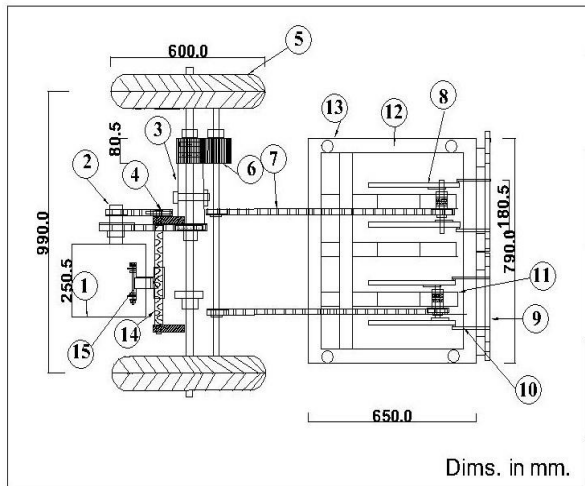
The seedling platform has a corrugated tin for easy sliding seedlings when spraying water the back. Seedling platform movement is moving reciprocating through its connection from behind with a two-lane shaft moves reciprocating. And sliding down the chest on the course of 118 cm long. Installed him from behind up and down the two moving base there inside them ball bearing helps the speed of movement, a length of 60 cm and a width of 10 cm. The Compactors seedlings so that the platen facilitates to capture finger nails transplanting of seedlings with the reciprocating movement of the machine was issued.



**Fig. 8. Photograph of the seedling platform who manufactured to use with seedlings trays.**

**Power transmission system**

Figs. 9 and 10 show the power is transmitted from the engine shaft to the sprockets mechanism is used to transmit power to the transplanting unit by chains. The powers transmitted to all movable shaft on the machine frame by ball bearings varying in their diameters assembled on the shaft. At the end of the engine shaft of 20 mm diameter there is two gears of 14 and 10 teeth are fixed. The 14 teeth gear transmitted the power to the ground wheel shaft through the gear having 22 teeth. And the second gear having 10 tooth transmitted the power to the shaft is moving seedling platform. Fig. 11. A clutch unit to connect and disconnect the motion from the engine to the ground wheel and a transplanting group. This group consists of two gears the first one takes the motion of the engine directly through the chain and the other transmits motion to a transplanting group by another reflective gear of the motion. Moving this group by ball bearing and connected with wheel Ground shaft by a nail through a clutch unit to connect and disconnect the motion. In the end the power is transmitted from the reflective gear to a transplanting group from four gears the reflective gear shaft and another two gears having 15 tooth are fixed with two group of transplanting.

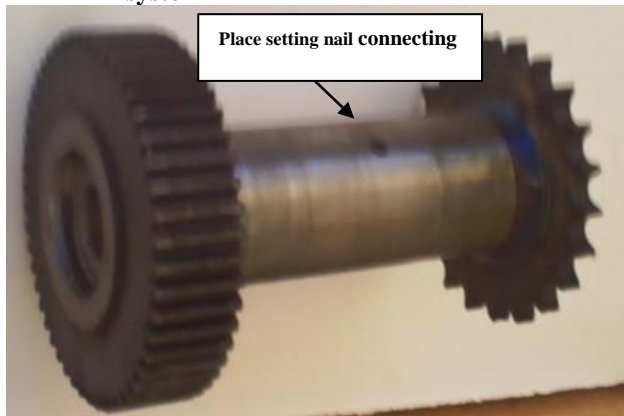


**Fig. 9. Power transmission system**

1- Engine 2- Engine shaft 3- Connect and disconnect the driveline 4-Chain 5-Wheel 6- Reverse gear movement 7-Chine 8- Finger nails seedlings 9-Fixed shaft 10- Connecting rod 11- Finger nails stand 12- Chassis of transplanting unit 13- connection point with chassis of machine.



**Fig. 10. Photograph of the power transmission system**



**Fig 11. Photograph of a clutch unit to connect and disconnect the motion from the engine to the ground wheel**

**Float transplanting machine manufacturer**

Fig. 12 shows the float for transplanting machine is installed below the unit transplanting by four shafts, spiral. Working to help increasing the forward speed machine. It also helps to stabilize the seedlings when the traffic beside them from Pressure on the adjacent soil for the seedlings. It is made of wood to help buoyancy



**Fig. 12. Photograph of the float transplanting machine prototype.**

**Soil mechanical analysis:**

Four random samples of soil were taken from a depth level of 20 cm. The mechanical analysis of the soil was conducted in the lands and soil research institute, in Sakha. Results of the mechanical analysis and listed in Table 2.

**Table 2. The soil mechanical analysis.**

Sand, %	Silt, %	Clay, %	Organic matter, %	Soil texture class
14.75	25.0	58.0	2.25	Clay

Soil conditions before transplanting were shown in Table 3.

**Table 3: Field condition data before transplanting.**

Item	Treatment
Water depth, cm	2.0
Hardpan depth, cm	12.0
Cone depth, cm	9.5
Soil penetration resistance, kg/cm <sup>2</sup>	24

Rice crop variety of Sakha 78 was used to prepare the mat type seedling. After treatment sprouted paddy seed was sown in the ground and trays at a seed rate 250 g/tray. Seedling conditions recorded on the day of transplanting operation is shown in Table 4.

**Table 4: Seedling conditions data.**

Item	Traditional seedlings	Seedlings Trays
Number of leaves	3.2	2.4
Number of plant / cm <sup>2</sup>	3.8	4.1
Plant height	18.5	17.0
Moisture ratio, %	85.6	84.0
Plant age, day	25	25

The operational limits of the developed machine prototype were determined through primary experiments, whereas the working availability of that machine as using both movable and seedling platforms are listed in Table 5

**Table 5. The working availability of the developed machine prototype**

Character	Movable platform	fixed platform
Hill density, hill/m <sup>2</sup>	23.8	22.0
Number of seedlings per hill	4.2	5.1
Plant height, cm	17.0	18.5
Labor requirement, man /fed.	3.0	3.0
Fuel consumption, l/h.	0.6	0.6
Percentage of damaged hill, %	9.5	9.5
Percentage of missing hill, %	10.2	8.2
Percentage of floating hill, %	12.3	10.3
Av. Transplanting efficiency, %	68	72
Av. Slip, %	5.3	5.3

**Experimental procedure**

To illustrate and evaluate the performances of the developed transplanting machine prototype and to compare the movable and fixed seedling platforms transplanting methods, the methodology of this study could be divided into three subsequent divisions.

The first division was to make the correct decisions concerning the selection of the power source for suitable developed machine prototype. Therefore, the traction performance of that prototype was evaluated at four different traction surfaces versus different provided power sources. The four investigated different traction surfaces were: - paved, plowed soil, soil irrigated 3hours ago, and soil irrigated one day ago. While, the different provided power sources were (gasoline engine, one man, two man and three men). The effects of these traction variables were evaluated in terms the resulted actual forward speed, and the resulted depositing longitudinal seedling spacing.

The second division was to evaluate the transplanting performances of developed machine prototype as affected by, provided power source, the two seedling platform types, three nail finger spaces (1,1.5, and 1.8 cm), and four transplanting depth levels of (2 – 3 – 5 – 7 cm). The effects of these traction variables on the transplanting performances of developed machine prototype were evaluated in terms: - effective machine field capacity, machine transplanting efficiency,

The third division was mainly established to estimate and compare the total machinery cost for both the locally manufactured machine, and the corresponding imported rice transplanter.

**Methods of measurements**

**Slip ratio, %**

The slip percentage of the develop machine wheel was determined by using the following equation:

$$S = \frac{L_1 - L_2}{L_1} \times 100, \% \dots \dots \dots (1)$$

Where:

S = Slip ratio, %;

L<sub>1</sub> = Advance per 10 revolutions of wheel on asphalt, m;

L<sub>2</sub> = Advance per 10 revolution of wheel on the tested surfaces, m;

**The effective field capacity**

The effective field capacity (Ef<sub>c</sub>) was calculated by using the following formula (Kepner *et al.*, 1982).

$$Ef_c = 1/T$$

Where:

Eff<sub>c</sub> = Effective field capacity, fed. / h. .... (2)

T = total time (t + t<sub>1</sub> + t<sub>2</sub> + t<sub>3</sub> + .....);

t = theoretical time;

t<sub>1</sub> + t<sub>2</sub> + t<sub>3</sub> = the total time lost during transplanting operation,

t<sub>1</sub> = time lost for turning

t<sub>2</sub> = time lost for repairing and

t<sub>3</sub> = time lost for adjusting the machine.

**Transplanting efficiency**

Transplanting efficiency for each treatment was determined using the formula.

$$T.E = [N_t - (N_d + N_m + N_f)] / N_t, \% \dots \dots \dots (3)$$

Where:

T.E = Transplanting efficiency.

N<sub>t</sub> = theoretical number of seedlings per unit length;

N<sub>d</sub> = number of damaged seedlings per unit length;

N<sub>m</sub> = number of missed seedlings per unit length;

N<sub>f</sub> = number of floated seedlings per unit length;

**Percentage of damaged seedlings (pd)**

The percentage of damaged seedlings was calculated from equation according to (RNAM 1995)

$$Pd = N_1 / N_2 * 100, \% \dots \dots \dots (4)$$

Where:

Pd = percentage of damaged seedlings

N<sub>1</sub> = Number of damaged seedlings in 10 m row length

N<sub>2</sub> = The total number of seedlings in 10 m row length

**Percentage of floated seedlings (pf)**

The percentage of floated seedlings was calculated from equation according to (RNAM 1995)

$$Pf = N_3 / N_2 * 100, \% \dots \dots \dots (5)$$

Where:

Pf = percentage of floated seedlings

N<sub>3</sub> = Number of floated seedlings in 10 m row length

N<sub>2</sub> = The total number of seedlings in 10 m row length

**Cost Estimations:**

The total machinery costs for both locally manufactured and the imported transplanters were determined by using the following equation (Awady *et al.*, 2003)

$$C = \frac{p}{h} \left( \frac{1}{a} + \frac{i}{2} + t + r \right) + (1.2 W. S. F) + \frac{m}{144} \text{ (LE/h)} \dots (6)$$

Where:

C = hourly cost, L.E /h;

P = price of machine manufacturer (prices level);

h = Yearly working hours, hours;

a = life expecting of the machine, year (8 year); i =

Interest rate/ year ratio (10%/yr); t = taxes, overheads

ratio (5% /yr); r = repairs and maintenance ratio (10%

/yr);

1.2 = A factor accounting for lubrication;

W = power, (6.0 hp);

S = specific fuel consumption (0.25 l/kW.h);

F = fuel price (2.25 L.E.);

m = operator monthly salary (1200 L.E./man) and

144 = Reasonable estimation of monthly working hours.

Operational cost per fed can be determined using the following equation:

$$\text{Operational cost} = \frac{\text{Hourly cost}(L.E / h)}{\text{Effective field capacity}(fed / h)}, (L.E/fed) \dots (7)$$

**RESULTS AND DISCUSSIONS**

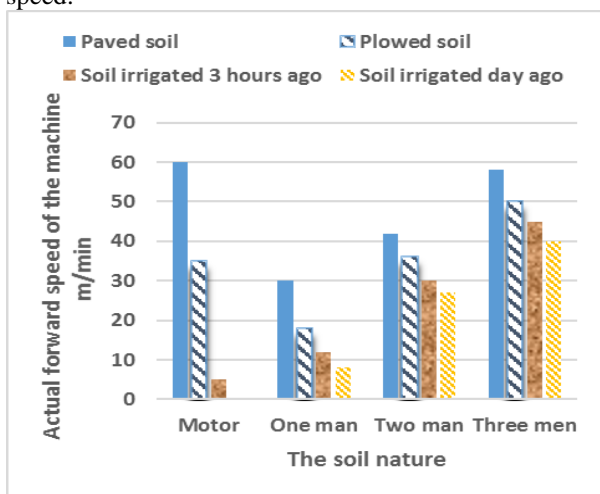
The data obtained from the present work could be summarized under the following headings: -

**A) Inspection of the traction performance of the developed machine prototype**

As indicated before the traction performance of the developed transplanting machine prototype was evaluated at four different traction surfaces versus different provided power sources. The effects of these traction variables were evaluated in terms the resulted actual forward speed, and the resulted depositing longitudinal distance between seedlings.

**The resulted actual forward speed**

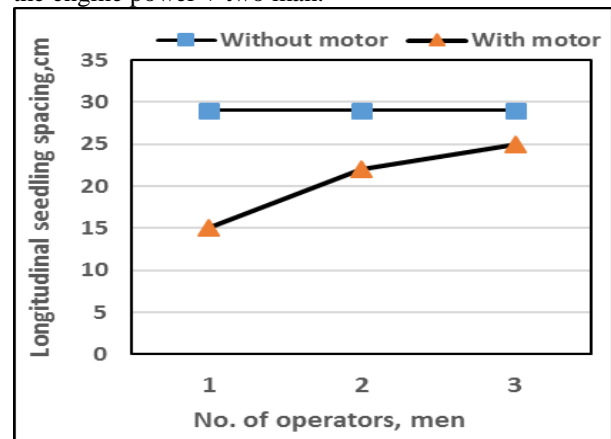
The data indicated in Fig.13 show the effect of the soil traction surface and the power source (engine, one man, two man and three men) on the actual resulted forward of the machine. The data revealed that the maximum values of actual resulted forward speed were accomplished with operating the developed machine on the paved road. These values were 60,30,42 and 60 m/min these resulted as providing the machine with the following power source engine, one man, two man and three men) respectively. The corresponding actual resulted forward speed that accomplished operating the developed machine on the soil irrigated one day ago were 0, 8, 27 and 40 m/min respectively. While The actual resulted forward speed values were 35,18,36 and 50 and were 5,12,30 and 45 m/min for operating the developed machine on the plowed soil, soil irrigated 3hours ago respectively. It may in general concluded that the traction surface is greatly affects the forward speed of developed machine. Therefore, its recommended to supply that machine with a suitable gearbox to maximize shaft torque by decreasing its speed.



**Fig. 13. Effects of the traction surface and the power source (engine, one man, two man and three men) on the actual forward speed of the machine.**

**The resulted depositing longitudinal seedling spacing.**

The observations indicated in Fig. 14 shows the effect of the provided power source (without engine and with engine) on the longitudinal seedling spacing. This data reveals that the highest recorded value of the longitudinal seedling spacing was 29 cm without providing engine power. while the lowest recorded value was 15 cm with providing the engine power +one man. The optimum recommended longitudinal distance 22 cm between the seedlings was achieved providing the engine power + two man.



**Fig. 14. Effect of the No of operator's men, (without and with engine power) on the resulted longitudinal seedling spacing.**

**B) Inspection of the transplanting performance of the developed machine**

As indicated before the transplanting performances of developed machine prototype as affected by, provided power source, the two seedling platform types, three nail finger spaces, and four transplanting depth levels. The effects of these traction variables on the transplanting performances of developed machine prototype were evaluated in terms: - effective machine field capacity, machine transplanting efficiency,

**Effective field capacity, fed/h.**

Data illustrated in Fig. 15 show the effect of the numbers of operator's men, normal seedlings and seedling trays on the effective field capacity. It was found that as the provided human power source increased from one man, two man and three men tends to increase the effective field capacity from 0.07, 0.2 and 0.29 fed./h in the case of normal seedlings. Also and the effective field capacity increases from 0.067, 0.192 and 0.283 fed./h respectively with seedlings trays. It can be noticed that increasing the effective field capacity with seedling platform fixed about seedling platform movement. That's because the percentage of breakdowns increased with seedling platform moving about seedling platform fixed. Therefore, the effective field capacities generally are decreased because the transplanting machine are indicated on the widths of 72 cm are used.



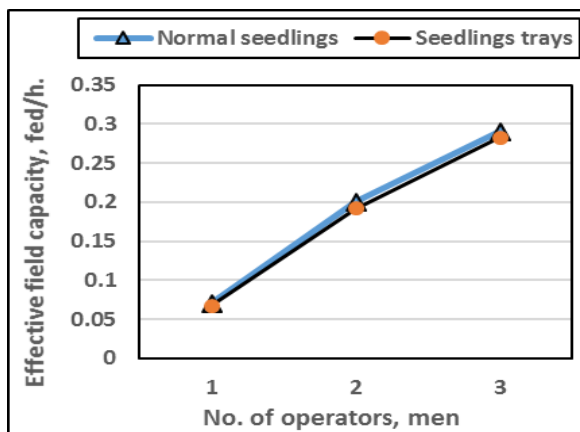


Fig. 15. Effect of number of operators men, normal seedlings and seedling trays on the effective field capacity, fed/h.

**Transplanting efficiency, %.**

The effect of the widening slot finger nails transplanting with (seedlings trays and normal seedlings) and the movement source on transplanting efficiency was studied and the results as presented in Fig. 16. It was found that increasing the widening slot finger nails transplanting from 1 to 1.8 cm at normal seedlings and three men tends to increase the transplanting efficiency from 56 to 72 %. While the transplanting efficiency decrease from 68 to 60 % at same conations with seedling trays. Generally, the results show that, the transplanting efficiency increasing by increase the movement source from one man to three men with normal seedlings and seedling trays respectively. The transplanting efficiency increased by increase the widening slot finger nails transplanting with normal seedlings. Because it helps finger nails to constipation the seedlings. But decreased with seedling trays at the same conditions Because it helps finger nails to fall of some seedlings. The highest value of the transplanting efficiency was recorded at 72 % with normal seedlings, used three men and widening slot finger nails transplanting of 1.8 cm.

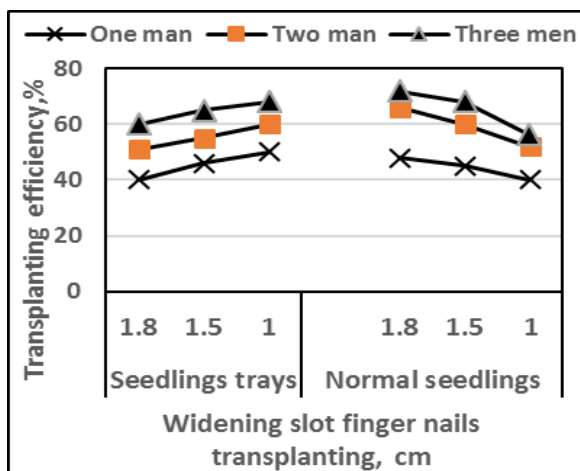


Fig. 16. Effect of the widening slot finger nails transplanting with (seedlings trays and normal seedlings) and the movement source on transplanting efficiency, %.

**Depth of transplanting, cm.**

Data illustrated in Fig. 17 shows the effect of the depth of transplanting, normal seedling and seedling trays on transplanting efficiency. It was noticed that increasing the depth of transplanting from 2 to 5 cm tends to increase the transplanting efficiency from 55 to 76 % and from 50 to 66 % with normal seedlings and seedling trays respectively. But increasing the depth of transplanting from 5 to 8 cm tends to decrease the transplanting efficiency from 76 to 60 % and from 66 to 55 % with normal seedlings and seedling trays respectively. The best depth of transplanting was recorded at 5 cm.

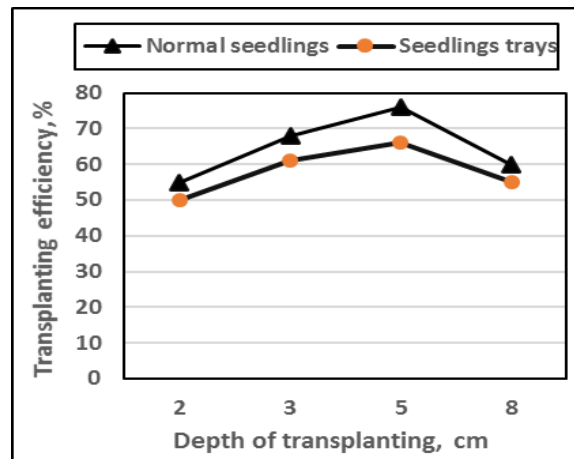


Fig. 17. Effect of the depth of transplanting, normal seedling and seedling trays on transplanting efficiency, %.

**C) Estimations the total machinery cost**

The total machinery cost for both the locally manufactured machine, and the corresponding imported rice transplanter were estimated and compared. Therefore, the total machinery cost was estimated according eq. 6 and 7. and the proper assumption listed in Table 6 and shows in Fig. 18 and 19.

Table 6. Important assumption for calculating the machinery system costs

Character	Transplanting machine manufacturer	Machine imported transplating	Manual transplating
Machine costs	12000	140000	-
No. of hours / year	350	400	-
No. of labors /fed.	3	2	20
Age of machine	8	10	-
Operator monthly salary	1200	1200	-
Field capacity, fed/h.	0.29	0.8	-
Total cost, L.E /h.	29.53	198.37	-
Total cost / fed.	101.82	247.96	600

The effect of the number of operator's men, normal seedling and seedling trays on the total cost was studied and the results as presented in Fig. 18. It was found that increasing the number of operator's men from

one man to three men tends to decrease the total cost from 421.85 to 101.82 L. E/fed and from 440.74 to 104.34 L. E/fed. with normal seedlings and seedling trays respectively. The highest value was recorded at 440.74 L. E/fed. with seedling trays and used one man. But the lowest value was recorded at 101.82 L. E/fed with normal seedlings and used three men. Also illustrated in Fig. 19 show the effect of the transplanting machine manufacture, machine imported transplanting and manual transplanting on the total cost. It can be noticed that the average recorded data is presented in Table 6. The total cost was recorded with transplanting machine manufacturer of 101.82L.E/fed, with machine imported transplanting of 247.96 L. E/fed and with manual transplanting 600 L.E/fed.

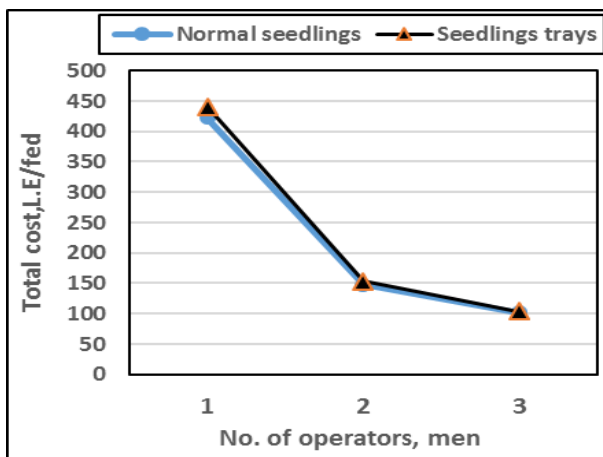


Fig. 18. Effect of the number of operators men, normal seedling and seedling trays on the total cost, L.E/fed.

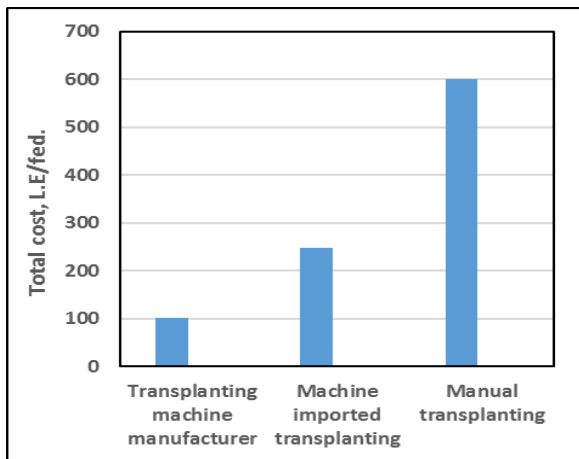


Fig. 19: Effect of the transplanting machine manufacture, machine imported transplanting and manual transplanting on the total cost, L.E/fed.

**CONCLUSION**

The main results of the present study can be summarized in the following points:

- 1- The maximum percentage of the effective field capacity of 0.29 fed/h with normal seedlings and used three men, 0.283 fed./h with seedling trays at same conditions.

- 2-The highest value of the longitudinal seedling spacing was recorded at 29 cm without engine and the best value of the longitudinal seedling spacing were recorded at 22 cm with engine and use two manes.
- 3-The highest value of the transplanting efficiency was recorded at 72 % with normal seedlings, used three men and widening slot finger nails transplanting of 1.8 cm.
- 4-The best depth of transplanting was recorded at 5 cm.
- 5-The lowest value of the total cost was recorded at 101.82 L. E/fed with normal seedlings and used three men.
- 6-The total cost was recorded with transplanting machine manufacturer of 101. 82L.E/fed, with machine imported transplanting of 247.96 L. E/fed and with manual transplanting 600 L.E/fed.

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## تطوير نموذج أولى لآلة مزدوجة الغرض لشتل الأرز

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يعتبر الشتل اليدوي في مصر من الطرق التقليدية لزراعة الأرز وهي تمثل الجزء الأكبر من المساحة المنزرعة وهذه الطريقة مكلفة جدا وذلك بسبب نقص العمالة اليدوية وارتفاع أسعارها والبدائل لذلك هو الاعتماد على الزراعة الميكانيكية والتي تمثل ثلث المساحات المنزرعة والتي بدورها بتكون أقل تكلفة من الزراعة اليدوية ولكن توجد مشكلة في استيراد هذه الآلات من الخارج وقطع غيارها لأنها تحتاج إلى عملة صعبة وارتفاع تكاليفها. ولذلك اهتم البحث بعمل نموذج أولى لآلة مزدوجة الغرض لشتل الأرز لتناسب المساحات الصغيرة وتم تصنيعها بالخامات المحلية في ورش التصنيع المحلي لتوفير العملة الصعبة وانخفاض تكاليف الإنتاج والشتل. هذه الآلة تناسب الشتلات التقليدية وشتلات الصوانى وذلك لأنها تحتوى على منصتين للشتل. أحدهما ثابتة وتناسب الشتلات التقليدية والأخرى متحركة حركة ترددية وتناسب شتلات الصوانى. كما تحتوى على نوعين من اضافير التقاط الشتلات ليناسب الشتلات التقليدية والصوانى وكل نوع اربع اضافير ليعطى اربع خطوط زراعة المسافة البينية بينهم 18 سم والطولية للشتلات 22 سم. كما يوجد بها محرك بنزين 6 حصان مثبت بها وينقل الحركة الى عجل التلامس مع الارض ومجموعة الشتل. كانت قدرة المحرك غير مناسبة لعدم وجود صندوق تروس لتغير السرعات وزيادة عزم المحرك فكان يستخدم للتنقل فقط بين الزراعات وعند عملية الشتل يستخدم لزيادة سرعة اجزاء الشتل لاعطاء مسافة طولية بين الشتلات مناسبة وكانت عملية الجر تتم باليد بواسطة العمال وكانت تحتوى على ثلاث اطارات من الكاوتش المجدد لسهولة الحركة بالأراضي الطينية وبها مقعد للسائق ويد لتشغيل وتبديل المحرك كما يوجد بها اربع فتيل حلزوني لضبط عمق الشتلات وتثبيت وحدة الشتل بالآلة وبها مجموعة تروس وجنازير لنقل الحركة. وقد اجريت التجارب بمركز ميكنة الارز بميت الديبة في صيف عام 2016 وكان صنف الارز المزروع سخا 78. ولقد تناول البحث دراسة تأثير كلا من القدرة على حركة الآلة بواسطة العمال اثناء عملية الشتل، نوعين من منصة الشتل (أحدهما ثابت ليناسب الشتلات التقليدية ومتحرك ليناسب شتلات الصوانى) و عمق الشتل (2 – 3 – 5 – 7) سم و اتساع فتحة ضوفر الشتل 1 – 1.5 – 1.8 سم وذلك على معدل اداء الآلة من خلال السعة الحقلية الفعلية، كفاءة الشتل، المسافة الطولية بين الشتلات و التكاليف الكلية من أهم النتائج التي تم التوصل اليها: 1- سجلت اعلى سرعة امامية فعلية للنموذج الاولى لآلة باستخدام المحرك مع اربع اسطح مختلفة للتربة فكانت 60 ، 35 ، 5 ، صفر م/دقيقة مع ارض صلبة ممهدة وارض محروثة وارض مروية منذ ثلاث ساعات وارض مروية منذ 24 ساعة على التوالي. 2- سجلت اعلى قيمة للسعة الحقلية عند 0.29 فدان/ساعة مع صدر الآلة الثابت والشتلات التقليدية وثلث عمال لجر الآلة. بينما كانت 0.283 فدان/ساعة مع صدر الآلة المتحرك وشتلات الصوانى وثلث عمال لجر الآلة. 3- سجلت اكبر مسافة طولية بين الشتلات عند 29 سم بدون استخدام محرك لزيادة سرعة اجزاء الشتل. بينما كانت أقل مسافة 15 سم مع استخدام المحرك وثلث عمال لجر الآلة. احسن مسافة طولية بين الشتلات عند 22 سم مع استخدام المحرك واثنين من العمال لجر الآلة. 4- سجلت اعلى كفاءة للشتل عند 72 % مع استخدام الشتلات التقليدية بالصدر الثابت واستخدام ثلاث عمال لجر الآلة ومع اتساع فتحة ضوفر الشتل الى 1.8 سم. 5- سجل احسن عمق للشتلات عند 5 سم مع استخدام الشتلات التقليدية وشتلات الصوانى. 6- سجلت أقل قيمة للتكاليف عند 101.82 جنية/فدان مع استخدام الشتلات التقليدية وثلث عمال لجر الآلة.