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Construction and Performance Evaluation of a knapsack Pneumatic Cotton Picker

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ABSTRACT
The study was conducted through season of 2020/2021to evaluate a fabricated local pneumatic cotton picker for harvesting cotton variety (Giza-94). The performance of machine was tested under different operational conditions included picking period times, cotton moister content and air suction speed. The performance of the fabricated machine was evaluated taking into account the following indicators: purity percentage, machine field capacity, power required, energy consumed and operational cost. Experimental results showed that the optimum operating parameters for cotton picking using pneumatic cotton picker were: suction hole diameter of 25 mm, cotton moisture content of 10 % and air suction speed of 50 m/s, which recorded maximum machine field capacity, acceptable purity degree, minimum both energy required and operational cost of 0.072 fed/day, 79.4%, 6.4 kW.day/fed and 3108 L.E/fed.day, respectively; compared with manual picking which recorded 6250 L.E/fed.day.

1. INTRODUCTION

Cotton is one of the most important fiber crops in the world, and Egypt is one of only 4 countries in the world that produces extra-long, soft and strong cotton in terms of production quantity after India, China and Pakistan during the year (2021/2022) **El-Hamid, 2018**. The silky soft cotton once known as "white gold" was so valuable that products made from most of the crop was exported. According to the General Commission for Arbitration and Cotton Testing, the cultivated area in Egypt during the season, **GCACT 2021/2022** increased by 30% over the previous season, as the area in this season reached 96000 fed, and it is expected that the productivity of the area will increase in this season by 34% over the previous season. In Egypt, cotton picking is considered as a major problem in cotton production. Cotton is still hand-picked which gives a high-quality cotton but requires more time. So, it is a critical time for producers on many fronts. Also, costs associated with hand picking represent a large molecule of the production costs it up to 40% **Abd El-Mageed, 2010**. Cotton harvesting is the single largest cost of production, the timing and method of harvest can dramatically affect crop quality and yield. Cotton harvesters are two types, pickers and strippers. The pickers with spindles using to remove cotton from the boll of the plant, whereas strippers are non-selective, as they strip the entire plant of both opened and unopened bolls using brushes and paddles. Strippers are less expensive and require less maintenance than that required by pickers. However, it harvests cotton fully with foreign matter (burrs, leaves, and many branches from the plant stem, but lower gin turnout is expected, using of additional cleaning machinery at the gin **El-Yamani *et al*., 2017**. Machine harvest losses are more than hand harvest and lower fiber quality has been reported by the manufacturer **Sessiz and Esgici, 2015**. The Spindle pickers are capable of harvesting 95- 98% of the cotton produced but the field harvest loss approaching 20% **Willcut *et al*., 2010**. Recently, pneumatic cotton picker can be used as a mechanism which would reduce the harvest cost and maintain the cotton fiber quality comparing with the spindle type **Durgesh *et al*., 2017**.

Meanwhile, the portable cotton picker is suitable for small farms **Ambati and Majumdar, 2013**. As cited by (**Ibrahim *et al*., 2014),** the main problem of mechanical picking of Egyptian cotton in the physiological characteristics especially about height of plant and branching density. Also, the conditions of Egyptian agriculture like small agricultural holding, sporadic fields and narrow roads between fields that not prepared for passing the machines. In addition, the Egyptian farmers cannot bear the machine operational costs. Despite of these problems, the recent increased area of the planted Egyptian cotton directed the attention towards applying the mechanical cotton harvest.

This study aimed to develop and evaluate a knapsack pneumatic cotton picker to suit the Egyptian conditions and the following criteria were taken into account: manufacture of a simplified pneumatic cotton-picking machine, identification of the most suitable operating parameters affecting the pneumatic cotton picker and evaluation the picking machine economically.

2. MATERIAL AND METHODS

The main experiments were carried out through successive agricultural season of 2020/2021 at Agricultural and Biosystems Engineering Department, Faculty of Agriculture, Damietta University to develop, construct and fabricate a knapsack pneumatic cotton picker. The field experiments were carried out in Kom El-Nour and Kafr El-Daleel in Mit Ghamr city, Dakahlia Governorate, Egypt to evaluate the performance of the constructed pneumatic cotton picker.

1. MATERIALS:

1.1. The used crop:

White cotton variety (Giza-94) was used in this study for harvesting using the fabricated pneumatic cotton picker. The specifications of the cotton variety (Giza-94), which were examined at the Cairo Research Center, are shown in Table (2.1).

Table (2.1): Some physical properties of cotton.

Variety	Color	Value of color attributes		Micronaie Value	Maturity ratio fiber strength (MR)	Fiber strength			
		Brightness (Rp %)	Yellowness (+b)			UHM (mm)	Uniformity (uni)	Strength (g/tex)	Elongation (%)
Giza-94	White	78.4	8.6	4.3	0.94	34.0	87.4	43.4	7.1

1.2. Knapsack pneumatic cotton picker:

The picking machine was fabricated, developed and evaluated technically. Figure. 1. show a general 3D drawing of the developed picking machine. The modifications and the development of the pneumatic cotton picker were fabricated as follows:

1- Cotton tank: made of plastic (PVC) with total capacity of (7 liter) supported with a tightly cover to prevent air leakage into the tank. A wire mesh is placed inside it to prevent suction of the picked cotton moves to the suction fan.

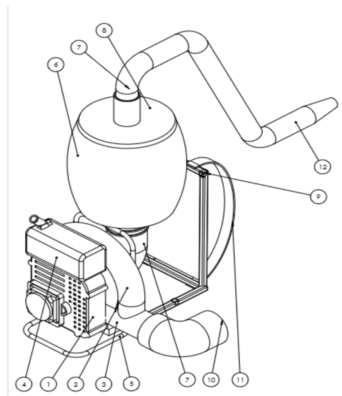
2-Engine: It is 1 hp (0.74 kW) power, 2-stroke cycle, -Gasoline fuel + 4% oil and air-cooling system.

3-Fuel tank: It has 1.5 liters capacity. Fuel flows from the fuel tank to the engine under gravity effect through a plastic tube of 4 mm diameter and 0.50 m length.

4-Blower: A centrifugal suction blower with outer diameter of 10 cm consists of a casing and 6 blades fixed on the motor shaft.

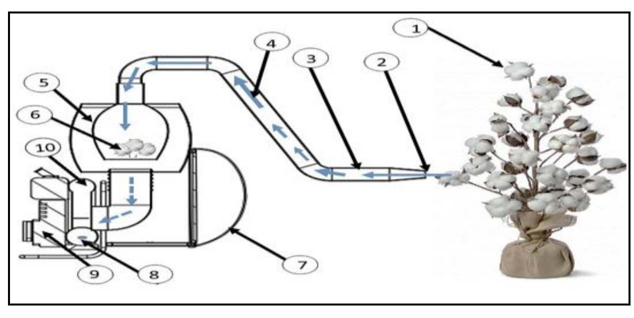
5-Suction tube: A suction tube made of plastic (PVC) with total length of 150cm and outer diameter of 6cm was attached with the cotton tank.

6-Suction hole: It is made of plastic (PVC) and it has a changeable diameter of 15, 20 and 25 mm. Fig. 2. show a geometric drawing of the cotton path from the boll to the cotton tank through the suction hole and suction tube, with the path of the air stream and the separation wire mesh between the suction and the tank.



No.	Part name	No. off
1	Engine	1
2	Blower	1
3	Air outlet	1
4	Fuel tank	1
5	Holder	1
6	Cotton tank	1
7	Air inlet	1
8	Tank cover	1
9	Frame	1
10	Air outlet	1
11	Belt carrier	2
12	Suction tube	1

Fig.1. 3D drawing of the knapsack pneumatic cotton picker.



No.	Part name	No. off	No.	Part name	No. off
1	Boll	1	6	Picked cotton	1
2	Suction hole (Air inlet)	1	7	Belt carrier	1
3	Suction tube	1	8	Air outlet	1
4	Suction movement path	1	9	Engine	1
5	Wire mesh	1	10	Blower	1

Fig. 2. Cotton path from the boll to the cotton tank.

2. METHODS:

The main experiments were carried out to develop, manufacture and evaluate the performance of a pneumatic cotton picker machine.

2.1. Experimental conditions:

Preliminary experiments were carried out to determine the most affected parameters on the developed cotton harvesting machine. The performance of the pneumatic cotton picker was experimentally measured under the following parameters:

- Three different picking period times of (7 to 11 am), (12 to 4 pm) and (4 to 8 pm) with average cotton moisture contents of 16, 10 and 11% (w.b), respectively.
- Three different air suction speeds of 19, 32 and 50 m/s, correspond to the blower rotating speeds of 2000, 3500 and 5500 rpm.
- Three different suction hole diameters of 15, 20 and 25 mm.

2.2. Measurements and determinations:

Evaluation of the cotton pneumatic picker was performed taking into consideration the following indicators:

- **Moisture content:** The wet samples were put in a crucible with a cover and recorded the weight of the samples (wet weight) then, samples were dried at 105°C for constant weight. The dry weight was recorded by calculating the percent of moisture content by using the following equation, (Parsons *et al*. 2001).

$$Mc = (Mw-Md)/Mw \times 100 \quad \ldots\ldots\ldots\ldots \quad (1)$$

Where: Mc = Moisture content of grains, (%), (w.b).

Ww = Sample mass before drying, (g), Wd = Sample mass after drying, (g).

- **Actual field capacity:** was the actual average time consumed during picking operation (lost time + productive time). It can be determined from the following equation, (Keppner *et al*., 1982):

$$F.C_{act} = \frac{60}{Tu + Ti}, \quad fed/h \quad \ldots\ldots\ldots \quad (2)$$

Where:

$F.C_{act}$ = Actual field capacity of the pneumatic cotton picker.

Tu = Utilization time per feddan in minutes.

Ti = Summation of lost time per feddan in minutes.

- **Purity percentage:** During picking operation of cotton, foreign materials are separated from the cotton fibers and the purity of the picked cotton is measured using the following equation:

$$Pd = \frac{W1 - W2}{W1} \times 100 \quad \ldots\ldots\ldots\ldots \quad (3)$$

Where: W1 = Total cotton weight, (g),

W2 = Clean cotton weight, (g).

- **Labor power:** Manual labor could be determined as mechanical power equal to (0.075 to 0.10 hp) at continuous work, (Lijedahl *et al*., 1951).

$$\text{Labor power} = 0.1\times0.735 = 0.0735 \text{ kW} \ldots\ldots\ldots \quad (4)$$

- **Engine power:** The power required (P.R) was calculated according to the following formula, (Hunt, 1983).

$$Po = (F.c\times\frac{1}{60\times60})\times\rho_f\times LCV\times427\times\eta_{th}\times\eta_m\times\frac{1}{75}\times\frac{1}{1.36} \quad . (5)$$

Where:

Po = Power required, (kW). Fc = Fuel consumption, *l*/h.

ρ_f = Density of the fuel (0.75 kg/*l* for Otto fuel).

L.C =Lower calorific value of fuel (10000 kcal/kg for Otto fuel).

427 =Thermo-mechanical equivalent, kg.m/kcal.

η_{th} =Thermal efficiency of engine (22% for Otto engine).

η_m = Mechanical efficiency of engine (80% for Otto engine).

The required power depends on the value of the fuel consumed, which affecting on the speed of engine, blower and air suction. So, the required power whereas following:

Po_1 at rotating speed at 2000 rpm (19 m/s) = 1.07 kW.

Po_2 at rotating speed at 3500 rpm (32 m/s) = 0.68 kW.

Po_3 at rotating speed at 5500 rpm (50 m/s) = 0.27 kW.

- **Energy consumed:** The following formula was used to obtain the energy consumed:

$$Ec = \frac{Po}{FC.act} \ldots\ldots\ldots\ldots \ldots \quad (6)$$

Where: Ec = Energy consumed, (kW.day/fed),

Po= Required power, (kW).

Labor cost: The labor cost was estimated using the following equation:

$$\text{Number of Labors} = \frac{area/day}{FC/day} = \frac{1}{0.020} = 50 \text{ Labor.} \ldots\ldots \quad (7)$$

So, the labor cost for picking at one day was 125 L.E/day with total cost of (125×50 = 6250 L.E/fed).

- **Operational cost:** The operational cost was estimated using the following equation:

$$\text{Number of machines} = \frac{area/day}{FC/day} = \frac{1}{0.072} = 14 \text{ machine.} \ldots\ldots\ldots\ldots \quad (8)$$

$$Co = \frac{Mc}{FC.act} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

Where: Co = Operational cost, (L.E/fed),

Mc = Machine hourly cost, (L.E/h),

The machine hourly cost was determined using the following equation:

$$Mc = \frac{P}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r\right) + (1.2\ W.\ S.\ F) + \frac{m}{144} \quad \ldots\ldots \quad (10)$$

Where: Mc = Machine cost, (L.E. /h). P = Price of machine, (L.E). h= Yearly working hours, (h/year).

i = Interest, (rate/year). a= Life expectation of the machine, (h). t= Taxes, over heads ratio.

r = Repairs and maintenance ratio. W = Engine power, (HP). F = Fuel price, (L.E/*l*). S = Specific fuel consumption, (*l*/hp.h) m = Monthly worker wage, (L.E) 1.2 =Factor accounting for lubrications.

144: Reasonable estimation of monthly working hours.

3. RESULTS AND DISCUSSION

The main results obtained are summarized under the following points:

1. Effect of some operating parameters on field capacity:

Results in Figure. 3. show the effect of air suction speed on field capacity. Increasing speed from 19 to 50 m/s led to increase field capacity values from 0.024 to 0.040 fed/day, from 0.048 to 0.064 fed/day and from 0.056 to 0.072 fed/day at different suction hole diameters of 15, 20 and 25mm,

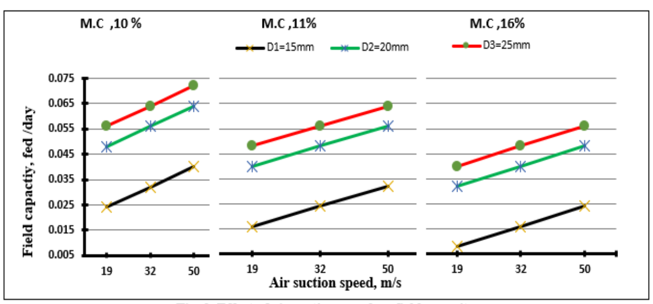


Fig. 3. Effect of air suction speed on field capacity.

respectively at cotton moisture of 10 % and from 0.008 to 0.024 fed/day, from 0.032 to 0.048 fed/day and from 0.040 to 0.056 fed/day at different suction hole diameters of 15, 20 and 25mm, respectively at cotton moisture of 16 %. These show that increasing air suction speed 19 to 50 m/s led to harvesting a large amount of cotton with a decrease in the time of harvesting. This result was due to increase field capacity.

Concerning to the effect of suction hole diameter on field capacity, results in Figure. 4. show the effect of suction hole diameter on field capacity. Increasing suction hole diameter from 15 to 25 mm led to increase field capacity values from 0.024 to 0.056 fed/day, from 0.032 to 0.064 fed/day and from 0.040 to 0.072 fed/day at different air suction speed of 19, 32 and 55 m/s, respectively at cotton moisture of 10 % and from 0.008 to 0.040 fed/day, from 0.016 to 0.048 fed/day and from 0.024 to 0.056 fed/day at different air suction speed of 19, 32 and 55 m/s, respectively at cotton moisture of 16 %. These results show that increasing suction hole diameter 15 to 25 mm led to harvest a large amount of cotton with a decrease in the time of harvesting. This result was due to increase field capacity.

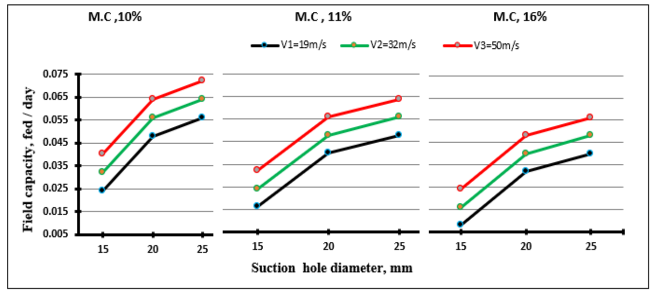


Fig.4. Effect of suction hole diameter on field capacity.

As to the effect of cotton moisture content on field capacity, results in Figure.5. show Increasing cotton moisture content from 10 to 16 % led to decrease field capacity values from 0.024 to 0.008 fed/day, from 0.032 to 0.016 fed/day and from 0.040 to 0.024 fed/day at different air suction speeds of 19, 32 and 55 m/s, respectively at suction hole diameter 15 mm and from 0.056 to 0.040 fed/day, from 0.064 to 0.048 fed/day and from 0.072 to 0.056 fed/day at different air suction speed of 19, 32 and 55 m/s, respectively at diameter suction hole 25 mm. These results show that increasing moisture content 10 to 16 % led to decrease field capacity. This result was due to increasing the strength of the cotton fibers adhesion to the boll. By comparing with manual picking the field capacity was about 0.020 fed/day.

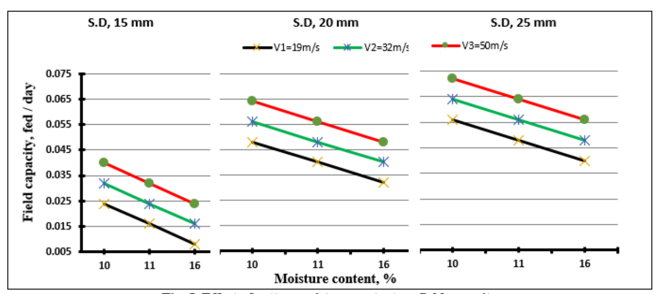


Fig. 5. Effect of cotton moisture content on field capacity.

2. Effect of some operating parameters on purity percentage:

Results in Figure.6. show the effect of air suction speed on purity percentage. Increasing air suction speed from 19 to 50 m/s led to decrease purity percentage values from 96.2 to 94.5 %, 96.8 to 95.2 % and 92.1 to 79.4 % at different suction hole diameters of 15, 20 and 25mm, respectively at cotton moisture of 10 %, and from 96.7 to 95 %, 97 to 96.5 % and 93 to 90 % at different suction hole diameters of 15, 20 and 25mm, respectively at cotton moisture of 16 %.

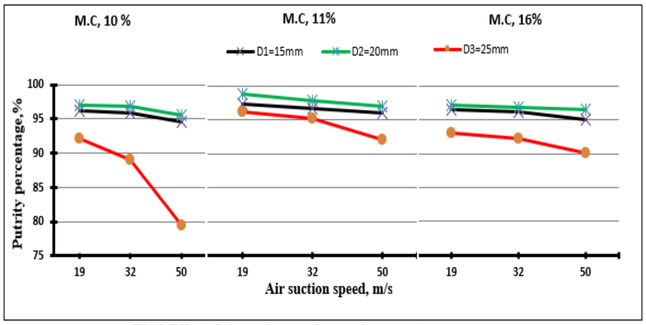


Fig.6. Effect of air suction speed on purity percentage.

Concerning to the effect of suction hole diameter on purity percentage, results in Figure. 7. show the effect of suction hole diameter on purity percentage While increasing suction hole diameter from 15 to 20 mm led to increase purity percentage values from 96.2 to 96.8 %, from 95.8 to 96.2 % and from 94.5 to 95.2 %. While increasing suction hole diameter from 20 to 25 mm led to decrease purity percentage values from 96.8 to 92.1 %, from 96.2 to 89 % and from 95.2 to 79.4 % at different air suction speed of 19, 32 and 55 m/s, at cotton moisture of 10 % respectively and increasing suction hole diameter from 15 to 20 mm led to increase purity percentage values from 96.7 to 97 %, from 96.2 to 96.8 % and from 95 to 96.5 %. While increasing suction hole diameter from 20 to 25 mm led to decrease purity percentage values from 97 to 93 %, from 96.8 to 82.2 % and from 96.5 to 90 % at different air suction speed of 19, 32 and 55 m/s, respectively at cotton moisture of 16 %. These results show that using suction hole diameter 15 to 20 mm led to increase the percentage of crust inclusions and dry leaves. While using suction hole diameter 20 to 25 mm led to decrease the percentage of crust inclusions and dry leaves diameter 20 was the best and appropriate.

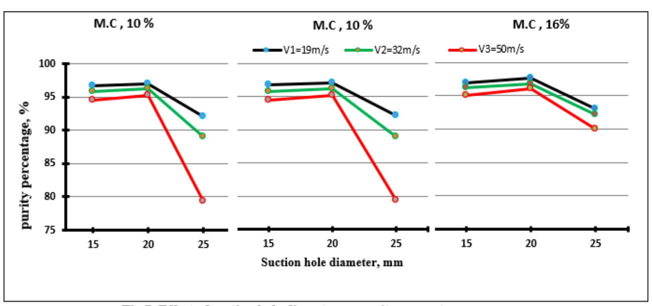


Fig.7. Effect of suction hole diameter on purity percentage.

Results in Figure.8. show the effect of moisture content on purity percentage. Increasing cotton moisture content from 10 to 11 % led to increase purity percentage values from 96.2 to 97.3 %, from 95.8 to 96.7 % and from 94.5 to 96 % while increasing cotton moisture content from 11 to 16 % led to decrease purity percentage values from 97.3 to 96.7 %, from 96.7 96.2 % and from 96 to 95 % at different air suction speeds of 19, 32 and 55 m/s, respectively at suction hole diameter 15 mm and increasing cotton moisture content from 10 to 11 % led to increase purity percentage values from 92.1 to 96.1 %, from 89 to 95.2 % and from 79.4 to 92 %, while increasing cotton moisture content from 11 to 16 % led to decrease purity percentage values from 96.1 to 93 %, from 95.2 to 92.2 % and from 92 to 90 % at different air suction speed of 19, 32 and 55 m/s, respectively at diameter suction hole 25 mm. These results show that increasing moisture content 10 to 11 % led to decrease the percentage of crust inclusions and dry leaves. This result was due to increasing purity degree while increasing moisture content 11 to 16 % led to increase the percentage of crust inclusions and dry leaves. Comparing with manual harvesting the purity percentage was 99%.

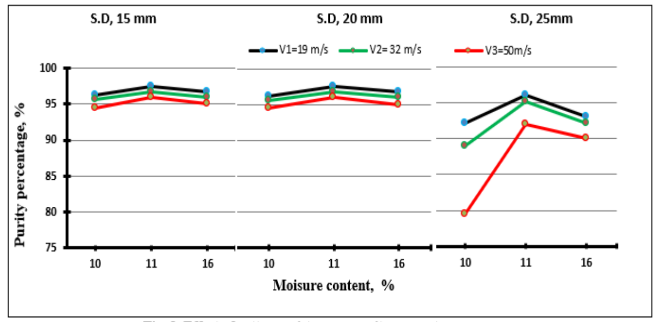


Fig. 8. Effect of cotton moisture on purity percentage.

3. Effect of some operating parameters on energy consumed:

Results in Figure.9. show the effect of air suction speed on energy consumed. Increasing speed from 19 to 50 m/s led to decrease energy consumed values from 47.5 to 11.5 kW.day/fed, from 23.8 to 7.2 kW.day/fed and from 20.4 to 6.4 kW.day/fed at different suction hole diameters of 15, 20 and 25mm, respectively at cotton moisture of 10 % and from 142.5 to 19.2 kW.day/fed, from 36.8 to 9.6 kW.day/fed and from 28.5 to 8.2 kW.day/fed at different suction hole diameters of 15, 20 and 25mm, respectively at cotton moisture of 16 %.

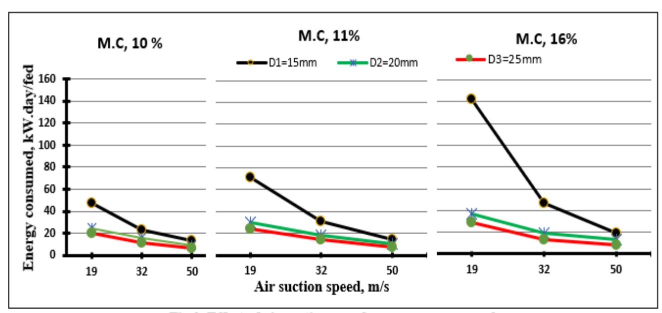


Fig.9. Effect of air suction speed on energy consumed.

These results show that increasing air suction speed 19 to 50 m/s led to increase fuel consumed. This result was due to decrease energy consumed.

Concerning to the effect of suction hole diameter on energy consumed, results in Figure.10. show the effect of suction hole diameter on energy consumed. Increasing suction hole diameter from 15 to 25 mm led to decrease energy consumed values from 47.5 to 20.4 kW.day/fed, from 23.4

to 11.7 kW.day/fed and from 11.5 to 6.4 kW.day/fed at different air suction speed of 19, 32 and 55 m/s, respectively at cotton moisture of 10 % and from 142.5 to 28.5 kW.day/fed, from 46.9 to 15.6 kW.day/fed and from 19.2 to 8.2 kW.day/fed at different air suction speed of 19, 32 and 55 m/s, respectively at cotton moisture of 16 %. These results show that increasing suction hole diameter 15 to 25 mm led to increase the power required. This result was due to increase energy consumed.

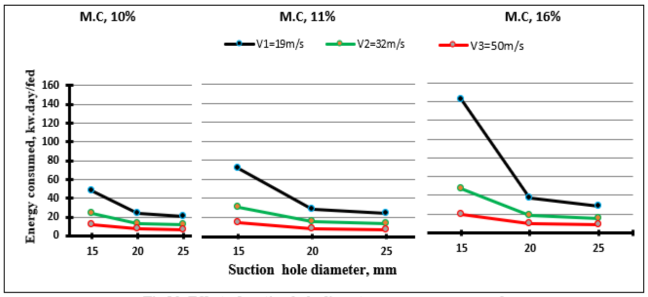


Fig.10. Effect of suction hole diameter on energy consumed.

As to the effect of moisture content on energy consumed, results in Figure.11. show the effect of moisture content on energy consumed. Increasing moisture content from 10 to 16 % led to increase energy consumed values from 47.5 to 142.5 kW.day/fed, from 23.4 to 46.9 kW.day/fed and from 11.5 to 19.2 kW.day/fed at different air suction speed of 19, 32 and 55 m/s, respectively at suction hole diameter 15 mm and from 20.4 to 28.5 kW.day/fed, from 11.7 to 15.6 kW.day/fed and from 6.4 to 8.2 kW.day/fed at different air suction speed of 19, 32 and 55 m/s, respectively at suction hole diameter 25 mm. These results show that increasing moisture content 10 to 16 % led to increase the power required. This result was due to decrease energy consumed.

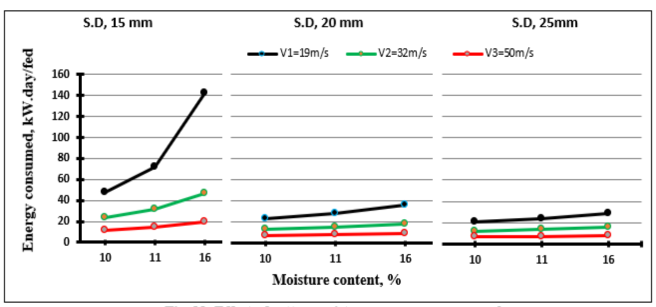


Fig. 11. Effect of cotton moisture on energy consumed.

4. Manually operational cost:

Manual field capacity for one day using one worker was 0.0025 fed/day×8=0.020 fed/day, so picking cotton for one feddan at one day required 50 labors according to actual field capacity according to equation number (7). While using the knapsack pneumatic cotton picker needs about 14 machines according to equation number (8).

5. Effect of some operating parameters on operational cost:

The mechanical operation cost using a knapsack pneumatic cotton picker was varied due to the change of machine field capacity, air suction speed, suction hole diameter and cotton moisture content as followings:

Results in Figure.12. show the effect of air suction speed on operational cost. Increasing speed from 19 to 50 m/s led to decrease operational cost values from 9324 to 5600 L.E/fed.day, from 4662 to 3500 L.E/fed.day and from 3990 to 3108 L.E/fed.day at different suction hole diameters of 15, 20 and 25mm, respectively at cotton moisture of 10 % and from 28000 to 9324 L.E/fed.day, from 7000 to 4662 L.E/fed.day and from 5600 to 3990 L.E/fed.day at different suction hole diameters of 15, 20 and 25mm, respectively at cotton moisture of 16 %. These results show that increasing air suction speed 19 to 50 m/s led to increase field capacity. This result was due to decrease operational cost.

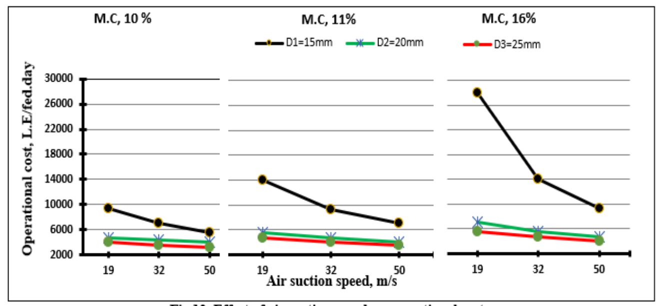


Fig.12. Effect of air suction speed on operational cost.

Concerning to the effect of suction hole diameter on operational cost, results in Figure.13. show the effect of suction hole diameter on operational cost. Increasing suction hole diameter from 15 to 25 mm led to decrease operational cost values from 9324 to 3990 L.E/fed.day, from 7000 to 3500 L.E/fed.day and from 5600 to 3108 L.E/fed.day at different air suction speed of 19, 32 and 55 m/s, respectively at cotton moisture of 10 % and from 28000 to 5600 L.E/fed.day, from 14000 to 4662 L.E/fed.day and from 9324 to 3990 L.E/fed.day at different air suction speed of 19, 32 and 55 m/s, respectively at cotton moisture of 16 %.

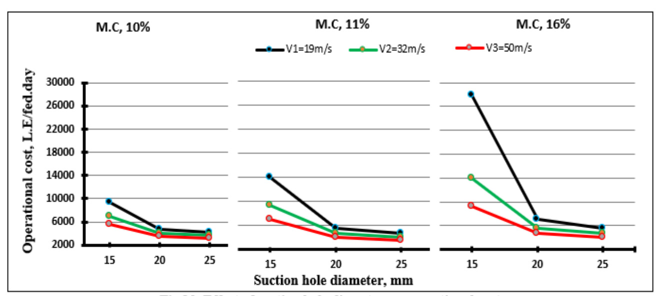


Fig.13. Effect of suction hole diameter on operational cost.

These results show that increasing suction hole diameter 15 to 25 mm led to increase the field capacity. This result was due to decrease operational cost.

As to the effect of moisture content on operational cost, results in Figure.14. show the effect of moisture content on operational cost. Increasing moisture content from 10 to 16 % led to increase operational cost values from 9324 to 28000 L.E/fed.day, from 7000 to 14000 L.E/fed.day and from 5600 to 9324 L.E/fed.day at different air suction speed of 19, 32 and 55 m/s, respectively at suction hole diameter 15 mm and from 3990 to 5600 L.E/fed.day, from 3500 to 4662 L.E/fed.day and from 3108 to 3990 L.E/fed.day at different air suction speed of 19, 32 and 55 m/s, respectively at suction hole diameter 25 mm. These results show that increasing moisture content 10 to 16 % led to decrease the field capacity. This result was due to increase operational cost. Comparing with manual picking was 6250 L.E/fed.day. In this study, it was clarified that the using a knapsack pneumatic cotton picker is better than using a manual picking in the number of workers and cost, as the cost of manual reaping was about 6250 L.E/day, while using a knapsack pneumatic cotton picker was about 3108 L.E/day.

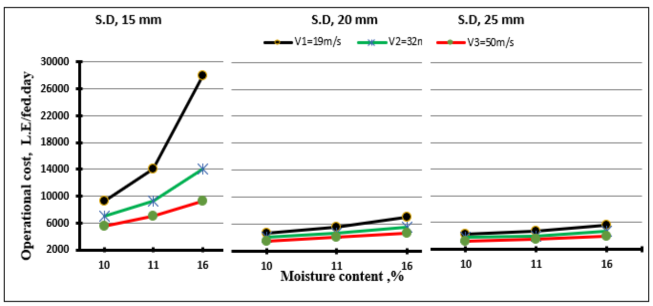


Fig.14. Effect of cotton moisture on operational cost.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

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REFERENCES

BURT, E. C., BAILEY, A. C., PATTERSON, R. M., & TAYLOR, J. H. 1979. Combined effects of dynamic load and travel reduction on tire performance. Transactions of the ASAE, 22(1), 40-0045.

DESHMUKH, Aniket S.; MOHANTY, Akash. 2016. Cotton mechanization in India and across globe: a review. Int J Adv Res Eng. Sci Technol, 3.1: 66.

EL-HAMID, Abd, et al. 2018. Modification of an air-carrier sprayer for cotton picking at small holdings area. Journal of Soil Sciences and Agricultural Engineering, 9.10: 513-517.

EL-YAMANI, A.; MAREY, S.; SAYED-AHMED, I. 2017. Influence of mechanical harvesting process on productivity and quality of cotton fiber. Journal of Soil Sciences and Agricultural Engineering, 8.6: 301-306.

FAULKNER, W. B., WANJURA, J. D., BOMAN, R. K., SHAW, B. W., & PARNELL, C. B. 2011. Evaluation of modern cotton harvest systems on irrigated cotton: Harvester performance. Applied Engineering in Agriculture, 27.4: 497-506.

GEDAM, Nikhil; MAHALLE, A. K. 2015. Design &Analysis of cotton-picking machine in view of cotton fiber strength. International Journal of Engineering Research and General Science, 3.3: 206-214.

HUNT, D. 1983. Farm power and machinery management 8 the Ed. Iowa state Univ., Ames, USA.

IBRAHIM, M. M.; ALSHEKA, M. A.; ABDESALAM, M. S. 2014. Small unite for Egyptian cotton harvester. Misr Journal of Agricultural Engineering, 31.4: 1317-1330.

KEPPNER, W., LEHNDORFF-JUNGES, B., & SCHATZ, G. 1982. Sensitive probing of surfaces by electric quadrupole interaction demonstrated for indium metal. Physical review letters, 49.23: 1735.

PARSONS, Tom; BLAKELY, Richard J.; BROCHER, Thomas M. 2001. A simple algorithm for sequentially incorporating gravity observations in seismic travel time tomography. International Geology Review, 43.12: 1073-1086.

RAVINDER, R.; MAJUMDAR, G. 2013. Evaluation of portable cotton picker. International Journal of Agriculture Innovations and Research, 2.1.

SELVAN, M. M, DURAIRAJ, C. D., RANGASAMY, K., & RAMANA, C. 2012. A pneumatic powered cotton picker for major Indian cultivars and compatibility to women operators. Agricultural Mechanization in Asia, Africa and Latin America, 43: 42-49.

SESSIZ, A. 2012. The effect of machine harvesting on the technological properties of cotton fiber in different cotton varieties. 27. National Agricultural Mechanization Congress, S, 154-159.

SESSIZ, A., & ESGICI, R. 2015. Effects of cotton picker ages on cotton losses and quality. Scientific Papers-Series A, Agronomy, 58.3: 417-20.

SHARMA, Ankit; AHUJA, S. S.; SETHI, V. P. 2011. Field evaluation of the developed experimental cotton picking aid: Part II. AMA-Agricultural Mechanization in Asia Africa and Latin America, 42.3: 14.

تصنيع وتقييم أداء آلة محمولة ظهرياً لجني محصول القطن

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يعتبر القطن من أهم محاصيل الألياف في العالم، وتعتبر مصر واحدة من ضمن 4 دول فقط على مستوى العالم التي تنتج القطن فائق الطول من حيث كمية الإنتاج بعد الهند والصين وباكستان خلال عام (2022/2021). وطبقاً للهيئة العامة للتحكيم واختبارات القطن فقد زادت المساحة المنزرعة في الموسم (2022/2021) بنسبة 30 ٪ عن الموسم السابق له، حيث بلغت المساحة في هذا الموسم 96000 فدان ومتوقع أن تزيد إنتاجية المساحة في هذا الموسم بنسبة 34 ٪ عن الموسم السابق له. المشكلة الرئيسية لجني القطن المصري آلياً تكمن في الخصائص الفسيولوجية له فيما يتعلق بارتفاع النبات وكثافة التفريع، وكذلك ظروف الزراعة المصرية من حيث الحيازات الزراعية الصغيرة والمتفرقة والمسافة الضيقة بين النباتات غير مهيأة لمرور الآلات. بالإضافة إلى ذلك ارتفاع تكاليف تشغيل هذه الآلات. وعلى الرغم من هذه المشاكل فإن الزيادة الأخيرة في مساحة القطن المصري المزروع وجهت الانتباه نحو تطبيق حصاد القطن آلياً. تهدف الدراسة إلى تصنيع وتقييم أداء آلة لجني القطن تعمل بالهواء محمولة ظهرياً لتلائم الظروف المصرية، وقد تم أخذ المعايير التالية في الاعتبار: تصنيع آلة جني محصول القطن محمولة ظهرياً بخامات محلية، تحديد أنسب عوامل التشغيل التي تؤثر على أداء آلة الجني وكذا تقييم الآلة اقتصادياً.

المكونات الرئيسية لآلة جني القطن المحمولة ظهرياً المصنعة محلياً

1. خزان القطن: مصنوعة من البلاستيك (PVC) بسعة (7 لتر) مزود بغطاء محكم لمنع تسرب الهواء إلى الخزان. يتم وضع شبكة سلكية بداخله لمنع مرور القطن المحصود إلى مروحة الشفط.
2. المحرك: بقوة 1 حصان (0.74 كيلووات)، الوقود المستخدم فيه خليط من البنزين و4٪ زيت وذو تبريد هوائي.
3. خزان الوقود: تبلغ سعته 1.5 لتر، ينساب الوقود من خزان الوقود إلى المحرك بواسطة الجاذبية الأرضية خلال أنبوبة بلاستيكية بقطر 4 مم وطول 0.5 مم.
4. مروحة الشفط: من نوع الطاردة المركزية ذات غلاف و6 شفرات مثبتة على عمود المحرك.
5. أنبوبة الشفط: تصنع من بلاستك (PVC) بطول 150 سم وبقطر 60 مم، وتنتهي بفوهة شفط ذات أقطار متغيرة هي: 15، 20 و25 مم.

أجريت التجارب الأولية بقسم هندسة النظم الزراعية والحيوية بكلية الزراعة - جامعة دمياط، والتجارب الحقلية في أرض زراعية بقرية كوم النور - مركز ميت غمر - محافظة الدقهلية بجمهورية مصر العربية، وتم تحديد بعض العوامل التشغيل التي من خلالها يتم تقييم أداء هذه الآلة. وقد تحددت أهداف الدراسة فيما يلي:

1- تصنيع وتطوير آلة محلية الصنع لتناسب جني محصول القطن.

2- تحديد أنسب عوامل التشغيل التي تؤثر على أداء آلة جني القطن المحمولة ظهرياً.

3- تقييم أداء آلة جني القطن المصنعة محلياً من الناحية الاقتصادية.

تم تقييم أداء آلة جني القطن المحلية الصنع بأخذ عوامل التشغيل التالية:

- ثلاث فترات للجني هي: (7-11 صباحاً)، (12-4 مساءًا) و (4-8 مساءًا) بمتوسط محتوى رطوبي للقطن (16، 10 و11٪) على أساس رطب، على الترتيب.
- ثلاث سرعات للهواء عند فتحة الشفط هي: (19، 32 و50 م/ث) تقابلها ثلاث سرعات لمروحة الشفط هي: (2000 ، 3500 و5500 لفة/د).
- ثلاثة أقطار مختلفة لفتحة الشفط هي: (15، 20 و 25 مم).

تم تقييم أداء آلة جني القطن الهوائية والمصنعة محلياً من خلال القياسات التالية :درجة النقاوة، السعة الحقلية، القدرة المطلوبة، الطاقة المستهلكة وتكاليف التشغيل.

أظهرت النتائج التجريبية أن أعلى قيمة للسعة الحقلية للآلة كانت 0.072 ف/يوم والقيم المقبولة لدرجة النقاء 79.4٪، بينما كانت أقل قيمة للطاقة المستهلكة 6.4 كيلووات.يوم/ف وتكاليف التشغيل للآلة 3108 جنيه/ف يوم جميعها عند سرعة شفط للهواء 50 م/ث، قطر فتحة الشفط 25مم ومحتوى رطوبي للقطن 10٪.

وبالتالي توصي هذه الدراسة باستخدام آلة جني القطن المحمولة ظهرياً حيث بلغت تكاليف جني القطن بها 3108 جنيه/ف. يوم باستخدام 14 آلة، مقارنةً بالجني اليدوي التقليدي الذي بلغت تكلفته حوالي 6250 جنيه/ف.يوم باستخدام 50 عامل، مما أدى إلى توفير أكثر من نصف تكلفة الجني.

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