Current Journal of Applied Science and Technology

38(6): 1-15, 2019; Article no.CJAST.53549
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Performance Evaluation of Tractor Operated Groundnut Thresher

M. D. Amrutiya[1], J. M. Makavana[2*], A. R. Kachhot[1], P. M. Chauhan[2] and V. K. Tiwari[1]

[1]Department of Farm Machinery and Power Engineering, College Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh - 362001, Gujarat, India.
[2]Department of Renewable Energy Engineering, College Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh - 362001, Gujarat, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author MDA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JMM and PMC managed the analyses of the study. Authors ARK and VKT managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2019/v38i630457
Editor(s):
(1) Dr. Umar Nirmal, Senior Lecturer, Centre of Advanced Mechanical and Green Technology, Faculty of Engineering and Technology, Multimedia University, Malaysia.
(2) Dr. Ogunlade, Clement Adesoji, Lecturer, Department of Agricultural Engineering, Faculty of Engineering, Adeleke University, Ede, Osun State, Nigeria.
(3) Dr. Grzegorz Golanski, Professor, Institute of Materials Engineering, Czestochowa University of Technology, Poland.
Reviewers:
(1) Sunil Kumar, Banda University of Agriculture and Technology, India.
(2) Zakaria Fouad Fawzy Hassan, National Research Centre, Egypt.
Complete Peer review History: http://www.sdiarticle4.com/review-history/53549

Original Research Article

Received 10 November 2019
Accepted 16 January 2020
Published 18 January 2020

ABSTRACT

The production of groundnut in India is being rapidly increased in the last ten years and is expected to increase further in coming decade. Farmer mostly used traditional cultivation practices for production of groundnut, which are labour and time intensive. Therefore, time saving machineries suited to labours should be used by growers to handle harvest and post-harvest operations for this crop. The performance evaluation of the thresher for groundnut crop was conducted with 50 hp tractor. The experiment was carried out at the Cotton Research Centre and Instructional Farm of College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh for kharif groundnut for Virginia Bunch type varieties of GG-20 and GG-22, respectively. The pod output

**Corresponding author: E-mail: makavanajagu@gmail.com;*

capacity was observed as 524.66 kg/h (cylinder speed ~ 292 rpm) and 407.60 kg/h (cylinder speed ~ 421 rpm) for GG-22 and GG-20 varieties, respectively. The percentage of blown pods, un threshed pods, broken pods and spilled pods were observed as 14.51, 18.92, 0.126, 1.04% and 6.07, 14.59, 0.361, 0.99% for GG-22 and GG-20 varieties, respectively. The average threshing and cleaning efficiency were found as 81.08, 88.21 and 85.41, 88.74% for GG-22 and GG-20 varieties, respectively. The overall average cost of threshing operation was observed Rs.729.42 per hour and Rs.156 per quintal for both the varieties.

Keywords: Tractor; thresher; performance; evaluation; threshing efficiency; cleaning efficiency; groundnut.

1. INTRODUCTION

The peanut, also known as the groundnut and taxonomically classified as *Arachis hypogaea*, is a legume crop grown mainly for its edible seeds, and they are high in protein, oil and fiber. This plant is native to South America [1,2]. The botanical name of groundnut, *Arachis hypogaea*, is derived from two Greek words, Arachis meaning a legume and hypogaea meaning below ground, referring to the formation of pods in the soil. Peanut or groundnut is a self-pollinating, indeterminate, annual herbaceous legume crop [3]. It is also known as earth nut, peanut or monkey-nut [4,5,6]. It is commonly called the poor man's nut [7,8]. Peanut mostly grown due to its oil, protein and carbohydrates [3]. The oil of peanut is one of the most important vegetable oil regions where other oily vegetables cannot grow up [9]. Peanut has several uses as whole seeds or is processed to make peanut butter, oil, and other products [10]. Peanut is one of the most important oilseed plants in the world [11-15]. Its seeds contain 40 - 50% fat, 20 - 50% protein and 10 - 20% carbohydrate depending on the variety [16]. Groundnut is grown on nearly 24.73 million hectares in world with annual production of 403.70 lakh tons of nuts-in-shells and the productivity is 1630 kg/ha. It is grown on large scale in India, China, USA, Senegal, Indonesia, Nigeria, Brazil and Argentina [17-20]. The total area under groundnut cultivation in India is 4.56 million hectares, which accounts for the total production of 67.71 lakh tons with the productivity of 1486 kg/ha [21]. Country wise groundnut production for the year 2015- 2016 is shown in Table 1.

More than 150 varieties of groundnut have been released by AICRP for different agro-ecological situations of India, however only a few age old varieties like TMV-2, TMV-7, GG-11, Chitra Kaushal, SV-xi, JL-24 and AK-12-24, K-6, CO-2, Polachi-1, GAUG-10, and new varieties like TG37-A, GBPD-4, Narayani, ICGV-91114, TPG-41, TG-38, VRI-6 are popular among the farmers for large scale cultivation [22-26].

The spreading, semi spreading and bunch types groundnut varieties are grown in Gujarat.

Table 1. Area, production and yield of groundnut major countries

Sr. No.	Country	Area (Lakh ha)		Production (Lakh tons)		Yield (Kg/ha)	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
1	China	46.00	46.00	164.80	165.00	3580	3590
2	India	47.69	45.55	74.02	67.71	1552	1486
3	Nigeria	27.70	25.00	34.10	30.00	1230	1200
4	USA	5.40	6.30	23.50	27.20	4400	4310
5	Sudan	12.50	21.80	9.60	18.70	770	860
6	Myanmar	8.90	8.90	13.80	13.80	1550	1550
7	Indonesia	6.30	6.20	11.50	11.30	1830	1840
8	Senegal	8.80	11.40	6.70	10.70	760	940
9	Niger	7.80	7.40	4.00	3.50	520	470
10	Cameroon	4.70	4.00	6.40	5.50	1360	1380
Others		64.71	64.75	49.98	50.29	772	777
World		240.50	247.30	398.40	403.70	1660	1630

(Status paper on groundnut, 2017)

Table 2. State wise area, production and yield of groundnut

Sr. No.	States	Area (Lakh ha)			Production (Lakh tons)			Yield (Kg/ha)		
		2013-14	2014-15	2015-16	2013-14	2014-15	2015-16	2013-14	2014-15	2015-16
1	Gujarat	18.40	14.00	14.14	49.20	22.20	23.58	2668	1586	1668
2	AP	13.90	10.30	7.75	12.40	7.90	8.02	892	771	1035
3	Rajasthan	4.60	5.00	5.21	9.00	10.20	10.56	1992	2024	2028
4	Tamil Nadu	3.40	3.40	3.52	9.20	9.00	8.82	2723	2699	2509
5	Karnataka	6.60	6.50	5.91	5.70	5.60	4.85	863	870	821
6	MP	2.10	2.30	2.36	3.20	3.70	3.50	1573	1602	1483
7	Maharashtra	3.20	2.40	2.40	3.90	2.50	2.37	1248	1063	988
8	Telangana	-	-	1.27	-	-	2.06	-	-	1622
9	West Bengal	0.78	0.79	0.84	2.02	2.00	2.00	2573	2544	2372
Others		2.12	2.11	2.15	2.48	2.50	1.95	1308	1639	907
All India		55.10	46.80	45.55	97.10	65.60	67.71	1764	1400	1486

(Status paper on groundnut, 2016)

Table 3. District wise groundnut production in Gujarat State (2015-16)

Sr. no.	District	Area ('00ha)	Production ('000tonnes)	Yield (kg/ha)
1	Rajkot	2731	273	1680
2	Junagadh	2538	253	2052
3	Dwarka	1763	176	1627
4	Amreli	1419	142	2200
5	Jamnagar	1316	132	1856
6	Gir-somnath	1196	120	2413
7	Banaskantha	1166	117	1898
8	Bhavnagar	1093	109	1758
9	Kutch	447	45	2234

(SEA Kharif Groundnut Crop Survey 2015-16)

The spreading varieties like GAUG-10, GG-11, GG-13 etc. and GG-20 is semi-spreading while bunch type varieties of groundnut like JL-24, GG-2, GG-4, GG-7 etc. have been recommended and adopted by the farmers for cultivation in Saurashtra region. The groundnut is sown at the row spacing of 45 cm and 60 cm for bunch type and spreading type, respectivel.

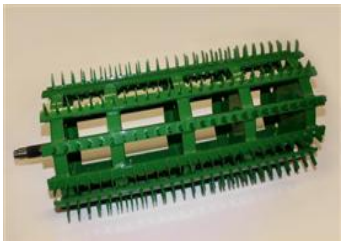

Fig. 1. Spike tooth type threshing cylinder

2. MATERIALS AND METHODS

A Groundnut Thresher which is Spike tooth type threshing cylinder type was taken for the study. In fact it is a modification of the drummy type. It is provided with an aspirator blower at the main grain outlet for final cleaning. Sieve assembly is also provided beneath the concave, driven by a crankshaft pulley, which gets its power from the cylinder shaft [27-29]. The working principle of a Spike tooth type threshing cylinder drum.

Fig. 2. Groundnut thresher

Table 4. Specification of groundnut thresher

A. General

1	Name	Groundnut thresher (square, box type tractor operated)
2	Make	Geeta works
3	Model	B
4	Type	Tangential flow
5	Year of manufacture	2015

B. Power unit

2	Type of prime mover	Tractor operated
3	Recommended power	35hp and above
4	Type of drive	PTO

C. Main drive

1	Type	Belt pulley
2	Size of belt, mm	2580
3	Diameter of pulley, mm	203

D. Threshing system

1. Cylinder

1	Type	Beater
2	Constructional feature	It is fabricated from circular CI flanges locked on the cylinder shaft at spacing. MS flat beater (perpendicular to the axis of cylinder) are welded on MS angle (3 nos.) fitted parallel to the axis of cylinder of which are bolted to each flanges with nut bolts.
3	Diameter, mm	540
4	Width, mm	825
5	No.& type of bearings	2 pillow block bearing
6	No. & size of beaters/projections/bars	7 (4+3 fitted perpendicular to each other, on each MS angle (3 nos.), blade edge)
7	Spacing between beaters, mm	230
8	No. of flanges	2

2. Concave

1	Type	Semi-circular, open
2	Effective width, mm	650
3	Effective length, mm	830
4	Effective area, m^2	0.5395
4	Concave clearance range, mm	15-30
5	Concave clearance, mm	20
6	Method of clearance adjustment	By raising and lowering the concave
7	Constructional feature	It is fabricated from longitudinal MS flats at spacing and semi-circular MS rods are inserted with MS pipes spacer across the longitudinal flats to maintain spacing
8	Concavity, mm	265
9	Nos. and spacing of cross bars, mm	4, 245
8	Method of fixing	It is mounted on two curved angle iron of size bolted by 2 nut bolts

E. Sieve

Sr. No.	Parameters	Upper sieve	Lower sieve
1	Type	Punched elliptical holes	Punched elliptical holes
2	Material and size	GI sheet, 0.79 mm	GI sheet, 0.79 mm
3	Size of holes, mm	32.09x2.07(F), 49.17x19.19(R)	56.43x7.77(F), 113.32x8.64(M), 49.38x19.14(R)
4	Density of holes in 100 cm^2	36(F), 3(R)	5(F), 5(M), 3(R)
5	Size of sieve, mm	1445x760	1510x750
6	Effective size, mm	685x150(F), 710x420(R)	695x525(F), 695x225(M), 695x560(R)
7	Effective area, cm^2	1027 (F), 2982(R)	3478(F), 1563(M), 3892(R)
8	Sieve slope, degree	5	10

F. Shaking Mechanism

1	**Pitman shaft**	
	Material	MS rod
	Size , mm	655x38.0 ϕ
	No and types of bearings on pitman shaft	2
	Provision for lubrication	One grease nipple is provided on each bearing cover.

2	**Hangers**	
	Numbers	4
	Length of angles, mm	
	Total	200(F), 240(R)
	Center to center	145(F), 190(R)
	Stroke length, mm	55
	Nos. and type of bearing on each hanger	2, Ball bearing

G. Blower

1	Number	1
2	Type	Suction type
3	No. of blade	4
4	Size of blade, mm	730 x 175 x 0.80
5	Diameter, mm	700
6	Provision for changing air displacement	Suction windows are provided
7	Nos. , location and size of window, mm	2, LHS-RHS, 400 ϕ
8	Nos. and type of bearings	2, Pillow block bearing

H. Crop feeding

1	Type	Hopper
2	Method of feeding	Manual
3	Size of feeding hopper, mm	815 x 325
4	Height of hopper form platform, mm	870
5	Height of feeding hopper from ground level, mm	2300

I. Transport

1	Type	Tractor mounted

J. Overall Dimensions

1	Length, mm	2770
2	Width, mm	1360
3	Height, mm	2120
4	Ground clearance, mm	430
5	Total mass, kg	1160

K. Main pod/ grain outlet

1	Size, mm	225×100
2	Inclination, degree	5
3	Height of outlet from ground level, mm	535

L. Foreign material outlet

1. For stones/soil clods

1	Size, mm	205x115
2	Inclination, degree	5
3	Height of outlet from ground level, mm	515

2. For soil powder

1	Size, mm	100x40
2	Inclination, degree	Vertical
3	Height of outlet from ground level, mm	825

3. Sieve overflow outlet

1	Size, mm	250x35
2	Inclination, degree	5
3	Height of outlet from ground level, mm	535

4. Straw outlet

1	Size, mm	845x390
2	Inclination, degree	40-75
3	Height of outlet from ground level, mm	985

3. RESULTS AND DISCUSSION

Experimental data collected during the course investigation. It is also including the evaluation of the various crop parameters like moisture content of pods and vine, pod-vine ratio. It also includes various performance parameter like crop feed rate, pod output capacity, percentage of blown pods [30,31], percentage of un threshed pods, percentage of broken pods, percentage of spilled pods, threshing efficiency and cleaning efficiency.

3.1 Field Testing and Evaluation

Performance of groundnut thresher was evaluated at Cotton research Centre and Instructional Farm of College of Agricultural Engineering & Technology, JAU, Junagadh for the varieties of GG-22 and GG-20, respectively.

3.2 Crop Parameters

The crop parameters such as crop variety and pod-vine ratio were determined during the study.

3.2.1 Type of crop and variety

The experiment was conducted on groundnut of GG-22 and GG-20 varieties. Both are Virginia Bunch type groundnut which are semi-spreading type.

3.2.2 Pod-vine ratio

Pod-vine ratio was determined by taking crop samples. The pods and plant matters (vine) were separated and it was observed as 0.3354 and 0.5836 for varieties GG-22 and GG-20 respectively.

3.3 Field Observations

Field observations such as moisture content, crop feed rate, fuel consumption and labour requirement were determined during the study.

3.3.1 Crop moisture content

The moisture content of pods and vine were measured by the oven drying method as shown in Appendix-III. It was found that moisture contents of pods are 11.73% (d.b.) and 6.81% (d.b.) for varieties GG-22 and GG-20, respectively. The moisture contents of vine are 11.53% (d.b.) and 12.92% (d.b.) for GG-22 and GG-20 varieties respectively.

3.3.2 Crop feed rate

Crop feed rate was measured as per standard method. Test results indicated that at threshing cylinder speed of 292 rpm and 421 rpm, the crop feed rate was varied from 2033.89 to 2117.65 and 1282.05 to 1333.33 for GG-22 and GG-20 varieties, respectively.

3.3.3 Fuel consumption

The hourly fuel consumption in case of threshing was 2.46 lit/hr and 2.14 lit/hr for the varieties GG-22 and GG-20, respectively. Both tests were carried out by 50hp tractor.

3.3.4 Labour requirement

Six labours were required during the threshing of groundnut crop. One labour was required for feeding of crop, one labour was required for straw handling, one labour was required for pod handling and others were required for crop handling.

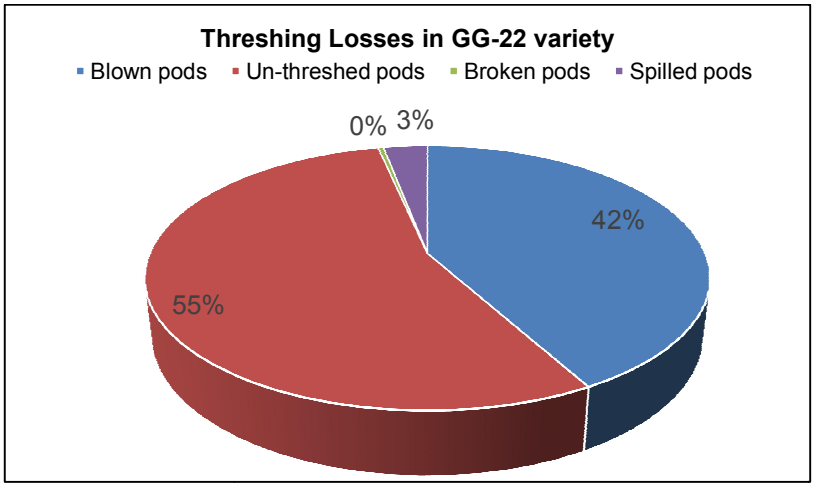

Fig. 3. Various losses during threshing operation for GG-22 variety

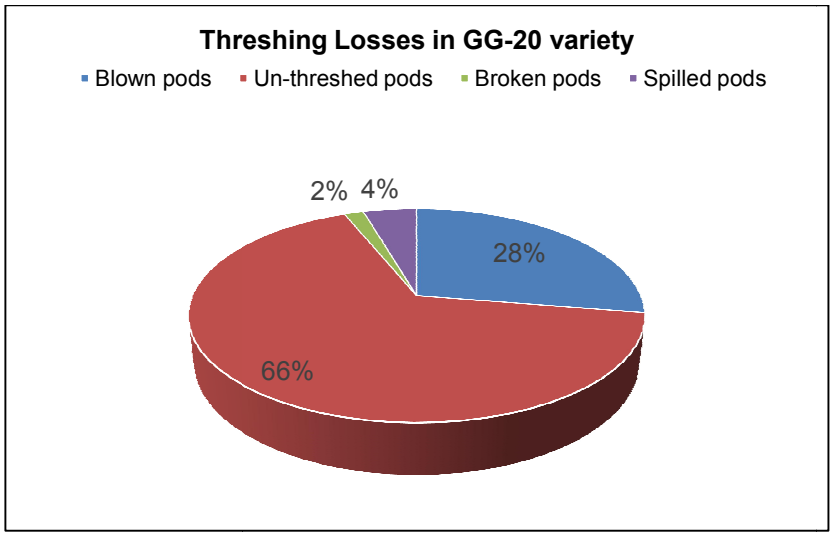

Fig. 4. Various losses during threshing operation for GG-20 variety

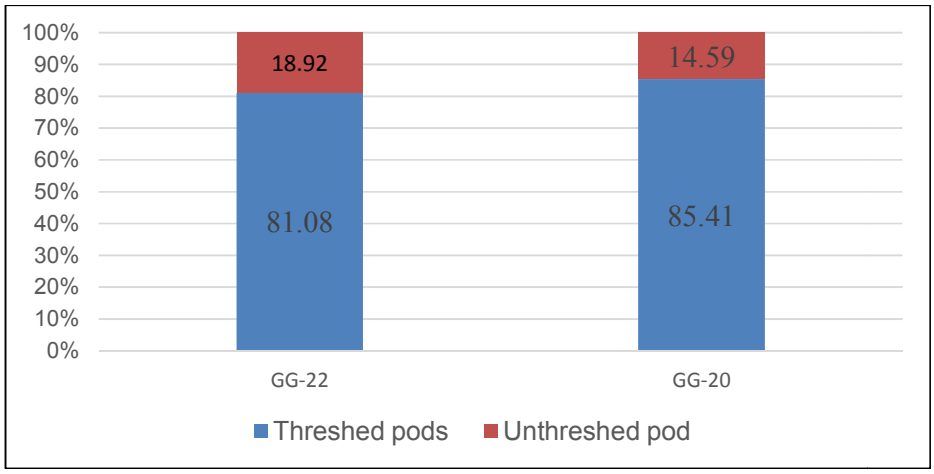

Fig. 5. Percentage of threshed and unthreshed pods for GG-22 and GG-20 varieties

Table 5. Determination of threshing parameters

Avg. crop feed rate kg/ha		Avg. pod utput capacity		Percentage of blown pods		Percentage of un threshed pods		Percentage of broken pods		Percentage of spilled pods		Threshing efficiency		Cleaning efficiency	
GG-20	GG-22	GG-20	GG-22	GG-20	GG-22	GG-20	GG-22	GG-20	GG-22	GG-20	GG-22	GG-20	GG-22	GG-20	GG-22
1304.36	21115.55	407.60	524.66	6.07	14.51	14.59	18.92	0.361	0.126	0.99	1.04	85.41	81.08	88.74	88.21

Assumptions:

Particulars	Thresher	Tractor
Machine life	8 years	10 years
Salvage value	10 % of initial cost	10 % of initial cost
Annual use	300 hours	1000 hours
Interest rate	10 %	10 %
Housing cost	1.5 % of initial cost	1.5 % of initial cost
Insurance cost	2.0 % of initial cost	2.0 % of initial cost
Repair & maintenance	5.0 % of initial cost	5.0 % of initial cost
Fuel cost	-	64 Rs. / lit
Labour cost	300 Rs. Per day of 8 hr.	-

Table 6. Threshing efficiency for GG-22 and GG-20 varieties

Sr. no.	For variety GG-22, %	For variety GG-20, %
1	81.56	86.48
2	79.30	83.61
3	82.38	86.13
Av.	81.08	85.41

Table 7. Cleaning efficiency for GG-22 and GG-20 varieties

Sr. no.	For variety GG-22, %	For variety GG-20, %
1	87.95	89.35
2	85.89	88.39
3	90.80	88.47
Av.	88.21	88.74

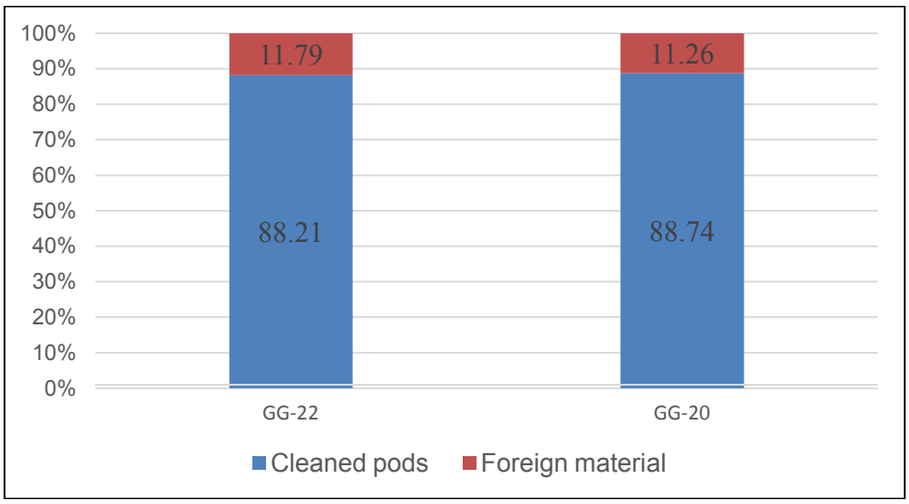

Fig. 6. Percentage of cleaned pods and foreign material for GG-22 and GG-20 varieties

3.4 Determination of Threshing Parameters

The threshing parameters such as crop feed rate, pod output capacity, percentage of blown pods, percentage of un threshed pods, percentage of broken pods, percentage of spilled pods, threshing efficiency and cleaning efficiency were determined during the study.

3.4.1 Threshing efficiency

Threshing efficiency was varied from 79.3% to 82.38% with an average value of 81.08% for the variety GG-22. It was varied from 83.61% to 86.48% with an average value of 85.41% for the variety GG- 20. Thus higher threshing efficiency was observed in GG-20 (85.41%) as compared to GG-22 (81.08%).

3.4.2 Cleaning efficiency

Cleaning efficiency varied from 85.89% to 90.80% with an average value of 88.19% for the variety GG-22. It was varied from 88.39% to 89.35 % with an average value of 88.74% for the variety GG-20. It was observed that due to sufficient drying of the crop the groundnut was separated easily and efficiently from the foreign materials (stone, soil and plant stem). Thus higher cleaning efficiency was obtained for both the varieties.

3.5 Cost of Operation

Cost of groundnut threshing was calculated in terms of fixed cost and Operating costs:

3.5.1 Cost calculation for thresher

Sr. No.	Particulars	Value	
		Thresher	Tractor
1.	**Fixed cost**		
a.	Depreciation, Rs/hr	57.75	67.50
b.	Interest, Rs/hr	28.23	41.25
c.	Housing, Rs/hr	7.70	11.25
d.	Insuarance and taxes, Rs/hr	10.27	15
	Total fixed cost, Rs/hr	103.95	135
2.	**Variable cost**		
a.	Fuel cost, Rs/hr	-	160
b.	Oil cost, Rs/hr	-	4.8
c.	Repair and maintenance cost, Rs./hr	25.67	37.5
d.	Wages, Rs/hr	225	37.5
	Total variable cost, Rs/hr	250.67	239.8
3	Total (Fixed + variable) cost, Rs/hr	354.62	374.8
4	Total threshing cost, Rs/hr	729.42	
5	Average cost of groundnut threshing, Rs/kg	1.56	

4. CONCLUSION

The average pod-vine ratio for groundnut variety GG-22 was observed as 0.3353 having moisture content of pods and vine as 11.73 and 11.53% (d.b.) respectively. The average pod-vine ratio for groundnut variety GG-20 was observed as 0.5836 having moisture content of pods and vine as 6.81 and 12.92% (d.b.) respectively. The crop feed rate for groundnut variety GG-22 was varied from 2033.89 kg/h to 2117.65 kg/h with an average value of 2115.55 kg/h at a threshing cylinder speed of 292 rpm. The crop feed rate for groundnut variety GG-20 was varied from 1282.05 kg/h to 1298.70 kg/h with an average value of 1304.69 kg/h at a threshing cylinder speed of 421 rpm. The average pod output capacity for groundnut variety GG-22 was observed as 524.66 kg/h and it was varied from 518.63 kg/h to 531.97 kg/h. The average pods output capacity for groundnut variety GG-20 was observed as 407.60 kg/h and it was varied from 375.41 kg/h to 454.79 kg/h. The average percentage of blown pods, un threshed pods, broken pods and spilled pods were observed as 14.51, 18.92, 0.126, 1.04% and 6.07, 14.59, 0.361, 0.99% for GG-22 and GG-20 varieties, respectively.

ACKNOWLEDGEMENT

The groundnut thresher was tested at Cotton Research Centre and Instructional Farm of College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh for groundnut varieties GG-20 and GG-22, respectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Akcali ID, Guven Onur. Physical properties of peanut in Turkey. AMA. 1990;21(3):55-60.
2. Bidir UB, Kilgour J. Groundnut harvesting machine for Northern Nigeria, AMA. 1994; 25(1):33-36.
3. Burns N, Grove SK. Understanding nursing research-eBook: Building an evidence-based practice. Elsevier Health Sciences; 2010.
4. Manes GS, Sharma R, Khurana R. Adoption status of safety measures on threshers. Journal of Research, 2006;43(1):134-137.
5. Nobahar Amin, Hamid Reza Zakerin, Marefat Mostafavi Rad, Saeed Sayfzadeh, and Ali Reza Valadabady. "Response of yield and some physiological traits of groundnut (*Arachis hypogaea* L.) to topping height and application methods of Zn and Ca nano-chelates." Communications in Soil Science and Plant Analysis. 2019;50(6):749-762.
6. Padmanathan PK, Kathirvel K, Duraisamy VM, Maian V, Influence of crop, machine and operational parameters on picking and conveying efficiency of an experimental groundnut combine. Journal of Applied Sciences Research. 2007;8(3):700-705.
7. Chen CC, Chon TH, Lu LH. Threshing performance of an impact type groundnut thresher. Journal of Agriculture Research of China. 1989;38(1):140-155.
8. Dafalla MA, Dawelbeit MI, Abouda SEK, Effect of some machine and crop factors on mechanical groundnut threshing. AMA. 1992;23(3):43-46.
9. Gashti Alireza Hosseinzadeh, Mohammad Naghi Safarzadeh Vishekaei, Mohammad Hadi Hosseinzadeh. Effect of potassium and calcium application on yield, yield components and qualitative characteristics of peanut (*Arachis hypogaea* L.) in Guilan Province, Iran." World Applied Sci. J. 2012; 16(4):40-546.
10. Padmanathan PK, Kathirvel K, Manian R, Duraisam VM, Design, development and evaluation of tractor operated groundnut combine harvester. Journal of Applied Sciences Research. 2006;2(12): 1338-1341.
11. Available:http://www.wikipedia.com
12. Hwang Y, Development of peanut combine harvester. AMA. 1983;14(2):11-16.
13. Indian Standard Test Guide for estimating cost of farm machinery operation, Indian Standard Institution (BIS), Manak Bhavan, New Delhi. IS: 9164; 2013.
14. Indian Standard Test Code for power thresher for groundnut, Indian Standard Institution (BIS), Manak Bhavan, New Delhi. IS: 11334; 2013.
15. Magar AP, Bhutada SH, Suryawanshi SL, Bombale VT. Performance evaluation of square beater bar type threshing drum on groundnut threshing. International Journal of Agricultural Engineering. 2010;2(2):293-298.
16. Omran MA, Omer MEE, Hassan IM, Modification and performance of multi-crop thresher, Journal of Science and Technology. 2005;6(2): 1-19.
17. Ghatge JS, Bandgar PS, Mehetre SA, Development and performance evaluation of pedal operated pod stripping machine. International Journal of Agricultural Engineering. 2014;7(1):217-220.
18. Goel AK, Nanda SK. Comparative performance of different methods of groundnut threshing. AMA, 1994;25(1):37-41.
19. Gole SV, Shahu R. Ergonomically designed thresher. AMA. 2009;40(2):73-75.
20. Govindraj G, Mishra AP. Labour demand and labour saving options: A case of groundnut crop in India. Agricultural Economics Research Review. 2011;24:423-428.
21. Available:http://eands.dacnet.nic.in/latest_2016.htm
22. Paramsivam P, Effect of cylinder speed and performance of axial flow thresher. Current Research University of Agriculture Science. 1997;26(10):177-179.
23. Rajasekar M, Arunkumar S, Divakar S, Santosh kuamr R, Design fabrication and performance analysis of groundnut thresher. International Research Journal of Engineering and Technology. 2017;4(2):1631-1637.
24. Reddy KM, Vijay Kumar D, Reddy BR, Reddy BS, Performance evaluation of

groundnut thresher for freshly harvested crop. International Journal of Agricultural Engineering. 2013;6(1):67-70.
25. Sheikh DA, Modification of grain thresher to work with groundnut. AMA. 2000;31(4):67-71.
26. Sheikh GA, Awsd KA, Mohamed AA, Improvement of the modified grain thresher for groundnut threshing. AMA. 2007;39(3): 67-72.
27. Singh M, Manes GS, Singh S, Development and testing of axial flow groundnut thresher. Indian Journal of Agricultural Sciences. 2009;79(9):740-744.
28. Singh M, Manes GS, Singh S. Development and testing of axial flow groundnut thresher. Indian Journal of Agricultural Sciences. 2009;79(9):740-744.
29. Thangavelu S, Swaminathn KR. Groundnut crop moisture content and rotor speed in stripping. AMA, 1986;17(1):39-41.
30. Wilson U, Sankat CK, Anwar MT. Design and performance of an axial flow peanut threhser. Transaction of ASAE, 1997;33(1): 35-42.
31. Zafar AW, Kalwar SA, Anwar MT. Design and performance of FMI axial flow groundnut thresher. AMA. 1997;28(1):31-34.

APPENDIX I

Size of Groundnut Pods for GG-22 and GG-20 varieties

Sr. No.	Size of groundnut pods GG-22		Size of groundnut pods GG-20	
	Length, mm	Width, mm	Length, mm	Width, mm
1	29.55	13.10	25.89	11.44
2	37.37	12.95	29.72	15.15
3	18.75	12.76	31.88	14.55
4	30.18	11.14	29.78	13.32
5	28.50	10.64	22.76	8.98
6	23.04	11.38	33.12	13.34
7	30.07	9.83	27.34	14.20
8	16.95	10.22	24.44	10.15
9	17.44	9.56	26.80	12.63
10	26.33	12.26	28.09	12.87
11	36.01	13.28	21.18	8.36
12	22.34	10.89	28.95	12.97
13	31.04	12.66	23.44	10.55
14	16.46	9.84	28.60	14.88
15	31.24	13.37	28.51	13.43
16	29.98	12.01	28.02	12.76
17	17.26	11.42	28.42	13.00
18	28.70	12.15	29.48	13.34
19	35.41	13.45	28.03	12.46
20	36.85	15.36	29.26	12.95
21	25.16	11.33	29.63	12.97
22	34.48	13.44	20.32	10.41
23	19.16	10.76	26.73	11.25
24	26.61	12.90	32.06	13.41
25	29.84	13.67	26.51	15.93
26	30.46	12.69	34.82	13.53
27	25.79	10.37	25.58	13.07
28	24.83	11.68	24.91	13.82
29	26.54	12.48	31.75	14.11
30	22.18	11.62	32.48	15.08

APPENDIX II

Determination of Pod-vine Ratio for GG-22 and GG-20 varieties

The determination of pod and vine ratio was calculated by taking 4 samples of crop at random. Then, the bold pods where separated from the vines manually for each sample and weighed.

Variety	Sample No. (A)	Total weight (g) (B)	Weight of pods (g) (C)	Weight of vines (g) (D)	Pod-vine ratio (%) E=(C/D)*100
GG-22	1	975.5	249.0	726.5	34.27
	2	1034.0	234.0	800.0	29.25
	3	831.5	196.5	635.0	30.94
	4	906.0	252.0	654.0	38.53
	5	1117	287.5	829.5	34.66
			Average		**33.53**
GG-20	1	1210	440	770	57.14
	2	1153	451	702	64.24
	3	1189	460	729	63.10
	4	1247	425	822	51.70
	5	1105	395	710	55.63
			Average		**58.36**

APPENDIX III

Determination of Moisture Content of Pod and Vine for GG-22 & GG-20 varieties

The moisture content of groundnut pods and vine was determined on dry basis. The oven dry method was used for determination of moisture content by taking five samples randomly. The samples were weighed and kept in oven for 24 hours at 105˚C. The samples were weighed after drying. The moisture content was calculated by using the following formula:

$$\text{MC}\ \%\ (\text{d.b.}) = \frac{W_1 - W_2}{W_2 - W}$$

Where:

W_1 = Mass of material and dish before drying (g)
W_2 = Mass of dish with dried material (g)
W = Mass of empty dish (g)

Variety	Pod sample No.	W_1 (g)	W_2 (g)	W (g)	Moisture content (d.b.) (%)
GG-22	**(A)**	**(B)**	**(C)**	**(D)**	**(E)=100(B-C)/(C-D)**
	1	69.0	64.5	26.0	11.68
	2	60.0	56.5	26.0	11.47
	3	75.0	69.5	24.0	12.08
	4	63.0	59.0	25.5	11.94
	5	77.5	72.0	24.0	11.46
	Average				11.73
	Vine sample No.	**W_1 (g)**	**W_2 (g)**	**W (g)**	**Moisture content (d.b.) (%)**
	(A)	**(B)**	**(C)**	**(D)**	**(E)=100(B-C)/(C-D)**
	1	36.5	35.5	26.0	9.26
	2	38.5	37.0	24.5	11.54
	3	38.5	37.0	25.5	9.67
	4	41.0	39.5	28.0	11.53
	5	40.0	38.5	24.5	9.67
	Average				10.33

Variety	Pod sample No.	W_1 (g)	W_2 (g)	W (g)	Moisture content (w.b.) (%)
GG-20	**(A)**	**(B)**	**(C)**	**(D)**	**(E)=100(B-C)/(C-D)**
	1	84.0	80.0	26.0	7.40
	2	80.5	77.0	24.0	6.60
	3	80.0	76.0	24.5	7.6
	4	81.5	78.5	25.5	5.65
	Average				6.81
	Vine sample No.	**W_1 (g)**	**W_2 (g)**	**W (g)**	**Moisture content (w.b.) (%)**
	(A)	**(B)**	**(C)**	**(D)**	**(E)=100(B-C)/(C-D)**
	1	38.0	37.0	25.5	8.69
	2	38.5	37.0	25.5	13.04
	3	43.5	41.0	28.0	19.22
	4	41.0	39.5	25.5	10.72
	Average				12.92

APPENDIX IV

Test results of the groundnut thresher performance

Observations for groundnut variety GG-22

Sr. No.	Parameters	Test Trials		
		I	**II**	**III**
1	Duration of test, hr	0.047	0.049	0.046
2	Variety of groundnut crop	GG-22	GG-22	GG-22
3	Feeding rate, kg/hr	2117.65	2033.89	2195.12
4	Pod output, kg/hr	518.63	523.38	531.97
5	Fuel consumption, lit/hr	2.44	2.51	2.42
6	Capacity, kg/lit			
	Input	867.89	810.31	907.07
	Output	212.55	208.52	219.82
7	Losses on the basis of total pod output (%)			
	Broken	0.088	0.123	0.168
	Blown	15.31	16.05	12.17
	Un-threshed	18.44	20.70	17.62
	Sieve overflow	0.00	0.00	0.00
	Total loss	33.84	33.53	29.96
8	Efficiency (%)			
	Cleaning	87.95	85.89	90.80
	Threshing	81.56	79.30	82.38
9	Machine parameters			
	1. PTO speed, rpm		342	
	2. Cylinder speed, rpm		292	
	3. Main blower speed, rpm		627	
	4. Shaker speed, rpm		182	
	5. Inclination of top sieve, degree		5	
	6. Inclination of bottom sieve, degree		10	

Observations for groundnut variety GG-20

Sr. No.	Parameters	Test Trials		
		I	II	III
1	Duration of test, hr	0.077	0.075	0.078
2	Variety of groundnut crop	GG-20	GG-20	GG-20
3	Feeding rate, kg/hr	1298.70	1333.33	1282.05
4	Pod output, kg/hr	392.59	375.41	454.79
5	Fuel consumption, lit/hr	2.160	2.064	2.196
6	Capacity, kg/lit			
	Input	601.25	645.99	583.81
	Output	181.75	181.88	207.10
7	Losses on the basis of total pod output (%)			
	Broken	0.372	0.337	0.373
	Blown	4.343	8.584	5.292
	Un-threshed	13.522	16.391	13.875
	Sieve overflow	0.000	0.000	0.000
	Total loss	18.237	25.312	19.540
8	Efficiency (%)			
	Cleaning	89.35	88.39	88.47
	Threshing	86.48	83.61	86.13
9	Machine parameters			
	1. PTO speed, rpm		480	
	2. Cylinder speed, rpm		421	
	3. Main blower speed, rpm		775	
	4. Shaker speed, rpm		236	
	5. Inclination of top sieve, degree		5	
	6. Inclination of bottom sieve, degree		10	

APPENDIX V

Calculation of cost of operation by Straight-Line Method

Assumptions:

Particulars	Thresher	Tractor
Machine life	8 years	10 years
Salvage value	10% of initial cost	10% of initial cost
Annual use	300 hours	1000 hours
Interest rate	10%	10%
Housing cost	1.5% of initial cost	1.5% of initial cost
Insurance cost	2.0% of initial cost	2.0% of initial cost
Repair & maintenance	5.0% of initial cost	5.0% of initial cost
Fuel cost	-	64 Rs. / lit
Labour cost	300 Rs. Per day of 8 hr.	-

Calculations:

Sr. No.	Particulars	Value	
		Thresher	Tractor
1.	**Fixed cost**		
a.	Depreciation, Rs/hr	57.75	67.50
b.	Interest, Rs/hr	28.23	41.25
c.	Housing, Rs/hr	7.70	11.25
d.	Insuarance and taxes, Rs/hr	10.27	15
	Total fixed cost, Rs/hr	103.95	135
2.	**Variable cost**		
a.	Fuel cost, Rs/hr	-	160
b.	Oil cost, Rs/hr	-	4.8
c.	Repair and maintenance cost, Rs./hr	25.67	37.5
d.	Wages, Rs/hr	225	37.5
	Total variable cost, Rs/hr	250.67	239.8
3	Total (Fixed + variable) cost, Rs/hr	354.62	374.8
4	Total threshing cost, Rs/hr	729.42	
5	Average cost of groundnut threshing, Rs/kg	1.56	

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/53549