Harvard Research and Publications International

June 30, 2020 Vol. 12 No. 1 ISSN: 0196 – 3488

JOURNAL OF AGRICULTURE AND AGRICULTURAL TECH.

ADAPTATION OF IAR MAIZE DEHUSKER SHELLER FOR THRESHING OF SOME OTHER SELECTED CROPS

[1]MUHAMMAD R. S., U. B. AHMAD[2] AND H. M. GARBA[3]

[1]Department of Agricultural and Bio-Environmental Engineering, Kaduna Polytechnic, Kaduna, Nigeria, [2]Department of Soil Science, Kano University of Science and Technology, Wudil [3]Department of Agricultural Technology, Federal College of Agricultural Produce of Technology, Kano.

Abstract

An existing IAR maize Dehusker Sheller developed by the Institute for Agricultural Research, Samaru. Ahmadu Bello University, Zaria was evaluated in the year 2010 for adoption to thresh some selected

Keywords

Output, threshing efficiency, cleaning efficiency, scatter loss, grain damage.

INTRODUCTION

After harvesting, most crops cannot be directly safely and conveniently stored. There is therefore the need to separate and clean the grains from the ear heads or cobs through threshing. The grains are then detached from the ear heads or cobs and are finally separated from other materials like the chaff, pods and shells through cleaning.

Threshing is therefore a necessary part of crop processing in to various products before consumption. Threshing helps farmer to quantify their annual production by measuring the threshed grain in ''tiers" or bags. Threshing becomes necessary operation that must be carried

crops (sorghum, cowpea and groundnut). Performance test carried out on sorghum at the combination of speed of 950rpm, feed rate of 0.4kg/sec and at moisture content of 18.16% wet basis gave a threshing efficiency output, threshing efficiency, cleaning efficiency and scatter loss of 44.71kg/hr, 94.4%, 91.6% and 14.72% respectively with no visible grain damage. Performance of the machine on cowpea at the combination of 75rpm, federate 0.4kg/sec and at moisture content of 18.16% wet basis gave a threshing efficiency output, threshing efficiency, cleaning efficiency and scatter loss of 44.4%, 91.6% and 14.72% respectively with no visible grain damage. Performance of machine on cowpea at the combination of speed of 750rpm, feed rate of 0.4kg/sec and at moisture content of 18.16% wet basis gave an output, threshing efficiency , cleaning efficiency and scatter loss of 27.27kg/hr, 75.56%, 43% and 14.94% respectively with no visible grain damage. The performance of the machine on groundnut at a combination of a speed of 750rpm, feed rate of 1.7kg/sec and moisture content of 11.7% wet basis gave an output, threshing efficiency, cleaning efficiency, scatter loss and grain damage of 230kg/hr, 25.49%, 46.75%, 22.24% and 2.8% respectively. Based on the results obtained, it is possible to adopt the existing JAR maize dehusker sheller for threshing of the above listed crops, but modifications on the machine is required for it to thresh the selected crops for high performance especially cowpea and groundnut.

out to ensure availability of food for human consumption. On the other hand, by threshing activities fodders are made available for animal feed. And chaff or straw can be used for animal bedding. Hence, both human and livestock benefit from threshing operations.

IMPORTANCE OF THRESHING

Threshing involves;

Dehusking: This is the removal of the outer coverage of the seed.

Winnowing: This is the separation and removal of the foreign materials from the shelled grain to obtain clean seed.

THRESHING METHODS

MANUAL THRESHING

Threshing of crops such as sorghum, millet etc. are carried out manually by beating with sticks once they are dry enough. But, some of the crops can easily be damaged if threshed too roughly or when too dried.

As for groundnut, cowpea and the like, shelling can be done by snapping the pods using fingers .A parts from the large labour requirements, manual threshing is very tedious and boring. In addition, the grains become contaminated with debris from contact with ground where the beating is done.

There exists JAR manually operated maize Sheller has a conical body with four rows of serrated ribs running axially on the inner side. The Sheller is held in one hand while a maize cob gets rotated against the serrated rib inside the cone. The performance output is dependent on the size of cob, maturity and moisture content. It ranges from 13 to 49kg/hr. grain damage is negligible. (IAR, 1987)

Animal Trampling

This is another method of threshing grain crops in many parts of world especially African and Asian continent. While slow and often resulting in impurities and damage to the grains, it makes threshing less difficult and tiring, and can be cheap if oxen or buffaloes are readily available.

Engine Powered Threshing

The basic unit of a threshing machine is a beater which beats or rubs the crop against a stationary plate. The beater achieves detachment of a grain from the ear-head or cobs either by impact or rubbing action or by the combination of the two. The machine is operated either by an internal combustion engine or electric motor or by power take off (PTO) of a tractor. The method is the most efficient and less laborious.

Tractor trading is another method of threshing which has become widespread for rice, wheat, barley and sorghum is by driving a tractor

round and round on the crop spread over the threshing floor. If tyre pressure is kept low to minimize grain damage, acceptable results are possible, and no added investment in machinery is required. (Lan and marc, 1992)

METHODOLOGY

EXISTING MACHINE CONFIGURATION AND WORKING PRINCIPLE

The existing IAR maize dehusker Sheller uses a peg type cylinder, which works against a stationary concave screen. The drum is mounted on a 28mm diameter shaft. The pegs are welded on the 85mm diameter drum. They are arranged in four rows staggered with each row having five pegs. The cylindrical pegs have a uniform height of 48.5mm above the drum. The prime over is a 5hp diesel engine. Power is transmitted through the use of cast iron pulleys and v-belts arrangement. Threshing is effected by the impact of the rotating pegs on crop material against along the concave screen. Separation of the grain from the chaff starts immediately the crop is fed in to the threshing chamber. Movement of the cobs is facilitated by spiral arrangement of the pegs on the drum before the rectangular thrower blades welded at the drum end finally eject them out. Cleaning is accomplished by the blower unit, which has five blades at an angle of 90 degrees to one another and to the axis of rotation and blade depth of 160mm. Air stream from the blower, blows off the chaff through a slanted rectangular duct. The overall dimension of the machine is 657 x 855 x 500mm. the frame is made up of 50 x 50 x 5mm angle iron (Nalado, 2006).

THE CROP VARIETIES

The crop varieties which are mostly commonly grown within the JAR mandate area were selected for the performance evaluation tests.

i. Sorghum: *kaura variety*
ii. Cowpea: *SAMPEA9*
iii. Groundnut: *PRP*
iv. Maize: *QPM*

CROP MOISTURE CONTENT DETERMINATION

The procedure used for measuring moisture content of grain or seed is quite different from that for measuring groundnut with pods. These are

explained separately below. The apparatus used for weight measuring is the mettle electronic balance (PN1210).

GRAINS

The procedure used here was as stipulated by American Society of Agricultural Engineers (ASAE) standard (i.e. ASAE 352.1: moisture content determination of grains and seeds). 25g each of sample grains (sorghum and cowpea) were put in tarred moisture dishes. Weight of the empty dish and weight of wet sample and dish were taken. The sample were then placed each inside the oven at 103 degree centigrade for 72 hours for cowpea and for sorghum at 130 degree centigrade for 18 hours. The weight of the dried sample was then measured; the moisture content (wet basis) is thus calculated:

$MCwb = (Wws - Wds)/ (Wws - Wd) \times 100\%$

Where;

MCwb = Moisture content (wet basis), %

Wd = Weight of empty dish, g

Wws = Weight of wet sample and dish, g

Wds = Weight of dried sample and dish, g

GROUNDNUT

A pod sample of 250g was taken as stipulated by ASAE S. 410 standard for moisture determination of pods. Shells were separated from kernels and the mass measured separately. The kernel and hulls was oven dried at 130^{o}C for 6 hours. Then moisture content of shells in percentage (wet basis) and moisture content of kernels in percentage (wet basis) were calculated using the procedure described above. The overall moisture content of whole pod, E, was calculated thus:

$E = (DB + CA)/100$

Where,

E = Moisture content of whole pod (wet basis), %

D = Moisture content of shells (wet basis), %

C = Moisture content of kernels (wet basis), %

B = Kernels, %

C = Shells, %

PERFORMANCE EVALUATION

The parameters evaluated were, output capacity, threshing efficiency, cleaning efficiency, percentage of scatter loss and visible grain damage (%). All the parameters were determined as given by Nalado (2006).

i. Threshing Capacity

$C = Q_t/t$, kg/hr

Where, C = Output Capacity, kg/hr

Q_t = Wet of whole grains collected per unit time, kg

T = threshing time, hr

ii. Threshing Efficiency

$\eta_{pt} = 100 - (A/T_g) \times 100$

Where, η_{pt} = Threshing Efficiency %

(A/T_g) = Fraction of unthreshed grain

A = Weight of unthreshed grain per unit time, kg

T_g = Total grain input per unit time by weight, kg

iii. Cleaning Efficiency, %

$\eta_{pc} = (B/D) \times 100$, %

Where, η_{pc} = Cleaning efficiency, %

B = Weight of whole clean grain per unit time at grain outlet, kg

D = Weight of whole material collected per unit time at the grain outlet, kg

iv. Grain Damage

$d_g = (G/100) \times 100\%$

Where, d_g = Grain damage, %

G = Weight of visually damaged grain isolated in 100g of threshed.

v. Scatter loss, %

$L_s = (E/T_g) \times 100\%$

Where, L_s = Scatter loss %

E = Weight of scattered grain collected per unit time, kg

T_g = Total grain input per unit time by weight, kg

OTHER MEASUREMENTS

CYLINDER SPEED MEASUREMENT

Cylinder speed was measured using a mechanical tachometer (TZ 500 model). For sorghum, three cylinder speed were selected; 850, 900 and 950 rpm. For cowpea and groundnut also three levels of cylinder speed were selected; 650, 700 and 750 rpm. These values of cylinder speed were arrived base on available literature contracted (Ndirika, 1997; Enaburekan, 1994: IAR, 1994 and Bahera et al, 1990).

FEED RATE

Varying the weight of the crop to be threshed and keeping the time of feeding constant was used to estimate the feed rates. Throughout the experiments, a single experienced operator of the thresher feeds the particular crop. For sorghum and cowpea experiment, the feed rates selected were; 0.2kg/min, 0.3kg/min and 0.4kg/min and that of groundnut; 1.0, 1.3 and 1.7kg/min were selected.

PERFORMANCE TEST

The performance of IAR maize dehusker Sheller was at three different cylinder speeds for sorghum, cowpea and groundnut. The kind of variety used for sorghum is "*kaura"*, for cowpea is "*SAMPEA9"* and for groundnut is *"SAMNUT22".*

For each experiment, three replications were done. And three different feed rates at a particular cylinder speed were selected for each crop. The time for threshing was recorded throughout the testing period. The grains that come out of the straw outlet of the machine and the grains that spilled out from the machine were collected and weighted differently, output and scatter loss were then calculated. Three moisture content was used, one for each crop. While threshing, some grains both threshed and unthreshed come out from the straw outlet and were collected. The unthreshed once were weighted and threshing efficiency were calculated. The grains that blown out were collected and weighted to also obtain scatter loss. Cleaning efficiency and grain damage were calculated.

RESULT AND DISCUSSION

The tables 4.1, 4.2 and 4.3 below shows the mean values of performance parameters of the IAR maize dehusker Sheller at variable feed rate, cylinder speed and constant moisture content (wet basis)for each crop (sorghum 18.16%, cowpea 23.56% and groundnut at 11.70%).

Table 4.1: The mean performance of IAR maize dehusker Sheller for sorghum

TEST	1			2			3		
Moisture Content (%)	18.16			18.16			18.16		
Cylinder Speed (rpm)	850			900			950		
Feed Rate (kg/min)	0.2	0.3	0.4	0.2	0.3	0.4	0.2	0.3	0.4
Output (kg/hr)	23.33	38.67	40.00	24.70	40.98	42.35	26.07	43.22	44.71
Threshing Efficiency (%)	83.33	90.01	85.17	85.00	91.10	89.17	90.00	94.17	94.40
Cleaning Efficiency (%)	77.30	84.93	87.97	81.84	89.43	88.83	86.39	89.77	81.60
Scatter Loss (%)	11.67	10.03	13.17	12.36	14.11	13.94	13.04	14.69	14.72
Grain Damage (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Result shows that, the threshing output increases with the increase in cylinder speed and feed rate as shown in table above. The maximum threshing output was obtained to be 44.71kg/hr at feed rate of 0.4kg/sec, 18.16%wb moisture content and at cylinder speed of 950rpm. While minimum output was obtained to be 23.33kg/hr at feed rate of 0.2kg/sec, moisture content of 18.16%wb and at cylinder speed of 850rpm.

Threshing efficiency increases with increase in cylinder speed and feed rate. For sorghum, maximum threshing efficiency was obtained to be 94.4% at moisture content of 18.16%wb, cylinder speed of 750rpm and at feed rate of 0.4kg/sec. while the minimum threshing efficiency was obtained to be 83.33% at same moisture content, feed rate of 0.2kg/sec and cylinder speed of 650rpm.

For sorghum at moisture content of 18.16%wb, maximum and minimum cleaning efficiencies were obtained to be 91.6% and 77.3% at cylinder speed of 950rpm and 850rpm and at feed rate of 0.2 and 0.4kg/sec respectively.

Scatter loss also increases with increase in cylinder speed as obtained from the results. At moisture content of 18.16%wb, maximum and minimum scatter loss was obtained to be 14.72 and 11.67% at feed rate of 0.2 and 0.4kg/sec and at cylinder speed of 950 and 850rpm. And no visible grain damage was observed for sorghum.

Table 4.2: The mean performance of IAR maize dehusker Sheller for cowpea

TEST	1			2			3		
Moisture Content (%)	23.56			23.56			23.56		
Cylinder Speed (rpm)	650			700			750		
Feed Rate (kg/min)	0.2	0.3	0.4	0.2	0.3	0.4	0.2	0.3	0.4
Output (kg/hr)	19.60	21.33	23.63	21.10	22.97	25.45	22.62	24.61	27.27
Threshing Efficiency (%)	56.00	55.56	56.00	56.70	61.11	64.31	60.00	71.11	75.56
Cleaning Efficiency (%)	25.00	30.89	33.46	26.92	35.55	41.57	28.85	39.67	43.00
Scatter Loss (%)	11.67	12.67	12.95	12.57	13.64	13.94	13.47	14.62	14.92
Grain Damage (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Results shows that, the threshing output increase with the increase in cylinder speed and feed rate as shown in the table above. The maximum threshing output was obtained to be 27.27kg/hr at feed rate of 0.4kg/sec, 750rpm cylinder speed and moisture content of 23.56%wb. While minimum output was obtained to be 19.60kg/hr at feed rate of 0.2kg/sec, cylinder speed of 650rpm and moisture content of 23.56%wb. The moisture content was high, as such affect the output.

Threshing efficiency increases with increase in cylinder speed and feed rate. At moisture content of 23.56%wb, threshing efficiency ranges from 57.8% to 75.56% which maximum was obtained at cylinder speed of 750rpm, feed rate of 0.4kg/sec and 650rpm cylinder speed and feed rate of 0.2kg/sec for the minimum threshing efficiency.

For cowpea at moisture content of 23.56%wb, maximum and minimum cleaning efficiencies was obtained to be 43% and 25% at cylinder speed of 750rpm and 650rpm and at feed rate of 0.2 and 0.4kg/sec respectively.

No visible grain damage was observed. Scatter loss also increase with the increase in cylinder speed as obtained from the results in the table above. Maximum and minimum scatter loss was obtained to be 19.94% and

11.67% at feed rate of 0.2 and 0.4kg/sec and at cylinder speed of 650 and 750rpm.

Table 4.2: The mean performance of IAR maize dehusker Sheller for groundnut

TEST	1			2			3		
Moisture Content (%)	11.70			11.70			11.70		
Cylinder Speed (rpm)	650			700			750		
Feed Rate (kg/min)	1.0	1.3	1.7	1.0	1.3	1.7	1.0	1.3	1.7
Output (kg/hr)	119.3	194.3	218	128.47	209	223.3	137.65	244.19	252
Threshing Efficiency (%)	38.44	40.33	43.14	42.31	43.67	45.09	44.87	46.00	46.75
Cleaning Efficiency (%)	10.00	16.39	18.80	10.76	17.65	22.24	11.54	18.91	25.49
Scatter Loss (%)	14.09	19.33	21.57	18.71	20.83	25.49	23.08	22.30	22.24
Grain Damage (%)	2.17	2.30	2.50	2.30	2.45	2.67	2.50	2.67	2.84

Results shows that, the threshing output increase with the increase in cylinder speed and feed rate as shown in the table above. The maximum threshing output was obtained to be 252kg/hr at 750rpm cylinder speed, feed rate of 1.7kg/sec and moisture content of 11.70%wb. While minimum output was obtained to be 119.30kg/hr at feed rate of 1.0kg/sec, cylinder speed of 650rpm and moisture content of 11.70%wb.

Threshing efficiency increases with increase in cylinder speed and feed rate. Maximum and minimum threshing efficiencies were obtained to be 46.75% and 38.44% at feed rate of 1.7kg/sec and 1.0kg/sec and cylinder speed of 750rpm and 650rpm.

Maximum and minimum cleaning efficiencies were obtained to be 25.49% and 10.00% at cylinder speed of 750rpm and 650rpm and at feed rate of 1.7 and 1.0kg/sec respectively.

Maximum and minimum grain damage was obtained to be 2.84% and 2.17% at cylinder speed of 750rpm and 650rpm and at feed rate of 1.7kg/sec and 1.0kg/sec. the grain damage increases with increase in cylinder speed as shown in the table above.

Scatter loss also increase with the increase in cylinder speed as obtained from the results in the table above. Maximum and minimum scatter loss was obtained to be 22.24% and 14.09% at feed rate of 1.7 and 1.0kg/sec and at cylinder speed of 750 and 650rpm.

CONCLUSION

The Institute of Agricultural Research (IAR) maize dehusker sheller was adopted to thresh some other selected crops viz; sorghum, cowpea and groundnut. Base on the analysis, it could be concluded that, it is possible to adopt the existing IAR maize dehusker sheller for threshing the selected crops using the same power source, but modifications on the machine is required for it to thresh the selected crops to obtain high performance especially on cowpea and groundnut.

The best performance of the machine on the crop (sorghum) was at a cylinder speed of 950rpm, feed rate of 0.4kg/sec and moisture content of 18.16%wb, output of 44.71kg/hr, threshing efficiency 94.4%, cleaning efficiency of 91.6%, and scatter loss of 14.72% with no visible grain damage.

The best performance of the machine on cowpea was at moisture content of 23.56%wb, cylinder speed of 750rpm and feed rate of 0.4kg/sec. output of 27.27kg/hr, threshing and cleaning efficiencies of 75.56% and 43%, scatter loss of 14.94% with no visible grain damage.

The best performance of the machine on groundnut was at moisture content of 11.7%wb, cylinder speed of 750rpm and feed rate of 1.7kg/sec. output of 252kg/hr, threshing and cleaning efficiencies of 46.75 and 25.49%, scatter loss and visible grain damage of 22.24 and 2.84% were obtained.

REFERENCES

American society of Agricultural Engineers: ASAE Standard S. 352-1, ASAE standard S. 401-1

Bahera, B. K., Dash, B. K. and Das, D. K. (1990): Development and Testing of Power Operated Wheat Thresher. Agricultural Mechanization in Asia, Latin America and Africa (AMA) 24(4): 15-21

Enaburekan, J. S. O (1994): Mathematical and optimization modeling of the threshing process in stationary grain threshers. Unpublished Ph.D Thesis, Department of Agric Engineering, ABU Zaria.

LAN, C. and Marc, R. (1992): Tools for Agriculture, intermediate technology publications in association with CTD and GRET, 4:92-94

Institute for Agricultural Research (IAR), (1994): Cropping Scheme Report, Agricultural Mechanization Research Program, ABU Zaria.

Nalado, D. D. (2006): Modification of IAR maize thresher for multicrop threshing, M.Sc. Project Agric eng dept. ABU Zaria.

Ndirika, V.I.O. (1997): Modelling the performance of stationary grain threshers. Ph.D Thesis (unpublished), dept of agric eng. ABU Zaria.