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RESEARCH ARTICLE

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DEVELOPMENT OF GRAIN SEPARATOR MACHINE

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ABSTRACT

Agriculture plays a vital role in the Indian economy. Indian agriculture is at crossroads and one of the major challenges is to reverse deceleration in agricultural growth. The grains on handling after harvest contain various proportions of material other than grains (MOG) such as stone, pod, stem and dirt. Separation of the MOG is essential to upgrade the quality of food material.

The development of a solar grain separation machine presents a review of former needs/approaches. The Available evidence suggests that the grain separation machine in the rural areas by the traditional use of hand beating/ separation of the grains. This method reduces for time wasting, energy sapping and more labor.

The objective of this work is to decrease the time required for dust separation thus it will be supportive for agriculture field. In agricultural field the grain separator machine is required for farmers to decrease the labor cost and also the time. And easily accessible in terms of cost and availability at regional level and also the materials used for the machine construction should be light in weight. This paper describes an overview of grain separator machine with its different components, principle of operation and applications, design, results and discussions.

Key words: cleaning efficiency, cleaning loss, grain separation and sieving.

INTRODUCTION

Agriculture is the backbone of Indian Economy. Agriculture is basically an energy conversion industry. A farm is an energy consumer and a producer, because with the use of the different energy inputs, energy output as a crop production is available. India has a major agribusiness sector, which has achieved remarkable successes over the last three and a half decades. Unprocessed foods are susceptible to spoilage by biochemical processes, microbial attack and infestation. The right post harvest practices such as food processing techniques play a significant role in reducing spoilage and extending shelf life.

Harvesting constitutes a major operation among agricultural activities and differs according to the part of the plant to be harvested. Almost all the food, feed, fiber and fuel commodities go through a number of post harvest processing operations such as cleaning, grading, separation, drying, storage, milling, food processing, packaging, transport and marketing before it reaches to the consumers. Agricultural processing is directed towards the conservation of productive and value adding to make the material more readily usable, consumable and economically more remunerative.

Harvested grain (threshed / shelled / dried) needs further processing to get rid of various types of contaminations or undesirable matter, viz., inert material, common and grains of noxious weeds, other crop/variety grains, damaged grains and/or off-size grains.

Cleaning and grading result in reduced bulk of the material, high value products, safe and longer storage, more out-turn of better quality milled products. Improper cleaning usually results in grain loss. Cleaning helps to reduce bulkiness during subsequent post harvest operations. To remove straw pieces, unfilled grains and other foreign materials, cleaning and winnowing can be done manually, using wind energy or with the use of machines. Traditional winnowers like the winnowing basket and wooden boxes with perforations are used also motorized grain cleaners using electric power are in use.

Separation removes unwanted materials like straws, chaff, weed seeds, soil particles and rubbish from the grain. It improves grain stability, reduces dockage during milling, gives good quality milled and improves the milling output. It also reduces insects, pests and disease infestation. Removing dockage from grain is a common handling practice Food processing requires clean grains to insure purity. Separation grain for seed also requires considerable cleaning to insure the highest quality seed. Although cleaning grain for marketing purposes may not require the degree of foreign material removal or size separation necessary for food processing or seed cleaning, the same technology is used. The primary differences are throughput rates and the number of cleaning processes to which the grain is subjected. For example, when cleaning for seed, nearly all weed seeds, broken and inferior sized kernels, and other inert material is separated from kernels. Additional separation processes are used to size seed kernels. The degree of dockage removal of grain destined for the market, like wheat used for food or seed, is determined by economics associated with the cleaning activity.

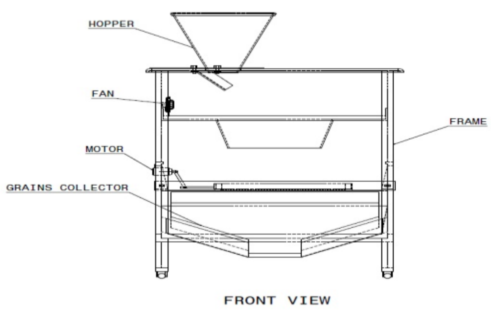
2. FOLLOWING PARAMETERS ARE MEASURED SUCH AS:

- Moisture Content.
- Cleaning Efficiency (Purity).
- Cleaning Loss.

3. OBJECTIVES OF RESEARCH:

1. To meet the new machinery that is used to do clean variety of grains.
2. The main objective of the project work is to get the cleaned variety of grains.
3. To use sustainable and profitable production methods.
4. To reduce adverse effects on the environment, and to use ethically justifiable cleaning methods.
5. Focusing on the quality of agricultural products.

4. COMPONENTS AND DESCRIPTIONS:



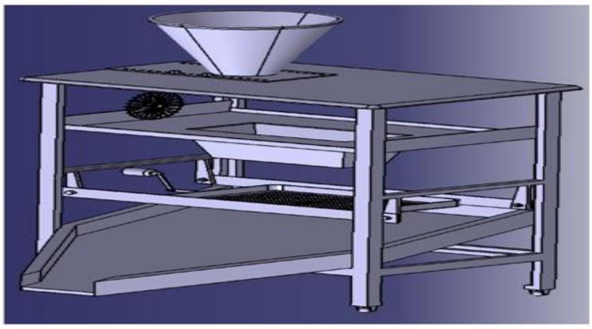


Fig: 1 solar grain separator machine

- Frame
- Sieve
- Solar panel
- Hopper

Frame: Structural frame acts as a base to hold all the mechanical components like Sieve tray, sieve plates, and motor with fan, hopper, solar panel, acts as vibrator shaft and many other components.

Sieve: Sieve plates which are made up of G. I. Steel for the purpose of cleaning of grains based on the bulk density of grains ranging from 618-634, standard available sieve plates are used which is 1mm, 5mm and 2mm diameter of sieve holes.

Solar panel:A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar module can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications.

Hopper: Hopper which is used to find out the mass flow rate when the grain passes which can also be considered for the ergonomic consideration aspect of view. A storage container used to dispense granular materials through the use of a chute to restrict flow, sometimes assisted by mechanical agitation.

Motor with fan:An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Each battery consists of a negative electrode material, a positive electrode material, an electrolyte that allows ions to move between the electrodes, and terminals that allow current to flow out of the battery to perform work

The fan is an electrical device, consists of blades on rotating produces pressurized air into the space.

Working principle: The uncleaned grains are fed into the grain cleaner machine through a feed hopper. As the uncleaned grains move towards the feed box which contains sieve plates. At the same time the fan speed blow the dropping of uncleaned grains. While the same time the sieve plates will be osculating motion take care of a cleared variety of grains based on sieve size. Depending on the size of the sieve filter, impurities present in the grains like stones and pebbles are collected in the sieve. Lighter impurities like dust and mud particles are separate when forced air helps to separate collected on one side and cleaned grain is collected on the other side.

Advantages:

- ✓ Separating and cleaning is easy, because of the main parts are screwed.
- ✓ Handling is easy, manual power not required.
- ✓ Repairing is easy.
- ✓ Comfortable for all middle class farmers.
- ✓ Good efficiency and low cost.

Disadvantages:

- Large quantity of cleaning is difficult.
- Solar energy can only be harnessed when it is daytime and sunny.
- Solar collectors, panels and cells are relatively expensive to manufacture, although prices are falling rapidly.

Applications:

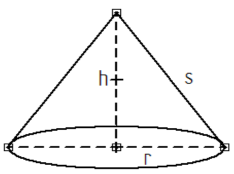
- Area of agriculture.

5. DESIGN CALCULATIONS:

5.1 Hopper Design:

- Hopper Design for mass flow rate.
- Sieve plates are used based on grain sizes.
- Power consumption.
- Solar Panel and Battery selection.

Circular cone formula w.r.t radius and height:



R=radius

H=height

S=slant height S= $\sqrt{r^2+h^2}$

V=volume V= $\frac{1}{3}\pi r^2 h$

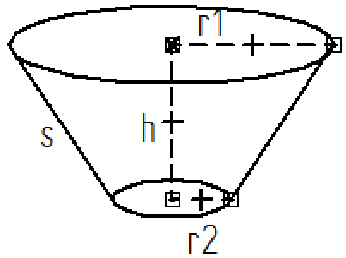
L=lateral surface area L= $\pi r s$

B=base surface area B= πr^2

A=total surface area A=L+B

π =3.142

Calculation of conical hopper:



R_1=radius (inlet)

R_2=radius (outlet)

H=height

S=slant height

V=volume

L=lateral surface area

B=base surface area

A=total surface area

π=3.142

Conical frustum formulas w.r.t "R" and "H"

Slant height:

S= $\sqrt{(r1-r2)^2+h^2}$

= $\sqrt{(0.17-0.0352)^2+0.32^2}$

= 0.34 mt^3

Volume:

V=1/3 π h [$r_1^2+r_2^2+(r_1r_2)$]

=1/3 π 0.4 [$0.2^2+0.075^2+(0.2*0.075)$]

= $0.025m^3$

Lateral surface area:

L=S= π (r_1+r_2)*s

= π (0.17+0.035)*0.34

= $0.21m^2$

Top surface area of conical:

T= π *r_1^2

=$3.142*0.17^2$

=$0.090m^2$

Base surface area of a conical:

B= π *r_2^2

=$3.142*0.035^2$

=3.848*10^10^{-3}

Total surface area of a conical:

A= π [$r_1^2+r_2^2+(r_1+r_2)*s$]

=π [$0.17^2+0.035^2+(0.17+0.035)*0.34$]

=$0.313m^2$

Rate of Discharge from Hoppers:

[a] Finger Millet Grain:

Mass flow [JOHANSON EQUATION]

$$m=\rho A \frac{\sqrt{Bg}}{2(1+m)\tan\theta}$$

θ= Semi included angle of the hopper

M = discharge rate (kg/Sec)

ρ= bulk density (kg/m^3)

g = gravity acceleration (9.807 m/s^2)

b= base surface area of the outlet

m=1 for conical hopper

A=area of frustum

$$m = 732 * 0.31 \frac{\sqrt{0.038*9.81}}{2(1+1)\tan 30}$$

=0.0292kg/s

=29.29g/s

Wall friction: μ=tan θ

=tan 30^O

=0.57 (Co-efficient of friction)

To find velocity hopper outlet:

$$\frac{4\,v^2 \sin\theta}{B}+15\rho^{1/3}\mu^{2/3} V_0^{4/3}/\rho_p\, d^{5/3}$$

Where = v_{o} = average velocity of solids discharging (m/s)

B = Dia of outlet, m.

ρ & μ = Bulk density (kg/m^3) and Co-efficient of friction

θ= semi include angle of hopper

ρ_p=particle density (kg/m^3)

d= dia of particle (mm)

=4V² [sinθ /B+15.{ρ⅓*μ⅔*v^4/3/ρ*d^5/3}] = g

=4V² [sin 30/0.0384+15*(732⅓*0.57⅔*V⅜)/(732)*(0.02) = 9.81

=V_0 = 0.127m/s [Finger Millet Grain]

5.2 Solar Panel and Battery selection:

Hence Fan Specification: 12v, DC

So to run the 10W fan on for 1 hour will take

10*1=10Wh from the battery

Battery capacity is measured in Amp hours

Convert this to watt hours by multiplying the Ah by the battery voltage

For 10Ah, 12v battery the watt hours is given by

P=V*I

V=10v and I=10Ah

P= 10*12=120Wh

So, the 12W fan runs for

120/12=10h

This means the battery could supply 10W fan for 12 hours.

Energy generating capacity of solar panel over a period of time:

To calculate the energy it can supply to the battery, multiply watts by the hours exposed to sunlight, then multiply the result by 0.85(This factor allows for natural system losses)

For the solar 10W panel in 4 hours sunshine, 10*4*0.85 = 34Wh

For 1 hour, 10*1*0.85 = 8.5W

5.3 Power consumption:

Name	Formula sign	Unit	Symbol
Voltage	*V* or *E*	Volt	V
Current	*I*	Ampere (amp)	A
Resistance	*R*	Ohm	Ω
Power	*P*	Watt	W

5.3.1 Electric Power Formulas:

P = V I (1a) =5.6*0.75 = 4.2

P = R I^2 (1b) = 7.46*0.75^2 = 4.1

P = V^2/ R (1c) =5.6^2/7.46=4.2

Where

P = power (watts, W)

V = voltage (volts, V)

I = current (amperes, A)

R = resistance (ohms, Ω)

6. EXPERIMENTAL RESULTS AND DISCUSSION:

Performance test on the Solar operated Grain Cleaner:

The test was carried out by feeding 1kg, 2kg, 3kg, 4kg, and 5kg, into the feed using a hopper to maintain the mass flow rate. The result of different feeding rates is tabulated and shown in below table (1.1).

Performance test on the Grain sieve shaker:

1kg to 5kg of grains were mixed randomly with stones of various sizes and lighter impurities the mixture is fed into the grain cleaner and measurements were taken for various numbers of Speed. The results are presented in Table (1.1) for machine for separation. The results are shown in table for different number of strokes.

Tests were conducted on the following Grains: finger millet.

Fig: 2 Finger millet, Green & Horse Gram Grain

Finger millet:

Table: 1.1 Feeding rate and the percentage cleaned & loss grain

Sl. No	No. of Trials in Kg (inlet)	Fan Speed in rpm	No. of Strokes (N)	Power Consumed (P)			Outlet in		Percent age cleaned (%)	Cleaning Loss (%)
				Volts (V)	Current (I)	P=V*I	Hard Grains	Un Cleaned & Impurities grains		
1	1Kg	1570	40	5.7	0.78	4.44	760	240	76	24
2	2Kg	1935	56	6.6	0.83	5.47	1590	410	79.5	20.5
3	3Kg	2240	65	7.5	0.90	6.75	2440	560	81.33	18.66
4	4Kg	2578	74	8.3	0.97	8.05	3385	615	84.62	15.37
5	5Kg	2950	86	9.5	1.06	10.07	4305	695	86.1	13.9
	Average	2254.6	64.2	7.52	0.90	6.95	2496	504	81.5	18.46

Finger millet cleaning efficiency:

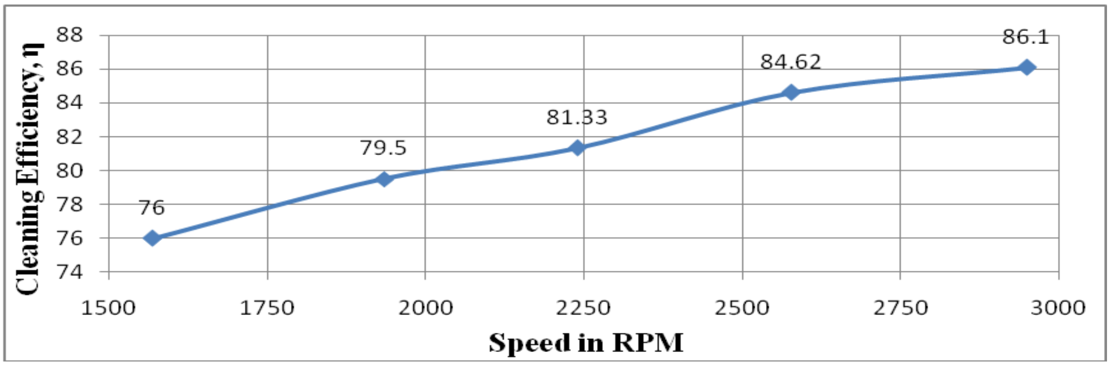


Figure: 3 cleaning efficiency of grains

Cleaning loss, %:

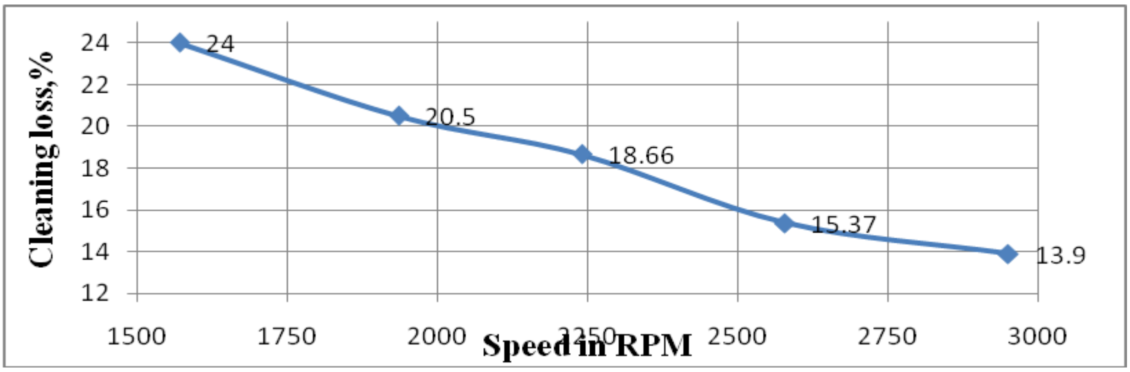


Figure: 4 cleaning loss of grains

Power consumption:

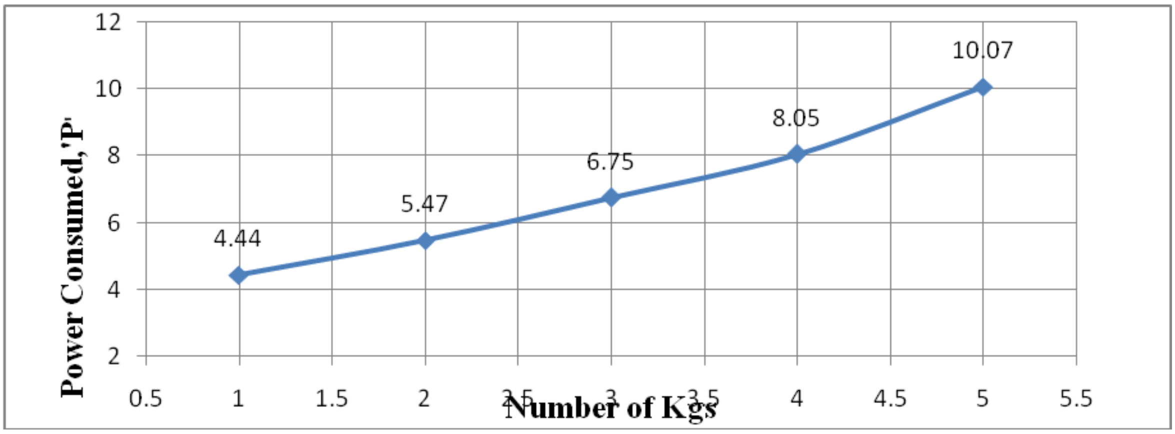


Figure: 5 power consumption of grains

The figure T1.1 shows the speed in RPM v/s cleaning efficiency, by analyzing all tests conducted above i.e. test-1 to test-5. It is clear that the efficiency of separation will increase with respect to the number of speeds. In the graph clearly shows that by filling through hopper at 1kg of impurities of grains, it will give an efficiency of 76%. Here such like conduct the test-2 to test-4 and finally test-5, 5kg of impurities gives 86.1% efficiency with the values obtained from all tests a graph of cleaning efficiency v/s various speeds is plotted on x & the y axis as shown in figure T1.1

The figure T1.2 shows the above the same procedure, but one thing is remaining percentage is cleaning loss, i.e. is 24% of test-1 to 76% and 13.9% of test-5 to 86.1%. The figure T1.3 shows the no of kgs v/s power consumption here the 1kg of impurities grains to separate it will take 4.44 watts. So like till continue up to test-5, and finally 5kgs of impurities grains takes 10.7watts power consumption. The values are obtained from all the tests a graph of power consumption v/s no of kgs is plotted as shown in figure T1.3.

CONCLUSION

The final outcome of this project work is that to decrease the time required for separation, dust, contaminations, impurities, and hauling from the heap of the harvested grains. And also to minimize labor cost, time and power. The machine is used in rural areas and The use of solar operated grain separator machine has been reduced the hazardous health implication and makes it safe for human consumption and the solar product appeals better and affordable by common people. That quality of locally produced grains by small grain growers is improved with little effort and reduced labor cost. No electricity is spent so this product saves the energy and saves the environment from getting polluted. And mainly very needful for small and medium class farmer.

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