"Testings, Results & Analysis of Payback Period of Portable Organic Waste Chopping Machine to Obtain Compost"

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Abstract

This paper presents various testing, results & analysis of payback period of chopping machine by which the farmer can become self dependent for his everlasting need of organic fertilizer. The study specifies factors influencing the productivity, efficiency, energy consumption of machine to chop the organic waste and recommends the poor farmer the benefit of using the machine. These are based on a systematic study of the organic waste chopping process and testing of a portable model of chopping machine. Also the unit consumption of electricity for chopping is calculated and a comparison between the chemical fertilizers & organic fertilizer is done to know for the money difference which is to be incurred by the farmer to adopt either of them.

Keywords: Chemical Fertilizer; Chopping Machine; Shredding Machine; Manure, Productivity, Efficiency, Energy Consumption, Payback Period, Agricultural Waste, Sieves, Etc

I. INTRODUCTION

India is basically agricultural country. Near about 75% people are engaged in agriculture work and its related sectors. They totally depend upon the agriculture. There are many types of crops cultivated by Indian farmers such as wheat, rice, gram, sesame, paddy, millet, mustard, various types of vegetables, fruits, Soya beans, cotton, groundnut, cereals like Tur etc. The industries depend upon the commercial crops like cotton, Soya beans, cereals etc .After harvesting a lot of crop residue is left in the farms in India which can be brought into use by making their compost. It will make the poor farmers to be self dependent & will certainly reduce the expenses on the chemical fertilizers.

The composting process happens due to the activity of micro-organisms (bacteria) and other larger organisms like worms and insects. These need certain conditions to live. These include moisture and air. To make the best possible compost, the micro-organisms must be able to work optimally. This can be achieved if the following four factors are combined to the best advantage:

1) Type of organic material
2) Air
3) Moisture
4) Temperature.

It has been realized that large quantity of agricultural wastes remains being unutilized because handling, storage and management related difficulties. The reasons are their low bulk density, large area/volume for storage. The farmers on the field burn most of these wastes after the harvesting of crops. Thus the agricultural waste burning phenomena is being repeated every year. In order to use these wastes for some economical benefits, so the necessary of such machine is felt to utilize all kinds of agricultural waste after shredding, which could be economical and practicable. Therefore, the shredder is designed and developed considering the physical properties of agricultural wastes like length, top width, root/stem diameter, moisture content, bulk density, chopped density etc.

It has been established fact that finer particles (4 to 5 cm) decompose faster as compared to large particles. This needs pulverizing, which increase the surface area of the waste materials several thousand folds, thus exposing very large areas for micro organic reaction. Shredder is ideal for disposal of course garden leaves and agricultural wastes. Such as twinges, small branches, flower stalks straw, tree pruning etc. The finally ground wastes mixed with grass, logs and leaves, produce a light compost that encourages improvement of soil. It provides more oxygen and more energy for all the organisms involved in soil fertility process.

Fig. 1: Leaf Humus

Fig. 2: Compost Obtained After Shredding Crop Residues

II. OBSERVATIONS OF LITERATUTRES

1) Each and every working part in crop residue crushing machine is mounted on separate shaft thereby requiring power of 9.786 KW to roll, cut & hammer crop stovers.
2) Shearing angles of blades are taken as 450 for natural debris vacuum shredder analysis.
3) Sweet Sorgham Harvester consist of 450 angle blades giving a good performance.
4) In multipurpose mechanize chopper both inclined at 200 & straight position blades can be utilized.
5) Studying the modified chopper thus provided for a conclusion that more the number of hole diameter of sieve, less is the composting period required & more is the productivity.

III. TESTING, RESULT & ANALYSIS

A. Testing:

Sample is selected according to the research work done in the previous chapter. Taking into consideration the various research papers and the raw material in the form of stems or lentils, leaves, etc fed in the machines, various testings are done by using different crop residues and size of sieves and ultimately various results are obtained. According to the working principle and experimental setup of shredder machine as discussed earlier samples of dry stems ,wet stems, dry leaves & wet leaves each weighing 1 Kg is done for about five times using different size of sieves and various results are obtained. Mean values of these readings are obtained. Mean values help us to calculate the ultimate results of Crop Residue Shredding Machine. The sample readings are tabulated in the following tables. In the testing tables following parameters like weight of sample, length, diameter & width of sample before cut and after cut, total no. of residues in 1 Kg fed in the machine, total no. of residues improperly cut & time required to cut the samples are mentioned. Testings were done and the following results were observed.

1) Testing Tables:-

Table – 1
Testing for Dry Stems in 15 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Diameter of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*740*	*20*	*5*	*1.3*	*48*	*6*	*0.5*	*2*
2	*1Kg*	*739.4*	*19.8*	*4.8*	*1.32*	*47*	*5*	*0.47*	*1.8*
3	*1Kg*	*740*	*19.9*	*4.87*	*1.29*	*49*	*6*	*0.49*	*1.9*
4	*1Kg*	*739.5*	*19.7*	*4.9*	*1.28*	*47*	*5*	*0.5*	*2.1*
5	*1Kg*	*739.8*	*19.9*	*5*	*1.3*	*49*	*7*	*0.48*	*1.7*
Total		*3698.7*	*99.3*	*24.57*	*6.49*	*240*	*29*	*2.44*	*9.5*
Mean		*739.74*	*19.86*	*4.914*	*1.298*	*48*	*5.8*	*0.48*	*1.9*

Table – 2
Testing for Dry Stems in 12 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Diameter of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*740*	*16*	*5*	*1.1*	*48*	*4*	*0.5*	*2.6*
2	*1Kg*	*739.4*	*15.8*	*4.8*	*1*	*47*	*3*	*0.47*	*2.5*
3	*1Kg*	*740*	*15.9*	*4.87*	*1.03*	*49*	*5*	*0.49*	*2.5*
4	*1Kg*	*739.5*	*15.7*	*4.9*	*1.1*	*47*	*3*	*0.5*	*2.6*
5	*1Kg*	*739.8*	*15.9*	*5*	*1.1*	*49*	*5*	*0.48*	*2.4*
Total		*3698.7*	*79.3*	*24.57*	*5.33*	*240*	*20*	*2.44*	*13*
Mean		*739.74*	*15.86*	*4.914*	*1.066*	*48*	*4*	*0.48*	*2.6*

Table – 3
Testing for Wet Stems in 15 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Diameter of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*900*	*30*	*5.02*	*1.7*	*37*	*8*	*0.8*	*2.6*
2	*1Kg*	*899.9*	*29.8*	*5.01*	*1.62*	*38*	*7*	*0.87*	*2.7*
3	*1Kg*	*898*	*28.7*	*5.00*	*1.6*	*36*	*6*	*0.7*	*2.5*
4	*1Kg*	*900.1*	*30.01*	*5.03*	*1.73*	*36*	*6*	*0.72*	*2.5*
5	*1Kg*	*900*	*30.01*	*5.02*	*1.701*	*37*	*8*	*0.85*	*2.6*
Total		*4498*	*148.52*	*25.08*	*8.351*	*184*	*35*	*3.94*	*13*
Mean		*899.6*	*29.704*	*5.016*	*1.6702*	*37*	*7*	*0.788*	*2.6*

Table – 4
Testing for Wet Stems in 12 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Diameter of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*900*	*23*	*5.02*	*1.3*	*37*	*5*	*0.8*	*3*
2	*1Kg*	*899.9*	*22.6*	*5.01*	*1.2*	*38*	*6*	*0.87*	*3.2*
3	*1Kg*	*898*	*22.2*	*5.00*	*1.1*	*36*	*4*	*0.7*	*2.9*
4	*1Kg*	*900.1*	*23.1*	*5.03*	*1.32*	*36*	*4.5*	*0.72*	*2.9*
5	*1Kg*	*900*	*23.03*	*5.02*	*1.301*	*37*	*5*	*0.85*	*3.1*

Total	*4498*	*113.93*	*25.08*	*6.221*	*184*	*24.5*	*3.94*	*15*
Mean	*899.6*	*22.786*	*5.016*	*1.244*	*37*	*4.9*	*0.788*	*3*

Table – 5
Testing for Dry Leaves in 15 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Width of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*150*	*13*	*90*	*5*	*273*	*19*	*0.7*	*2.4*
2	*1Kg*	*148*	*12*	*88*	*4.8*	*274*	*20*	*0.8*	*2.5*
3	*1Kg*	*149*	*12.5*	*88.7*	*4.88*	*274*	*19.5*	*0.76*	*2.5*
4	*1Kg*	*147*	*11.8*	*89*	*4.9*	*273*	*19*	*0.7*	*2.4*
5	*1Kg*	*149*	*12.3*	*90*	*5.01*	*274*	*20*	*0.8*	*2.5*
Total		*743*	*61.6*	*445.7*	*24.59*	*1368*	*97.5*	*3.76*	*12.3*
Mean		*148.6*	*12.32*	*89.14*	*4.918*	*273.6*	*19.5*	*0.75*	*2.46*

Table – 6
Testing for Dry Leaves in 12 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Width of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*150*	*12.2*	*90*	*3.8*	*273*	*13*	*0.7*	*2.9*
2	*1Kg*	*148*	*12.1*	*88*	*3.6*	*274*	*14*	*0.8*	*3.0*
3	*1Kg*	*149*	*12.15*	*88.7*	*3.64*	*274*	*13.5*	*0.76*	*2.91*
4	*1Kg*	*147*	*11.7*	*89*	*3.71*	*273*	*13*	*0.7*	*2.89*
5	*1Kg*	*149*	*12.13*	*90*	*3.77*	*274*	*14*	*0.8*	*2.96*
Total		*743*	*60.28*	*445.7*	*18.52*	*1368*	*67.5*	*3.76*	*14.6*
Mean		*148.6*	*12.056*	*89.14*	*3.704*	*273.6*	*13.5*	*0.75*	*2.92*

Table – 7
Testing for Wet Leaves in 15 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Width of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*160*	*25*	*96*	*8*	*232*	*27*	*1.2*	*3.1*
2	*1Kg*	*158*	*23*	*95.4*	*7.6*	*234*	*26*	*1.1*	*3.0*
3	*1Kg*	*158.9*	*23.4*	*95.6*	*7.8*	*234*	*26.5*	*1.2*	*3.12*
4	*1Kg*	*160*	*25.2*	*95*	*7.67*	*233*	*26*	*1.21*	*3.13*
5	*1Kg*	*159*	*24.3*	*96*	*8.1*	*232*	*27*	*1.23*	*3.23*
Total		*795.9*	*120.9*	*478*	*39.17*	*1165*	*132.5*	*5.94*	*15.6*
Mean		*159.18*	*24.18*	*95.6*	*7.834*	*233*	*26.5*	*1.18*	*3.12*

Table – 8
Testing for Wet Leaves in 12 mm Diameter Hole Sieve

Sr. No.	*Weight of Sample*	*Length of Sample*		*Width of Sample*		*Total No. of residues in 1 Kg*		*Time required (Min)*	
		Before Cut(mm)	*After Cut(mm)*	*Before Cut(mm)*	*After Cut(mm)*	*Fed*	*Improperly Cut*	*To Feed*	*To Cut*
1	*1Kg*	*160*	*22.3*	*96*	*6.7*	*232*	*19*	*1.2*	*4*
2	*1Kg*	*158*	*21.4*	*95.4*	*6.4*	*234*	*21*	*1.1*	*3.7*
3	*1Kg*	*158.9*	*22.1*	*95.6*	*6.5*	*234*	*20*	*1.2*	*3.9*
4	*1Kg*	*160*	*22.31*	*95*	*6.3*	*233*	*18.5*	*1.21*	*4.1*
5	*1Kg*	*159*	*22.2*	*96*	*6.71*	*232*	*19*	*1.23*	*4.2*
Total		*795.9*	*110.31*	*478*	*32.61*	*1165*	*97.5*	*5.94*	*19.9*
Mean		*159.18*	*22.062*	*95.6*	*6.522*	*233*	*19.5*	*1.18*	*3.98*

From these testings we conclude that we can save time and money by using the crop residue shredding machine. If we put 1Kg of organic residue in the shredding machine then we get an output of about 0.97Kg of chopped organic residue particles by consuming time of about 2.5 to 3 minutes for 15 mm diameter hole sieve whereas 3 to 4.2 minutes for 12 mm diameter hole sieve. Thus, if we go on continuous working of machine then we can obtain a greater output in very short time.

B. Result:

1) Productivity: - It is the quantity of product output expressed in terms of time.
Productivity = output obtained in Kg / Hour

Thus if 1 Kg of product is obtained in 'x' minutes, then 'n' Kg obtained in 1 Hour i.e. 60 minutes. Therefore 1 Kg / x = n Kg / 60

2) Energy Consumption in cutting & hammering: - It is the energy lost in doing the cutting & hammering work on crop residues.

Energy Consumption=Power required for cutting & hammering / machine Productivity

Where, Energy Consumption has unit KW. Hr/ Ton

3) Efficiency: - It is the ratio which gives the information about how much the machine is efficient. It can be expressed in terms of length, diameter and width, number of stems & leaves cut & in terms of time.

- In terms of Length: - L_B-L_A / L_B × 100 Where L_B is length of stem before cut & L_A is length of stem after cut.
- In terms of Diameter or Width: - D_B- D_A/ D_B× 100 & W_B-W_A / W_B × 100 where D_B & W_B are diameter & width of residue before cut whereas D_A & W_A are diameter & width of residue after cut.
- In terms of Number of stems fed & Number of stems improperly cut: - N_1-N_2/ N_1× 100 where N_1 are the number of stems & leaves fed in the cutting chamber & N_2 are the number of improperly cut stems & leaves.
- In terms of Time: - T_O-T_I / T_O× 100 where T_O is the time required to obtain the output product & T_I is the time required to feed the raw material i.e. crop residue in the machine.

The productivity, energy consumption & efficiencies for different sieves calculated using the above formulae are mentioned below in the table:-

Table – 9
Productivity, Energy Consumption & Efficiencies using 15 mm Hole Diameter Sieve

Sr. No.	*Material*	*Productivity Kg /Hr*	*Energy Consumption KW. Hr / Ton*	*Efficiency %*			
				In terms of Length	*In terms of Diameter & Width*	*In terms of quantity of crop residue cut or chopped*	*In terms of Time*
1	*Dry Stem*	*31.57*	*22.945*	*97*	*73*	*87.91*	*74.73*
2	*Wet Stem*	*23.07*	*31.40*	*96.66*	*66.70*	*81.08*	*69.6*
3	*Dry Leaves*	*24.390*	*29.70*	*91.70*	*94.48*	*92.87*	*69.5*
4	*Wet Leaves*	*19.230*	*37.670*	*84.80*	*91.80*	*88.62*	*62.17*

Table – 10
Productivity, Energy Consumption & Efficiencies using 12 mm Hole Diameter Sieve

Sr. No.	*Material*	*Productivity Kg /Hr*	*Energy Consumption KW. Hr / Ton*	*Efficiency %*			
				In terms of Length	*In terms of Diameter & Width*	*In terms of quantity of crop residue cut or chopped*	*In terms of Time*
1	*Dry Stem*	*23.07*	*31.40*	*97.85*	*78.30*	*91.66*	*81*
2	*Wet Stem*	*20*	*36.22*	*97.46*	*75*	*86.75*	*73.73*
3	*Dry Leaves*	*20.54*	*35.267*	*91.88*	*95.84*	*95.06*	*74.31*
4	*Wet Leaves*	*15.07*	*48.069*	*86.14*	*93.17*	*91.63*	*76.35*

C. Analysis:

Analysis is the process of breaking a complex topic into smaller parts to gain better understanding of it. In this chapter we analyze the efficiency of Motorized Organic Residue Shredding or Chopping Machine on the basis of various principles which are discussed in Chapter 4 of review of literature. Various Parameters like weight of crop residue, length, diameter & width of crop residues before cut and after cut, total no. of residues in fed in the machine, total no. of residues improperly cut & time required to cut the residues are taken into consideration while analyzing the efficiency of the machine. Sieves of different diameter hole are used while doing the analysis & the above parameters are compared on the basis of sieves attached to the machine. Graphs are obtained comparing the above parameters. In this chapter we also discuss the Pay Back Period of machine cost which provides for the tentative time which will be required by the farmer to earn or the owner of the machine to re earn the cost which he incurred in fabricating the machine. Following points explain the comparison of Portable Organic Waste Chopping Machine with other similar principles based machines.

1) The total power required for a prototype of crop residue machine is about 9.784 KW which works on Diesel Engine & flywheel is attached to it whereas our fabricated portable crop residue machine requires 724.404 W power through electric motor.(1)
2) Hammer blades, roller & knife blades are attached to different shafts for functioning in the prototype of crop residue machine whereas in the portable organic waste chopping machine the hammer blades & knife blades are mounted on the same shaft having same revolutions for both hammer & knife blades.(1)
3) Both blades having 300 as well as 450 blade angles provide for good cutting of stalks & stems. Thus 450 blade angle blades are used which provides for 91% efficient cutting of dry stems & 95.06% of efficient cutting of dry leaves by using 12mm hole diameter sieve. Whereas 87.91% efficient cutting of dry stems & 92.87% of efficient cutting of dry leaves is obtained by using 15mm hole diameter sieve.(3)
4) Dual power foliage chopper took 8 minutes by foot operation to chop 1 kg dried stems & leaves & about 5.55 minutes with electric motor. In context to fresh leaves the foot operation took about 10 minutes whereas the electric motor took 6 minutes to chop the same quantity of organic matter. In comparison to this our portable crop residue chopping machine took about 2.5 to 3 minutes to chop the residues using 15mm hole diameter sieve & about 3 to 4.2 minutes to chop the residues using 12mm hole diameter sieve.(4)
5) Thus by using bigger hole diameter sieves up to 25mm the composting period can be reduced to 95 days from 140 days. Thus our portable chopping machine can fulfill the never ending demand of organic fertilizer of farmers and can uplift the standard of living of farmers by making them self dependent for the need of fertilizer or compost manure which is necessary for both Kharif & Rabbi Season.

– Compost Requirement, Profit in Comparison to Chemical fertilizers per acre & Pay Back Period:-

According to survey of farms in Amravati District, mostly crops like Soya bean, Cereals like Tur, Moong,etc & Wheat are being cultivated mostly as kharif & Rabbi cash crops. These crops require fertilizers for their nourishment as well as it is essential to provide nutritive contents in the form of nitrogen & carbon to them to increase the fertility of the soil. So generally two chemical fertilizers are used to increase the nutritive value i.e. DAP (Di Ammonium Phosphate) & Urea.

One bag of DAP of 50Kg costs minimum amount of 1350 Rs. which is spread in 1 acre. Along with it Urea of about 20Kg per acre is spread in the farm to improve the water holding capacity of soil. Urea costs about 25Rs. per Kg. Thus 20 Kg urea costs for about approximately 300 Rs. Therefore the total amount of DAP 7 Urea is about 1650 Rs. per acre. In addition to this various sprays are sprayed on the crops as pesticides to kill various insects & caterpillars clinging on the crops. These sprays add to about 1500 Rs. per acre to the fertilizer amount. Thus total amount to be incurred in fertilizers is 3150 Rs. for one acre. Other miscellaneous expenses include transportation, lab-our, etc which includes about 1100Rs. & is to be added to 3150 Rs. Thus total amount to be spent by farmer for using chemical fertilizer is about 4250 Rs.

Organic compost required for one acre land is about 2 tractor trolleys which has maximum capacity of 1500 Kg per trolley. Thus 3000Kg of organic compost is required for one acre farm land. If the crop residue is chopped by the shredding machine for about 120 hrs i.e. either 8 hrs per day for 15 days or 4 hrs per day for 30 days before 3 months of the sowing season then the organic compost obtained after these 3 months will ultimately fulfill the need of fertilizer for one acre land. According to MSEB Electricity Slab for Single Phase, rate of one unit is 3.36 Rs. up to 100 units & from 100 to 300 units the rate per unit is 6.05Rs. 40 Rs. are the fixed charges per month & near about 100 Rs. charges of fuel consumption for generating electricity by MSEB per month are included in the unit consumption cost. Thus 1unit = 1.20 KW hr.

So for 15 or 30 days, total KW hr = 1200 Watt × 8 × 15 = 144000 Watt hr.

Thus total units = 144000 / 1200 = 120 units

So, Total Cost as per Slab = 120 × 6.05 + 40 + 100 = 866 Rs.

Lab-our charges for turning the layer of organic chopped waste kept for converting it into compost = 1000 for 3 months.

Cost on lab-our to remove the compost from dig & to load it in the trolley that is 350 Rs. per trolley.

Total lab-our cost = 700 for 2 trolleys & same cost i.e. 700 to unload it in the farm

So, total cost for using organic compost as fertilizer by farmer for 1 acre

= 3266 Rs.

Thus the difference between the cost of chemical fertilizer use & organic fertilizer use for 1 acre = 1384Rs. which will be the ultimate profit achieved by the farmer.

If the farmer produces organic fertilizer from selling point of view then by preparing about 15000 Kg of fertilizer which is equal to 10 trolleys of which each acre requires 2 trolleys & selling it for about 3500 Rs. per 2 trolleys, then the farmer can earn about 17,500 Rs. which is near about to the machine price & will certainly provide him for an opportunity to re- earn the cost which he incurred in fabricating or buying the machine. The payback period which is the time required to re- earn the money which is expended on the fabrication of the machine may vary which will certainly be more than 3 Months as the time duration required to get the compost after shredding is itself about 3 Months. Thus about 120 days if sold in the Kharif Season or about 180 days if sold in the Rabbi Season may be the payback period.

IV. CONCLUSION

Thus it is possible to automate a skilled manual process which would avoid worker fatigue & provide for better productivity, efficiency, less energy consumption, etc thereby providing a helping hand to the farmer brothers. Also the future scope for developing the generalized mechanism for any profile can be identified.

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