Investigation and development of a low cost miniature splitter pulse machine with polisher for semi urban areas intended model for sustainable manufacturing.

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Abstract: Now a daylight hours, it is a demand of an hour to widen the farm or agricultural machinery, consequently the government is also now captivated in the research and development of agricultural equipments, The objective of this research work is to accept up the pace the progression of Rural Industrialization in the country along the lines of Gandhian vision of sustainable and self reliant village economy & to upgrade the products of rural industry so that they gain wide adequacy in the local and global markets and Empowering rural men and Women Entrepreneurs. Our projected Miniature pulse splitter machine is Low Cost, effortless in manufacture and painless to operate & maintain. This mechanism offers dust free operation, does not cause pollution, retains proteins, natural shine etc. Dhal is one of the foremost factors in Vidarbha inexpensive characteristic. As dhal is customary source of protein and is integral part of Indian diet. At the same time, pulses occupy a foremost position next only to cereals as the daily food item in the India. By varying various parameters in splitter machine which affecting efficiency of process like emery abrasive grinding wheel, opening adjustment, speed of wheel etc. and have optimize setting on which machine will give utmost output, good nutritive quality of finished dhal and which gives good revenue to rural peoples. The horizontal wheel arrangement gives maximum contact area for dehulling. Use the emery abrasive material over the wheel for increasing roughness.

Overcome, operate, manage & manned by less skilled person of rural & semi urban areas. Solved idleness problems of rural peoples and getting good household profit as per their own working time. portable and will be available in low cost as compared to the machine previously present in the market costing a lakh rupees. A practical study is conceded out for finalizing the production rate of Miniature pulse splitter machine for rural & semi urban areas. There is lot of scope for reducing the range of production to suit small decentralized production units. This concept is called micro–splitting. It includes conversion of raw seed to polished finished split dhal in the same machine with very small capacity for rural & semi urban areas. studied about various traditional, modern mill and mini dal mill and existing methods for dehulling, have collected all relevant data about types of pulses, major pulses in Maharashtra region, process of dal and dehulling processes. After studying various aspects, we optimizing the dehulling process, selected the parameters which gives maximum efficiency such as: emery abrasive grade, opening between the wheels and rotating speed of wheels. Done analysis, calculations, fabrication and experiments on these variable parameters to find out the optimum settings to get desired output.

From the various experiments by taking readings, we plotted the graphs for respective emery abrasive grade no. and taking RPM of grinding wheel on horizontal X-axis and hulling efficiency on vertical Y-axis. From the graphs we conclude that the emery grade 20 gives maximum output on 5 mm gap and 200 RPM as 78.20 & grade 36 emery gives maximum output on 5 mm gap and 170 RPM as 76.06%. Both outputs are utmost for respective wheels, but grade 20 emery gives better quality dal as compared to grade 36 emery. Better quality in the sense of low quantity of crushed grain and waste, proper splitting, good dehulling with shine polish surface on split Bengal gram dal an etc.

Keywords: **Miniature pulse splitter, Rural Industrialization, self reliant, Empowering, Sustainable, cereals, dehulling, decentralized.**

1. INTRODUCTION

Pulses are one of the foremost crops in India. This research was related to pulse mill industry especially for manufacturing chana dhal also known as Bengal gram or chickpeas and tur dal. currently Dal mills are working on extremely large scale and are not able to fulfill the demand of dhal for manufacturing chickpeas (Dal) needed for rural peoples at lesser cost. In the in progress framework, it is very much significant to advance the farm machinery; the Government of India is also now promoting the research and development of agricultural equipments. The purpose of this proposed research work is to pick up the pace of the process of Rural Industrialization in the country along the lines of Gandhian vision of sustainable and self reliant village economy & to upgrade the products of rural industry so that they gain wide acceptability in the local and global markets and Empowering men and Women Entrepreneurs in rural areas.

The manufacture Miniature splitter pulse machine is trouble-free in construct and easy to operate and maintain. It consists of hopper for feeding of raw dhal, feed drive for maintaining the optimize feed to get good splitting of raw dal, horizontal abrasive grinding wheel arrangement giving maximum contact area for hulling or dehusking unit as shown in figure 1, which is covered with emery coating for increasing roughness, surrounded by a drum through which the hulled and un-hulled chickpeas or tur dhal is release and transfer to vibrating sieve separator arrangement.

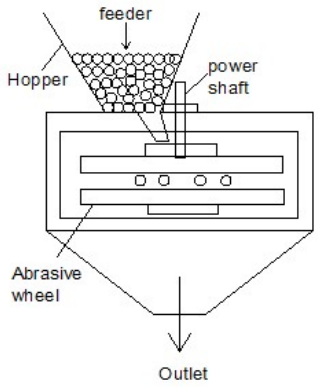


Fig.1 the huller process

Arrangement is made for collection of split or de-hulled chickpeas or tur dhal in one outlet, whole chickpeas or tur dhal in another outlet of sieve and unhulled dhal and cover or broken dhal and powder is collected in other outlet from the vibrating sieve. The miniature splitter machine runs on 0.5 hp DC brushless electric motor for varying the speed of grinding wheel and to get optimize result for good quality of split dhal. the split dhal move from the separator to polisher unit for making good polish dhal for enhancing the quality and shinning too, but polished dhal is not recommended as its reduces the nutritive value of dhal. For making polished dhal there is arrangement for inserting mustard or soybean oil in the polisher unit also leather belt is provided in inner surface of drum in the polisher unit. The machine offers benefits such as, it does not cause pollution, retains proteins, natural shine maintain productivity and easy in operation and very less maintenance etc.

Farmers currently sell their produce in raw form. That produce is passed through a network of intermediaries that includes several layers of traders, processing mills, and wholesalers/retailers. Farmers are systematically exploited in this process due to asymmetries in information and inefficiencies in this chain. Ultimately, the farmer receives less than 1/3rd of the retail price for processed dals. It is widely agreed that "poor market linkages", "weak infrastructure", and "many layers of intermediaries" hinder the growth of India's countryside, wherein over 2/3rd of the population lives.

Miserable poverty is regrettably the norm, not the exception, for the majority of rural peoples in India. The endeavor of the current research is to unearth out the optimum

conditions so as to increases the productivity of this variety of pulses. Hence eventually the benefit would the higher productivity and higher remuneration to the local farmers for their crop.

1.1. Necessitate For Dehulling

Semi-arid regions in developing countries such as India, Africa, and America etc. for example, can only maintain the cultivation of cereals such as Tur dal, sorghum, and maize. As a outcome, a considerable percentage of the population in many parts in Maharashtra depend on tur dal, chana dal, masoor dal or for everyday daily meal. Other crops such as wheat and bajri add to the daily diets of population. Rural peoples have traditionally improved the organoleptic quality of foods prepared from cereals by processing the grains to remove the outer layers (the pcricarp and testa). The pericarp (bran) contains mainly fibre, whereas the testa contains anti-nutritional substances, such as polyphenols, which give a bitter taste to the grain and inhibit the digestion of protein from the grain. Phytic acid, which is present in the bran and germ of tur dal combines with mineral elements such as calcium, iron, sodium, zinc, and magnesium, to form insoluble compounds (phytates) thus making them unavailable for human nutrition. The presence of high concentration of c-glycosyl flavors in undehulled tur dal changes test of food. Many of these a variety of anti-nutritional factors can be substantially reduced by dehulling. Most producers and consumers of tur dal face a daily task of dehulling and pulverizing the grains manually before being able to prepare the daily meal. Traditionally, tur dal is dehulled and splitted due to following reasons:

1. To eradicate the outer layers, which contain mostly fiber, the presence of which affects cooking quality and taste and texture of the product, and adds bulk to the daily meal.
2. To take out sources of bitter taste (polyphenols or tannins) that are often found in the outer cover of pulse seed or in the testa layer immediately under it.

The average rural homemaker and her children will save substantial energy and time if they have access to machinery or mechanism that can make available a convenient and inexpensive dehulling and grinding service.

1.2 Why Miniature Pulse Splitter for Semi Urban Areas- A Case Study

Agriculture visit at various villages in Wardha district and make us move toward to subsequent conclusions in 5 acre Agriculture land for chickpeas. Total investment is followed on harvesting chickpeas from sowing chickpeas seeds to getting raw chickpeas: Rs.75, 000 (approx.) includes seeds, spraying, labour charges, medication & other costs etc nearly for 4 to 5 months from October or November to February or March. Total average output of 50 quintals in 5 acre land of raw chickpeas is attaining and if considering average rate of Rs.3,700 per quintal then a farmer got Rs.1,85,000(approx.) for 50 quintals , therefore a profit getting to a farmer = Rs.185000 - Rs.75000= Rs.1,10,000 (approx.) per 50 quintal. The market visit makes the following conclusions for finished polished split chickpeas dhal:3 no. chickpeas finished polished split dhal quality manufactured by large scale dhal mill is Rs.4,500 per quintal.(Rs.2,25,000 per 50 quintals)

2 no. chickpeas finished polished split dhal (mini fatka) quality manufactured by large scale dhal mill is Rs.5, 200 per quintal.(Rs.2,60,000 per 50 quintals)

1 no. chickpeas finished polished split dhal (fatka) quality manufactured by large scale dhal mill is Rs.5, 600 per quintal.(Rs.2,80,000 per 50 quintal).

Considering Average rate of finished polished split dhal in market: Rs.5,200 per quintal.(Rs.2,60,000 per 50 quintal).Considering 2 NO. Finished polished split dhal Quality, then

Rs.2,60,000-1,10,000= Rs.1,50,000/-Profit for50 Quintal getting to marketer or seller(per quintal i.e.Rs.3000/-). Agriculture visit at various villages in Wardha district and make us come to following conclusions in 5 acre land for red gram or pigeon pea. Total investment is followed on harvesting red gram or pigeon pea from sowing red gram seeds to getting raw red gram: Rs. 90,000 (approx.) includes seeds, spraying, labour charges, medication & other costs etc nearly for 7 to 8 months from June or July to January or February. Total average output of 50 quintals in 5 acre land of raw red gram or pigeon pea is attaining and if considering average rate of Rs. 5,600 per quintal then a farmer got Rs. 2,85,000 (approx.) for 50 quintals , therefore a profit getting to a farmer = Rs.2,85,000 - Rs.90,000 =Rs.1,95,000 (approx.) per 50 quintal. The market visit makes the following conclusions for finished polished split red gram dhal:3 no. red gram finished polished split dhal quality manufactured by large scale dhal mill is Rs.7,000 per quintal.(Rs. 3,50,000 per 50 quintals).2 no. red gram finished polished split dhal (mini fatka) quality manufactured by large scale dhal mill is Rs. 7,600 per quintal.(Rs.2,60,000 per 50 quintals).1 no. red gram finished polished split dhal (fatka) quality manufactured by large scale dhal mill is Rs. 8,200 per quintal.(Rs. 4,10,000 per 50 quintal).Considering Average rate of finished red gram polished split dal in market: Rs. 7,600 per quintal.(Rs. 3,80,000 per 50 quintal).Considering 2 NO. red gram Quality, then Rs. 3,80,000 - Rs. 1,95,000= Rs.1,85,000/-Profit for 50 Quintal getting to marketer or seller(per quintal i.e.Rs.3700/-), so if farmer convert raw pulse to finished split dhal then farmer got a very good profit and Solved Unemployment problems & good household profit as per their own working time.

1.3 Traditional methods of dehulling, splitting and grinding

Dehulling of pulses using a chakki:
Pulses are traditionally milled in South-East Asian countries where they constitute staple foods in the diet. India alone consumed over 12 million tonnes of pulses in 2005 (FAO, 2010). Most traditional methods are performed at home by families or by small communities. The original method used in ancient times was hand pounding with stones or mortar and pestle, followed by the use of quern stones. The earliest form was a saddle quern that consisted of a large gritty base stone and a small, fist-sized smooth stone. Seed could be fractured into rough splits, or with continued pounding reduced to a flour. The saddle quern later evolved into rotary and oscillatory querns (also known as chakki). These consist of two large abrasive stones that fit together, the bottom one slightly convex and the upper one slightly concave. The top stone has a central hole in which seed is slowly fed while the top stone is rotated by a wooden handle

Fig 2.: Dehulling of Tur dal using a Chakki

(Fig.2), as the top stone is rotated, the seed tumbles between the two abrasive stones, resulting in dehulling and splitting of the seed. Continued turning of the top stone further

reduces the split seed to flour. Chakki-type mills are still often used by many households in South-East Asia (Singh et al., 1992, 2000).

1.4 Modern/Industrial Methods of Dehulling and Splitting

The traditional stone chakki design was used as a template for the attrition-type mills as commercial-scale dehulling and splitting of pulses emerged. The two-stone principle was retained and the much larger stones were rotated using the energy of harnessed animals (such as bullocks) or running water (such as in the flour mills of Europe).The mills were adapted as electricity became an available power source, and automation increased. Now, the stones are artificial and coated with carborundum (derived from silicon carbide) of various abrasive grades (grit size). These new improved attrition-type mills are often called under runner disk shellers (URD Shellers). The orientation of the stones can be either horizontal (as in the original chakkis) or vertical, and the gap between the stones can be adjusted to the seed size to optimize dehulled seed and/or dhal yields (Fig.3).

Fig.3 Commercial chakki mill.
(Source: Government of Punjab)

1.5 Economical Aspects

Tur and Bengal gram is one of the major agricultural products in Maharashtra region. The average selling price of raw tur is about Rs.5,200/- per quintal and raw Bengal gram is about Rs.3700/- per quintal from farmers to the traders. And the market price of tur dal increases due to cost incurred in its processing of converting from raw tur to split dal. The average selling price of split and polished tur dal after all processes is about Rs 7000/- per quintal and finished split Bengal gram is about Rs.5600/- per quintal. The traditional process which are used for hulling and splitting the tur are:

I. Use of traditional dal mill
II. Modern Floor mill
III. Large scale Dal mill

The hand saddle quern wheel or called hand chakki used for hulling and splitting dal is outdated now. Generally the modern floor mills are most accepted means of decorticating and milling. The cost of milling on the modern floor mill is about Rs 300/- per quintal. But main thing is the efficiency of the floor mill is not more than 60%. It means nearly 40% of the product goes waste. Also a gap between the grinding wheels should be adjusted frequently for milling the dal. If the adjusted gap is more than the output will be not proper and if it's too narrow, seeds will be crushed. Other way of dal processing is the large scale dal mill which gives the efficiency higher than the floor mill nearly 70%. Another way of dal processing is the mini dal mill nowadays. They give the efficiency higher than the floor mill & large scale dal mill nearly 75%, but the cost of milling is about RS. 400/- per quintal and cost is a lakh of rupees. The efficiency of this machine is about 75%. Even if the efficiency is larger but the initial investment for dal mill is Rs.1,50,000/- and it is not available in remote rural area as it is too costly, therefore the

rural people have to come to the town .This adds extra transportation cost in the price of tur dal . In due course of time there is a need and demand and it is necessary to developed such a miniature dal machine which is low in cost, ease in operation, maintenance free. These will improve their economics and get benefited; otherwise profit goes in pocket of business man.

2. REVIEW OF LITERATURE

Khodabakhshian R, Bayati M.R., Shakeri M., Khojastepour M [1] in his research paper "Systematic Design of a Pistachio Hulling Machine" studied that the greatest pistachio producer and exporter country in the word is Iran. Fine processing, post processing and transportation of pistachio, have great effects on its quality, food value, physical properties and marketability of this product. Then any applicable research for processing of pistachio, have direct and indirect effects on developing technology of this industry and as a result, farmers can get more income. In this study, various methods of pistachio hulling using a systematic design method have been carefully investigated and after that, new suitable and multipurpose machine for pistachio processing has been presented that can do hulling, washing and dehydrating processes simultaneously. In order to hull pistachio in this machine, centrifugal force is used. The unit consists of two main parts: the hulling set and the power transmission system. The hulling set consists of a rotating drum and a separate rotating circular base – plate.
Journal: AIJSTPME (2010) 3(2): 7-13

Naik R. Balasaheb "Economic Analysis of selected Pulse processing mills , , Agricultural Economics (2013) [2] in his research study the prosperity of pulse processing was intimately associated with the installed capacity and its utilization and executive practices in case of different sized dhal mills. The small sized dhal mills obsessed comparatively advanced potentials for increasing their profits through full capacity consumption as compared to medium and large sized dhal mills. Of the different troubles reported by the dhal millers, seasonal accessibility of pulses for dispensation, the labour troubles, petite supply of electricity and power cuts, time lag between purchasing of pulses and the receivable payments and financial constraints were the most important ones. Appropriate supervision practices with resourceful use of obtainable resources are keys to resolve the troubles and success too.
Vilas salokhe, Division of Agricultural and Food Engineering Asian Institute of Tech. Bangkok, Thailand[3] in his research paper " Development of sunflower seed decorticator" studied in order to evaluate the performance of sunflower seed decorticator, three wooden impellers having different configuration and four types of striking surfaces made out of different materials were tested. Four different speeds were used to test the performance. The data was statistically analyzed. It was found that types of striking surface and impeller configuration do have significant effect on the decortications efficiency of the sunflower seed decorticator. It was observed that combination of four groove impeller and plywood striking surface at speed of 2250 rev/min gave maximum performance.

Tannin Sorghum, M. A. Mwasaru, R. D. Reichert, S. Z. Mukuru [4] in his research paper "factors affecting the abrasive dehulling efficiency of high" studied the High-tannin sorghum gives low yields when the grain is abrasively dehulled. Consequently, the factors affecting dehulling performance of this grain were investigated with a small-sample dehuller, the Tangential Abrasive Dehulling Device. Ten grinding wheels, which varied in grit size, grade, structure, and surface finish, were specially manufactured and tested on three soft-endosperm, high-tannin sorghum cultivars. Flour extraction (tannin), defined as

100 minus the required percent kernel removed to reduce the tannin content to 0.5%, ranged from 19 to 91%.
Journal : Chem. 65(3): 171-174.

Idriss Audu, A.O. Oloso and Bobboi Umar[5] in his research paper "Development of a Concentric Cylinder locust bean Dehuller" studied locust bean dehuller was developed so as to decrease the quantity of time and labour obligatory in the conventional physical dehulling of African locust bean (Parkia biglobosa) seeds, which are processed into a food condiment and flavoring agent that is well-liked in many African countries. The dehuller predominantly consists of two concentric cylinders, a power transmission shaft and a prime mover. The gap between the two cylinders constitutes the dehulling chamber. After design and construction, the dehuller was evaluated based on three parameters, namely humidity contented of beans, length of the dehulling head and the speed of rotation of the inner cylinder. Tests showed that efficiency of the machine augmented linearly with increases in all the three parameters. The throughput of the dehuller decreased with increases in moisture content and length of dehulling head, but increased with increase in dehulling speed. Researcher studied the maximum values of dehulling efficiency and throughput obtained were 70.3% and 0.51 kg/min. correspondingly. This paper describes the design and performance evaluation of the dehuller as well as the implication of the results obtained.

U.J.Etoarmaihe, K.C.Ndubueze [6] in his research paper "Development and Performance Evaluation of a Dehulling Machine for African Breadfruit (Treculia Africana)" studied the power-driven African breadfruit seed dehuller was designed, fabricated and tested. outcome showed that the machine had a maximum dehulling efficiency of 86% at 225 rpm speed and a maximum dehulling capacity of 176.2 kg/hr at 425 rpm speed. There were significant effects of speeds on both the dehulling capacity and dehulling efficiency of the machine at 5% level of significance. The dehulling capacity increased with speed while the dehulling capacity decreased with increased speed. The predictable cost of the machine is N35000 (USD250).

3. PROBLEM IDENTIFIED

1. As per market survey and comparison study, it is concluded that, when farmer sold raw dal to market or large scale dhal mill, and after processing, split & polish dal rate is nearly to double when it is sold in market.
2. Idleness and hunger problems to rural farmer in non agricultural period i.e. I the month of March to May.
3. Meet rising demand for more food of higher quality in good rates to rural farmers.
4. Economical issues (not everyone will be able to afford it).
5. Process the raw Dal at the point of generation to avoid unnecessary transportation cost for waste removed from raw material of Dal.

4. PURPOSE

1. Overcome, develop, handle & manned by less skilled person of rural & semi urban areas i.e. to provide with the semi automatic solution to rural areas.
2. Utilization of rural man power during non agricultural period in the villagers (round the year 24x7).
3. Set up the agricultural based processing unit at the point of generation of material.
4. Unemployment problems & good household profit as per their own working time or convince.
5. Convenient, simple in operation, effortless and will be available in low cost as compared to the machine already present in the market costing a lakh rupees.

6. Study of techno-economic feasibility.

5. METHOLOGY

The proposed miniature splitter pulse machine was tested for split and polishes dal by varying the existing dal mill with appropriate alteration such as altering grade of abrasive wheel i.e. coarse, super coarse & extra coarse, space adjustments in abrasive wheel and rotating speeds of abrasive wheel of the miniature splitter pulse machine. This proposed miniature splitter pulse machine is having all process in one unit such as pitting & splitting, separating split dal and other by use of vibrating sieve which separates whole hulled dal, unhulled dal, husk, powder and broken dal. The following is the flow diagrams for milling of pulses are as follows in fig.4:

Fig. 4: Flow diagram for milling of pulses

The machine consists of four units viz. pitting and splitting unit, division unit, polisher unit and blower unit (Fig. 5). It requires one horse power DC single phase electric motor for complete operation.

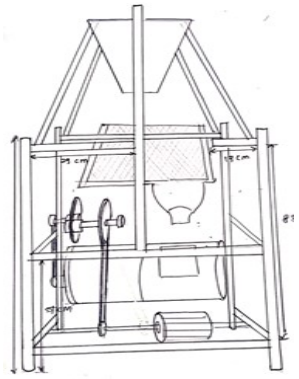


Fig.5: schematic view of miniature splitter pulse machine

1. Pitting unit (dehusking unit): It consists of an abrasive horizontal grinding rotating & stationary wheel in regulate to attain smooth flow of grains during dehulling. The grinding rotating & stationary wheel is covered by a specific opening depending on size of dhal. The vibrating sieve makes possible the partial separation of split dal, whole hulled dal, unhulled dal, husk and powder and broken dhal. The inlet feed and outlet feed

are provided on side plates at the top and bottom, respectively with separate controls by hand wheel and lever.

2. Separation unit:

The unit comprises of the three components viz. blower, vibratory sieve unit and cyclone separator.

3. Polisher unit: It is contrived by a DC electric motor and the hopper is accumulating at one end. There is an arrangement for passing the mustard oil for improving the quality and nutritive value of dal. The drum with leather rotates inside a screen, passing through the screen dust get distant and the pulses which are polished pulses out of the outlet which is at the other end of the machine. The polishing of dal is not recommended, as it reduces the protein contents in dal by removing thin upper layer from dal.

4. Blower unit: A blower is also make available with the machine, which smooth the advancement of separation of hull or husk or dust.

The emery abrasive grinding wheel for dehusking and splitting of 20 & 36 no., the opening adjustment is in between 4 mm to 6 mm, the speed variation from 170 rpm to 220 rpm. The hand lever at outlet control was modified by providing screw mechanism for precision control of outlet opening. Various feeler trials for each feed rate, various speeds, various gap and various abrasive grade were undertaken for maintaining constant feed rates for better polishing and getting good quality of dal. This was done by feeding 1 kg grains in the hopper and inlet and outlet was kept closed, then the inlet was opened and about 1 kg grains were allowed to pass in the gap between the roller and the sieve (until its full capacity). Then the outlet was opened to such a level so as to maintain the flow rate of 100 kg/h as well as better polishing. Same procedure was adopted for deciding the other feed rates such as 110 kg/h, 130 kg/h and 150 kg/h. The variety of grains Bengal gram of Wardha district used for testing was Grade-1. The sample size was 1 kg for each replication. Before starting the test, the physical properties of the grains such as moisture content, hardness. For brining moisture content to the desired level of 12.5%, known amount of water was sprinkled over the grains and kept for conditioning for about 30 minutes.

6. RESULTS

Following are the output efficiencies of miniature splitter pulse machine for per 1000 gm of Bengal gram i.e. 1 kg input:

For Grade 20 Emery			
	Gap (mm)	RPM	Efficiency
20	4	170	74.30 %
		185	75.40 %
		200	76.10 %
		220	75.84 %
	5	170	77.06 %
		185	77.60 %
		200	**78.20 %**
		220	77.40 %
	6	170	72.65 %
		185	74.15 %
		200	75.25 %
		220	74.80 %

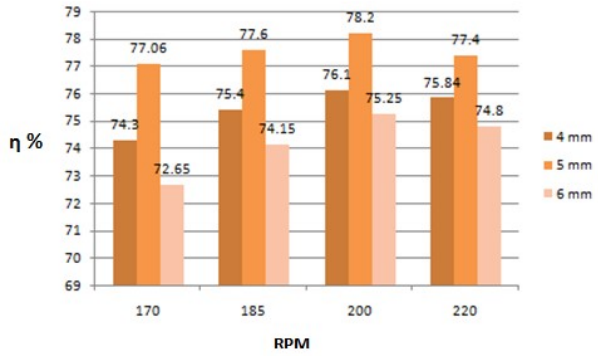
Table 1 shows RPM Vs efficiency for Grade 20 Emery

For Grade 36 Emery			
	Gap (mm)	RPM	Efficiency
36	4	170	74.70 %
		185	73.25 %
		200	72.15 %
		220	71.84 %
	5	**170**	**76.06 %**
		185	75.65 %
		200	72.38 %
		220	72.40 %
	6	170	71.05 %
		185	70.15 %
		200	71.25 %
		220	71.10 %

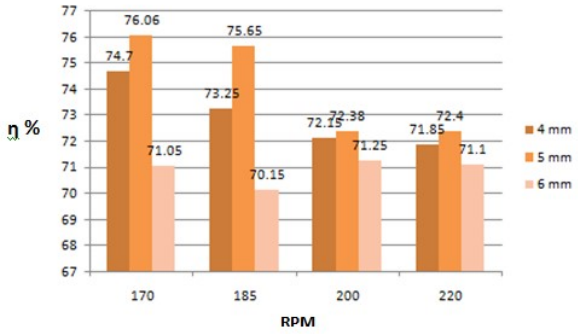
Table 1 shows RPM Vs efficiency for Grade 20 Emery

Graphical Representation:

RPM Vs Efficiency graph for 24 grade emery



RPM Vs Efficiency graph for 24 grade emery



7. CONCLUSION

A significant work has done on this research work to establish the feasibility of this venture and to initiate operations. Through such work, we have created the required backward and forward linkages to less developed formers & economically struggling ruler families. Thus, we constructed

a machine which is compact in size, less power consuming, effortless from other available dhal mills. Low cost, higher production rate and simplify design of miniature splitter pulse machine along with polishing, separating unit development is done continuously which can be useful for not only dhal but separation & polishing of other crops also. The market-based nature of this research work ensures its long-term viability and sustainability.

Firstly studied about various traditional, modern mill and mini dal mill and existing methods for dehulling, have collected all relevant data about types of pulses, major pulses in Maharashtra region, process of dal and dehulling processes. After studying various aspects, we optimizing the dehulling process, selected the parameters which gives maximum efficiency such as: emery abrasive grade, opening between the wheels and rotating speed of wheels. Done analysis, calculations, fabrication and done experiments on these parameters to find out the optimum settings to get desired output.

From the various experiments on miniature splitter pulse machine we taken readings and plotted the graphs for respective emery abrasive grade no. and taking RPM of grinding wheel on horizontal X-axis and hulling efficiency on vertical Y-axis. From the graphs we conclude that the emery grade 20 gives maximum output on 5 mm gap and 200 RPM as 78.20 & grade 36 emery gives maximum output on 5 mm gap and 170 RPM as 76.06%. Both outputs are utmost for respective wheels, but grade 20 emery gives better quality dal as compared to grade 36 emery. Better quality in the sense of low quantity of crushed grain and waste, proper splitting, good dehulling with shine polish surface on split Bengal gram dal an etc.

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