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DESIGN MODIFICATION OF WHEAT AND BARLEY THRESHING MACHINE

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ABSTRACT

Wheat and barley provide over two-thirds of the human food in Ethiopia, with grain protein content similar to other cereals. In Ethiopia, barley and wheat research to date has focused mostly on breeding and on improving agronomic practices, Mechanization has not been widely researched; conventional methods of threshing wheat and barley crop is done on the special flat ground called 'obdi' which is usually plastered by cow dung. Nevertheless, considerable yield losses are incurred while threshing. The wheat and barley threshing process traditionally is tedious, labor-demanding, and most of the time cause of children out of school while harvesting and threshing. Besides this, as the threshing is done on the ground, the quality of the wheat and barley crop is affected as it can become mixed with the soil, sand, and other contaminants. This affects the market value of wheat significantly as wheat becomes polluted by foreign matter, predominantly minute grains of sand and soil, which are not easy to clean and cause discomfort in the consumption of 'Budena'. Generally, that is why this project focused on developing a complete wheat threshing machine to overcome wheat threshing and cleaning challenges, thereby decreasing tremendous wheat grain post-harvest loss because of the traditional method of threshing and cleaning, due to lack of solely threshing machine of this Ethiopian golden crop. The thresher was evaluated and tested at drum speeds of 700, 750 and 800 rpm and feed rates of 23, 25 and 28 kg/min using simulation software. A split plot method of experimental design was used and the variables were replicated three times and total of 27 observations were used to analyze data. The results showed that the minimum total grain losses of 2.706 %, threshing efficiency of 99.250% and cleaning efficiency of 99.028 were recorded under drum speed of 750 rpm and feed rate of 23kg/min.

Keywords: cleaning efficiency, threshing capacity, threshing efficiency, separations lose.

INTRODUCTION

Agriculture in Ethiopia is the foundation of the country's economy, accounting for half of gross domestic product (GDP), 83.9% of exports, and 80% of total employment. Ethiopia's agriculture is plagued by periodic drought, soil degradation caused by overgrazing, deforestation, high levels of taxation and poor infrastructure (making it difficult and expensive to get goods to market). Yet agriculture is the country's most promising resthisce. A potential exists for self-sufficiency in grains and for export development in livestock, grains, vegetables, and fruits. As many as 4.6 million people need food assistance annually.

Agriculture accounted for 50% of GDP, 83.9% of exports, and 80% of the labor force in 2006 and 2007, compared to 44.9%, 76.9% and 80% in 2002/2003, and agriculture remains the Ethiopian economy's most important sector. [4] Ethiopia has great agricultural potential because of its vast areas of fertile land, diverse climate, generally adequate rainfall, and large labor pool. Despite this potential, however, Ethiopian agriculture has remained underdeveloped. Because of drought, which has repeatedly affected the country since the early 1970s, a poor economic base (low productivity, weak infrastructure, and low level of technology), and overpopulation, the agricultural sector has performed poorly. For instance, according to the World Bank between 1980 and 1987 agricultural production dropped at an annual rate of 2.1 percent, while the population grew at an annual rate of 2.4 percent. Consequently, the country faced a famine that resulted in the death of nearly 1 million people from 1984 to 1986. [5]

Figure-1. Farm.

The world's population now exceeds 6 billion people, consuming a daily average of about 2 700 kcal per caput, compared with a population of 2.5 billion in 1950 and an average daily intake of fewer than 2 450 kcal per caput.[1] This means that, over the last 50 years, the increase in global agricultural production has been 1.6 times greater than the total production level obtained in 1950, after 10 000 years of agricultural history.

PROBLEM OF THE STATEMENT

Wheat and barley provide over two-thirds of the human food in Ethiopia, In Ethiopia, barley and wheat research to date has focused mostly on breeding and on improving agronomic practices, Mechanization have not been widely researched; conventional methods of threshing wheat and barley crop is done on special flat ground that is usually plastered by cow dung. Nevertheless, considerable yield losses are incurred while threshing. The wheat and barley threshing process traditionally is tedious, labor demanding, and most of the time cause of children out of school while harvest and threshing. Besides this, as the threshing is done on the ground, the quality of the wheat and barley crop is affected as it can become mixed with the soil, sand and other contaminants. This affects the market value of wheat significantly as wheat becomes polluted by the foreign matter, predominantly minute grains of sand and soil, which are not easy to clean. Generally, that is why this project focused on developed complete wheat threshing machine to overcome wheat threshing and cleaning challenges, thereby decreasing tremendous wheat grain post-harvest loss because of traditional method of threshing and cleaning, due to lack of solely threshing machine of this Ethiopian golden crop.

OBJECTIVE

General Objective

The main objective of this project work is to design of portable wheat thresher machine in order to change the traditional way of wheat thrashing on the farm.

Specific objective

- To design an appropriate wheat and barley thresher with full analysis.
- Thrashing with Less time taken, with high efficiency, easily operated by both the semi-skilled and un-skilled labors
- To substitute forging currency
- To be suited completely for production by 'village technology' methods
- Should be designed with lightweight and easily portable from place to place.

SCOPE OF THE PROJECT

The scope of this project is to design and to improve the traditional barley and wheat trashing mechanism. The design includes material selection, dimensional analysis, component selection and part fabrication, model/prototype preparation and testing processes.

LIMITATION OF THE PROJECT

The limitation of the project only used for agriculture industry on the farm and also the machine functionalities diesel engine operated system.

SIGNIFICANT OF THE PROJECT

The project provides a way to strengthen small and medium farmers in the country by developing appropriate technology. By doing this, the farmers' competitiveness, productivity, efficient utilization, and innovation capability of farmers is improved; the continuity of these improvements in the future assists the policy and strategy of the country.

Specifically, the project could be useful for the farmers on the farm as well as for the community in the following aspects:

- That is low production time and less consumption of human power
- Easy to manufacture using available materials and easily portable.
- Does not need more skilled person to operate.
- Easy to repair and maintenance.3
- Save time and energy lost during trashing barley and wheat on the farm.
- It requires a small place for production.

LITERATURE REVIEW

Threshing Equipment

Introduction

Threshing is the action of separating the grain, for example of cereals, grain legumes or grasses, from the stalk of the plant. One traditional method of threshing is that of beating the plants with a wooden stick or with a hinged wooden flail, with the heads of the plant inside a sack, or with the unenclosed heads lying on a mud or concrete threshing floor. Another traditional method is to drive cattle repeatedly over the plants so that threshing occurs by the action of the hooves. An improvement on that technique is to use an animal-drawn threshing sledge or threshing rollers. The main problems of these types of animal-powered threshing are fouling, burying, or cracking of the grain. These human and animal-powered methods of threshing are still widely used. [8]

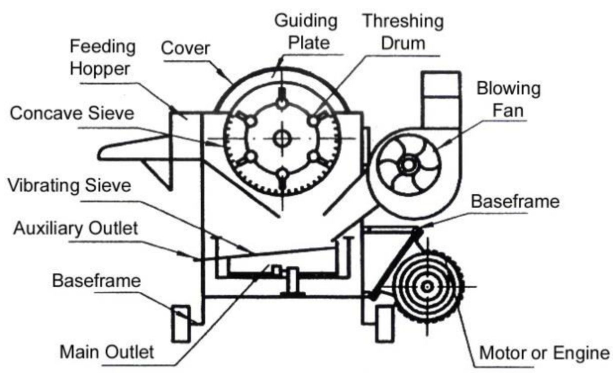

Figure-2. Thrasher machine [5].

Principles and types of threshers

The operation of detaching the grains from the ear head, cob or pod is called threshing. It is basically the removal of grains from the plant by striking, treading or rupturing. The traditional method of threshing using manual labors requires 150-230 man-h/ha. Threshing is normally done after the grain moisture content is reduced to 15 to 17%. In various parts of world, threshing is accomplished by treading the grains under the feet of animals or under the tractor tires, striking the grains with sticks, pegs or loops and removing the grains by rubbing between stone or wooden rollers on a threshing floor or between the rasp bar and a concave of combine. The threshing can be achieved by three methods: Rubbing action, Impact and Stripping.

Threshers are the most important component of farm mechanization. If threshing is not done timely, all efforts made by farmers and inputs given to crop goes wasted. The traditional method of threshing by animal is very slow. It gives low output. Due to low output, the cost of operation is high and there is a huge loss of grains because of rodents, birds, insects, wind, and untimely rain and fire hazards. Wheat threshers overcome these difficulties to a great extent. Wheat threshers are of two type viz. animal-drawn and power threshers.

MATERIAL AND METHODS

Introduction

This chapter covers different aspects of methodology used during the project. It presents the different options available to carry out the study and gives reasons why a particular method was selected at different stages of the project. As a lot of data collection is involved in the project, the way the collection was made can affect the outcome of the project. For this reason, the data collection method selected on the of the project also discussed here.

Data Collection Techniques

Depending on the research perspective and strategy chosen, the researcher must choose methods for collecting data. The data or information collected by the researcher can be either primary, i.e., the researcher collects the material himself, or secondary, i.e. already documented material, which can be done in either quantitative or qualitative way. In this thesis, both primary and secondary data are used.

Methodology

This paper started from observation, gather information and discussion about the design of machine. This discussion covering most part of project time. Then we inform this instructor about the selection of this machine. Then go to literature review about the title. The most important in this manner is a determined the project scope, objective and project planning so that we could easy get a clear overview.

After gathering and collect all related information and obtaining new idea and knowledge about the project would continue with design process. We calculate the force analysis that excreted on the machine by this result we select material type that has to be used to this machine this type of selection is considered:

- The availability,
- Durability, and
- Cost of the material.

In this stage, the knowledge and idea should throw out in sketching process. After several designs sketched, the best design would be chosen from among previous designs so that we could carry on designing process. Then the selected design would be transferred to engineering drawing using solid work and other software.

Methods

a) Data collection (for literature review, method of report writing, material Selection…)

b) Collect the necessary information
- By using the internet
- By asking farm workers
- By make contact with this advisor and instructor in this department
- By visiting farms

c) Work on design calculation for stress and force which are acting on machine.
- By referring books
- By contacting department instructors

DESIGN ANALYSIS

In its simplest terms, design analysis is methods that find physical behavior of a machine member. Will it break? Will it deform? Will it get too hot? These are the types of questions for which design analysis provides accurate answers. Instead of building a prototype and developing elaborate testing regimens to analyze the physical behavior of a product, engineers can elicit this information quickly and accurately on the computer using different software. Because design analysis can minimize or even eliminate the need for physical prototyping and testing, the technology has gone main stream in the manufacturing world over the past decade as a valuable product development tool and has become omnipresent in almost all fields of engineering [6]. In the field of mechanical engineering, design analysis can solve a wide range of product development problems. Engineers can use design analysis to predict the physical behavior of just about any part or assembly under any loading conditions: from a simple beam under a bending load to car crash simulations and vibration analysis of aircraft. The true power of design analysis is the ability to perform any of these types of studies accurately without building a single thing. All that is needed is a CAD model [6].

Design consideration

The machine design should be simple, detachable, efficient and affordable. While designing this machine following points need to be considered.

Reduction in human efforts

As compared to the conventional method this machine should reduce the human efforts and also increase the efficiency of work.

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DESIGN CONCEPTS - THRESHING MECHANISMS, POWER PRODUCTION AND TRANSMISSION

On designing this thresher, things to be considered are; threshing velocity, Pulley Analysis, Belt Analysis, Shaft Analysis, Determination of Power Required to Thresh off Grains from Stalk, Determination of Torque Required to Comb off Grains from Stalk, pulley Arm Considerations and blowers. The - rasp-bar-and wire concave mechanism can be used for almost all crops, provided that clearance stators-to-beaters is correct and that beater speed is correct for the crop being threshed. Threshing velocity refers to the velocity of the beaters, hoops or pegs which strike and rub the heads of grain. Too high a velocity results in breaking or even shattering of the grain and too low a threshing velocity causes insufficient separation of grain. Several power transmission techniques were found chains, V-belts and flat belts. Shock loadings resulted in excessive belt slippage which could have been fixed by increasing drum mass, flywheel effect and angular momentum. This design uses mainly ball bearings. It is better to go for double-metal-sealed (e.g., type 6204.2Z), since they have some protection against dust and lack of lubrication, but they have slightly increased drag and therefore energy loss when compared with unsealed bearings. It is difficult to make proper conclusions without extensive mechanical, field testing, and user acceptability testing. The labor productivity of people operating the machine is expected to be about 1.4 times that of traditional methods, for threshing and for milling.

DESIGN OF WHEAT AND BARLEY THRESHER

Design Analysis

Design matrix

Design matrix a method used to compare the different models according their material property, function, operation, availability, cost required etc. and is used to choose the most acceptable, excellent, preferable, model for design purpose.

Table-1. Design matrix table.

No	Function requirement	Model designation			
		Concept 1	**Concept 2**	**Concept 3**	**Concept 4**
1	Physical functionality				
	Average size of component	3	4	5	5
	Less number of components	2	3	4	4
	Complexity	4	4	4	5
	Weight	3	4	4	4
	Operability	4	4	4	5
2	Mechanical functionality				
	Wear failure avoidance	3	4	4	4
	Fatigue and creep failure avoidance	4	5	5	5
	Deflection, buckling, and jerk avoidance	4	4	4	4
	Corrosion failure avoidance	3	4	4	4
	Reliability	4	4	4	4
	Durability	3	4	4	4
	Stability	5	5	5	5
3	Materials functionality				
	Strength	5	5	5	5
	Availability	3	4	4	4
	Affordability	3	3	4	4
	Manufacturability	5	5	5	5
	Maintenance	2	3	4	5
	Total +ve weight for each of concepts	60	69	73	76
	% Weight	64.5	70	73.5	84.5

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Design Analysis

Design specification
Engine power= 8.3kw
Engine speed= 540-750rpm
Design of v- belt
Reason
1. Center to center distance is small.
2. Very strong
3. Give compactness due to the small center distance of the pulleys.
4. The drive is positive b/c the slip b/n the belt and the pulley groove is negligible.
5. It provides longer life.
6. It can be easily installed and removed
7. Since the v belt is made of endless and there is no joint trouble. Therefore, the drive is smooth.

Characteristics of V Belt drive

Initial cost- cheaper, Maintenance- low, Lubrication – none, Shock absorption- better, Life- longer and Noise- low

Forces or loads- very heavy loads cannot be transmitted under normal conditions
Efficiency = 87-97%.
Assume d_1= diameter of smaller pulley
d_2= diameter of larger pulley
n_1= rpm of smaller pulley
n_2= rpm of larger pulley
Based on the give data let the engine rpm, n_1=750rpm
Drum rpm, n_2=650rpm
From data the drum velocity to be 600-700 rpm.
Now from relation we have the following.
$n_1/n_2=d_2/d_1$
Assume d_1= 200mm
Now, $n_1/n_2= d_2/d_1$ substituting the above values and we get
$D_2= n_1*d_1/n_2$= 230.76mm
Say d_2= 250mm
The peripheral speed the belt is given by:
$V_1= \pi*d_1*n_1/60$
Substituting the above values and we get:
$V_{belt}= V_1 =\pi*200*750/60$=7.85398m/s this is the same with that of the speed of smaller pulley.
Speed of larger pulley is also given by:
$V_2=\pi*d_2*n_2/60$
$V_2= \pi*250*650/60$
V_2= 8.508m/s (peripheral speed of larger pulley)

Design of key for smaller pulley
Assume
Type of key: rectangular key
Material selected: mild steel
σ=560-670Mpa
τ= 320Mpa
FS=3, with τ_{all}=106.7Mpa
σ_{all}= 200Mpa from at shaft diameter d= 25mm, the corresponding values of the key width and thickness are:

From table at shaft diameter, d=25mm the corresponding width and thickness of the key are: w=10mm, t= 8mm
Now the length of the key is obtained by considering the key in shearing and crushing.

Considering shearing of the key (or torque transmitted) of the key.
$T= l*w*\tau* d/2$
$= l*10*106.7*25/2=13337.5*l$
Where $T=60*p/ (2* \pi*N)$
$= 60*9.545/ (2* \pi*N)$ since P=9.545Kw
Calculating this and we get T=121.59Nm
Equating T=13337.5*l
121.59Nm=13337.5*l
L= 9.11mm

Remark: The length of the key should be at least equal to hub length.
Since the hub length is taken as L=50mm
Now the length of the key should be Lk=50mm

Checking the key for shearing and crushing

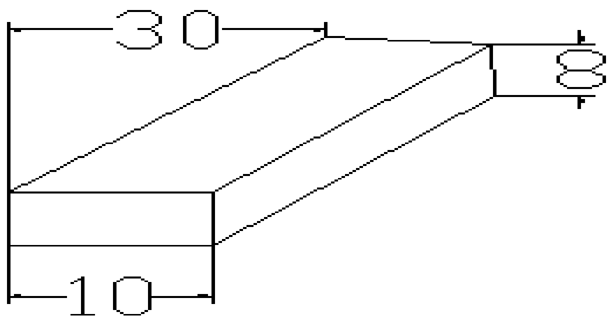

Figure-3. key dimensions.

Let's now check the induced shear and crushing stresses in the key.
Shearing:
$\tau_s= F/A_s$
where F= force applied
d_s= 25mm
A_s= shear area
T= 121.59Nm
F= T/r= 9727.2N
$r=d_s/2 = 25/2$= 12.5mm
$A_s= l*w= 600*10^{-6}$
τ_s= 16.212Mpa.

Since this is less than (16.212Mpa<50Mpa). Therefore, it is safe.
Crushing:
$\sigma= F/A_c$
where A_c= crushing are
$= l*t/2= 40*10^{-6}$
F=9272.2N
Now, σ= 38.63Mpa

Since this is less than (38.63<80). Therefore, design of the key for crushing is safe.

Design of key for larger pulley
Assumption:
Type of key: Rectangular key
Material selected: Mild steel
σ=560-670Mpa
τ= 320Mpa
FS=3, withτ_{all}=106.7Mpa
σ_{all}= 200Mpa from at shaft diameter d=30mm, the corresponding values of the key width and thickness are:

From table at shaft diameter, d=30mm the corresponding width and thickness of the key are: w=10mm, t= 8mm

Now the length of the key is obtained by considering the key in shearing and crushing.

Considering shearing of the key (or torque transmitted) of the key.
T= l*w*τ* d/2
= l*10*106.7=16005*l
Where T=60*p/ (2* π*N)
= 60*9545/ (2* π*650)
since P=9.545Kw
Calculating this and we get T=140.22*10^3
Equating T=16005*l
140.22*10^3= 16005*l= L= 8.76mm
Remark: The length of the key should be at least equal to hub length.
Since the hub length is taken as L=60mm
Now the length of the key should be Lk=60mm

Checking the key for shearing and crushing

Let's now check the induced shear and crushing stresses in the key.
Shearing:
τ_s= F/A_s
where
F= force applied shaft diameter, d_s= 30mm
As= shear area
T= 140.22Nm
F= T/r= 9348N
r=d_s/2 = 30/2= 15mm
A_s= l*w= 600*10^{-6}
τ_s= 15.58Mpa………………ans.

Since this is less than (15.58Mpa< 50Mpa). Therefore, it is safe.
Crushing:
σ= F/A_c
where
Ac= crushing are
= l*t/2= 240*10^{-6}
F= 9348N
σ= 38.95Mpa

Since this is less than (38.95<80). Therefore, design of the key for crushing is safe.

Cap is generally regarded as a simple support beam, supported by holding down bolts and loaded at the center.
A= distance between center of holding down bolts.
W= load supported at the center
l= length of the bearing
t = thickness of the cap

The weight applied on the bearing will be the sum of the
Weight of the beater W_b,
Weight of the pulley $W_{p,}$
Weight of the shaft Ws.
Material for the shaft: steel, ρ_{steel}= 7800kg/m^3
Where W_s = m*g
m= ρ*v
v= A*l
where A=cross sectional area of the shaft
l= length of the shaft
V= π*d^2/4*l
l= 1340mm
d= 25mm
A= 706.86*10^{-6}
V= 947.17*10^{-6}
W_s= 7800*947.17*10^{-6} *10=73.88N
Now at W_b= 111.4N, W_p= 623N, Ws= 73.88N
W= W_b+W_p+W_s= 808.28N
Now the load applied on each bearing is W/2= 404.14N.
Material selected for the cap:
Cast iron with: σ_{ut}=100-200Mpa,τ_u= 120Mpa
E= 100-200Gpa, take E=150Gpa
ρ_{CI}= 7200kg/m^3
FS=4
Maximum bending moment at the center
M=w*a/4
at a= 84mm
σ_{all}= 200/4= 50Mpa
σ_b= M/Z
Z= 169.8.14mm^3
Section modulus of the cap Z= lt^2/6
Z= 169.8mm3
l=d= 62mm
t^2= 16.43mm^2
t= 4.05mm= say t =10mm.

When an oil hole is provided in the cap, diameter of the hole should be subtracted from the length of the bearing.
Cap of the bearing should also be investigated for the stiffness. For simply supported beams at the center the deflection is:
δ= W*a^3/48*E*I where I= l*t^2/12
I= 5166.7mm^4, t= 10mm,
E= 150*10^3Mpa
δ= 0.038mm

In order to design the holding down bolts, the loads on each of the bolts is taken 33% higher than the normal load on each bolt. Load on each bolt (4*W/3*n). [11]

Where n is number of bolts used for holding the cap.
Since there are 2 bolts in this bearing support.
= 4*W/3*n= 4*404.14/3*2=269.43N.

Since the load design for a bolt should be 33% higher than the normal load
Now W= 269.43N+.33*269.43N=358.34N.
From this
[π *dc^2*σ_b/4=4*W/3*n]
d_c= core diameter of the bolt
σ_b= tensile stress for the material of the bolt.

For the bolt material σ_b= 100/4= 25Mpa
with SF=4
Calculating the above and solve for dc,
d_c= 3.49mm. Say d_c= 14mm from standard the corresponding dimension will be M18 coarse series
Pitch 2.5mm
Major diameter of nut and bolt d=D= 18mm
Nut d_c= 15.294mm
Bolt d_c= 14.933mm
Depth of thread (bolt) =1.534mm
Stress area 1925mm2
Total required number
Bolts= 4 (through bolt type)
Bearing caps= 2
Stresses in screwed fastening due to static loadings
Initial stress due to screwing forces

1. Tensile stress due to stretching of the bolt. The maximum safe axial load which may be applied is:

P_{safe}= permissible stress * area A at the bottom of the thread or stress area.
The stress area is given by: A= $(\pi*(d_P+d_C/2)^2)/4$ where d_p, dc are pitch and minor diameter of the thread.
A= $(\pi*(d_P+d_C/2)^2)/4$= 192.47mm^2
P_{safe}= σ_{all}*A= 3849.5Mpa…………………….ans.

2. Torsion shear stress causes by the frictional resistance of thread during tightening.

τ= $16*T/(\pi*d_c^3)$ where d_c= min diameter of the thread.
The torque transmitted
T= 60*p/2* π*N= 121.937Nm
d_c= 14.933mm
τ = 0.186Mpa

3. Shear stress across the threads.

For screw (bolt) τ_{sb}= p/ π*d_c*b*n where b is width of the thread section at the root.b= p/2= 1.25mm,
n is number of threads, n= 7
Where d is major diameter of the nut, d_{cb}= 18mm
Substituting the above values and we get:
τ_{sb}= 9.37Mpa………………ans.
For the nut τ_{sn}= p/ π*d*b*n at d_{cn}= 15.294mm
τ_{sn}= p/ π*d*b*n= 9.156Mpa……………………..ans.
4. Compression or crushing stress on threads
σ_c= $4*p/((\pi(d^2-d_c^2)*n)$
(d) major dia.=18mm
$d_c$minor diameter= 14.933mm,
n =number of thread, 7
σ_c= 6.93Mpa………………………..ans.

4. Bending stress is negligible, since, the surfaces under the head or nut is perfectly parallel to the bolt axis.

Stress due to external forces

1. Tensile stress

External load applied p= $\pi/4*(d_c^2*\sigma_t)$
d_c internal diameter of the thread.
σ_t= permissible tensile stress
σ_t= 4p/ π*dc^2*σ_t=21.977Mpa

2. shear stress

Shearing load carried by the bolts
P_s= $\pi/4*d^2*\tau*n$
d major diameter, n number of bolts
τ permissible shear stress (coupling bolts or bearing)
d= 18mm
τ= 2.16Mpa……………………ans.
Maximum shear stress τ_{max}= $\frac{1}{2}*\sqrt{\sigma_t^2+4*\tau^2}<|\tau|$
= 11.19Mpa < 30Mpa therefore it is safe.
σ_{max} $=\sigma_t/2+1/2\sqrt{\sigma_t^2+4*\tau^2}<|\sigma|$
= 21.979/2+11.19
22.18Mpa< 25Mpa.Therefore it is safe.

Material Selection for Critical Components

Selecting the right material for the machine can fulfil the functional requirement for the specific part is very important. We use to select the suitable material we follow the digital logic methods.

The steps for digital logic methods are:-

- Set the functional requirements for the part under consideration. This are used to set rating factor;
- Rank the rating factors (properties) then determine the weight factors;
- Total number of decision /N/= $n(\frac{n-1}{2})$ Where n number of rating factors/properties/
- Write the most suitable candidate materials and enlist properties from standard data table/the data quantitative or qualitative/
- Normalize the outcomes of the parts;
- Value outcomes and overall satisfaction of parts. The overall satisfaction shall at last ranked, and the ranked shows the result on the basis of the allocated weight factors which gives the best overall satisfaction for the functional requirements of the part.

Manufacturing Processes

This portion addresses the process and Operation sheet for critical components of the project.

The manufacturing process is part of the production process which is directly concerned with the change of shape or dimensions of the part being produced. It is usually carried out as a unit operation, which means that it is a single step in the sequence of steps required to transform the starting material into a final product. Each part or component of a product must be designed so that it is not only meets design requirements and specifications, but also can be manufactured economically and with relative cost.

General steps to manufacture components of the machine: -Take the material for the component according to the design consideration. Check the selected diameter (dimension) to assure by proper measuring tool. Mark the selected material to the recommended dimensions (layout). Select the appropriate machine or tool for cutting the material to prepare the rough dimension.

Hold the selected material in the selected machine or tool to make the rough dimensions.

Perform the operation within the recommended and measured dimensions on the marked line with allowance.

Manufacturing Operation

It is series of operation in which components are manufactured in their sequential order. Manufacturing operations can be divided into two basic types:-

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a) Processing operations and

b) Assembly operations

A processing operation transforms a work material from one state of completion to a more advanced state that is closer to the final desired product. It adds value by changing the geometry, properties, or appearance of the starting material. In general, processing operations are performed on separate work-parts, but certain processing operations are also applicable to assembled items (e.g., painting a spot-welded car body). The processing operation is done by using operation sheet which is the best & simplest way of showing how the part is manufacture through different steps to complete the work. Therefore, process operation of this project is explained by using operation sheet.

An assembly operation joins two or more components to create a new entity, called an assembly, subassembly, or some other term that refers to the joining process (e.g., a welded assembly is called a weldment).

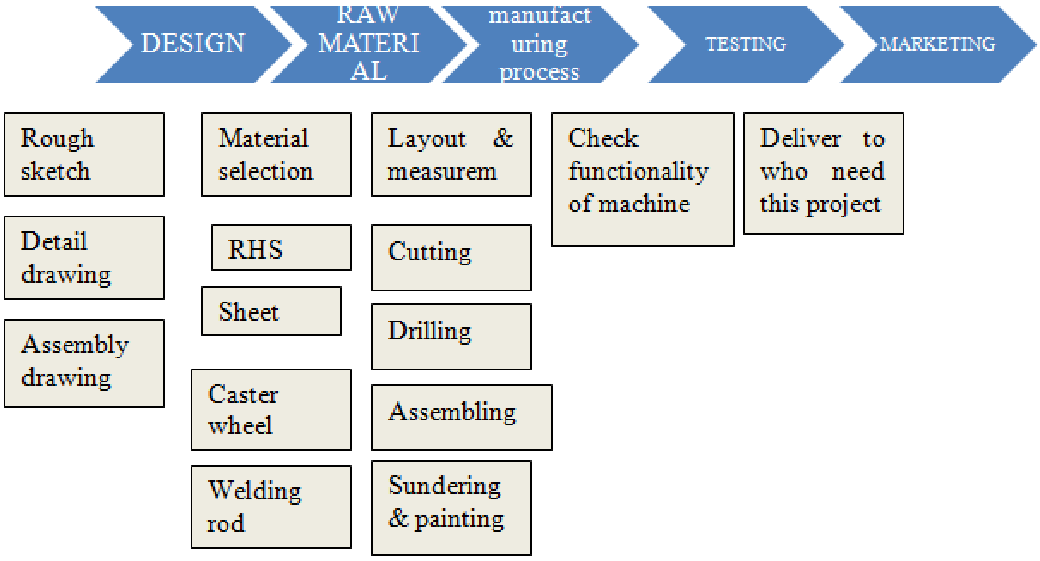

Figure-4. Manufacturing chart.

Figure-5. Rendering image thrasher.

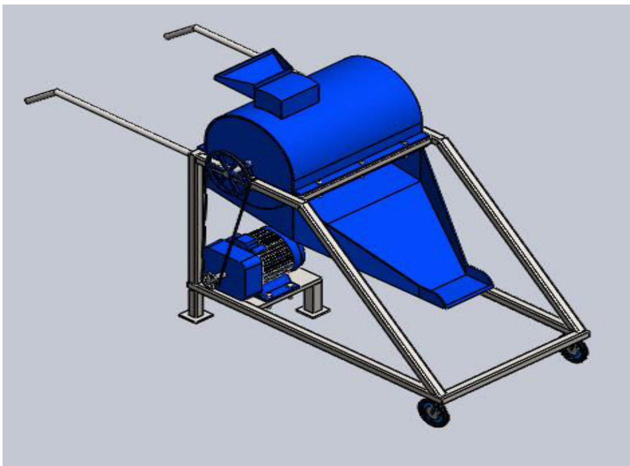

Figure-6. Assembly drawing of the thresher.

RESULTS AND DISCUSSIONS

The threshing losses are affected directly by different operating parameters such as feed rate, threshing drum speed, etc.

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Drum Losses

Generally, the threshing losses expressed as drum losses which represent un-threshed seed losses increased by increasing feed rate and decreased by increasing threshing drum speed. From the table of ANOVA drum or threshing lose is highly significant with drum speed and feeding rate and also significant with the combination of drum speed and feeding rate as well as not significant with replication and combination of replication with two independent variables at significance level of ($p < 5\%$). Increasing feed rate from 23kg to 28 kg at drum speed of 700 rpm increased the drum losses from 1.564 and 2.501 respectively.

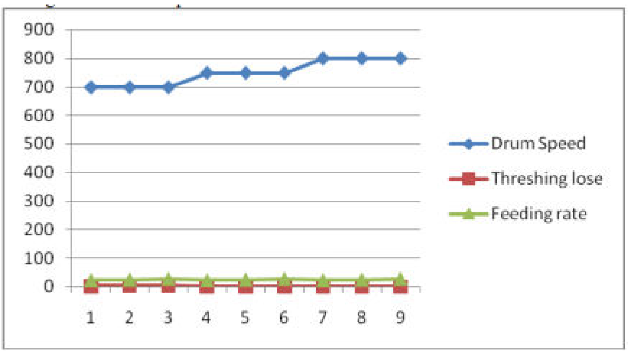

Figure-7. Threshing lose with feeding rate and drum speed.

The increase in the percentage of drum losses by increasing feeding rate is attributed to the excessive plants in the threshing chamber. Consequently, plants leave the device without complete threshing which tends to increase drum losses. While the vice-versa was noticed with drum speed. Increasing drum speed from 700 to 800 rpm at feed rate of 23 kg/min decreased the drum losses from 1.564 to 0.340% respectively. This decrease is due to the more adequate time to separate seeds from the straw. The result obtained agreed with Gol and Nada (1991) which concluded that the important factors affecting the efficiency of mechanical threshing element are operation speed and crop conditions.

Separation Losses

The separation losses increased by increasing both feed rate and drum speed. An ANOVA table shows that separations lose is highly significant with feeding rate and drum speed. Increasing feed rate from 23 to 28 kg/min at drum speed 700 rpm, increased the separation losses from 1.25 to 2.035 respectively. This increase is attributed to the excessive plants in the threshing chamber, it gives the opportunity to the threshed plant to stay on the cleaning without blown in other ways while the drum speed is increased from 700 to 800 rpm the separation loses increase from 1.254 to 3.090 respectively 23kg /min feeding rate. When the drum speed is increased the shaking action of the cleaning part is increased that makes the grain thrown out, as well as assisting the fan blower to blow the grain out

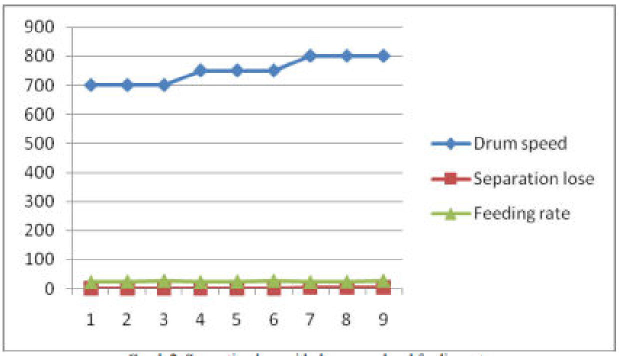

Figure-8. Separation lose with drum speed and feeding rate.

The increase in the percentage of separation losses by increasing drum speed was attributed to the high threshing and impacting forces applied to the plants.

Threshing Efficiency

The threshing efficiency is affected by different operating parameters such as feed rate and threshing drum speed. From ANOVA it is clear shown that threshing efficiency is highly significant with both feeding rate and drum speed. As shown in mean table or graph 4, increasing drum speed from 700 to 800 rpm, the threshing efficiency of the machine is increased from 98.460 to 99.661% at a feeding rate of 23kg/min. As well as when the feeding rate is increased from 23 to 28kg/min at a constant drum speed of 700 rpm, the threshing efficiency of the machine decreased from 98.460 to 97.56% respectively. The decrease in the percentage of threshing efficiency by increasing the feed rate is attributed to the excessive plants in the threshing chamber. Consequently, the seeds leave the device without completely threshing the grain from the head. So that the grand mean of the threshing efficiency of the machine at the two independent variable range was 98.905%. ElHadad (2000) stated that the threshing efficiency increased with increasing drum speed and decreasing feed rate.

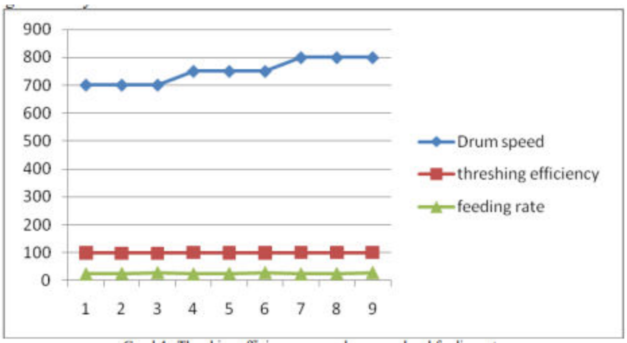

Figure-9. Threshing efficiency versus drum speed and feeding rate.

Threshing Capacity (TC)

From ANOVA table the threshing capacity of the machine is highly significant with both drum speed and feeding rate and not significant with replication and any

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combination of the independent variables. As the feeding rate increased from 23 to 28kg/min at constant drum speed of 700 rpm the threshing capacity increased from 314.1 to 366.9kg/hr respectively. The total grand mean of threshing capacity of the machine is 428.9kg/min. The grain straw ratio of the crop highly affects the threshing capacity of the machine. During the performance evaluation of the machine the average grain straw ratio observed was 27%.

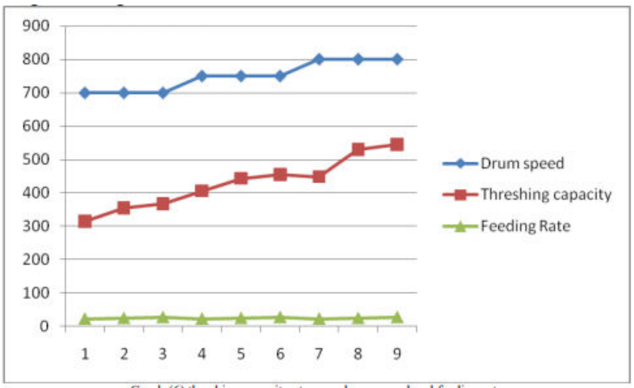

Figure-10. Threshing capacity at range drums speed and feeding rate.

CONCLUSION AND RECOMMENDATION

Conclusions

It is with full confidence to say that this machine will do effectively and lighten the burden of this poor farmer's duties if is proper manufactured with the described design specifications as this is done from the outset by looking and tracing the problems the actual machine.

The machine described in this report will effectively thresh wheat and barley using a power of 8.3KW with 750 rpm of motor speed. And also thresh sorghum. This crop normally requires a spike tooth type mechanism). This design can be modified to provide all the necessary equipment's such as, gear box (speed reducer), sieves and some necessary modified dimensions with this number of belt strands. This machine is suitable for all farmers in Ethiopia who are suffering with traditional way of threshing device.

The labor productivity of people operating the machine is expected to be about 1.4 times that of traditional methods, for threshing. The machine should pay for itself within a reasonable time period depending on utilization of

The machine is suited completely for production by 'village technology' methods, since no components require high levels of technical equipment and skill. It would appear that the use of a wheat and barley thresher multiplies labor productivity by factor of 2.3 over hand threshing.

Recommendation

a) The design is done on certain reasonable assumptions such as disk dimension, small pulley dimension, number of gear tooth, number of tongs, beater dimension etc. so that these concepts should be carefully taken in to consideration as they bring significant change in the overall performance of the wheat and barley thresher.

b) During installation, production, and threshing of the components great care should be taken to maintain the results of the design.

c) Since modern threshers in Ethiopia is not that much therefore further investigations should be taken to improve this threshing mechanism (machines) for further improvement.

d) Since this thresher is not require highly skilled person to install, operate therefore every farmer should be trouble free on buying, working and using this thresher.

e) The clearance between the inlet and concave will be 33mm and the out let clearance will be 25mm. As obtained from actual data.

f) The crops must be dry, in order to be threshed well by the machine, but in this case, it do not lose its moisture content.

g) Concave clearance will be 11mm with each diameter of 10mm irons and total of 28 tongs.

h) The sieves should be inclined at 7^0 during assembling.

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