ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

School Of Mechanical, Chemical and Material Engineering

A Project thesis

On

DESIGNING AND MANUFACTURING OF ANIMAL DRAWN TEFF ROW PLANTER MACHINE

A Thesis/project submitted in partial fulfillment of the requirement for the award of the degree of

Masters of Science

in

Manufacturing Technology Teachers Education

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DECLARATION

We hereby declare that the work which is being presented in this project entitle "**ANIMAL DRAWN TEFF ROW PLANTER MACHINE** ", is developers original work and has not been presented for a diploma /degree of any other Institution/University and we have acknowledged and referenced all materials used in this work.

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This is to certify that the above declaration made by the candidates is correct to the best of my knowledge and belief. This project has been submitted for examination with my approval.

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Abstract

The existing teff planter machine had three furrow openers, two hopper divisions for seed and fertilizer, no clutch on the ground wheel to minimize wastage during turning. A project was carried out on design and manufacturing of animal driven teff row planter machine by selecting the best parameters from previous model studies. The machine design analysis was made for critical elements of the machine, proper local standard materials were selected, and manufacturing process had been explained for basic machine components. The purpose of this machine is to plant the seed teff and applies fertilizer effectively and uniformly and cheaply in the growth stages of teff. The machine consisted of trapezoidal frame, trapezoidal seed and fertilizer hopper , seed and fertilizer metering device, four furrow openers with depth control provision, ground wheel with chain and sprockets for transmitting power to the metering mechanism, Seed delivery tube, seed covering device and clutch for disengaging power to the drive wheel during turning. The seed and fertilizer hopper was made trapezoidal shape with height of 215 mm, upper side 800×310 mm, bottom side 800×130 mm and made up of steel sheet which includes four sub small sections carrying seed and another four sub small sections carrying fertilizer. The cup feed mechanism was selected for metering teff seeds as there is no seed damage and hence does not affect germination. For fertilizer metering, orifice type mechanism was provided. The Comparative performance of the new row planter technique incorporated in the designed planter was compared with traditional hand broadcasting method. Finally manufacturing, assembling testing of different components, Seed rate of the machine is 4.58kg/ha, there was no damaged seed caused by metering mechanism, theoretical field capacity, effective field capacity and field efficiency was considered as criteria for evaluation of the designed planter and the selling price of the machine is 9819.30 birr.

Key words: *Teff row planter, furrow opener, metering mechanism and seed and fertilizer hopper.*

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ABBREVIATIONS, SYMBOL AND ACRONYMS

ADLI	Agricultural Development Led Industrialization
AISC	American institute of steel construction
ASTU	Adama Science and Technology university
ATA	The Ethiopian Agricultural Transformation Agency
Br	Birr
CBA	Cost-Benefit Analysis
CSA	Central Statistical Agency
DFM	Design for manufacturing
DIA	Diameter
EELPA	Ethiopian electrical light and power authority
GC	Gorgonian calendar
GI	Galvanized iron
GOE	Government of Ethiopia
Ha	Hector
HSS	High speed steel
Kg/m3	Kilogram per meter cubed
KWH	Kilo watt hour
L	Length
MM	Millimeter
Mpa	Mega Pascal
MS	Mild steel
MT	Metric tons
Mt/ha	Metric tons per hector
N	Newton
No.	Number
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
Pcs	Pieces
Pkt	Packet
q/t	Quintal per hector
Qt .	Quintal

R	Radius
SAE	Society of automotive engineering
SHS	Square hollow steel
SMEs	Small and micro enterprises
St.	Standard
V. Caliper	Vernier caliper
%	Percentage

CHAPTER-ONE

INTRODUCTION

1.1 Background

Teff has enormous potential for growth as it has been given very little attention in research (especially plant breeding), development and public support. Teff's scientific name is Eragrostis teff (Zucc.) and is believed to have originated in Ethiopia. Currently, teff is cultivated as a forage crop in countries like Australia, India, Kenya and the Republic of South Africa with limited human consumption in USA. The crop is the second most widely produced and consumed cereal in Ethiopia. According to Seyfu , teff has remained an important crop to Ethiopian farmers for several reasons, namely: the price for its grain and straw are higher than other major cereals; the crop performs better than other cereals under moisture stress and waterlogged conditions; its grain can be stored for a long period of time without being attacked by weevils; there is no disease epidemic that has threatened its performance; 'Injera' made of teff flour is a staple diet of most Ethiopians, while the straw provides a nutritious feed for cattle; finally, the straw is used as a house plastering material. CSA data over the past few years show that teff ranked first in terms of area coverage (accounting for 28% of the area) and is second to maize in terms of volume of production among cereals, accounting for about 20% of the total produce in the category [1].

The average growth rate of Meher (main rainy) season production of teff over the past few years has been around 11% per year, according to the CSA. Increased productivity is believed to contribute about 6% of the growth while about 5% was attributed to expansion in area cultivated to teff [1].

Teff is likely to remain a favorite crop of the Ethiopian population and the crop is also gaining popularity as a health food in the western world. Studies show that teff is a gluten free crop, which makes it suitable for patients with celiac disease [2].

1.2 Statement of the problem

It is well known that broadcasting of teff and applying of fertilizer is done by hand in Ethiopia and there are some experiments to manufacture the teff row planter machines in research centers .Since these machines are not yet distributed to the farmer the yield of teff per hectare remained low. In team study observation and discussion the following problems have been seen:-

- Lack of uniform distribution of teff and fertilizer in the farm;
- Waste of seed teff as the amount hand broadcasted is higher to overcome un even distribution to bring overlapping of teff sown ;
- Requires higher man power to broadcast;
- Loss of more energy due to ergonomical problems;

Application of planting of teff is still performed largely by traditional methods in Ethiopia. Farmers normally use hand-broadcasting method for broadcasting teff. In this method, teff cannot be uniformly distributed in the field. As a result low efficiency and high cost are being incurred. To obtain satisfactory crop yield one should plant particular amount of teff in a given area uniformly. The principal disadvantage of traditional hand-broadcasting method is the non-uniform distribution of material and thus non-optimal use of resources. Furthermore, it requires experienced manpower to broadcast. It was expected that spreading of teff by mechanical means could be more uniform and achieve high field capacity compared to traditional hand broadcasting. So it is necessary to design metering device broadcaster to solve the problem to get uniform mass distribution of teff in the field, increasing the yield and also reducing machinery cost it can be also used for fertilizer broadcasting.

So by considering the above problems, developers propose to design and manufacture teff row planting machine by modifying the above problems.

1.3 Objectives of the study

1.3.1 General objective

The general objective of this project is to fabricate animal drawn teff planter machine which is useful for planting seeds applying fertilizer, covering the seeds and fertilizer with soil, all at a time.

1.3.2 Specific objective

The specific objectives of this project are as follows:-

- ❖ Design and development a metering device type broadcaster.
- ❖ To fabricate and test the designed planter for evaluation.
- ❖ To develop the seed tube to drop the seed in furrow.
- ❖ To design and develop covering device to cover the seed

1.4 Scope of the project

- ❖ To make the machine effective and efficient, design analysis is made for critical elements of the machine, proper local standard material should be selected, and manufacturing process should be explained for basic machine components.
- ❖ Producing 2D and 3D standard production drawing.
- ❖ Manufacturing the real object with optimum cost and testing the effectiveness of the machine.

1.5 Significance of the project

The significance of this project is: -

- ❖ To increase production and productivity of teff and the income of small scale framers.
- ❖ To minimize wastage of seeds, labor cost and save time.
- ❖ To reduce foreign currency for importing the machine.
- ❖ To encourage technology transfer in Ethiopia.

1.6 Beneficiary of the project

The beneficiaries of the project are small scale farmers and SMEs.

1.7 Limitation of the project

- There is no enough research works and materials on teff row Planter machine;
- Limited budget and time constraint;
- Shortage of accurate machineries;
- Language problem during interview and discussion with farmers.

1.8 Organization of the project

Chapter one describes a general introduction of the Thesis and the project. Chapter two reviews literatures about particles of teff row Planter machine. Chapter three presents data collection and analysis. Chapter four presents machine parts design, the design analysis of the critical components of the machine and material selection. Chapter five covers manufacturing process of the machine and assembly of the components. Chapter six deals with Product cost analysis and operational and maintenance instructions of the machine. Chapter seven cover result and discussion. Chapter eight give a short recommendation and conclusions.

1.9 Working principles and feasibility of the project

1.9.1 Technical feasibility

The animal driven teff row Planter machine will be manufactured using simple mechanisms. Unlike any of the other alternatives, the machine uses locally available materials. Another advantage of using locally available parts is that the animal driven teff row Planter machine is easy to repair and parts can also be replaced easily if it is necessary because they are available in the market .It is mechanically simple enough that any seed planter repair shop would be able to service the machine. Therefore, by taking these points in to consideration the animal driven teff row Planter machine is technically feasible.

1.9.2 Operational feasibility

Animal driven teff row Planter machine will have simple mechanisms. This makes it simple to operate. Any person with small skills can operate the machine by taking a one day training. The seeder machine is animal driven. Hence the machine is operationally feasible.

1.9.3 Economic feasibility

Since the materials and parts are available in the market in abundance, they can be purchased with a reasonable price. In general the cost for manufacturing the machine is reasonable.

Therefore any small scale farmers that want to broadcast teff and to use for themselves and provide products the market can afford to buy the animal driven teff row Planter machine with a reasonable price. Due to these reasons this machine is economically feasible.

1.9.4 Efficient

It is much more efficient to animal driven teff row Planter machine than to use by hand. The machine requires less energy and man power when compared to traditional one.

1.9.5 Affordable

The target buyer of the machine is small scale farmers. Since the machine can be driven or operated by animal, it can be used everywhere both rural and urban when the land is prepared for sowing.

The machine is also inexpensive to operate because the user does not need to pay for high man power. This is especially important in places where the man power is extremely expensive.

CHAPTER -TWO
LITERATURE REVIEW

2.1. Introduction

Teff is Ethiopia's most important staple crop. Teff has the largest value in terms of both production and consumption in Ethiopia and the value of the commercial surplus of teff is second only to coffee .However, despite its importance in Ethiopia, teff yields are low. In the production year 2012 -2013, yields were 1.4 metric tons (mt) per hectare (ha), significantly lower than other cereals, such as maize (3.1 mt/ha), sorghum and wheat (both 2.1 mt/ha). This low teff yield is seemingly explained by the limited knowledge about possible avenues for improving teff productivity, combined with problems inherent to teff botany. Teff research has received limited national and international attention, the latter presumably because of its localized importance in Ethiopia [2].

Moreover, teff yields are low because of agronomic constraints that include lodging, low modern input use, and high post-harvest losses. Recently it has been argued that the traditional sowing technology is a major constraint to increased teff productivity. Farmers typically plant teff by broadcasting, scattering teff seed by hand at a high seed rate. Alternative planting methods, such as row planting seeds or transplanting seedlings, in which the seed rate is reduced and more space between plants is given, are seen as being superior to traditional broadcasting. Experiments on these alternative planting methods in controlled settings have shown large and positive impacts on teff yields. As a consequence, in 2013 the Ethiopian government rolled out a nationwide campaign to promote the use of improved technologies for teff production, including row planting, aiming to scale up their adoption to almost 2.5 million teff farmers. However, the impacts of the widespread promotion campaign of row planting of teff, in particular, on land and labor productivity are unknown. This is mainly due to a lack of reliable and objective farm level data. Moreover, no systematic effort has yet been put into examining farmers' perceptions after they experimented with the new sowing techniques [2].

Patterson and Reece (1962) investigated the motion of spherical particles on a spinner with a near-center fed neglecting particle bounce off of the spinner vanes. They developed analytical models for on-spinner particle motion and found reasonable agreement between their models and experimental measurements of the radial and total velocities of steel ball bearings leaving the spinner plate as well as the angle between where particles are dropped and where they leave the spinner plate.

Tajuddin (1989) designed, developed and tested a hand rotary-broadcasting device for broadcasting seeds, fertilizers and granular insecticides in laboratory and field. The uniformity co-efficient of distribution was determined for spreading urea using the broadcasting device and compared with that of the hand broadcasting process. The device's coverage was 1.26 ha/hr in paddy. The unit had a weight of 3.6 kg and cost of US$ 55 and average Uniformity Coefficient of Distribution was 50 % (Tajuddin, 1989)

These previous investigations have showed that how to model the dynamics of particles distributed by a spinner disc spreader and also prepare the necessary information for the design of spreader using particles trajectory.

Hofstee (1994, 1995) utilized an ultrasonic transducer to determine the velocity and direction of particles leaving a spinner spreader. He found that the friction coefficient between a particle and the spinner plate and vane is a significant variable; however, obtaining representative values for this variable for use in on-spinner models is difficult.

Aphale et.al, (2003) conducted experimental and analytical study to investigate particles trajectories on and off spinner spreader. They use sixteen different granular fertilizers the experiment data for on spinner trajectories generally lie between the analytical models for the pure rolling and pure sliding condition using a sliding friction coefficient of 0.5.

The contribution of this paper is to analyze the impact of the promotion campaign of row planting of teff on land and labor productivity and infer farmers' perception about the new planting technique and the promotion thereof.

2.2. Physical properties of Teff

Zewdu and Solomon investigated that the physical properties of teff seed in the moisture content of 5.6% to 29.6%. The length, width and equivalent-sphere diameter of teff seeds increased from 1.01 to 1.27 mm, 0.59 to 0.68 mm and 0.71 to 0.87 mm, respectively.

Zewdu and Solomon further conducted experiment on teff seed and they found that the Sphericity decreased from 0.70 to 0.63 with increase in the moisture content from 5.6% to 21.43% and increased to 0.69 with further increase in moisture content to 29.6% and the thousand mass of teff seed increased from 0.257 to 0.421 g with the corresponding increase in moisture content. According to Zewdu and Solomon they found that the bulk and true densities of samples decreased with increase in moisture content .A decrease from 840 to 696 kgm^{-3} and 1361 to 1207 kgm-3 was observed for bulk and true densities, respectively, in the moisture content range studied.

Zewdu and Solomon they conducted experiment on the moisture-dependent properties of teff seed and they found that the angle of repose change as the moisture content increase. Arise in moisture content from 5.6% to 29.6% w.b resulted increment of angle of response 23.740 to 51.60 .Angle of repose is the maximum slop at which stack of any losses or fragmented bulk material will stand without sliding. The coefficients of friction of teff seed was changed from 0.29 to 0.53 on mild steel as moisture content increase from 5.6% to 29.6% respectively.

2.3. Sowing

2.3.1. Introduction Sowing

Sowing takes place in the same period as soil preparation, or just after. Conversely to hand sowing, mechanical sowing makes it possible to achieve a good regularity of seed distribution. The objective is to place seeds in optimal conditions to use natural resources (light, water, minerals), and achieve a uniform distribution of seeds. Sowing density and pattern depend on the varieties and species concerned and on environmental conditions.

Sowing effectiveness varies with the conditions of seedbed preparation (importance of tillage), and use of sowing implements (depth adjustment, row and seed spacing, appropriate choice of the feed system) [15].

Using animal-drawn seeders may be impossible, for instance, in ridge cultivation because of the lack of appropriate equipment. It proves also poorly suitable for mixed cropping (different seed sizes and sowing densities). Among the various sowing techniques applied with cultivation in flat ground (the most common method of soil preparation), some can be performed with animal-drawn implements as dibbling and row seeding (or drilling).
Drilling can be carried out with multiple-row seeders (3 to 9 rows). With such equipment, it is possible to control row spacing, seed rate and covering. These seeders are of little use in sub-Saharan Africa because of their high cost and also because soil preparation and seeds are poor in quality. For a seeder with a 1–1.5 m working width, pulled by a pair of oxen, the working time is between 3 hours and 5 hours per hectare [15].

Precision seeding assumes evenness in seed or pocket spacing in the row. In sub Saharan Africa, one-row seeders pulled by a single animal are the most widely used implements for dibbling grain crops (maize, millet, sorghum), and also with single seeders for groundnut and cowpea . Light, simple, robust and low in cost, these seeders require good working conditions: conveniently loosened soil, without weeds or plant residues; well-adjusted equipment, and appropriate feed system; clean, sorted and graded seeds; and a 0.8–1.1 m per second working speed. Pulled by a donkey or a horse, their working time is between 4 hours and 6 hours per hectare. With several draft animals, two or more seeders can be combined [15].

Direct seeding consists of dropping the seeds into a furrow open with a coulter or a disk, without previous seedbed preparation. Although rarely used in animal traction, the technique is increasingly appreciated in light soils by cotton companies in southern African countries (e.g., Zambia, Zimbabwe, Tanzania), and in Brazil as well. Because good weed control is required, herbicides are used in high rainfall areas [15].

2.4. Seeders and Planters

2.4.1. Introduction

Seeders and planters are essential for the reproduction of crops. Their function is metering and placing in the soil of seeds or plants or of parts thereof. Thus, seeders are used for generative reproduction, whereas planters aid in vegetative propagation. However, in some parts of the world, the term planter is used for a seeder. Both seeders and planters are either used as solo machines or in combinations with preceding soil cultivating machines. In some cases, combinations with fertilizing equipment also are common [15].

2.4.2. Seeders

Generally, seeders comprise one or several hoppers, which contain the seeds of metering parts, and of equipment for seed placement in the soil. The metering either aims at equidistant spacing of the seeds or is restricted to feeding a stream of seeds into a conveying tube. The former case can be defined as precision seeding, whereas for the latter case, the term bulk seeding might be appropriate. Since in most cases the seeds are placed in a row, the definitions of precision drilling as well as bulk drilling make sense.
Precision drilling is used mainly for rather widely spaced crops, such as corn, beans, sugar beets and sunflower. With closely spaced crops, precision drilling is too expensive and therefore bulk drilling common [15].

2.4.3. Comparative performance of in line animal driven seed and fertilizer seeder with hand sowing methods

Energy saving

It was reported that by using three row animal drawn ferti-seed drill for wheat crop ,a saving of 76.37percent man hours and 59.92 percent animal -hours was obtained when compared with the behind the plough sowing .(Mehtaand Varshney,1970) Sing h(1971)

Revealed that by using aferti-seed drill for wheat crop, a saving of 69.96 percent in man-hours and 55.17 percent in animal hours was achieved when compared, with the conventional method.

Sharma e tal. ,1989 studied that the animal drawn mechanical sowing has resulted in 49.19 percent savings in energy In comparison with the traditional method of sowing wheat crop.

Rahama and Hussein, 1993 reported that the amount of labor required for the planting operation using the traditional method was greatly reduced with tin: use of animal drawn plough-seeder .The reduction recorded 83 percent and 50 percent in the case of sorghum and groundnut respectively.

Cost saving

Singh (1971) reported that using a ferli-seed drill for wheat crop reduced the cost of sowing by roughly about one-fifth of the conventional method .

Awadhwal etal , (1987)reported that the use of a wheeled Tool carrier saved the cost (23-39percent)of sowing and fertilizer application when compared with die traditional implements.

2.5. Survey on Existing Planting method

2.5.1.Traditional broadcasting method

Traditionally, farmers broadcast teff seed using a high seed rate of between 25 and 50 kg per hectare. It is argued that this practice (Figure 2.1) reduces yield because the uneven distribution of seed increases competition between teff plants for water, light, and nutrients, and makes weeding more difficult once the plants have matured. As a solution, it is recommended to reduce the seed rates and to plant in rows (Figure 2.1) or, alternatively, to transplant seedlings from a nursery plot. Reducing the seed rate to 2.5–3.0 kg per hectare reduces competition between seedlings and allows for optimal tillering or branching out of the plants. By row planting or transplanting, land management and especially weeding can be done more easily. The incidence of lodging is also found to be reduced, as the stem of row planted teff is better able to support the weight of the filled head of grain [1].

Figure 2.1Teff sowing practice using traditional broadcasting (left) versus row planting (right) [2]

Ethiopian farmers use the method of hand broadcasting for sowing teff seeds. This is mainly due to the very small seed size of the seeds of the crop which makes row planting difficult. Typically, the farmers apply between 25 to 50 kgs of teff seeds per hectare. In addition, in order to enhance germination, teff needs moderate soil compaction to make the seedbed firm and flat so as to prevent the soil surface drying quickly which causes seed desiccation. In most parts of the country, soil compaction of teff field is done using cattle, sheep, goats and/or donkeys and sometimes humans [1].

Figure 2.2 Traditional broadcasting and covering of teff seed [2].

2.5.2. Manually Row planting method

Manually row planting method requires substantial increase in labor input when adopting row planting. Figure 2.3 shows the observed results of the effect of manually row planting on the labor required for the different operations involved in teff production. As expected, additional labor input is needed for sowing the seeds and applying the fertilizer. In order to plant one hectare of teff, the total person-hours needed for row planting the seed is more than one third higher than for traditional broadcasting.

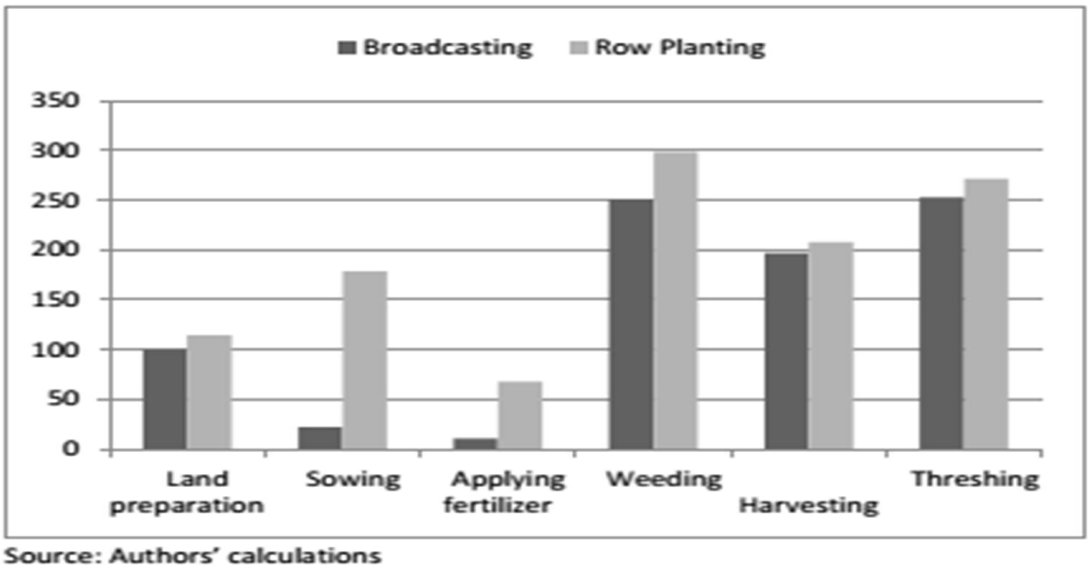

Figure 2.3 Effect of promotion of row planting on teff production labor requirement (in person-hours per hectare), by operation [2].

It is estimated that row planting requires an additional 43 person-days of work per hectare compared to traditional broadcasting. Row planting not only increases total labor requirements, but it significantly decreases labor productivity. This suggests that farmers employing row planting need to invest more labor in the teff production process to achieve the same output in grain as they obtain from broadcasting. This finding is fundamental, as the most important determinant of farmers' adoption of a new agricultural technology is not the increase in land productivity, but the increase in labor productivity associated with the technology [1].

Figure 2.4 Manually teff   row planting method **[2].**

2.5.3. Imported broadcaster machine

The imported broad caster the picture below shows it has two hopers the seed hopper is on the rear side and the fertilizer hopper is towards the front side. However, both are attached side by side and are of trapezoidal shape. The two hopers increase in the weight and the power transmition will be from wheel to shaft and from wheel shaft to seed metering shaft and to fertilizer metering shaft this mechanism is complicated and have high cost [1].

Figure 2.5 Imported type broad caster machine [14].

2.5.4. Local animal drawn planter fabricated at Awash Melkasa Agricultural research center.

While row planting is considered as one of the potential techniques to increase yield levels, farmers are not aware of the practice as row planting technology has only very recently been developed and tested for teff . The adoption of row planting is likely to be slowed by its technical challenges: given the small size of the teff seed, row planting is most effectively carried out with a planting machine, which controls the seed rate, or through transplanting which is both unfamiliar to farmers and labor-intensive. An alternative may be mechanical broadcasters, if these are able to achieve a reduced seed rate. The pictures below show trials of a row planter developed by Awash Melkassa research center.

Figure 2.6 locally manufactured teff row planter [1]

With the bases of the above survey developers decided to develop and manufacture teff row planter machine because of Planting by broadcasting does not optimize yields. It is believed that low seeding rates would result in higher yields compared to yields achieved by using higher seeding rates .Through transplanting which is both unfamiliar to farmers and labor-intensive. Manually row planting method requires additional man labor than traditional broadcasting method the locally manufactured planter machine have only three furrow opener, no clutch, the length of the handle short this is not comfortable for the farmers and seed and fertilizer hopper in different direction seed tubes are fare away one to another because of this seed and fertilizer cannot reach at a time. To minimize higher seeding rates and improve yields by allowing for lower seeding rates row planting is the most preferable method of sowing .

To solve the problem of locally manufactured seed planter by adding the number of furrow openers from three to four to minimize wastage of time, the clutch used to minimize wastage of seeds and fertilizer during turning hence it better to design and manufacture clutch on to the ground wheel, by putting seed and fertilizer metering mechanism side by side it can reach at a time and to reach at proper distance of seed and fertilizer by combining together to overcome the above mentioned problems. This machine is drawn by animal (oxen, donkey, mule and camel) and resolves the shortages of machine that we have observed in study team survey especially Awash Melkasa and Adea liben woredas .

CHAPTER- THREE

MATERIALS AND METHODS

3.1. Material

In making the thesis work successful, focusing on the need assessment of the project, developers are using exploratory research method. Exploratory research might involve a literature search or conducting focus group interviews. The exploration of new phenomena can help our need for better understanding and test the feasibility of a more extensive study, or determine the best methods to be used in a subsequent study. For these reasons, exploratory research is broad in focus and provides definite answers to specific research issues.

The objective of exploratory research is to identify key issues and key variables. Developers used four data gathering techniques to understand current problems of teff row Planter and for the need of this machine; the researchers collected data by interviewing, direct observation, document analysis and questionnaires (closed and open questionnaires).

After the quantitative and qualitative data are gathered from those sources developers designed and manufactured teff row Planter machine as a solution to minimize wastage of seeds and fertilizer and to increase yields and to avoid wastage of seeds and fertilizer and time consuming of broad casting activities.

The following methodologies were used to achieve the thesis objectives:-

- **Literature survey on the subject matter**: the sources used at most are books, journals, and websites.
- **Consultations and informal discussions:** Consultations were detained with the study team advisor, and informal discussions were conducted with other individuals who have agricultural and engineering knowledge about the teff row Planter machine.
- **Data collection**: data has been collected from farmers and agricultural research centers through different methods like informal discussions and observations.

- ❖ **Design of critical components of the machine**: Critical components of the machine are designed to perform the required function using calculations.
- ❖ **Material selection**: the proper materials have been selected for the components of the machine according to the required properties.
- ❖ **Manufacturing of the components**: each components of the machine are produced to the required design in the work shop.
- ❖ **Assembly of the components**: All components of the machine are assembled step by step according to the assembling procedure.
- ❖ **Testing the performance of the machine:** checking for proper functioning of the machine.

3.2. Methods (Methodology)

3.2.1.Data Collection

Both primary and secondary data were used in the study .The primary data were collected through questioner, group discussions and interviews by using checklists prepared for this purpose. In addition, secondary data were collected from relevant sources such as Agricultural transformation agency, Ethiopian institute of agricultural research and Federal democratic of Ethiopia ministry of agriculture, published and unpublished documents.

3.2.2. Survey questionnaire

To assess about teff row Planter in selected areas of Awash Melekasa Woreda Wakegna and Roge kebeles and Adea liben Weroda Kurkura and liben kebeles, a survey questionnaire was developed. A questioner was carried out with farmers living in around Awash Melekasa Woreda Wakegna and Roge kebeles and Adea liben Weroda Kurkura and liben kebeles, group discussion was also carried out with Awash Melkassa agricultural research center of agricultural mechanization experts , Debrezeit agricultural research center of teff research experts in order to collect information on available teff row Planter machine and properties and ASTU agricultural Engineering department for their comments and suggestions before finalizing it. The questionnaire was finalized by taking the above suggestions into account. Twenty questionnaires were distributed to the randomly selected farmers, agricultural extension workers and agricultural research centers. The composition of the persons who were participated in the response of the questionnaire includes: families, single men and women, agricultural extension workers and others who work in related area.

The objectives of the questionnaires are:-

- To identify the problems related with teff row Planter system.
- To assess attitudes and tendency towards teff row Planter machine.
- To know how many of the farmers are willing to use teff row Planter machine.

The survey questionnaire contains about ten questions requiring two types of answers.

A. The first type uses options from the alternatives (objective)
B. Subjective type questions, which need brief answer.

3.2.3. Interviews

Structured interviews (face to face) was conducted with different farmers around Melekasa Woreda Wakegna and Roge kebeles and Adea liben Weroda Kurkura and liben kebeles and agricultural extension workers to obtain information on teff row Planter machine utilization and constraints faced by farmers. Most of the interview questions conducted is similar to the questions in the questionnaire. This is used to cross-check the response given by the respondents on both methods of assessment.

Objectives of conducting the interviews:

- To investigate feeling of the people who use teff row Planter machine in Awash Melekasa Woreda Wakegna and Roge kebeles and Adea liben Weroda Kurkura and liben kebeles.
- To observe overall activities and processes in the respective areas of teff broadcasting.
- To assess the needs of users and getting idea that how to be changed current traditional hand broadcasting system in to teff row Planter machine.

3.2.4. Direct observation

Direct observation method was also used for collecting the required data and information. The teff row Planter machine has been observed from Awash Melkassa agricultural research center, from internet and some documents of previous researches and respective institutional profile also have been observed.

3.3. Sample and Sampling Technique

Sampling involves selecting relatively small number of elements from the large defined group of elements and expecting that the information gathered from small group allow generalization to be made about the larger group of population.

The sampling units are the defined target population elements available for selection during the sampling process. In this research, Awash Melekasa Woreda Wakegna and Roge kebeles and Adea liben Weroda Kurkura and liben kebeles of small scale farmers are selected purposely as the total population since the result can be considered for the whole small scale farmers in the country.

A total of 20 numbers of small scale farmers are selected from the population of 40 number of small scale farmers that are currently involving in the teff broad casting(producers) at Awash Melekasa Woreda Wakegna and Roge kebeles and Adea liben Weroda Kurkura and liben kebeles.

The reason why Melekasa Woreda Wakegna and Roge kebeles and Adea liben Weroda Kurkura and liben kebeles are selected for this study is because the woreds are near to the university, they are highly teff producers and due to limited budget and time constraints the researchers couldn't include other places. The sampling is selected by using systematic random sampling method. The sample ratio can give sufficient information because it is taken 50% out of total population.

3.4. Data analysis (Research Questioners Results)

The findings indicate that, there is a demand of teff row Planter machine by the farmers and to buy the machine, it is scarce on market.

Table 3.1 Major findings of the result.

No.	Questions	No. of respondents (sample size)	Yes	No
1.	Are you currently using traditional hand broadcasting method?	20		100%
2.	Have you ever a chance to used teff row Planter machines before?			100%
3.	Are you interesting to buy if teff row Planter machine will be made at Adama Science and Technology University with reasonable cost?		85%	15%
4.	Are you using other method of teff broadcasting?		20%	80%
5.	When you need to buy teff row Planter machine, is that available in the market in reasonable cost teff?		90%	10%

Research question one, Are you currently using traditional hand broadcasting method? The respondents answered 100% of the sample is "yes it is true that currently almost all small scale farmers are using traditional hand broadcasting method. As they are said, "traditional broad casting is need high seed rate, low yield and time taking".

Research question two, Have you ever a chance to used teff row Planter machines? Revealed that all participants (100%) answered "no "on this question. Of course, since there is no teff row Planter machine on market, they didn't use such machines before.

Research question three, says that Are you interesting to buy if teff row Planter machine will be made at Adama Science and Technology University with reasonable cost?, according to gathered data the majority of participants respond 85% of them replied " yes " on this point. These shows, almost all teff planter small scale farmers are interesting to buy and use after the machine manufactured. This is data analysis of the question.

Research question four, Are you using other method of teff broadcasting? For this question the respondents replied their feelings that 20% of the sample taken answered “yes “to the question. This shows, there is no experience in other methods of broadcasting teff. The rest 80% of respondents they answered “no”, this shows they lack awareness about the broadcasting methods.

Research question five, describes that about when you need to buy teff row Planter machine, and is that available in the market in available cost teff? For this question, (90%) of the respondents replied “yes” to the point. This shows, there are no other alternative teff row Planter machines on the market that can add the yield of teff . The other 10% of the participants answered “no” indicates that they have no market information about the machines.

3.6. Qualitatively Data Analysis

This analysis is important to get wide and in depth information from the respondents. The questionnaires also prepared for the respondents openly that he/she can describe freely much information on the space provided. It helps to get genuine information from respondents because the researchers are not to interfere the participant’s idea.

The respondents, as they replied according to their experiences, there were no teff row Planter machines rather they used traditional hand broad casting .These traditional hand broad casting method have side effect that need high seed rate, high man power ,difficult for weeding and have less yield . According to them, the reasons why they are using traditional hand broad casting are due to unavailability of the machine on the market. To improve teff yield, they understand teff row Planter machines are very important and they are delighted to see this machine when it is solving their problems in the near time.

3.7.Machine parts design and material selection

3.7.1. Introduction to material selection

The Material and processes selectionare integral parts of the design of any machine component. Strength and rigidity are traditionally key factors considered in the selection of a material. Equally important are the relative reliability and durability of the part when made from alternative materials. When the component is expected to operate at extreme temperatures, this must be considered carefully when selecting the material [5].

In recent years, choices of materials have been increasingly influenced by recyclability, energy requirements, and environmental pollution. Cost and availability are also vitally important. The cost to be considered is the total cost of the fabricated part, including labor and overhead as well as the material itself. The relative cost and availability of various materials vary with time, with the result that the engineer is frequently called upon to evaluate alternative materials in light of changing market conditions. In summary, the best material for a particular application is the one that provides the best value, defined as the ratio between overall performance and total cost [5].

Material selection is a step in the process of designing any physical object. In the context of product design, the main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of candidate materials.

Clearly material selection is not a trivial process. The impediments to getting it right are:-

- Lack of broad knowledge of various materials
- Materials Data Accuracy Problems
- A lack of clear goals (e.g. no product design specification).

The design engineer is to select materials under two main conditions:-

- For new parts or components in combination with other new parts.
- Materials to replace existing parts or components where the current performance is inadequate.

In either case the designer must follow a problem solving process such as:-

- Determine the material requirements
- Screen Possible candidate materials
- Selection of a range of possible candidate materials
- Develop design solution(s) based on the confirmed capabilities of the materials [5].

3.7.2. Material selection for critical parts (components)

The criteria for selection of the materials for the critical components of the machine is based on the availability of the materials, suitability of the material for the working condition in service, the cost of the materials, the type of force that apply on them, the work they are expected to perform, the environmental condition, their useful physical and mechanical properties [5].

The best material is one which services the desired objectives at the minimum cost and the following factors should be consider while selecting material.

- ❖ Availability of the material in the form and shape desired;
- ❖ Total cost of the material including initial and future cost;
- ❖ Material properties as they relate to service performance requirements;
- ❖ Suitability of material for working condition in service;
- ❖ Substitutability of the materials; and
- ❖ The processing of the material into a finished part.

Generally material selection factors are service performance (specifications), availability, economics (total cost), material properties, manufacturing processes, formability and join ability and finishing and coatings [5].

Selecting the right material for the machine which can fulfill the functional requirement for the shaft is very important. To select the suitable material the digital logic methods was followed. The steps for digital logic methods are:-

- ❖ Set the functional requirements for the part under consideration. This are used to set rating factor show in table 3.2.
- ❖ Rank the rating factors (properties) then determine the weight factors show in table 3.3;

Total number of decision $N=\frac{n(n-1)}{2}$…...3.1[5].

Where:

n = number of rating factors (properties).

- ❖ Write the most suitable candidate materials and list properties show in table 3.4.
- ❖ Normalize the outcomes of the partsshow in table 3.5.
- ❖ Value outcomes and overall satisfaction of parts show in table 3.6 and table 3.7.

Depending on the above criteria the following materials are selected for the basic components teff row planter machine. The most critical machine elements that need design analysis in the manufacturing teff planter machine are shaft, chain, sprocket, and bearing [5].

3.7.2.1. Material selection for Shafts

A shaft is a rotating machine element which is used to transmit power from one place to another. The power is delivered to the shaft by some tangential force and the resultant torque (or twisting moment) set up within the shaft permits the power to be transferred to various machines linked up to the shaft [5].

In order to transfer the power from one shaft to another, the various members such as pulleys, gears etc., are mounted on it. These members along with the forces exerted upon them causes the shaft to bending. When a shaft of high strength is required, then alloy steel such as nickel, nickel- chromium or chrome-vanadium steel is used.

If strength considerations turn out to dominate over deflection, then a higher strength material should be tried, allowing the shaft sizes to be reduced until excess deflection becomes an issue. If concentricity is important, it may be necessary to rough machine, then heat treat to remove residual stresses and increase the strength, and then finish machine to the final dimensions by the process called “cylindrical grinding”[6].

Generally, the shaft materials should have the following properties:

- ❖ Material should have better yield strength and tensile strength.
- ❖ Low notch sensitivity factor.
- ❖ Material should be tough enough, machineable and light in weight.
- ❖ Wear resistant and good heat treatment properties.
- ❖ To less prone to environmental effects.

To achieve the required functional requirement of shaft materials, the Number of properties to be evaluated isdensity, modules of elasticity, toughness, tensile strength, and yield strength.

No. of decisions (N) $=\frac{\mathbf{n(n-1)}}{\mathbf{2}}$

N = $\frac{5(5-1)}{2}$ = 10, where n is no. of properties to be evaluated

Weight factor (W_f) = positive decision/ Total No. decisions ……..3.2[5]

Performance index ($\boldsymbol{\mu}$) = (normalized value) (weight factor)….....3.3[5]

Table 3.2 Application of digital logic with different decisions no.

Property	Decision No.									
	1	2	3	4	5	6	7	8	9	10
Density	1	0	1	1						
Modules of elasticity	0			1	0	1	1			
Toughness		0	0	0	0	1	0	1		
Tensile strength							0	0	1	
Yield strength							0		0	1

Table 3.3 weight factor for the shaft

Property	Positive decision	Weight factor (wf)
Density	3	0.3
Modules of elasticity	3	0.3
Toughness	2	0.2
Tensile strength	1	0.1
Yield strength	1	0.1
Total	10	1.0

Table 3.4Selected shaft material properties

Material	Density kg/m^3	Modules of Elasticity (Mpa)	Toughness (Mpa)	Ultimate Tensile strength (Mpa)	Yield strength (Mpa)
SAE 1020	7680	207	25	380	207
SAE 1010	7680	207	28	325	180
SAE 1045	7680	207	8	825	614
SAE 1040	7680	207	33	621	414

Table 3.5 Normalized outcome for shaft

Material	Density kg/m^3	Modules of Elasticity (Mpa)	Toughness (Mpa)	Ultimate Tensile strength (Mpa)	Yield strength (Mpa)
SAE 1020	100	100	75.75	46	33.7
SAE 1010	100	100	84.85	39.4	29.3
SAE 1045	100	100	24	100	100
SAE 1040	100	100	100	75.3	67.4

Table 3.6 Shows performance index (value out comes)

Material	Density (0.3)	Modules of Elasticity(0.3)	Toughness (0.2)	Ultimate Tensile strength (0.1)	Yield strength (0.1)
SAE 1020	30	30	15	4.59	3.37
SAE 1010	30	30	17	3.925	2.93
SAE 1045	30	30	4.8	10	10
SAE 1040	30	30	20	7.5	6.74

Table 3.7 Overall satisfactions

Annelid SAE 1020	82.96
SAE 1010	83.855
W-1000 of SAE 1045	84.8
SAE 1040	94.24

The result shows that on the bases of allocated weighting factor SAE 1040 gives the highest overall satisfaction among these materials. Therefore, this material is preferable for the production shaft (suitable material selected for the shaft is SAE 1040 for designing) and the required safety factor is 5. The yield strength for steel SAE 1040 is 414Mpa and the ultimate tensile strength is 621Mpa.

3.8. Design for the critical component of the machine

Seed planter is a machine used for placing the seeds in a continuous stream in furrows at uniform rate and at controlled depth with an arrangement of covering the seeds with soil. According to the power source used, seed planters may be classified in to Bullock drawn seed planters, tractor drawn seed planters.

According to the type of seed metering done animal drawn seed planters may be classified into manually metered seed planters and mechanically metered seed drill. In manually metered seed planters a person drops the seeds in the furrows, in mechanically metered seed planters a mechanical device called seed metering mechanism is used to meter the seeds. Seed planters fitted with fertilizer dropping attachments are called seed-cum-fertilizer drills; they deliver both the seeds and fertilizers simultaneously in an acceptable pattern. Seed cum fertilizer drill has a large seed box which is divided into two compartments, one for seed and another for fertilizers distribution. Seed cum fertilizer drill performs the following functions

1. To carry the seeds and fertilizer in separate compartments.
2. To open furrows at uniform depths
3. To meter the seeds and fertilizers
4. To deposit the seed and fertilizer in the furrows in an acceptable pattern
5. To cover the seed and fertilizer and compact the soil around the seed.

Engineering design process or mechanical engineering design process is a series of steps that each designer have to go through, to reach to the solution of the problem or to satisfy the need. Figure3.1 shows the steps or phases of a general engineering design process [5].

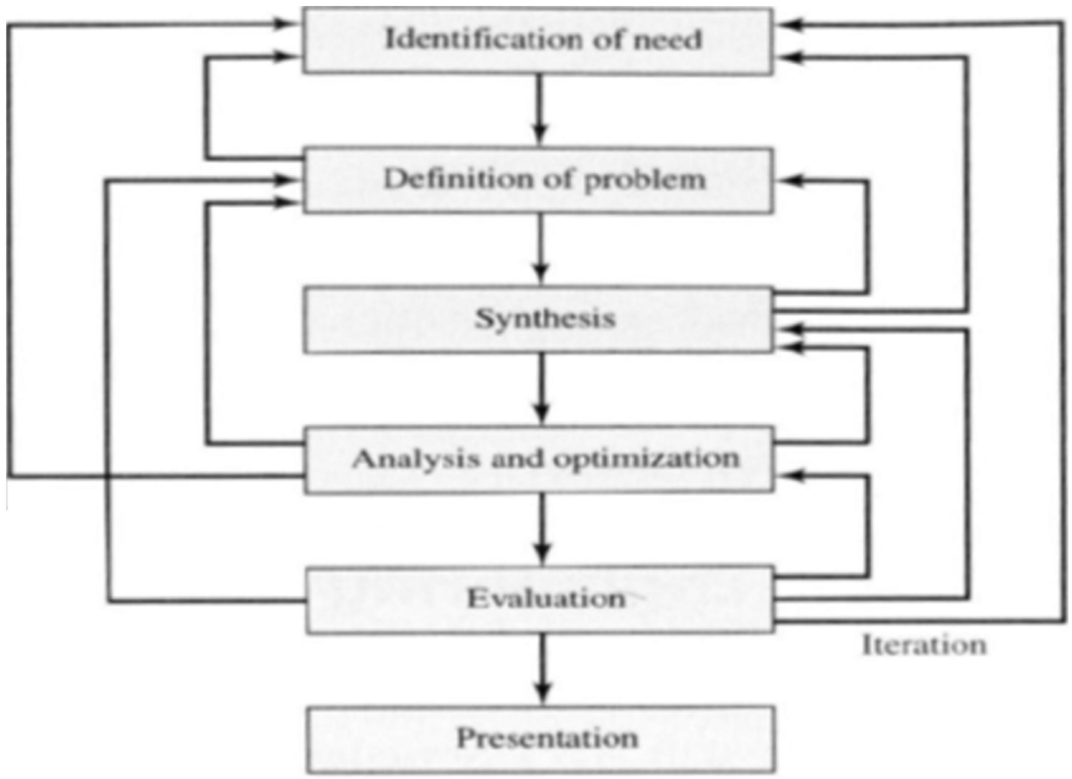

Figure 3.1 Engineering design process [5]

3.8.1. Design analysis of Shaft drives

The traction force (figure 3.2) is derived from the basic source of the oxen force when they pull the teff planter machine during seed drill. The typical weight which was indicated by different research result for individual ox in Ethiopia is 290-310N [9].

N.B Study team taken average of ox force 300 N

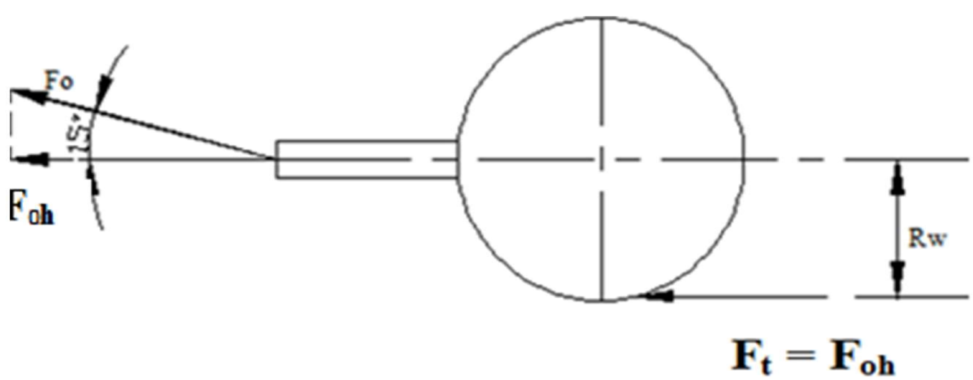

Figure 3.2 Traction force on the ground wheel.

F_t=F_{oh} because both traction force and horizontal force of the oxen are due to action and reaction force.

$$F_{oh} = F_t = F_o\cos\boldsymbol{\theta} \quad \text{..3.4}$$

Where:

F_t =is Traction force

F_o =is force of oxen pull

F_{oh} =is horizontal force of oxen.

θ =Angle between the line of pull and horizontal

R_w =Radius of ground wheel[13].

The average weight of the pair ox is 600 N and the angle of furrower inclined from the ground is 15^0 due to agricultural recommendation of the angle of "mofer" and "maresha "during tilling.

Calculate the traction force F_t

$F_t = 600N \text{ x } \cos15^0$

F_t= 580 N

After getting the traction force (580N), the next is calculating the twisting moment acting on the wheel shaft with the ground wheel radius 318 mm.

$$T_w = F_t \text{ X } R_w \quad \text{..3.5}$$

Where:

$T_{w=}$ is twisting moment (or torque) on the wheel shaft.

$R_{w=}$ is radius of ground wheel.

T_w = 580 N X 318 mm = $1.84\text{x}10^5$Nmm

T_w = 184 Nm

3.8.2. Twisting Moment and Bending Moment on wheel Shaft

When the shaft is subjected to combined twisting moment and bending moment, then the shaft must be designed on the basis of the two moments simultaneously. Various theories have been suggested to account for the elastic failure of the materials when they are subjected to various types of combined stresses.

Determine the total weight (or force) that applies to carry by the wheel shaft as the following expression.

The Hopper capacity in terms of volume V_h is calculated in m^3 as,

$$V_h = Qs/\rho \quad \text{......3.6}$$

$$V_h = A \times L \quad \text{......3.7}$$

Where:

A = cross sectional area in m^2

V_h = volume of the hopper in m^3

Qs = hopper capacity in Kg

L = length of hopper in m and

ρ = density of material filled in hopper in Kg/m^3[14]

The cross sectional area of the seed and fertilizer hopper is determined by:-

$$A = h\,(B + h \cot \alpha) \quad \text{......3.8}$$

Where:

h = height of seed hopper in mm

B = width of hopper in mm

α = angle of slope in degree [14]

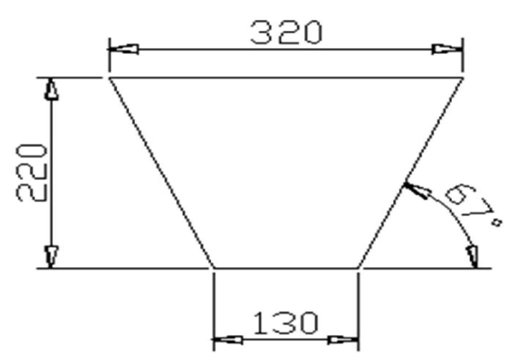

Figure 3.3 Side view of seed hopper.

According to Zewdu and Solomon, 2007 found the bulk density of teff seed is768 kg/m^3.

Weight of the seed and fertilizer capacity is

$$W_c = M \text{ x gravitational acceleration} \quad \text{......3.9}$$

Where: W_c is weight of the seed and fertilizer capacity

M is mass of the hopper in Kg.

W_c = 29 Kg x 10 M/s^2 = 290 N

Mass of the hopper material is

$$M_{HM} = V_{HM} \times \boldsymbol{\rho} \quad \ldots\ldots 3.10$$

Where:

M_{HM} =is mass of the hopper material in Kg.

V_{HM} =is volume of hopper material in Kg/m^3

M_{HM} = 1.725 x10^{-3} m^3 x 7850 Kg/m^3

M_{HM} = 13.6 kg

$$W_{HM} = M_{HM} \times \text{gravitational acceleration} \quad \ldots\ldots 3.11$$

Where:

W_{HM} =is weight of the hopper material in N.

W_{HM} = 13.6Kg x 10 M/s^2 = 136N

Weight of the main frame material is

$$M_f = V_f \times \boldsymbol{\rho} \ldots\ldots 3.12$$

Where:

M_f =is mass of the frame in Kg

V_f= is volume of the frame in M^3

M_f = 2.74 x10^{-4}m^3 x 7850 Kg/m^3

M_f = 13Kg

$$W_F = M_f \times \text{gravitational acceleration} \quad \ldots\ldots 3.13$$

Where:

W_F is weight of the frame in N

W_F = 13Kg x 10 M/s^2 = 130N

Determine the weight of the handle material

$$M_h = V_h \times \boldsymbol{\rho} \quad \ldots\ldots 3.14$$

Where:

M_h is mass of the handle in Kg

V_h is volume of the handle in M^3

$M_h = 3.75 \times 10^{-4}\, m^3 \times 7850\ Kg/m^3$

$\mathbf{M_h = 3kg}$

$W_h = M_h$ x gravitational acceleration …..…………….3.15

Where:

W_h is weight of the handle in N

$W_h = 3Kg \times 10\ M/s^2 = 30N$

Therefore the overall weight supported, W= 290N +136N + 130N + 30N = 586N. This load is distributed to all part of the wheel shaft but we divided those loads between the two parts of shafts that are supported at their ends equally.

Figure 3.4 shows that the load of one support carries 293N, the distance from the center of the ground wheel to the center of shaft is 530 mm and the distance from center of bearing to the center of shaft is 430 mm. The maximum bending moment acts on the middle of the wheel shaft at Points 3.Where R_1 and R_2 are the reaction force on the ground wheel.

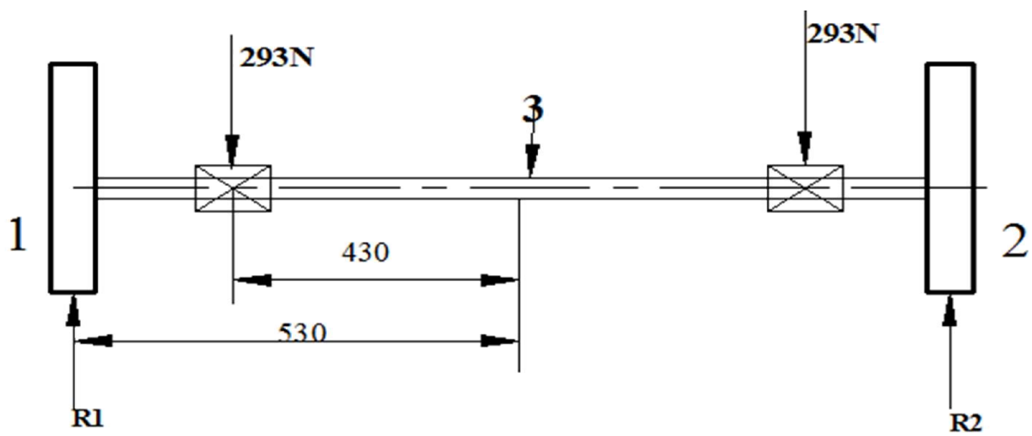

Figure 3.4 The Axle with ground wheels.

When the shaft is subjected to combined twisting moment and bending moment, then the shaft must be designed on the basis of the two moments simultaneously [6].

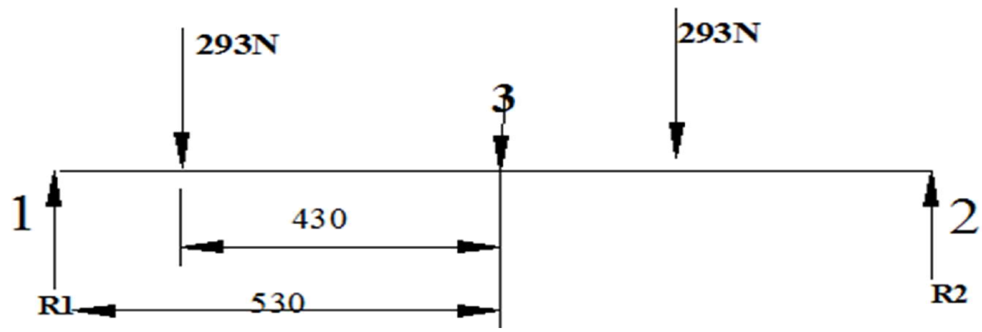

Figure 3.5 Free Body Diagram

As shown in figure 3.5 the maximum bending moment of the shaft will occur at point 3 and when apply 293 N load there is also reaction force on R_1.

M_3 = (R_1 x 530mm)-(W/2)(430mm),

Where:-

M_3 = is the maximum bending moment on the wheel shaft.

R_1 = and $R_2$are reaction force of the wheel from the ground.

W = is over all weight loaded on the wheel shaft.

Reaction forces R_1 and R_2

$\sum$ **Fy** = 0 ……………………………………………………3.16

(R_1 + R_2) - (W/2 + W/2) = 0

R_1 + R_2 = W,

Since R_1= R_2 (symmetry)

R_1= R_2 = W/2

M_3 = R_1(530mm)-W/2(430mm)

M_3 = 293 N(430mm)-293N(215mm)

M_3 = 29.3x10^3 Nmm

The maximum bending moment on the wheel shaft is 29.3x10^3 Nmm.

The ultimate tensile strength of the selected material is shown in table 3.3.

The allowable tensile stress, σ

σ=$\sigma tu/f.s$ = 621/5 = 124 Mpa =124N/mm^2

The yield strength of the selected material is shown in table 3.3.

The allowable shear stress, τ

$\tau = \tau_u$/f.s = 414/5 = 83 N/mm^2

Let d = Diameter of the shaft in mm.

According to maximum shear stress theory, equivalent twisting moment T_e,

$$\mathbf{T_e = \sqrt{M_3^2 + T_w^2}} \text{ ....3.17 } \mathbf{[6]}$$

$T_e = \sqrt{(29.3 \text{x} 10^3 \text{Nmm})^2 + (1.84 \text{x} 10^5 \text{Nmm})^2}$

$T_e = \sqrt{3.7969 \text{x} 10^{10}}$

T_e= 1.86 x 10^5 Nmm.

Calculate the diameter of shaft from the equivalent twisting moment (T_e) as follows,

$$\mathbf{T_e = {}^{\pi}/_{16}\ \tau \text{ x } d^3} \text{ ....3.18 } \mathbf{[6]}$$

$d^3 = {}^{16Te}/_{\pi}\,\tau = 16 \text{ x } 1.86 \text{ x } 10^5/83\ \pi$

$d = \sqrt[3]{11{,}413 \text{ mm}^3}$

d=23mm

According to maximum normal stress theory, equivalent bending moment M_e,

$$\mathbf{M_e = \frac{1}{2}(M_3 + \sqrt{M_3^2 + T_w^2})} \text{ .... 3.19 } \mathbf{[6]}$$

$M_e = \frac{1}{2}(M_3 + T_e)$

$M_e = \frac{1}{2}(29.3 \text{x} 10^3 \text{Nmm} + 1.86 \text{ x } 10^5 \text{Nmm})$

M_e = 107,650 Nmm

Calculate the diameter of shaft from the equivalent bending moment (M_e) as follows,

$$\mathbf{M_e = \frac{\pi}{32}\sigma_b d^3} \text{ ....3.20 } \mathbf{[6]}$$

Using rearranging the formula

$d^3 = \frac{32Me}{\pi\sigma_b} = \frac{32 \text{ x } 107{,}650 \text{ Nmm}}{\pi \text{ x } 124\text{N/mm2}} = 8{,}843 \text{ mm}^3$

$d = \sqrt[3]{8{,}843 \text{ mm}^3}$

d = 21 mm

Taking the larger of the two values, we have d = 23

Therefore use 25mm diameter of shaft, as our design and standard requirement for shaft of ground wheel and for bearing place.

3.8.3.Distortion of the wheel Shaft Due to Bending

The deflection of any machine shaft supported on plain bearings should not exceed 0.6L, where L is the distance from the load point to the center of the bearing in meters.If the shaft is of uniform cross-section, then the lateral deflection of a shaft may be obtained by using the deflection formulae as in strength of materials. Deflection is not affected by strength, but rather by stiffness as represented by the modulus of elasticity, which is essentially constant for all steels. For that reason, rigidity cannot be controlled by material decisions, but only by geometric decisions.

Deflection of shaft can be calculated by using:

$$\boldsymbol{\delta} = \frac{\rho L^3}{48EI} \qquad \text{..3.21} \textbf{[6]}$$

Where:

P = force (load applied on the shaft)

I = Moment of inertia

E = Modulus of elasticity.

L=Length of the shaft from the maximum load point to the center of the bearing.

$$\mathbf{I = \frac{\pi}{64}\, xd^4} \qquad \text{..3.22 } \textbf{[6]}$$

Where:

d= diameter of shaft in diameter

$I = \frac{\pi}{64}\ x25^4 = 19{,}175\ mm^4$

The length of the shaft between the maximum load and the center of the bearing is 215mm (0.215m) and the maximum bending moment on the wheel shaft is $63x10^3$Nmm.The modulus of Elasticity of the selected material SAE 1040 is 207Gpa.

$\delta_{max} = \frac{\rho L^3}{48EI} = \frac{293(215)^3}{3x207000x19{,}175} = 0.015\ mm$

3.8.4. Twisting Moment on the Metering shaft

The metering shaft is subjected only to a twisting moment (or torque), then the diameter of the shaft may be obtained by using the torsion equation.

$$T/J = \tau/r \quad \text{.......................................} 3.23 \; [5]$$

Where:

T_m=is Twisting moment (or torque) acting upon the metering shaft

J=is Polar moment of inertia of the shaft about the axis of rotation

τ=is Torsional shear stress and

r=is Distance from neutral axis to the outer most fibre

Since the metering shaft is solid shaft, polar moment of inertia is

$$J = \pi/32 \times d^4 \quad \text{...} 3.24 \; [5]$$

Substituting equation II to equation I

$T_m = \pi/16 \, \tau \times d^3$

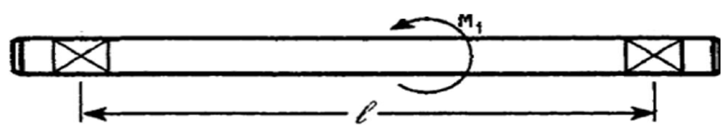

Figure 3.6 Metering shaft.

In order to determine the diameter of the metering shaft first find the torque that apply in the shaft from the torque apply in the ground wheel shaft by the sprocket ratio.

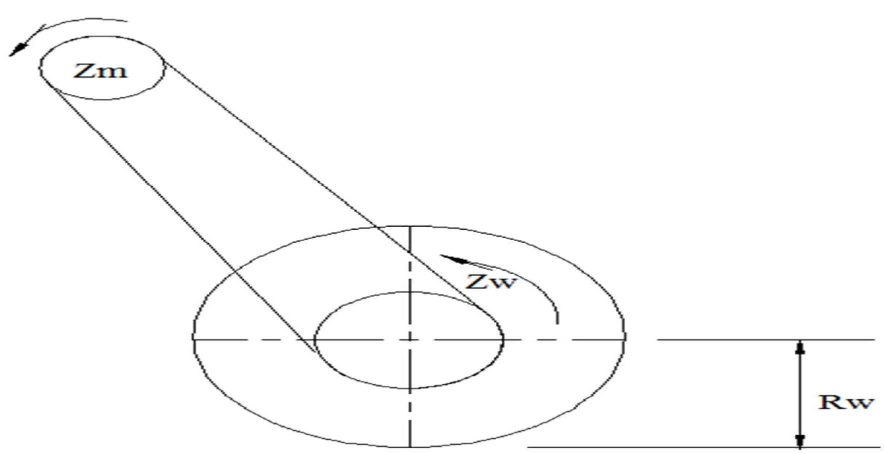

Figure 3.7 Ground wheel with chain and sprocket

$$\mathbf{T_m = \frac{Z_m}{Z_w} \times T_w} \quad \text{..} 3.25$$

Where:

Z_w =is the number of sprocket teeth on the wheel shaft (driver)

Z_m =is the number of sprocket teeth on the metering shaft(driven).

$T_m = \frac{16}{48}$ x 1.84 x10^5Nmm = 61.3 x 10^3 Nmm.

T_m = 61.3 Nm

Calculate the diameter of the metering shaft,

$T_m = {}^{\pi}/_{16}\, \tau x d^3$

30.6 x 10^3 Nmm = ${}^{\pi}/_{16}$ 83 x d^3

d^3 = (16 x 61.3x10^3) / (83π) = 3762mm3

d = 16mm

Therefore use 20mm diameter of shaft, as our design and standard requirement for metering shaft and for bearing place.

3.8.5. Deflection of the Metering Shaft Due to Torsion

Angular deflection in a right circular cylindrical shaft due to torque T is

$$\frac{T}{J} = \frac{G\theta}{L}, \quad \theta = \frac{TL}{GJ} \qquad \ldots 3.26$$

Where:-

θ= deflection or angle of twist in radians

T = Twisting moment or torque on the shaft

J = Polar moment of inertia

G = Modulus of rigidity for the shaft material and

L = Length of the shaft from the maximum load point to the center of the bearing

$$\mathbf{J = \frac{\pi}{32}\, xd^4} \qquad \ldots 3.27$$ **[5]**

Where:

d= diameter of shaft in diameter.

$J = \frac{\pi}{32}$ x20^4 = 15,708 mm^4

Twisting moment Tm= 61.3 x 10^3 Nmm. Since the selected material is SAE 1040 having a modulus of rigidity (G) equals 79.3Gpa = 79.3 x10^3N/mm^2.

Therefore, deflection or angle of twist (θ).

$$\theta = \frac{TL}{JG}$$

$$\theta = \frac{61.3\ x10^3 Nmmx\ 215mm}{15.708\ x10^3 mm4\ x79.3x10^3\ \frac{N}{mm^2}}$$

$\theta = 0.0011$, Since the twist angle is less than one degree, the design of the shaft is safe from being twist.

3.9.Selection of bolted connections

Bolts are machine components used to connect and fasten parts together temporary for easy maintenance. Bolts are used to prevent the relative movement of two or more parts, and then the shear stress is induced in the bolts. The shear stresses should be avoided as far as possible.

It should be noted that when the bolts are subjected to direct shearing loads, they should be located in such a way that the shearing load comes upon the body (i.e. shank) of the bolt and not upon the threaded portion.

The connections that need bolts to make maintenance and transportation easy are:

- ❖ A bolt and nut connections used to secure the wheel shaft hub and hopper support using one fastener.
- ❖ To connect the bearing housing to the frame on both end Metering shaft.

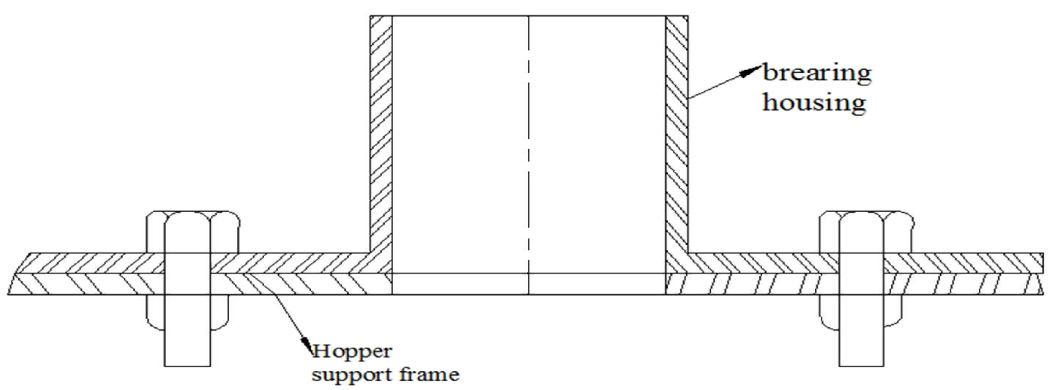

Figure 3.8 Bolted connection bearing housing with hopper support frames

Calculate diameter of Bolt connect on the ground wheel shaft.

The twisting moment (or torque) apply on the wheel shaft is $1.84\ x\ 10^5$ Nmm and the diameter of this shaft is 25mm. determine the force that apply on the wheel shaft.

$$T_w = F_w \times D/2 \quad \text{...3.28[8]}$$

Where:

F_w=is apply on the wheel shaft &

D =is diameter of wheel shaft.

$F_w = 2(1.84 \times 10^5\ Nmm) / 25\ mm = 14{,}720\ N$

This force is equally distributed through the four bolts.

Therefore the force applied in each bolt ($F_{b)}$ is:-

$F_b = 0.25F_w = 0.25x14720N = 3680N$

Using maximum shear stress theory,

$$\tau_{max} < 0.5\sigma_y/n \quad \text{...3.29}$$

Where:

τ_{max}= is the maximum shear stress

σ_y =is yield strength of bolt a and

n= is factor of safety, by taking n = 5

Table 3.8 Strength specifications for different property classes of metric steel bolts.

Property Class	Nominal Size range in mm	Proof Strength (MPa)	Yield Strength (MPa)	Tensile Strength (MPa)	Material
4.6	5-100	225	240	400	Low or Medium carbon steel
4.8	1.6-16	310	340	420	Low or Medium carbon steel, fully or partially annealed
5.8	5-24	380	420	520	Low/Medium carbon steel, cold worked

The bolt has yield strength which low or medium carbon steel (Property class 4.6) having yield strength of σ_y = 240Mpa from data books.

τ_{max}= 0.5x240/5 = 24N/mm^2

$$\tau = F_b / A \quad \text{...3.30 [8]}$$

Where:

F_b – is force applied on bolt = 3680N

A = is stress area on bolt = $\Pi d^2/4$, d is diameter of bolt.

$$\tau = 4F_b/\Pi d^2 \text{or } d = \sqrt{\frac{\mathbf{4F_b}}{\boldsymbol{\pi\, x\tau xn}}} \text{……………………..} \quad 3.31$$

$d = \sqrt{\frac{4x(3680)}{\pi\ x24x4}}$ = 7mm, d = **M10** to be safe.

Therefore use M10 bolt to connect the bearing house with the frame of the hopper. .

Calculate diameter of Bolt connect on the metering shaft.

The twisting moment (or torque) apply on the metering shaft is 61.3 x 10^3 Nmm and the diameter of this shat is 20mm. determine the load that apply on the shaft (F_m).

$T_m = F_m$ x D/2,F_m= $2T_m/D$ where F_w is apply on the wheel shaft

F_m = 2(61.3 x 10^3 Nmm) / 20 mm = 6,130 N. This force is equally distributed through the four bolts.

Therefore the force applied in each bolt ($F_{b)}$ is:-

$F_b = 0.25F_w$ = 0.25x6130N = 1532N

$d = \sqrt{\frac{4\ x\ 1532}{\pi\ x24x4}}$ = 5 mm, d = **M8** to be safe.

3.10. Selection of Chain and Sprockets

The function is used to transmit power from drive wheel to seed and fertilizer metering shaft. First of all a chain set connects the drive wheel to the driving shaft. This shaft is connected to fertilizer and seed metering shafts with the help of chain set which provide drive to the seed metering device and fertilizer metering device.

The chains are made up of number of rigid links which are hinged together by pin joints in order to provide the necessary flexibility for wrap round the driving and driven sprockets. These sprockets have projecting teeth of special profile and fit into the corresponding recesses in the links of the chain.

Calculate length of chain and centre distance;

The chains are mostly used to transmit motion and power from one shaft to another, when the centre distance between their shafts is short such as in bicycles, motor cycles, agricultural machinery, conveyors, rolling mills, road rollers etc. The chains may also be used for long centre distance of up to 8 metres [7].

The outside diameter of small sprocket (D_{os}) and the number of teeth is 70mm and 16 respectively. The outside diameter of large sprocket (D_{ol}) and the number of teeth is 210mm and 48 respectively. The minimum centre distance between the smaller and larger sprockets should be 30 to 50 times the pitch. The center to center distance is 233mm the pitch distance of the sprockets is 12 mm.

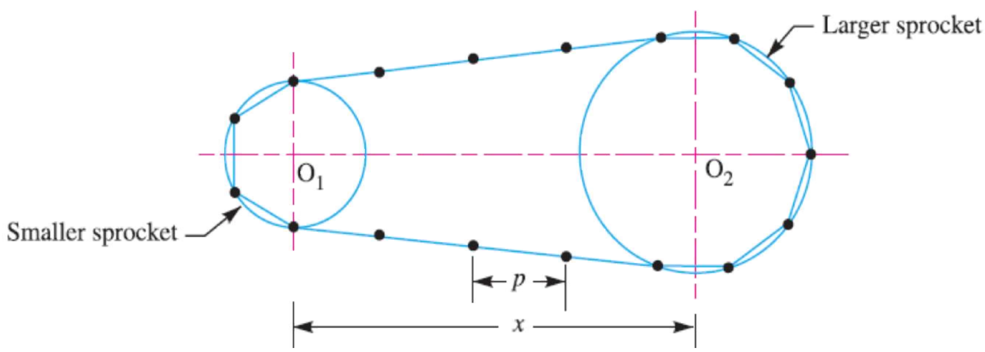

Figure.3.9 Length of chain

The length of the chain (L) must be equal to the product of the number of chain links (K) and the pitch of the chain (p). Mathematically

$$\mathbf{L = K.p} \qquad \text{……3.33 [6]}$$

The number of chain links may be obtained from the following expression,

$$\mathbf{K = \frac{T1+T2}{2} + \frac{2x}{p} + \left[\frac{T2-T1}{2\pi}\right]^2 \frac{p}{x}} \qquad \text{……3.34 [6]}$$

$$\mathrm{K} = \frac{\mathbf{16+48}}{\mathbf{2}} + \frac{\mathbf{2(233)}}{\mathbf{12}} + \left[\frac{\mathbf{48-16}}{\mathbf{2\pi}}\right]^{\mathbf{2}} \frac{\mathbf{12}}{\mathbf{233}}$$

K = 32 + 38.83+ 0.89 = 72

Therefore Length of the chain,

L = K.p= 72 × 12 = 864 mm

L = 0.864 M

3.11. Selection of Radial Ball Bearings

A bearing is a machine element which supports another moving machine element (known as journal). It permits a relative motion between the contact surfaces of the members, while carrying the load. A little consideration will show that due to the relative motion between the contact surfaces, a certain amount of power is wasted in overcoming frictional resistance and if the rubbing surfaces are in direct contact, there will be rapid wear [7].

In order to reduce frictional resistance and wear and in some cases to carry away the heat generated, a layer of fluid (known as lubricant) may be provided. The lubricant used to separate the journal and bearing is usually a mineral oil refined from petroleum, but vegetable oils, silicon oils, greases etc., may be used.

The bearings may be classified depending upon the direction of load to be supported and depending upon the nature of contact.

1. Depending upon the direction of load to be supported. The bearings under this group are classified as :
   (a) Radial bearings, and
   (b)Thrust bearings. In radial bearings, the load acts perpendicular to the direction of motion of the moving element. In thrust bearings**,** the load acts along the axis of rotation.
2. Depending upon the nature of contact. The bearings under this group are classified as :
   (a)Sliding contact bearings, and
   (b) Rolling contact bearings.

In sliding contact bearings, the sliding takes place along the surfaces of contact between the moving element and the fixed element [7].

The standard dimensions and designations of bearings are given in millimetres. These dimensions are a function of the bearing bore and the series of bearing. There is no standard for the size and number of steel balls. The bearings are designated by a number. In general, the number consists of at least three digits.

Additional digits or letters are used to indicate special features e.g. deep groove, filling notch etc.

The last three digits give the series and the bore of the bearing. The last two digits from 04 onwards, when multiplied by 5, give the bore diameter in millimetres. The third from the last digit designates the series of the bearing.

The most common ball bearings are available in four series as follows:

1. Extra light (100),
2. Light (200)
3. Medium (300),
4. Heavy (400)

a. If a bearing is designated by the number 305, it means that the bearing is of medium series whose bore is 05 × 5, i.e., 25 mm.
b. The extra light and light series are used where the loads are moderate and shaft sizes are comparatively large and also where available space is limited.
c. The medium series has a capacity 30 to 40 per cent over the light series.
d. The heavy series has 20 to 30 per cent capacity over the medium series. This series is not used extensively in industrial applications [7].

The effective load on bearing in a chain drive may be obtained by using a factor, f,

$$P_{eff} = k_s \text{ x } F_n \quad \ldots\ldots 3.35$$

F_n is chain driving tension = 387N is calculated before as effective chain tension

Ks = 1.5, since Light shock load is assumed to be generated on the bearing

P_{eff} = 1.5 x 387N = 580 N

To choose a bearing one would first be required to fix the life of the bearing that would be expected when bearing is placed in the machine .this life is a function of type of machine and its service.

The life in working hours, LH may be calculated from:

$$L_H = \frac{\text{Nx}10^6}{60\text{x RPM}} \quad \ldots\ldots 3.35$$

N = (LHX 60 X rpm)/ 10^6

Where:-

N = Life in number millions of cycles.

N = (6,000 hours x 60 x 70rpm)/10^6, **N = 25** million cycles

(6000 is average working hours for short periods or intermittently machines).

The basic dynamic capacity C, of a bearing has been defined as constant load on bearing that will result in bearing life of 1 million revolutions.

In order to select a most suitable ball bearing, first of all, the basic dynamic radial load is calculated. It is then multiplied by the service factor (KS) to get the design basic dynamic radial load capacity.

$$\mathbf{C=P\sqrt[3]{N}} \qquad \text{......3.36 [7]}$$

Where:

C = Basic dynamic load rating

P = Equivalent load on bearing

N = Life in number millions of cycles.

$$C = 580\ \sqrt[3]{25 \text{ million cycles}}$$

C = 1.7 KN

In order to select a most suitable ball bearing, first of all, the basic dynamic radial load is calculated. It is then multiplied by the service factor (KS) to get the design basic dynamic radial load capacity.

Therefore, the design basic dynamic radial load capacity = C x Ks =1.7KN x1.5 = 2.6KN. (Ks =1.5, since Light shock load is assumed to be generated on the bearing).

After finding the design basic dynamic radial load capacity, the selection of bearing is made from the catalogue of a manufacturer.

Hence, the design basic dynamic radial load capacity = 2.6KN is less than the selected bearing (204) and bearing (205) of single row deep groove ball bearing of basic dynamic load rating C= 10KN and 11KN respectively.Therefore the chosen bearing (204) and bearing (205) are suitable for the desired performance.

3.12. Design of welded connections

The seed guider are used to take delivery of seeds from seed metering to the seed delivery tube and it welded round pipe at the front part of the hopper by fillet welds all around. Shear force produces a primary shear in the welds of magnitude is

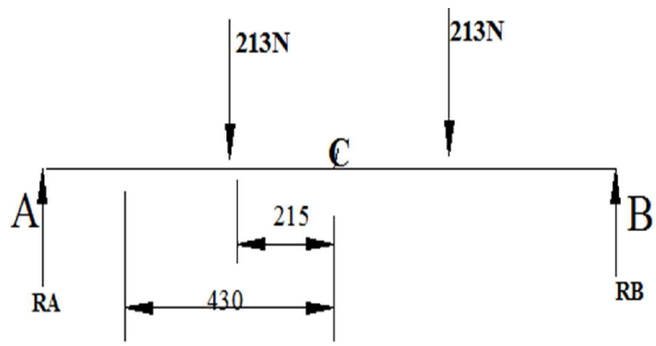

Figure 3.10 FBD of seed guider and hopper.

Bending moment M due to R_B about point C induces a throat shear stress component of weld at point C.

M_c = 213 x 215 = 45,800 Nmm.

According to the American welding society, the yield strength for E70xx electrode, τ_y=393Mpa and Stresses Permitted by the AISC Code for Weld Metal in bending is between 0.60 & (0.66)τ_y [6] .

The unit second moment of area is

$$\mathbf{I_u = \pi r^3} \qquad \text{3.38 [6]}$$

The second moment of area I, based on weld throat area is

$$I = 0.707hI_u = 0.707h\, x\pi r^3 \qquad \text{3.39 [6]}$$

Therefore taking τ =0.66(393) = 259Mpa. M_c=45,800Nmm, and r=20mm to calculate the weld throat height.

The weld throat height is

$$H = \frac{\mathbf{0.707x\tau x\pi r^2}}{\mathbf{M}} \qquad \text{3.40}$$

$$H = \frac{0.707x259x\pi x20^2}{45,800} = 5mm$$

Weld using E70xx electrode diameter 2.5mm in two passes to get 5mm throat size.

3.13. Ergonomics consideration of the machine

The word ergonomics comes from two Greek words: ERGO which means work and NOMOS which means law. Ergonomics is a science focused on the study of human fit, and decreased fatigue and discomfort through product design[10].

Ergonomic applied to teff row planter design requires that consider how the products design fit the people that are using them. When products fit the user, the result can be more comfort, higher productivity, and less stress.

Ergonomics can be an integral part of design, manufacturing, and use. Knowing how the study of anthropometry, posture, repetitive motion, and workspace design affects the user is critical to a better understanding of ergonomics as they relate to end-user needs. [10].

In the design of work and everyday-life situations, the focus of ergonomics is man. Unsafe, unhealthy, uncomfortable or inefficient situations at work or in everyday life are avoided by taking account of the physical and psychological capabilities and limitations of humans. [10].

In ergonomics, absenteeism, injury, poor quality and unacceptably high levels of human error are seen as system problems rather than 'people' problems, and their solution is seen to lie in designing a better system of work rather than in better 'man management' or incentives, by 'motivating' workers.

Therefore, to design and manufacturing teff row planter machine ergonomics consideration should be apply how the product design fit the handle comfortably during ploughing.

CHAPTER -FOUR

MANUFACTURING PROCESS AND ASSEMBLY OF THE MACHINE

4.1. Introduction

Manufacturing process is that part of the production process which is directly concerned with the change of form or dimensions of the part being produced. It does not include the transportation, handling or storage of parts, as they are not directly concerned with the changes into the form or dimensions of the part produced [6].

Manufacturing operations can be divided into two basic types:-

- Processing operations and
- 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 discrete work parts, but certain processing operations are also applicable to assembled items [7].

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. The following are the various manufacturing processes used in Mechanical Engineering.

1. **Primary shaping processes.** The processes used for the preliminary shaping of the machine component are known as primary shaping processes. The common operations used for this process are casting, forging, extruding, rolling, drawing, bending, shearing, spinning, powder metal forming, squeezing, etc [7].
2. **Machining processes.** The processes used for giving final shape to the machine component [7].
3. According to planned dimensions are known as machining processes. The common operations used for this process are turning, planning, shaping,

drilling, boring, reaming, sawing, broaching, milling, grinding, hobbing, etc. [7].

4. **Surface finishing processes.** The processes used to provide a good surface finish for the machine component are known as surface finishing processes. The common operations used for this process are polishing, buffing, honing, lapping, abrasive belt grinding, barrel tumbling, electroplating & super finishing etc[7].
5. **Joining processes.** The processes used for joining machine components are known as joining processes. The common operations used for this process are welding, riveting, soldering, brazing, screw fastening, pressing, sintering, etc. [7].
6. **Processes effecting change in properties.** These processes are used to impart certain specific properties to the machine components so as to make them suitable for particular operations or uses. Such processes are heat treatment, hot-working, cold-working and shot peening [7].

4.2. Design for manufacture (DFM)

″Design for manufacture″ aims in ″economy in manufacture″ means through which this economy can be obtained by the designer. The following aspects must be considered to achieve design for manufacture [8].

Design for manufacture (DFM) is a series of guidelines that should follow to produce a product easily and profitably. DFM guidelines focus on two issues:

1. **Design simplification** means reducing the number of parts and features of the product whenever possible. A simpler product is easier to make, costs less, and gives us higher quality [8].
2. **Design standardization refers** to the use of common and interchangeable parts. By using interchangeable parts possible to can make a greater variety of products with less inventory and significantly lower cost and provide greater flexibility [8].

Basic DFM guidelines used in this work are:

- ❖ Provide as large a tolerance on the components as possible consistent with functional requirements.
- ❖ Use of cheaper, alternate or indigenous materials.

- ❖ Minimum number of components in the product for reliability in performance.
- ❖ Use of as many standard items as possible.
- ❖ Ease of assembly and maintenance etc.

By considering the above guide lines, the teff row Planter machine is designed and manufactured practically. Therefore:

- ❖ Most bodies of the machine like frame, hoper, covering device, Seed and fertilizer metering, device and others are manufactured from cheap indigenous metals by providing large tolerance for each component without affecting the functional requirements.
- ❖ The standard items like sprocket, chain, bolt & nut and others are bought from market.
- ❖ Most components of the machine are assembled by temporary fasteners since it is easy to maintain and transport [8].

4.2.1 Manufacturing of teff row Planter machine

Manufacturing engineering is the art of making machines of the specified of quality on the planned production scale with the minimum consumption of materials and the maximum productivity of labor.

A prototype is a first or original example from which others have been or will be copied or developed. There are three main reasons for making a prototype.

- ❖ To test the plans
- ❖ To test the product
- ❖ To see how to produce the product

4.2.2 Part description, function and Fabrication procedures of the basic components of the machine

Frame

The frame works as a body in the planter on which all other parts are mounted (attached). The frame is made up of mild steel square pipe (30 × 30 × 3 mm) bolted together to provide the desired strength and rigidity. The furrow openers are attached to the frame which is used to drill the soil. Furrow openers are attached by bolts and the bolts can control the depth by adjustment.

Furrow openers

Furrow openers are attached to the lower portion of frame which is used to drill the soil. As the furrow openers drill the soil, the seeds and fertilizers come into the furrow opener through seed and fertilizer delivery pipes and drops the seed and fertilizer in the soil through openings the distance between furrow opener is 200mm.

Seed and fertilizer hopper.

Trapezoidal shaped seed and fertilizer hopper, made of mild steel sheet (1.5 mm thick), are mounted on the frame.

Seed metering and delivery system

The seed metering and delivery system consists of following-

Seed box (hopper): it is used to store the seed and fertilizer in the planter

Seed metering device : these rotating plates have grooves which guide the seed and drop it in to the cups.

Seed guider : These cups receive seeds that are dropped by the rotary plates and then dispense the seeds to the seed delivery pipe. These seed cups must be smooth and free from any obstacle from the inside to ensure unobstructed delivery of the seeds.

Seed and fertilizer delivery pipes: It is used to take the seed and fertilizer from cups to the seed and fertilizer boot.

Seed and fertilizers delivery pipes are attached to the seed and fertilizer hopper with the help of galvanized pipe cups. These pipes carry the seed and fertilizer from the cups to the seed and fertilizer boot. The tubes should be connected to seed and fertilizer cups firmly so that these may not come out during field operation. The following precautions should be taken care of

- ❖ Tubes should be protected from bending and breakage.
- ❖ Old/bent tubes should be replaced.

- ❖ Excessive bend in the tubes should be avoided otherwise the bend will cause obstruction in free flow of seed/fertilizer and result in non-uniform application and poor crop establishment.
- ❖ The tubes must be inserted about one 25mm into the seed/fertilizer boot to ensure proper seed/fertilizer delivery.

Seed boot: Seed boot finally drops the seed into the slit in the soil opened by the furrow opener.

Ground wheel

Ground wheel is attached in the middle of the front bar of the frame. The function of ground wheel is to transmit power to the seed and fertilizer metering shafts.

Power transmission unit/ chain mechanism

The power transmission unit has the following main components-

1. Ground wheel
2. Shaft
3. Sprocket
4. Roller chain

The function of power transmission unit is to provide drive from ground wheel to all parts of the planter for example seed and fertilizer shaft. First of all a chain set connects the ground wheel to the wheel shaft. This shaft is drive to fertilizer and seed metering shafts.

4.2.3 Operation sheet of the main parts of the machine

Seed and Fertilizer hopper

Trapezoidal shaped boxes used to hold seed and fertilizer, made of mild steel sheet (1.5 mm thick), are mounted on the frame (Figure 4.1). The dimension of the hopper is 800 x 210 x 215mm. The hopper is divided in to eight equal parts by hopper divider each divisions have 225 X 310X 1.4mm dimension, four divisions are used for teff seed and four divisions for fertilizer ,used to hold seed and fertilizer metering mechanism ,hopper shaft bearing …etc. Finally it is covered by hopper cover door with dimension of 820 X 330 X1.5mm the manufacturing procedure shows in table 4.1.

Material------------Mild steel sheet

Blank size---------800 x 310 x 215mmx 1.5mm

Quantity --------- 01

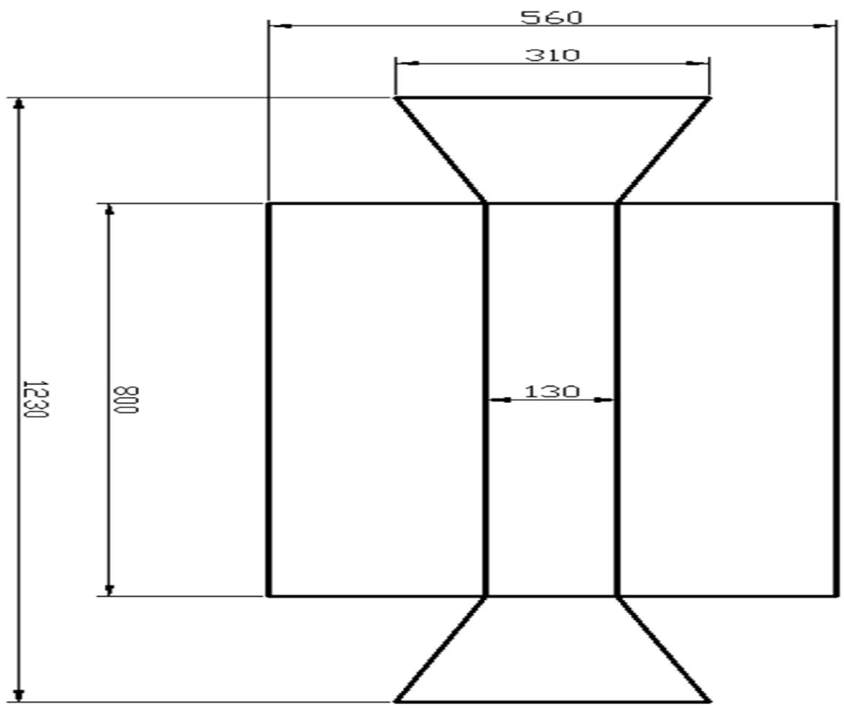

Figure 4.1 Seed and Fertilizer hopper

Table 4.1 Manufacturing procedures of Seed and Fertilizer hopper

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure, layout &cut blank sheet metal at to size	560 x1230mm	Tape rule, try square & Scriber		4
2.	Measure and layout, bottom, rear and front sides of the hopper separately.	Bottom =130x800 mm, rear and front =215mm x800 mm left and right side 130x 215mm height at an angle of 67^0	Tape rule, try square & scriber		3
3.	Cut the right and the left side at trapezoidal shape	left and right 130x215mm height		Hand Shear	5

	at an angle of 67^0				
4.	Bending the front and the rear parts of the hoper	rear and front =215mm x800 mm	Rubber mallet	Manual bending	6
5.	Join the two sides with front and rear by spot welding		Ballpeen hammer	Spot welding machine	8
6.	Layout and punch the center of the hole	Dia. 20 at the center from both sides of hopper (65mm) with the height of 101.5mm from the bottom.	Steel rule, scriber, center punch and ball peen hammer		4
7.	Drill	Dia. 20 mm	HSS drill bit 5-20mm dia. ,Drill chuck	Radial drill	3
				Total Time	**33 min**

Seed metering device.

Figure 4.2 shows Seed metering device made from planter middle metering disk and outer metering disk welded together by spot welding (Manufacturing procedure shows in table 4.2).

Material------------mild steel sheet metal

Blank size---------184x 6mm thick.

Quantity --------- 04

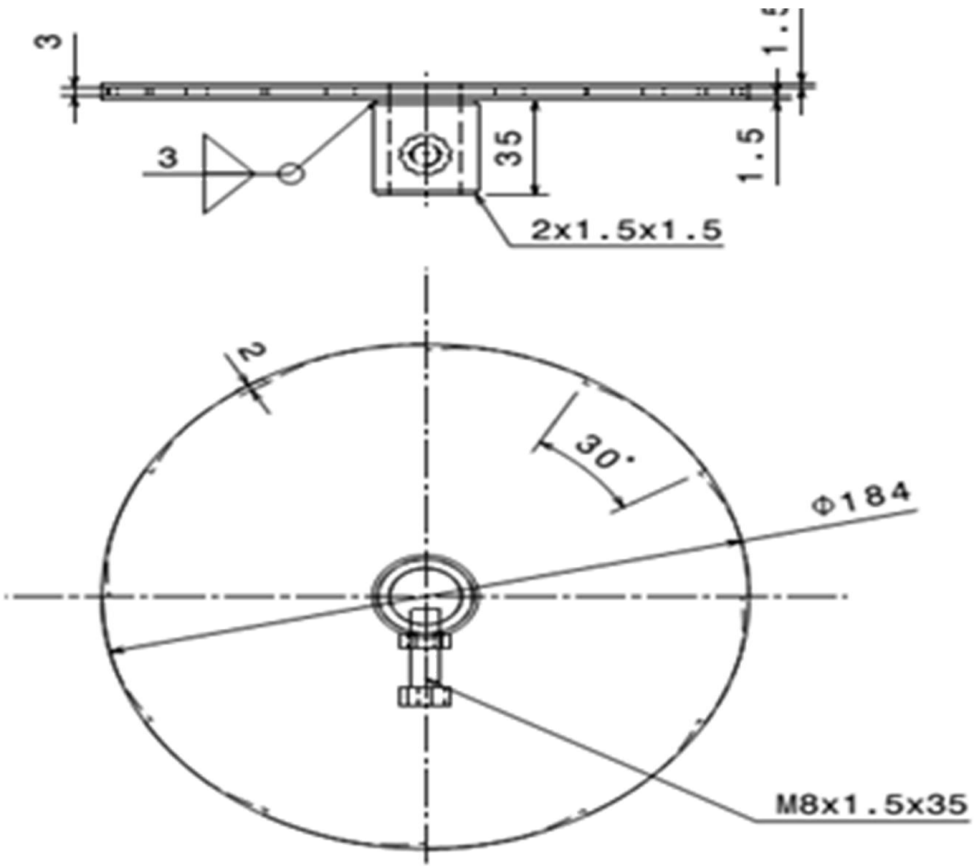

Figure 4.2 Seed metering device

Table 4.2 Manufacturing procedures of Seed metering device.

No	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout & cut at size for middle metering disk	Dia. 184mm x3mm	Tape rule, steel rule & scriber	Hand Shear	3
2.	Layout and cut	Dia. 180mm and divided the circumference of the circle with difference of 30^{0}	Bevel protractor	Manual bending	3
3.	Fill or grind the curves		Smooth flat file	Portable grinder	5
4.	Measure ,	Dia. 184mm x 1.5mm	Tape rule,	Hand Shear	3

	layout & cut at size two outer metering disk	thickness	steel rule & scriber		
5.	Drill	Dia.20.5	Drill bit 5 -20.5 ,drill chuck	Radial drill	3
6.	Join the middle metering disk and two outer metering disk together by spot welding			Spot welding.	5
				Total Time	**22 min**

Fertilizer metering device.

Figure 4.3 shows Fertilizer metering device holds metering tube, extension bar and fertilizer metering bush is made up of galvanized pipe, mild steel round bar , mild steel round bar respectively and used to apply fertilizer to the tube (Manufacturing procedure shows in table 4.3).

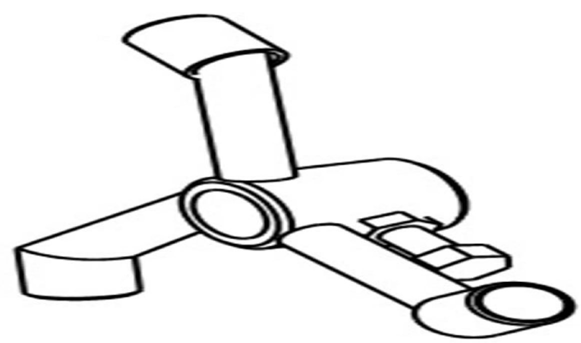

Figure 4.3 Fertilizer metering device

Table 4.3 Manufacturing procedures of Fertilizer metering device.

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout & cut at size the metering tube	Dia. 18 mm L=12	Tape rule, steel rule & scriber	Hand hack saw	2
2.	Chamfer	1 x1mm	Smooth flat file		2
3.	Measure ,	Ø 12 mm	Tape rule,	Power hack	2

	layout & cut at size the extension bar	L=60	steel rule & scriber	saw	
4.	Rough facing on one side	Ø 12 mm L=60-58mm	Carbide cutter & V. caliper	Lathe machine	3
5.	Finish Facing on one side	Ø 12 mm L=60-57.5mm	Carbide cutter & V. caliper	Lathe machine	3
6.	Rough facing on the other side	Ø 12 mm L=57.5-55.5mm	Carbide cutter & V. caliper	Lathe machine	3
7.	Finish Facing on one side	Ø 12mm L=57.5-55mm	Carbide cutter & V. caliper	Lathe machine	3
				Total Time	**18 min**

Fertilizer & Seed metering bush

Figure 4.4 shows fertilizer & seed metering bush made up mild steel round bar with external dia. 30 and internal dia.20.5 used to hold seed and fertilizer metering device on the metering shaft (Manufacturing procedure shows in table 4.4).

Material------------ Mild steel bar
Blank size--------- dia.40 x 40mm
Quantity ----------- 08

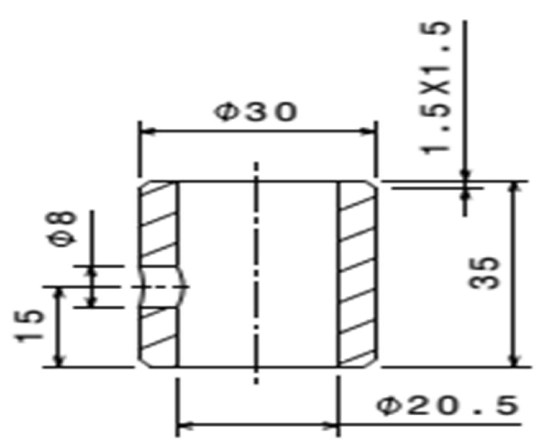

Figure 4.4 Fertilizer & Seed metering bush

Table 4.4 Manufacturing procedures of Fertilizer & Seed metering bush

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø40x40mm	Tape rule , Venire caliper & scriber	Power hack saw	3
2.	Rough Facing on one side	L=40 -38mm	Carbide cutter & V. caliper	Lathe machine	4
3.	Finish Facing on one side	L=38 -37.5mm	Carbide cutter & V. caliper	Lathe machine	2
4.	Chamfering	1.5 x45^0	Carbide cutter & V. caliper	Lathe machine	2
5.	Rough Facing on other side	L=37.5-35.5	Carbide cutter & V. caliper	Lathe machine	3
6.	Finish Facing on one side	L=35.5-35	Carbide cutter & V. caliper	Lathe machine	2
7.	Chamfering	1.5 x45^0	Carbide cutter & V .caliper	Lathe machine	2
8.	Drilling	Dia. 20.5 through the length	Drill bit dia. 5-20.5, drill chuck, sleeve& V .caliper ,	Lathe machine	6
9.	Rough Turning	Ø40-35.5 mm L=35	Carbide cutter & V.caliper	Lathe machine	4
10.	Finish Turning on the side	Ø35.5-35mm L=35mm	Carbide cutter & V.caliper	Lathe machine	2
11.	Drill	Ø8mm with height of 15mm from one end	HSS drill bit 5-8mm, V. Caliper, center punch	Radial drill	5
				Total Time	**35 min**

Metering shaft

Figure 4.5 shows metering shaft is made up of mild steel bar with dimension Ø20x970mm and seed metering shaft (hopper shaft) with the help of chain set which provide to drive the seed metering device and fertilizer applier box roller (Manufacturing procedure shows in table 4.5).

Material------------SAE1040

Blank size---------Ø25x1000mm

Quantity------------01

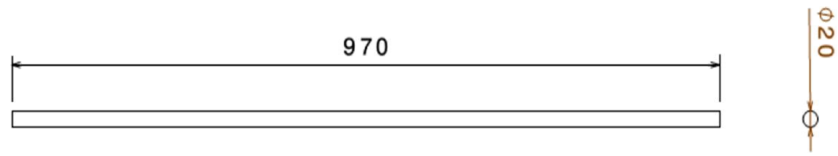

Figure 4.5 Metering shaft

Table 4.5 Manufacturing procedures of Metering shaft

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø25x1000mm	Tape rule , Venire caliper & scriber	Power hack saw	3
2.	Rough Facing on one side	L=1000 -986mm	Carbide cutter & V. caliper	Lathe machine	6
3.	Center drill	At depth 5mm	Center drill, drill chuck, & V. Caliper	Lathe machine	3
4.	Finish Facing on one side	L=986 -985mm	Carbide cutter & V. caliper	Lathe machine	2
5.	Rough Turning on one side	Ø25-20.5mm L=493mm	Carbide cutter & V. caliper	Lathe machine	4
6.	Finish Turning on the side	Ø20.5-20mm L=493mm	Carbide cutter & V. caliper	Lathe machine	3
7.	Chamfering	$2x45^0$	Carbide cutter & V.caliper	Lathe machine	2
8.	Rough Facing on other side	L=985-971	Carbide cutter & V. caliper	Lathe machine	4
9.	Finish Facing on one	L=971 -970	Carbide cutter & V.	Lathe	2

	side		caliper	machine	
10.	Rough Turning on one side	Ø25-20.5mm	Carbide cutter & V. caliper	Lathe machine	4
11.	Finish Turning on other side	Ø20.5-20mm	Carbide cutter & V. caliper	Lathe machine	2
12.	Chamfering	$2x45^0$	Carbide cutter & V. caliper	Lathe machine	2
				Total Time	**37 min**

Ground wheel

The function of drive wheel is to transmit power to the seed and fertilizer metering device .The Ground wheel s (Figure 4.7) are made of mild steel sheet metal and are integral parts of the seed metering mechanism. The wheels have spindles that rotate the metering devices shaft. The diameter of the wheels is 636 X 100 mm and spokes of 296.5 mm long cut from 14mm diameter iron rod were welded at 60^0 to the wheel and the periphery of the bushing which suspends the shaft. Chains are attached to the Ground wheel and to the driving shaft (Manufacturing procedure shows in table 4.7).

Material------------Mild steel sheet metal

Blank size---------2000 x100x 3mm.

Quantity --------- 02

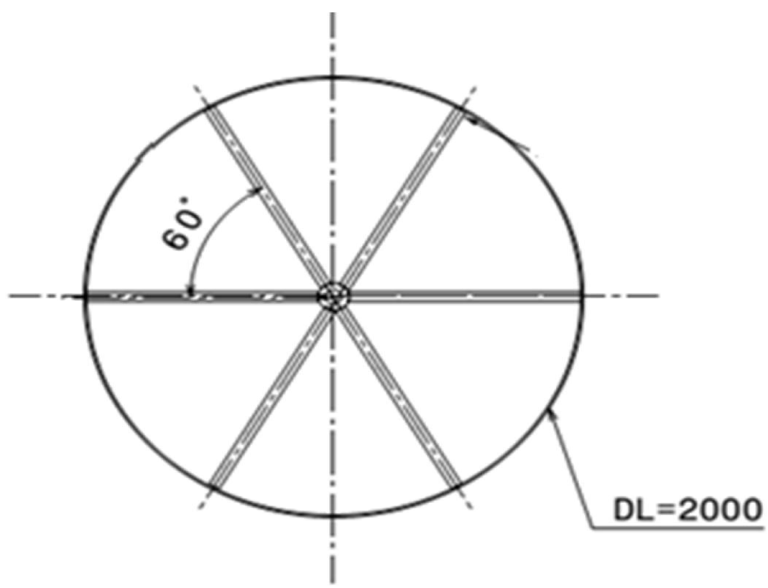

Figure 4.7 Ground wheel

Table 4.6 Manufacturing procedures of Ground wheel

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout and cut	L=2000x100x3 mm	-steel rule, tape rule ,try-square & scriber	Hand shear	3
2.	Rolling	Ø636		Roller	6
3.	Weld the joining part of the circumference		Electrode Ø 2.5	Shield metal Arc welding	7
4.	Weld the reinforcement bar	L=296 Ø 14	Electrode Ø 2.5	Shield metal Arc welding	12
5.	Weld spokes at the periphery of hub		Electrode Ø 2.5	Shield metal Arc welding	12
				Total Time	**40**

Wheel shaft

It is a machine element ,the function of wheel shaft is power transmission unit (Figure 4.7) , to provide power from wheel to hopper shaft (Manufacturing procedure shows in table 4.7).

Material------------SAE1040

Blank size---------Ø30x1205mm

Quantity------------01

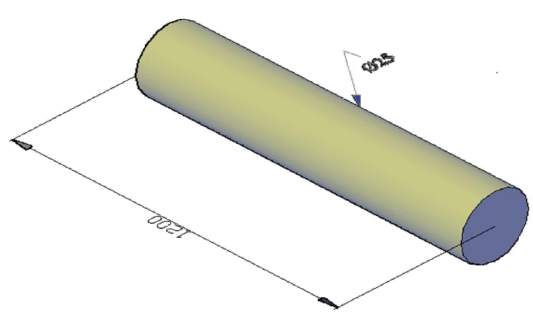

Figure 4.7 wheel shaft

Table 4.7 Manufacturing procedures of wheel Shaft

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø30 L=1205mm	Tape rule , Venire caliper & scriber	Power hack saw	4
2.	Rough Facing on one side	L=1205-1203mm	Carbide cutter & V. caliper	Lathe machine	5
3.	Finish Facing on one side	L=1203-1202.5mm	Carbide cutter & V. caliper	Lathe machine	2
4.	Center drill	2.5mm depth	Center drill, drill chuck, & V.caliper	Lathe machine	3
5.	Rough Turning on one side	Ø30-25.5mm L=1202.5mm	Carbide cutter & V. caliper	Lathe machine	4
6.	Finish Turning on the side	Ø25.5-25mm L=1202.5mm	Carbide cutter & V. caliper	Lathe machine	2
7.	Chamfering	$2x45^0$	Carbide cutter & V. caliper	Lathe machine	2
8.	Rough Facing on other side	L=1202.5-1200.5mm	Carbide cutter & V. caliper	Lathe machine	4
9.	Finish Facing on one side	L=1200.5-1200mm	Carbide cutter & V. caliper	Lathe machine	2
10.	Rough Turning on one side	Ø25-20.5mm	Carbide cutter & V. caliper	Lathe machine	4
11.	Finish Turning on other side	Ø20.5-20mm	Carbide cutter & V. caliper	Lathe machine	2
12.	Chamfering	$2x45^0$	Carbide cutter & V. caliper	Lathe machine	2
				Total Time	**36 min**

Wheel hub (for first wheel)

Wheel hub is made up of mild steel solid bar used to hold the wheel shaft (Figure 4.8**)** with external diameter 40mm and internal diameter 25.5mm shaft (Manufacturing procedure shows in table 4.8).

Material------------Mild steel solid bar

Blank size---------Ø50x105mm

Quantity------------01

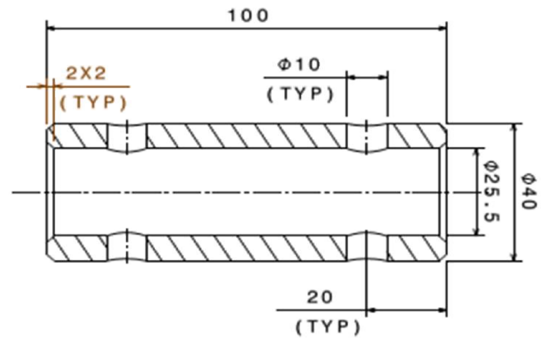

Figure 4.8 Wheel hub (for first wheel)

Table 4.8 Manufacturing procedures of Wheel hub (for first wheel)

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø50x105mm	Tape rule , Venire caliper & scriber	Power hack saw	6
2.	Rough Facing on one side	L=105 -103mm	Carbide cutter & V. caliper	Lathe machine	5
3.	Finish Facing on one side	L=103 -102.5mm	Carbide cutter & V. caliper	Lathe machine	2
4.	Chamfering	2 x45^0	Carbide cutter & V. caliper	Lathe machine	2
5.	Rough Facing on other side	L=102.5-100.5mm	Carbide cutter & V. caliper	Lathe machine	6
6.	Finish Facing on one side	L=100.5-100mm	Carbide cutter & V. caliper	Lathe machine	2
7.	Chamfering	1.5 x45^0	Carbide cutter & V. caliper	Lathe machine	2
8.	Center drill	2.5mm depth	Center drill, drill chuck, & V. caliper	Lathe machine	3

9.	Drilling	Dia. 25.5 through the length	Drill bit dia. 5-25.5, drill chuck, sleeve& V.caliper	Lathe machine	9
10.	Rough Turning	Ø50-40.5 mm L=100mm	Carbide cutter & V. caliper	Lathe machine	4
11.	Finish Turning on the side	Ø40.5-40mm L=100mm	Carbide cutter & V. caliper	Lathe machine	2
12.	Drill	Ø10mm and 20mm far away from two ends	HSS drill bit 5-10mm, V. Caliper, center punch	Radial drill	8
				Total Time	**51 min**

Wheel middle hub (for second wheel)

Wheel middle hub is made up of mild steel solid bar used to hold the wheel shaft (figure 4.9) with external diameter 40mm and internal diameter 25.5mm shaft (Manufacturing procedure shows in table 4.9).

Material------------Mild steel solid bar

Blank size---------Ø50x40mm

Quantity------------01

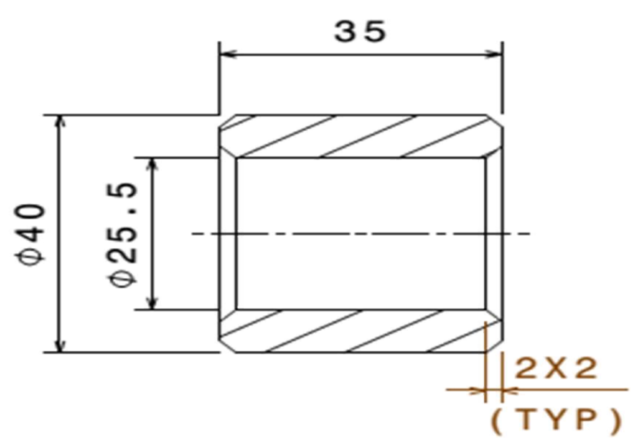

Figure 4.9 wheel middle hub (for second wheel)

Table 4.9 Manufacturing procedures of Wheel hub (for second wheel)

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø50x40mm	Tape rule , Venire caliper & scriber	Power hack saw	5

2.	Rough Facing on one side	L=40 -38mm	Carbide cutter & V. caliper	Lathe machine	4
3.	Finish Facing on one side	L=38 -37.5mm	Carbide cutter & V. caliper	Lathe machine	2
4.	Chamfering	2 x45^0	Carbide cutter & V. caliper	Lathe machine	2
5.	Rough Facing on other side	L=37.5-35.5mm	Carbide cutter & V. caliper	Lathe machine	3
6.	Finish Facing on one side	L=35.5-35mm	Carbide cutter & V. caliper	Lathe machine	2
7.	Chamfering	1.5 x45^0	Carbide cutter & V. caliper	Lathe machine	2
8.	Center drill	2.5mm depth	Center drill, drill chuck, & V. caliper	Lathe machine	3
9.	Drilling	Dia. 25.5 through the length	Drill bit dia. 5-25.5, drill chuck, sleeve& V. caliper ,	Lathe machine	6
10.	Rough Turning	Ø50-40.5 mm L=35mm	Carbide cutter & V. caliper	Lathe machine	6
11.	Finish Turning on the side	Ø40.5-40mm L=35mm	Carbide cutter & V. caliper	Lathe machine	2
				Total Time	**37 min**

Wheel outer hub (for second wheel)

Wheel outer hub (figure 4.10) is made up of mild steel solid bar used to hold the wheel shaft with external diameter 40mm and internal diameter 25.5mm (Manufacturing procedure shows in table 4.10).

Material------------Mild steel solid bar
Blank size---------Ø50x35mm
Quantity------------01

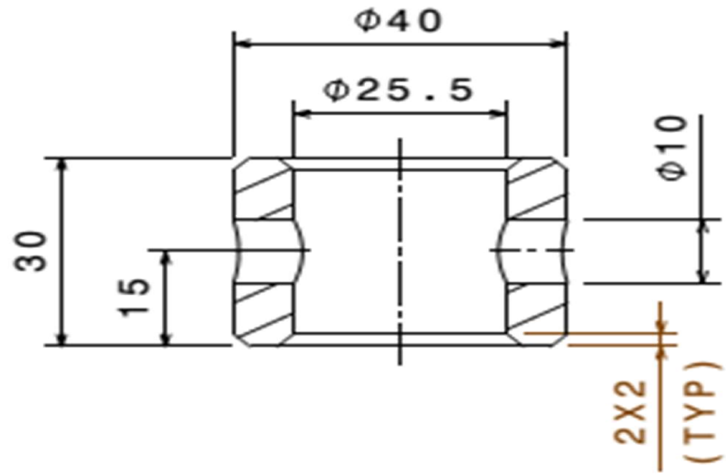

Figure 4.10 wheel outer hub (for second wheel)

Table 4.10 Manufacturing procedures of Wheel outer hub (for second wheel)

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø50x35mm	Tape rule , Venire caliper & scriber	Power hack saw	3
2.	Rough Facing on one side	L=35 -33mm	Carbide cutter & V. caliper	Lathe machine	3
3.	Finish Facing on one side	L=33 -32.5mm	Carbide cutter & V. caliper	Lathe machine	2
4.	Chamfering	2 x45^0	Carbide cutter & V. caliper	Lathe machine	2
5.	Rough Facing on other side	L=32.5-30.5mm	Carbide cutter & V. caliper	Lathe machine	3
6.	Finish Facing on one side	L=30.5-30mm	Carbide cutter & V. caliper	Lathe machine	2
7.	Chamfering	1.5 x45^0	Carbide cutter & V. caliper	Lathe machine	2
8.	Center drill	2.5mm depth	Center drill, drill chuck, & V. caliper		3
9.	Drilling	Dia. 25.5 through the	Drill bit dia. 5-	Lathe	6

		length	25.5, drill chuck, sleeve& V. caliper ,	machine	
10.	Rough Turning	Ø50-40.5 mm L=30mm	Carbide cutter & V. caliper	Lathe machine	4
11.	Finish Turning on the side	Ø40.5-40mm L=30mm	Carbide cutter & V. caliper	Lathe machine	2
12.	Drill	Ø10mm on the center of the work piece.	HSS drill bit 5-10mm, V. Caliper, center punch	Radial drill	5
				Total Time	**37 min**

Pinion bushing

The Pinion bushing (figure4.11) are made up of mild steel solid bars of 33 mm external diameter and 20.3 mm internal diameter and length 35mm.The Shaft passes through the Pinion bushing (Manufacturing procedure shows in table 4.11).

Material------------Mild steel solid bar

Blank size---------Ø40 x 40mm

Quantity --------- 02

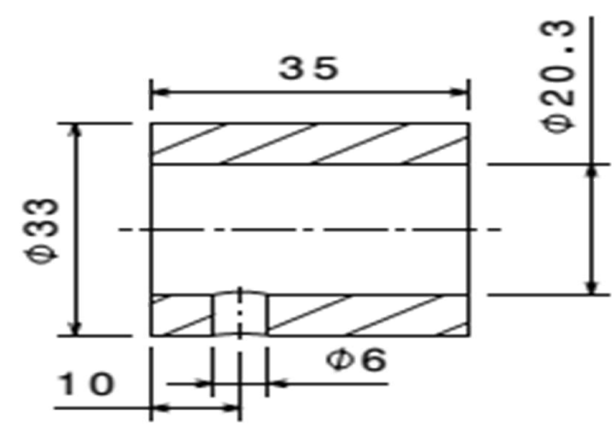

Figure 4.11 Pinion bushing

Table 4.11 Manufacturing procedures of Pinion bushing.

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø40x40mm	Tape rule , Venire caliper & scriber	Power hack saw	3
2.	Rough Facing on one side	L=38 -36mm	Carbide cutter & V. caliper	Lathe machine	3
3.	Finish Facing on one side	L=36 -35.5mm	Carbide cutter & V. caliper	Lathe machine	2
4.	Rough Facing on other side	L=35.5-33.5mm	Carbide cutter & V. caliper	Lathe machine	3
5.	Finish Facing on one side	L=33.5-33mm	Carbide cutter & V. caliper	Lathe machine	2
6.	Center drill	2.5mm depth	Center drill, drill chuck, & V. caliper	Lathe machine	3
7.	Drill	Dia. 25.3 through the length	Drill bit dia. 5-25.5, drill chuck, sleeve (mandrill) & V. caliper	Lathe machine	6
8.	Rough Turning	Ø40-33.5 mm L=35mm	Carbide cutter & V. caliper	Lathe machine	4
9.	Finish Turning on the side	Ø33.5-33mm L=35mm	Carbide cutter & V. caliper	Lathe machine	2
10.	Drill	Ø6mm and 10mm from one end to the center to be drill.	HSS drill bit Ø 3, 4, 6 mm &V. Caliper	Radial drill	5
				Total Time	**33 min**

Sprocket bushing

Sprocket bushing **(figure 4.12)** is made up of mild steel solid bar used to hold the sprocket, have with external diameter 33mm and internal diameter 25.3mm (Manufacturing procedure shows in table 4.12).

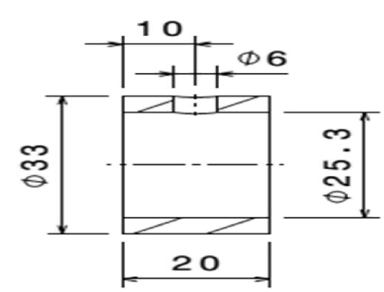

Figure 4.12 Sprocket bushing

Material------------Mild steel solid bar

Blank size---------Ø40x25mm

Quantity------------01

Table 4.12 Manufacturing procedures of sprocket bushing

No.	Operations	Measurements	Tools and equipment	Machinery used	Time (minute)
1.	Measure , layout &cutting to size	Ø40x25mm	Tape rule , Venire caliper & scriber	Power hack saw	3
2.	Rough Facing on one side	L=25 -23mm	Carbide cutter & V. caliper	Lathe machine	3
3.	Finish Facing on one side	L=23 -23.5mm	Carbide cutter & V. caliper	Lathe machine	2
4.	Rough Facing on other side	L=23.5-20.5mm	Carbide cutter & V. caliper	Lathe machine	3
5.	Finish Facing on one side	L=20.5-20mm	Carbide cutter & V. caliper	Lathe machine	2
6.	Center drill	2.5mm depth	Center drill, drill chuck, & V. caliper	Lathe machine	3
7.	Drill	Dia. 25.3 through the length	Drill bit dia. 5, 10, 15, 20, 25.5, drill chuck, sleeve (mandrill) & V. caliper.	Lathe machine	6
8.	Rough Turning	Ø40-33.5 mm L=20mm	Carbide cutter & V. caliper	Lathe machine	4
9.	Finish Turning on the side	Ø33.5-33mm L=20mm	Carbide cutter & V. caliper	Lathe machine	2
10.	Drill	Ø6mm at the center of the work piece depth 3.85mm.	HSS drill bit Ø 3, 4, 6 mm &V. Caliper	Radial drill	4
				Total Time	**32 min**

4.2.3.1 Assembling the machine

Assembly is the last production stage and must continuously be adapted to changing market demands minimization of the number of parts in a product is highly important objective for assembly – oriented product design.
The objective of assembly is to form a part of higher complexity with a specified function in a specific period of time from the individual parts.

The principal activity during assembly includes different operations, such as:-

- ❖ Adjustment
- ❖ Inspection and
- ❖ The performance of secondary functions such as cleaning & debarring etc...

The teff row Planter machine is designed in such a way that it will be convenient and simple for assembly purpose.

The shafts, hopper ,seed and fertilizer metering mechanism, bearing, bearing holder, sprocket, chain, furrow opener, furrow opener holder, etc. are the important parts of the machine which are assembled to the main parts by temporary fasteners.

Table 4.13 Basic hand tools for assembling the machine

No	Item description with technical specification	Unit	quantity	Remark
1.	Open end wrench No. 13-14	Pcs	1	
2.	Open end wrench No. 16-17	Pcs	1	
3.	Open end wrench No. 22-24	Pcs	1	
4.	Adjustable wrench	Pcs	1	
5.	Rubber Mallet	Pcs	1	
6.	Ball peen hammer 1.5kg	Pcs	1	
7.	Engineering level	Pcs	1	

Procedures of assembling components

Figure 4.13 shows Sub-assembly of frame

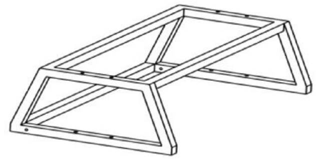

Figure 4.13 Sub-assembly of frame

Figure 4.14 shows Sub- assembly of furrow opener

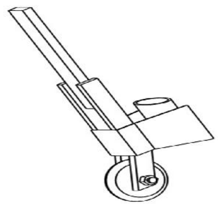

Figure 4.14 Sub -assembly of furrow opener

Figure 4.15 shows Sub- assembly of covering device

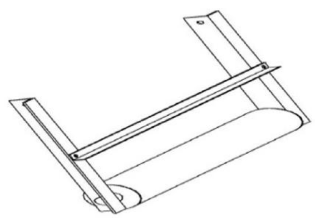

Figure 4.15 covering device

Assembly of teff row Planter

- Insert the ground wheel with frame at the recommended location.
- Fix and tighten the hopper on the frame by bolts.
- Fix the metering shaft in hopper.
- Insert seed and fertilizer metering device with hopper shaft.
- Fix the handle to the main frame.
- Mount the covering device with frame.
- Fix the beam attachment with frame.
- Assembly of furrow opener by bolt with frame.
- Check for correct functioning of the teff row planter machine. Figure 4.16 shows assembly of teff row planter machine.

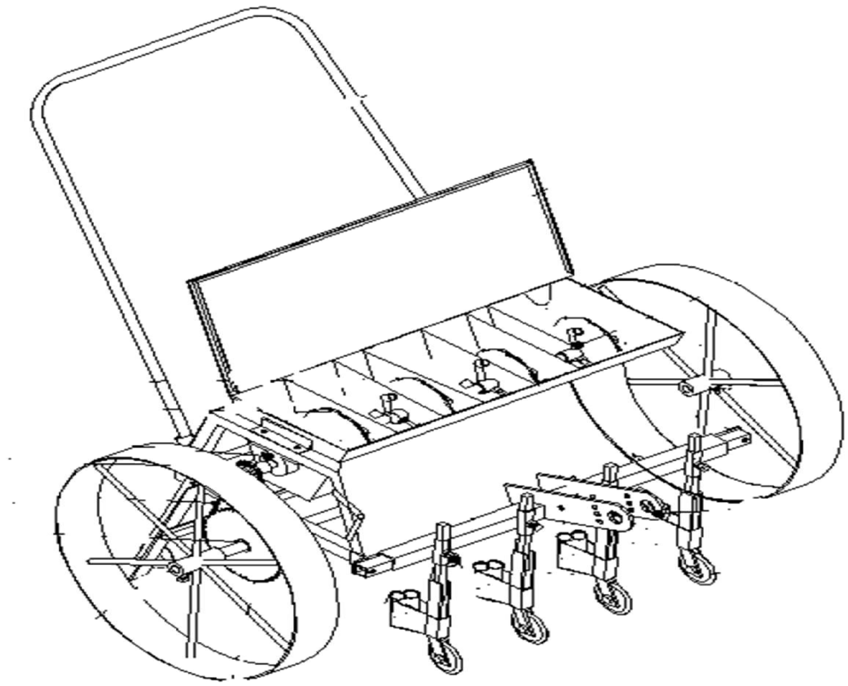

Figure 4.16 Assembly of teff row Planter

Painting of the machine

To prevent surface corrosion and for aesthetic purposes, first of all the surface of the component of the machine should be polished with wire cup to remove corrosion and other dusts. It is also filled by metal body filler if deformed or irregular surface is observed and is polished by fine sand paper (No. 80, No 120) to make the surface leveled and smooth.

Finally the parts should be painted with antirust by using paint brush and consequently, it should be painted with the user desire color repeatedly until getting uniform feature and beauty

CHAPTER – FIVE

PRODUCT COST ANALYSIS AND MAINTENANCE AND REPAIR

5.1. Introduction

Cost Analysis is the element-by-element examination of the estimated or actual cost of contract performance to determine the probable cost to the manufacturer. The goal is to form an opinion on whether the proposed costs are in line with what reasonably economical and efficient performance should cost. The costs can be compared with actual costs previously incurred for similar work, the cost or pricing data received from other vendors, and independent cost estimate breakdowns.

5.2. Manufacturing Costs

The term manufacturing costs usually refers to material used, direct labor incurred, and overhead incurred in a manufacturing industry. Material used, direct labor, and manufacturing overhead at the time incurred are not expenses; rather they incurred costs. In the manufacturing process, material, labor, and overhead do not expire; rather through manufacturing activity they become transformed from one type of utility to another.

In manufacturing, cost is usually expressed in a monetary (Birr) unit per unit output. The determination of the factor cost for a components, sub assembly of final assembly based on defined of manufacturing process plan. The manufacturing planning function is the determination of a process sequence or operation utilizing labor, equipment and tooling to produce any manufactured item. In addition to estimating individual operation and product factory cost, estimates are also completed for projects or over all systems within the manufacturing organization.

In order to arrive at selling price of a product, costs above factory costs and profit margins must be determined. The major reason for the cost estimating function to be located within the manufacturing organization is that many decisions are based on cost estimate specific products. Examples included decisions concerning what process to use, staffing, scheduling, makes versus by, and pricing recommendations to sales marketing.

Other functional areas of the business have need for cost estimates. These needs casually be satisfied by the manufacturing based cost estimating functions. The only exception to this organization alignment is in the job-shop environment where the product is always customer engineered and the lead time for responding to bid requests is very short. In this case, merit exists to place the cost estimating function in product design.

5.2.1. The costs of raw materials and the cost of standard items

The net material cost (table 5.1) is the cost of purchasing the raw material less the value of scrap produced the weight of the purchased starting material w_o & of the finished part w_f is determined. If the unit price of the starting material is C_o & that of the scrap is C_s the material cost per piece C_p is

$$\mathbf{C_p = W_oC_o - (W_o - W_f)C_s} \quad \text{...6.1}$$

Price for purchased materials

Table 5.1 Price of the exact dimension of row materials for project

No.	Material Description	Specification	Unit	Qty	Unit price		Total price		Remark
					Birr	Cen	Birr	Cen	
1.	Mild steel sheet metal	1000x2000 x1.5 mm	Pcs	02	700	00	1400	00	
2.	Mild steel sheet metal	300x2000x3	pcs	01	1000	00	300	00	
3.	Mild steel flat iron	30x3000x5mm	pcs	01	300	00	150	00	
4.	Mild steel flat iron	80x670x6mm	pcs	01	600	00	67	00	
5.	MS square pipe	40x40x6000x3mm	pcs	01	550	00	550	00	
6.	MS square pipe	30x30x2000x3mm	pcs	01	450	00	150	00	
7.	MS Round bar	Ø14x1200 mm	pcs	01	300	00	60	00	

8.	MS round bar	Ø40x800 mm	pcs	01	850	00	113	30	
9.	MS round bar	Ø30x2200 mm	pcs	01	600	00	220	00	
10.	Angle iron	40x40x800x5mm	pcs	01	800	00	106	65	
11.	GI pipe	Ø22x800 mm	pcs	01	200	00	26	65	
12.	GI pipe	Ø26x2700 mm	pcs	01	250	00	112	50	
13.	GI pipe	Ø87x800 mm	pcs	01	1300	00	173	30	
14.	square bar	15x15x1000mm	pcs	01	1200	00	200	00	
						Sub Total	**3629**	**40**	

Table 5.2 Standard item cost

No	Material Description	Size Required	Unit	Qty	Unit price		Total price		Remark
					Birr	Cent	Birr	Cen	
1.	Hexagonal bolt & nut	M10x45	Pcs	10	8	00	80	00	
2.	Hexagonal bolt & nut	M8x40	Pcs	24	6	00	144	00	
3.	Radial ball bearing	204	pcs	02	280	00	560	00	
4.	Radial ball bearing	205	pcs	02	280	00	560	00	
5.	Chain and sprocket mechanism	Small sprocket Ø70,18 teeth and large sprocket Ø210,48 teeth	pcs	01	760	00	760	00	
6.	Hack saw blade	18T/inch	Pcs	5	27	00	135	00	
7.	Anti-rust	Litter	Pcs	1	55	00	55	00	
8.	Paint green	Litter	Pcs	1	55	00	55	00	
9.	Grinding disk	Dia. 180	Pcs	1	40	00	40	00	
10.	Cutting disk	Dia. 180	Pcs	1	35	00	35	00	
11.	Drill bit	Ø6mm	Pcs	1	10	00	10	00	
12.	Drill bit	Ø8mm	Pcs	1	10	00	10	00	
13.	Drill bit	Ø10mm	Pcs	1	10	00	10	00	
14.	Drill bit	Ø12mm	Pcs	1	10	00	10	00	
15.	Wire brush		Pcs	1	20	00	20	00	
16.	Paint brush	3”	Pcs	1	15	00	15	00	

17.	Thinner	Litter		02	60	00	120	00	
18.	Carbide cutter	20x20x150	pcs	02	200	00	400	00	
19.	Electrode	Ø 3.2mm	Pkt	01	150	00	150	00	
						Sub-total cost	**3169**	**00**	

Total Materials Cost = Cost of raw materials+ Cost of Standard items

= 3629.40Birr + 3169.00Birr

Total material Cost = 6798.40 Birr

5.2.2. Manufacturing Labor cost

The cost to keep an operator on the job may be on an hourly basis, per unit of output basis, or a combination of both. Labor cost is generally considered an operator cost, however, most operators do minor repairs when the machines are down of one piece can be calculated [12].

Labor (table 5.3) is charged at hourly rates that include 30 percent benefits in manufacturing industry. The charge rates are Br 15per hour for unskilled labor and 25.00 per hour for skilled labor. The skilled labor rate is generally used with the machining equipment. Labor per manufacturing component for an operation such as welding is calculated by using the work rate on the manufacturing industry. A small amount of extra labor is added to allow for downtime for tasks such as making adjustments and maintenance. This is applicable for general manufacturing industry but our labor estimations have been based upon the hours accumulatively spent on the project as technician earning a 150.00 Br per daily expense. To start cost study developers concerned labor expense data from different areas especially in small scale industry around Adama city. Most of those industries are one daily wage worker paid only 150.00(one hundred fifty Br) as stated on the table below 18.75 Br per hour.

Approximately 32.13 hours was spent on the fabrication of the machine.

Table 5.3 Manufacturing Labor cost

No.	Activity (operation)	Time(min.)	No. of workers	Total Labor time,(hrs)	Cost (Br /hr)	Total cost in Birr
1.	Fabrication of hopper	33	2	1.1	18.75	20.60
2.	Fabrication of metering device	357	2	11.9	18.75	223.13
3.	Fabrication of Ground wheel	201	2	6.7	18.75	125.60
4.	Fabrication of Handle	29	1	0.48	18.75	9.05
5.	Fabrication of Beam attachment	28	2	0.93	18.75	17.50
6.	Fabrication of Pinion & Sprocket bushings	65	1	1.08	18.75	20.30
7.	Fabrication of Furrow opener components	168	2	5.6	18.75	105.00
8.	Fabrication of frame	50	1	0.83	18.75	15.60
	Sub-total	931	13	28.62		**536.78**

Table 5.4 Sub-assembling labor cost

	Activity (operation)	Time(min.)	No. of workers	Total Labor time,(hrs)	Cost (Br /hr)	Total cost in Birr
1.	Sub-assembly of furrow opener	23	2	0.76	18.75	14.37
2.	Subassembly of ground wheel component with frame	20	2	0.66	18.75	12.50
3.	Sub assembly of	10	1	0.17	18.75	3.13

	frame with hopper					
4.	Sub assembly of metering device with hopper	20	2	0.67	18.75	12.50
5.	Sub assembly of handle with frame	10	1	0.17	18.75	3.13
6.	Sub assembly of covering device with frame	10	1	0.17	18.75	3.13
7.	Sub assembly of beam attachment with frame	5	1	0.08	18.75	1.50
8.	Sub assembly of furrow opener with frame	20	1	0.33	18.75	6.25
9.	Painting	30	1	0.5	18.75	9.40
Total		148	12	3.51		**65.91**

Total Labor Cost = Labor cost for manufacturing components + Labor cost for assembling components.

Total labor cost =536.78 +65.91=602.69 birr

5.3. Over Head cost

In general overhead expenses are absorbed by the business and factored into the selling price as a percentage of the direct labor cost. They may include indirect costs such as accounting, advertising, depreciation, indirect labor, insurance, planning, legal fees, rent, research and development, repairs, supplies, taxes, telephone, travel, and utilities.

The overhead costs of the project (depreciation and electric consumption costs) are discussed below.

5.3.1. Electrical power consumption cost

It is the amount of electrical power which needed to operate the machine to perform the operation. Electrical power can be determined by a unit watt (w) or kilowatt (kW). Power consumption payment is 0.69 birr per kw/hr. Depending on this; it is possible to evaluate the total amount of payment that used to manufacture the project. It needs to change the amount of power consumed by the machines in to birr. The electrical machines used and time consumed is indicated below in table 5.6:-

Table 5.5 Machines & time consumed

No.	Manufactured parts	Power hack saw	Lathe machine	Shielded metal Arc welding machine	Drilling machine	Spot welding	Portable hand grinder
1.	Hopper components				0:09	0:20	
2.	Metering device components	0:10	1:20	0:30			0:15
3.	Ground wheel components	0:10	1:30	0:20	0:10		
4.	Handle components			0:15	0:05		
5.	Beam attachment			0:20	0:30		0:30
6.	Pinion & Sprocket bushings	0:10	0:50				
7.	Furrow opener components	0:30		0:30			
8.	Frame			0:40	0:10		
	Total time	**1:00**	**3:40**	**1:55**	**1:04**	**0:20**	**0:45**

Now let's calculate the energy used for each machine multiplying their power rating with their machining time.

Note: - Power rating of each machine is taken from their life history card

Example-1 Shield metal arc welding machine

Power rating (p) =4.9KW

Working time (t) =1:55hr

Energy consumed (E) =?

E=Pxt ……………………………………………………...6.2

= (4.9x1) + (4.9x55/60)

E=4.9KWH + 4.492KWH =<u>9.39KWH</u>

Note: - The energy consumed for each machine is done with the same procedure of the above example.

Note: - The electrical power cost for 1KWH is 0.69 Birr, source from EELPA

Table 5.6 Electrical power consumption cost

No	Machine type	Power rating of the machine in KW	Total machining time in hour	Energy consumed in KWH	Payment for 1KWH in Birr	Total payment in birr
1.	Power hack saw	0.75kw	1:00	0.75	0.69	0.52
2.	Lathe machine	2.2kw	3:40	8.06	0.69	5.56
3.	Shield metal arc welding machine	4.9kw	1:55	9.39	0.69	6.48
4.	Pedestal Drilling machine	1.3kw	1:04	1.386	0.69	0.96
5.	Portable hand grinder	2.0kw	0:45	1.5	0.69	1.04
6.	Spot welding	1.6kw	0:20	0.53	0.69	0.37
					Sub-total cost	**14.93**

5.3.2. Depreciation costs

Depreciation is defined as the reduction in value of the machine over time as it is working at a specific task. Depreciation occurs due to wear that gradually declines the capacity of the piece of equipment to perform its function. The objective of the depreciation schedule is to recover the initial investment cost of equipment each year over its economic life [12].

Straight-line method assumes that the value of the equipment reduces at a constant rate for each year over its economic life. The straight-line method is the simplest way for estimating depreciation costs and may be most preferable method to calculate equipment cost per unit of time. The mathematical formula for the yearly depreciation charge using the straight-line method is: [12].

$$\mathbf{D = \frac{P-S}{N}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6.3$$

Where:

D = depreciation charge

P = Initial purchase price (actual price)

S = Salvage value (percent of initial price; P) (take average 25% salvage rate)

N = Economic life (in year or scheduled machine hours)

Example: The depreciation cost of lathe machine is calculated as follows and the same is done for other machines.

Purchased cost of lathe machine 100,000.00 birr

Salvage value after 10 years will be 25,000 birr

Now, the depreciation cost per one year will be calculated in straight line method as follows.

$$D=\frac{P-S}{N}=\frac{100{,}000-25{,}000}{10}$$

=7500.00 birr per year

If the estimated scheduled machine hours are 1,920 (240 x 8-hours shifts per year), depreciation cost per scheduled machine hours is:

Depreciation charge per hour (D) = Depreciation charge per year divided by 1,920 hr./yr. Therefore the time period over which hourly depreciation charge (cost) of lathe machine =3.90 birr/hr.

Another consideration we have taken is the depreciation cost for other tools and equipment to be 25% of machine depreciation. The depreciation of those machines can take also from the colleges scheduled data.

Table 5.7 Depreciation cost of different machines [12].

No.	Types of machine used	Life span (year)	Machine price	Deprecation vales / hour	Operation time	Total deprecation value
1.	Power hack saw	10	30,000.00	1.17	1:00	1.17
2.	Lathe machine	10	100,000.00	3.90	3:40	14.30
3.	Shield metal Arc welding	5	25,000.00	1.95	1:55	3.74
4.	Pedestal Drilling machine	10	70,000.00	2.73	1:04	2.91
5.	Portable hand grinder	3	1500.00	0.19	0:45	0.15
6.	Spot welding	10	45,000.00	1.76	0:20	0.59
					Sub-total	**22.86**

Total cost of the machine

Total cost of teff row planter machine

- ❖ Manufacturing cost:-

Material cost = 6798.40 Birr

Labor cost = 602.69 Birr

Overhead cost = 37.79 Birr

Manufacturing cost = 7438.88 birr

Contingencies: - it is compensation due to some errors and unexpected failure of time in our project it is usually taken as 10% of the manufacturing cost.

Contingency = 10%x7438.88Birr =**743.88 birr**

Total manufacturing cost = Manufacturing cost + Contingency

= 7438.88Birr + 743.88 birr

= 8182.77 birr

- ❖ Profit: - it is usually taken as20% of total manufacturing cost

  Profit =20/100x8182.77 birr

  Profit = 1636.55 Birr

- ❖ Selling price = Profit + Total manufacturing cost

  = 1636.55 +8182.77 birr

  Selling price = 9,819.32 birr

Purchasing approach of the machine

The farmers borrowed 9819.32birr from a bank at 8% interest rate and they have to pay it back in 5 years. The debt can be repaid at end of each year 1,963.86 birr principal plus interest due.

Table 5.8 Purchasing approach description

A	**B**	**C**	**D**	**E**	**F**
Year	Amount Owed	Interest Owed	Total Owed	Principal Payment	Total Payment
		i*B	B+C		
1	9819.32	785.54	10604.86	1,963.86	2749.40
2	7855.46	628.44	8485.9	1,963.86	2592.3
3	5891.61	471.33	6365.94	1,963.86	2435.19
4	3927.75	314.22	4245.97	1,963.86	2278.08
5	1963.86	157.10	2125.96	1,963.86	2120.96
Sum		**2,356.63**		**9,819.30**	**12,175.93**

The developer's team cannot compare to cost of the machine because there is no in market still the machine is in experiment.

5.4. Maintenance and Repair

5.4.1.Introduction

Maintenance is the process of repairing parts or machines that are worn out by using new accessories, repairing the damaged parts, and taking before failure happens. Maintenance and repair of parts and components is very necessary and important to effective operation of the machine. Effective maintenance is one of the most cost-effective methods for ensuring reliability, safety, and energy efficiency. Generally maintenance is work necessary to maintain and preserve the teff row planter machine in a condition suitable for its designate purpose and includes preventive, predictive, and corrective (repair) maintenance (plus many more tools/techniques) [16].

Maintenance is the combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function.

Maintenance is not merely preventive maintenance, although this aspect is an important ingredient. Maintenance is not lubrication, although lubrication is one of its primary functions. Nor is maintenance simply a frenetic rush to repair a broken machine part or building segment, although this is more often than not the dominant maintenance activity.

In a more positive vein, maintenance is a science since its execution relies, sooner or later, on most or all of the sciences. It is an art because seemingly identical problems regularly demand and receive varying approaches and actions and because some managers, foremen, and mechanics display greater aptitude for it than others show or even attain. It is above all a philosophy because it is a discipline that can be applied intensively, modestly, or not at all, depending upon a wide range of variables that frequently transcend more immediate and obvious solutions. Moreover, maintenance is a philosophy because it must be as carefully fitted to the operation or organization it serves as a fine suit of clothes is fitted to its wearer and because the way it is viewed by its executors will shape its effectiveness [16].

Admitting this to be true, why must this science-art-philosophy be assigned—in manufacturing, power production, or service facilities—to one specific, all-encompassing maintenance department? Why is it essential to organize and administer the maintenance function in the same manner that other areas are so handled?

Let us, however, begin by looking at how the maintenance function is to be transformed into an operation in terms of its scope and organization, bearing in mind its reason for being—solving the day-to-day problems inherent in keeping the physical facility (plant, machinery, buildings, services)—in good operating order. In effect, what must the maintenance function do?

5.4.2. MAINTENANCE AND THEIR FUNCTIONS

Following are some of the important functions of the maintenance program.

- Inspection or checkups.
- Lubrication.
- Planning and Scheduling.
- Records and analysis.
- Training to maintenance staff.
- Storage of Spare Parts.

Inspection or Check-Ups.

Inspection is an essential function of the maintenance program. Crews kept for this purpose should be well-trained. These crews carry out both the external and internal inspection. External inspection means to watch for, and detect defects form abnormal sound, Vibration, heat, smoke etc. When machine is in operation; internal inspection means inspection of internal parts, such as gears, bushes, bearings, tolerances in the parts etc., during the period, when machine is under pre-planned shutdowns. Frequency of inspection should be decided very carefully, as too less inspection may cause break down, as defects could not be traced out and rectified immediately; while too much inspection means wastage of machine time and labor productivity. Hence frequency should be decided on the basis of past experiences and scheduled program for inspection.

Lubrication.

Mechanical components like gears, bearings, bushes and other friction surfaces etc. give good performance for long periods, when they are systematically lubricated. Systematic lubrication means the application of right type of lubricant at the right time, at right place and in right quantity. For lubrication, a lubrication schedule should be prepared and that should be followed strictly.

Planning and Scheduling.

Every preventive maintenance work should be pre-planned in detail on the basis of the analysis done on the past records.

A scheduled program thus prepared should be followed strictly. Thus program should be in detail specifying the point requiring daily, weekly, monthly, half yearly or yearly attention.

Records and Analysis.

Good record keeping is essential for good maintenance, as it helps in fore casting maintenance. For his purpose following records are generally maintained:

- Operation manual
- Inspection Register
- Maintenance Instruction manual (catalogues)
- Log books
- History Cards and History Registers
- Defects Register etc.
- Spares procurement Register
- Drawings

With the help of these records possible cause for major repetitive failures can be examined and rectified so as not to repeat so early. These records help the plants Engineers and General Manager to take decisions. The analysis made on the basis of these records help in:

- Preventing defect rather than rectifying after break-downs.
- Knowing the machines reliability and thus helps in production planning.
- Decided life of the machine.
- Forecasting defects and planning to rectify them before the failure occurs.
- Frequency of inspection and checkups.

- ❖ Deciding for the purchase of a machine, which may suit best on the basis of past experience. In spite of best inspection and other measures failures are bound to occur but they can be reduced to a large extent.

Training of Maintenance Personnel.

For the success of maintenance a sound training is Essential for the maintenance personnel. Hence the technicians and supervisors are trained to carry out maintenance, inspection and repaired in a systematic way.

Storage of Spare Parts.

Sometimes machine remains idle for want of spare parts for considerable time and thus it, affects considerable loss of production. Hence it is essential to keep the spare parts so as to avoid loss of production. But the judgment and experience of high order is required for deciding the number of such parts, as storage of a large number of parts will mean blocking of capital. The level of spare parts must be determined by considering different factors such as source of supply, delivery, period and availability of that spare part in the market. Standardization will help of reduce the spare parts inventory.

5.4.3. Maintenance Activities

Activities of maintenance function could be either repair or replacement activities, which are necessary for an item to reach its acceptable productivity condition or these activities, should be carried out with a minimum possible cost.

5.4.4. Maintenance Objectives

- ❖ Maximising production or increasing facilities availability at the lowest cost and at the highest quality and safety standards.
- ❖ Reducing breakdowns and emergency shutdowns.
- ❖ Optimising resources utilisation.
- ❖ Reducing downtime.
- ❖ Improving spares stock control.
- ❖ Improving equipment efficiency and reducing scrap rate.
- ❖ Minimising energy usage.

- ❖ Optimising the useful life of equipment.
- ❖ Providing reliable cost and budgetary control.
- ❖ Identifying and implementing cost reductions.

5.4.5.Maintenance and Repair teff row Planter machine parts

A well maintained and properly adjusted teff row Planter machine gives trouble free service for a long time. It also helps in timely completion of operations .The following important points may be kept in mind for the maintenance and repair of various components of the teff row planter machine.

Seed and Fertilizer Hopper

- ❖ The hopper should be thoroughly cleaned as these may rust very fast due to environmental moisture. This will damage the hopper and machine will not be useful for the next crop sowing season. The hopper must be cleaned as under:
- ❖ Raise the machine above ground so that the Ground wheel s move freely
- ❖ Remove seed and fertilizer from hopper.
- ❖ Open the flow gates of seed and fertilizer cups.
- ❖ Rotate the Ground wheel till the seed and fertilizer from different seed and fertilizer cups are emptied. Clean the hopper and cups with the help of a cloth or brush.
- ❖ Wash the machine rollers/seed/fertilizer hopper with diesel to avoid rusting.
- ❖ Apply lubricating oil at appropriate places (bushes and sides of metering rollers) [14].

Drive/power Transmission System

For maintenance of drive system/power transmission system, keep following points in mind:-

- ❖ Ground wheel should move freely. If it is jammed, then apply grease or put oil in its bushes. If axle of wheel is bent or worn out, replace it.
- ❖ Ground wheel should be round, if it is bent then repair it.

- ❖ Sprockets of ground wheel and wheel shafts, hoper shaft (seed and fertilizer hopper) should be properly aligned. Sprockets should be properly tightened on their shafts so that these may not move freely on these shafts.
- ❖ Hopper shafts should move freely. If these are jammed due to rusting, then clean and apply lubricating oil/grease in the bushes.
- ❖ Bent wheel shaft should be repaired or replaced.
- ❖ Seed and fertilizer hopper should be thoroughly cleaned for free movement of feed shafts.
- ❖ Chain and sprocket should be properly tightened so that proper chain tension is maintained and mechanism moves freely.
- ❖ Worn out parts, loose, broken and worn out bushes should be replaced [14].

Seed Metering Mechanism

Usually fluted roller type seed metering mechanism is used in this seeding machine. It should be repaired and maintained as under.

- ❖ Side plate of seed metering shaft sprocket should be removed by loosening nuts/ bolts.
- ❖ Remove the nuts/bolts of all the seed cups.
- ❖ Remove metering rollers from the seed cups and replace broken rollers and notched plates.
- ❖ Take out the shaft on one side. All rollers will come out of seed cups.
- ❖ Put the rollers on the shaft and put again on the seed box.
- ❖ Complete system should move freely and rotate the sprocket till appropriate seed rate is achieved from all the rollers [14].

Fertilizer Metering Mechanism

In fertilizer metering mechanism, fertilizer settles on its parts due to environmental moisture which may cause obstruction in free and uniform flow of fertilizer. Large particles also cause hindrance in the mechanism.
Therefore, this system requires special attention as follows:

- After seeding a teff, fertilizer should be removed from the box and whole system should be cleaned with the help of brush or cloth.
- All the holes in the box should be properly open.
- Agitators provided on the shaft should also be cleaned and the lubricating oil/grease may be applied in the bushes of the fertilizer metering shaft.
- Tighten all nuts and bolts of the mechanism.

Likewise in other seeding machines which possess rotating cup type metering device should also be cleaned carefully. Each compartments, cup/ seed and fertilizer guide should be free from jamming and the roller should move freely [14].

Seed and Fertilizer Tubes

These are mostly plastic tubes connected to seed/fertilizer cups and their lower ends are connected to seed boots.

- Tubes should be connected to seed/fertilizer cups with the help of clamps so that these may not come out during field operation.
- Tubes should be protected from bending and breakage.
- Old/bent tubes should be replaced.
- Excessive bend in the tubes should be avoided otherwise the bend will cause obstruction in free flow of seed/fertilizer and results in non-uniform application of fertilizer in the field [14].

Furrow Openers

Furrow openers are attached to main frame with the help of bolts/nut. The furrow openers wear out or twist very fast. Therefore, these should be repaired frequently. The worn-out ones should be removed (replaced) as and when required.

General

- All the components of the machine should be painted
- Machine should be protected from rain, dirt and dust etc. during its storage.

- Moving parts should be greased/oiled at regular intervals so that the machine gives a trouble free service for a long time.
- Users training will lead to improvement in the performance of the machines [14].

Machine storage

Before storing the planter for any length of time, clean each part of the machine; apply grease/oil to the transmission chain and moving parts. Store the machine in a dry, well ventilated store. Keep the appropriate tools with the machine during storage to ensure that they will be available when needed again [14].

CHAPTER-SIX

RESULT AND DISCUSSION

As per design considerations the machine components were designed and fabricated successfully. Seed metering mechanism is used for seed as there is no any mechanical damage to seeds due to mechanical handling. The diameter of seed cup is 184mm with 12 cups are mounted along the periphery of the seed cup inclined pitch angle 30^0. A close visual inspection of the seeds that were released from the planter metering mechanism shows no visible sign of damage and reaches the seeds uniformly on the seed bed.

For this design, Trial tests were conducted to see if the seed metering mechanism, furrow opener, and seed covering device are functioning properly. The results show that they are functioning properly as expected. For a furrow opener, the ability to place the seed at a given sowing depth in the soil is an important factor in evaluating its performance. For the planter operation, the hopper was filled with seeds. As the ground wheel rotates, the seed metering device placed at the hopper also rotates, thereby releasing the teff. These seeds are then conveyed to the furrow through the seed delivery tube. The teff was then compacted by the roller type covering device.

It is necessary to calibrate the seed planter before putting it in actual use to find the desired seed rate. To calibrate the planter to a desired seed rate, first fix the seed metering strip in the appropriate delivery notch. Measure circumference of drive wheel (C_d) which is 2000mm and measure width of the planter (W_p) by multiply the four number of furrower with distance between two furrower 0.2m.

Put seed in hopper then rotate drive wheel manually to ten full rotations and collect seed delivered from each seed delivery tube separately in polythene bags. Developers determine the total seed weight 7.33 gram released in 10 Revolution (S_w).

Calculate Seed rate (kg/ha) = $\{S_w/(C_d \times W_p)\}$[14]

= $\{7.33/(2m \times 0.8m)\}$= 4.58 Kg/ha.

During testing there are not any problems comparing the paper with practical implications. Then, the project is functional as per the design.

Table 6.1 Detail specification of developed prototype of animal drawn teff row planter machine

N0.	Components	Specifications	Materials
1.	Ground wheel	Rim diameter: 636 mm, rim width: 100 mm	MS sheet 100×3
2.	Seed hopper	Four small hoppers with Trapezoidal shape cross section, height of hopper 215 mm, upper side 330×310 mm, bottom side 330×130 mm, angle of inclination of 67˚ with the horizontal.	MS sheet
3.	Fertilizer hopper	Trapezoidal shape cross section, height of box 215 mm, upper side 470×310 mm, bottom side 470×130 mm, angle of inclination of 60˚ with the horizontal.	MS sheet
4.	Seed metering mechanism	Cup feed metering mechanism, diameter of seed plate 184 mm, 12 cups around the periphery.	MS sheet
5.	Fertilizer metering	Metering tube 18mm dia, round bar dia.12x55 mm.	GI pipe, MS round bar
6.	Clutch	Dog clutch, length of handle 1100 mm.	MS flat 25×3 mm
7.	Power trans-mission unit	Large Sprocket 48 teeth 210 mm diameter and small Sprocket 16 teeth 70 mm diameter, chain pitch 10 mm, total chain length 736 mm.	
8.	Main frame	Total length of 5700 mm	MS sheet 30×30×3
9.	Furrow openers Disc type	Adjustable row to row spacing 200mm disc type with diameter of 96mm, disc angle 6˚and width of the disc is 8mm	Medium carbon steel
10	Seed delivery tube	Diameter 20mm, thickness 2 mm	Polythene tube

CHAPTER-SEVEN

SUMMERY, CONCLUSION AND RECOMMENDATIONS

7.1. Summery

Chapter one described a general introduction of the thesis and the project. Chapter two reviewed literatures about particles of teff row planter machine. Chapter three presented materials, machine parts design, the design analysis of the critical components of the machine and material selection. Chapter four covered manufacturing process of the machine and assembly of the components. Chapter five covered Product cost analysis and operational and maintenance instructions of the machine. Chapter six covered result and discussion. Chapter seven gave summery, short recommendation and conclusions.

7.2. Conclusions

The Modified teff row planter machine has remarkable influence in agriculture. The machine focused on the design and fabrication of an oxen driven four-row teff planter that is cheap, easily affordable, easy to maintain, less laborious to use, save more time required for seeding process and also it reduces lot of laborer cost. It was made of durable and cheap material affordable for the small scale farmers. It is very helpful for small scale formers. The planter will go a long way in making farming more attractive and increasing productivity of teff. The seed metering mechanism used for this work was the seed cup type with flutes on its periphery. Finally team study concludes that animal drawn teff row planter machine is:

- ❖ Improve planting efficiency.
- ❖ Increase in teff yield.
- ❖ Accurate Seed/fertilizer placement.
- ❖ Lesser maintenance cost.
- ❖ Adjusted at any required depth of seed.
- ❖ Improved the plant germination.
- ❖ Decreased labor requirement.
- ❖ Consume less time for sowing.
- ❖ Provide proper compaction over the seed.

It can be easily manufactured and distributed to various areas of our country and easily adapted as technology transfer to SMEs.

Therefore the main task of the study team is to promote this technology and have available to farmers at an affordable price.

7.3. Recommendations

The teff row planter is designed to plant four rows at a time. It can also plant more than four rows at a time by increasing the width of the machine and hopper dimension with the increase in the number of the furrow openers assembly to the desired dimension assembly to the desired dimension.

Although, developers tried to make this project is successful, what developers want to recommended about the machine as follows:

- Anyone can re-design by viewing from different end user perspectives.
- TVET institutions, agricultural sectors and SMEs should work for the success of manufacturing and fully distributing of this machine to small scale farmers so as to bring about effective changes on the well-being and productivity.

At the end, the developers recommend that this machine can be improved, modified or modernized by anyone who has a need and interest to do it so.

7.4. Future works

The project is feasible and functional as per design .It should be distributed to all small scale farmers in the country especially teff producer areas in order to initiate farmers and SMEs to create job for the people and to get government income tax. Thus, all concerned body should work on teff to get advantages from the sources. Since the design is concerned only on teff planter and fertilizer applying so for future the design can be modified by increasing the dimension of the hoper and the frame can add the number of furrow openers to tractor drive and it also recommended that future research be done to minimize cost.

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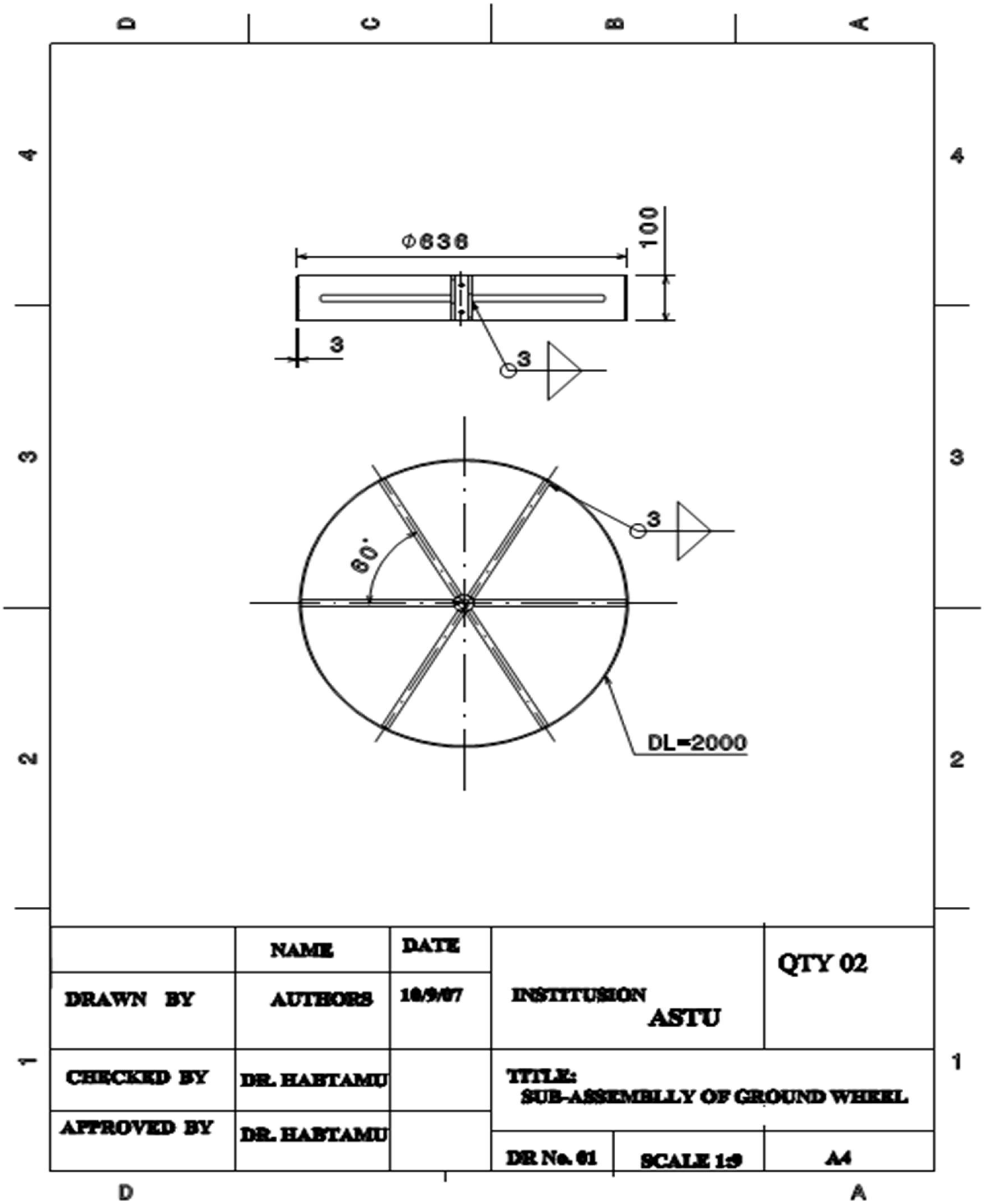
APPENDIX-A

Detail and assembly drawing

Detail drawing shows each and individual part drawing of the project or machine. The parts are drawn with appropriate scale whereas assembly drawing shows the overall view of the project.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100
3
3
60°
3
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NAME
DATE
QTY 02
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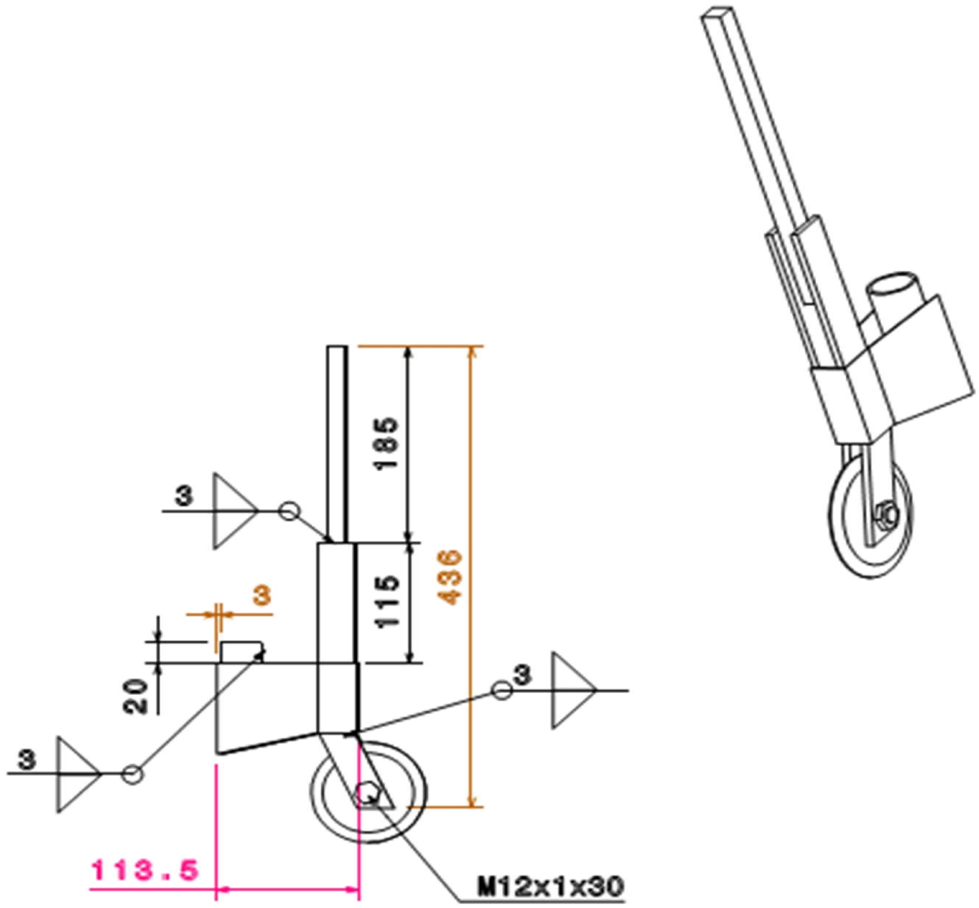
AUTHORS
10/9/07
INSTITUSION
ASTU
CHECKED BY
DR. HABTAMU
TITLE:
SUB-ASSEMBLLY OF GROUND WHEEL
APPROVED BY
DR. HABTAMU
DR No. 01
SCALE 1:9
A4



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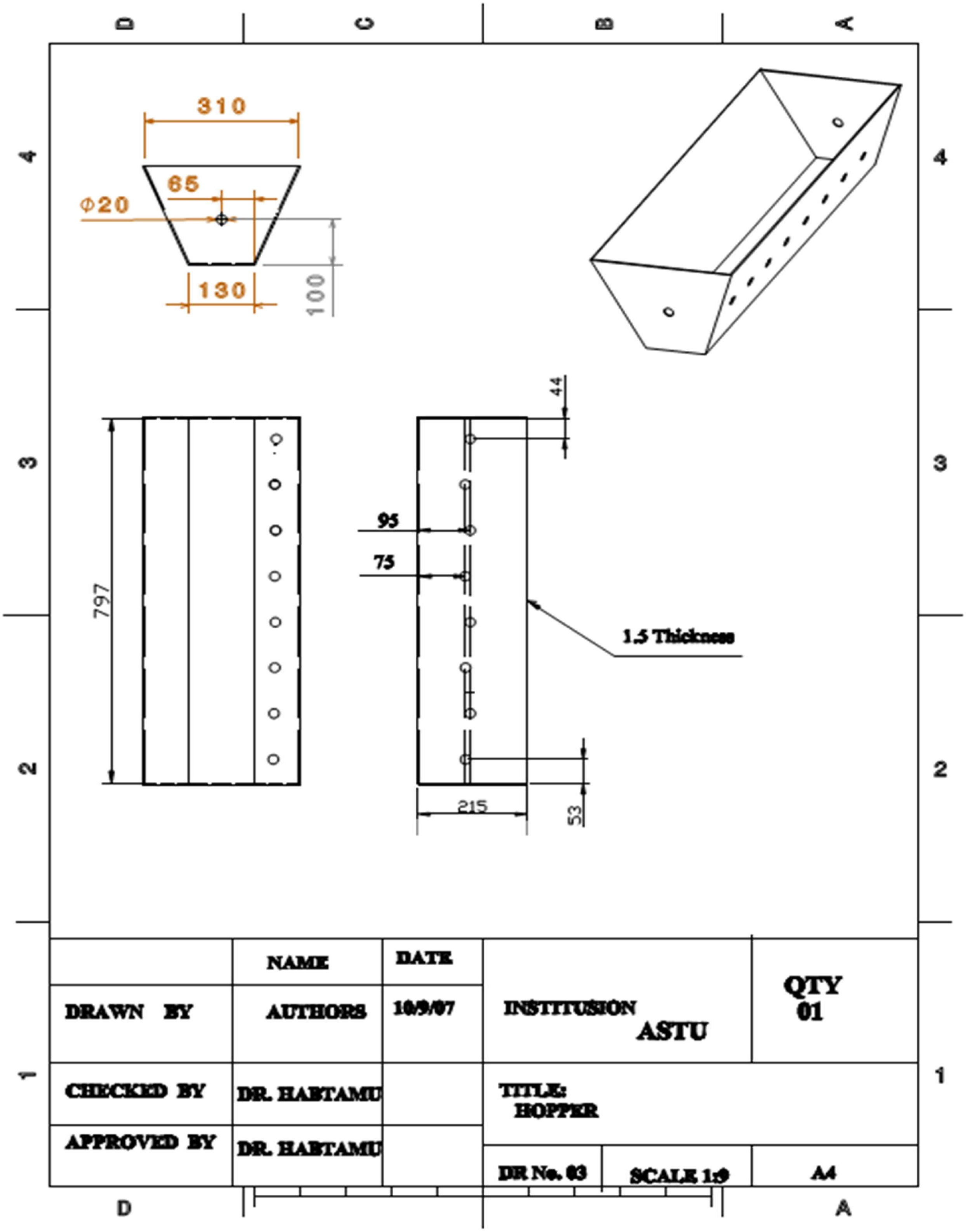
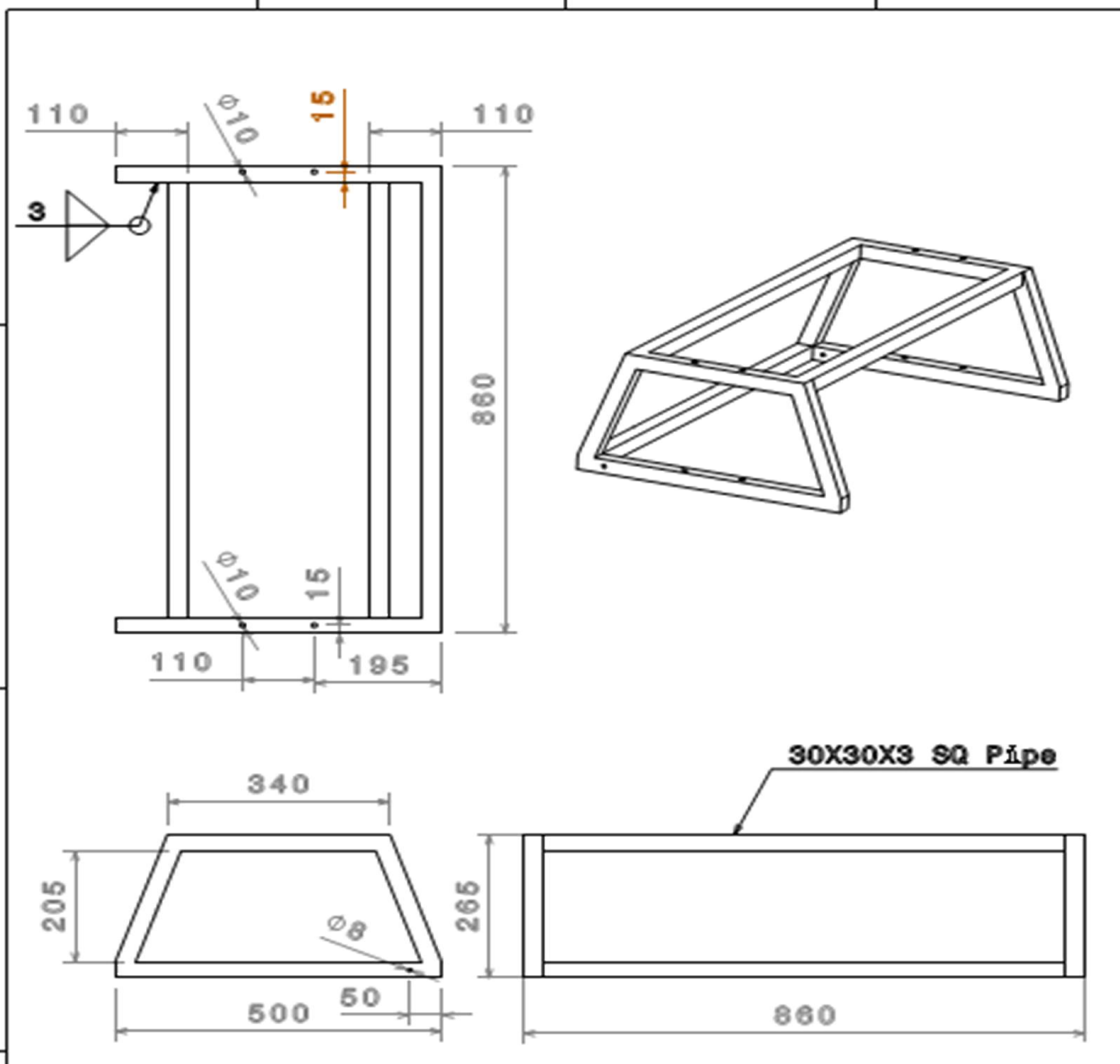

310
65
Φ20
130
100
44
95
75
797
215
53
1.5 Thickness
NAME
DATE
DRAWN BY
AUTHORS
10/9/07
INSTITUSION
ASTU
QTY
01
CHECKED BY
DR. HABTAMU
APPROVED BY
DR. HABTAMU
TITLE:
HOPPER
DR No. 03
SCALE 1:9
A4



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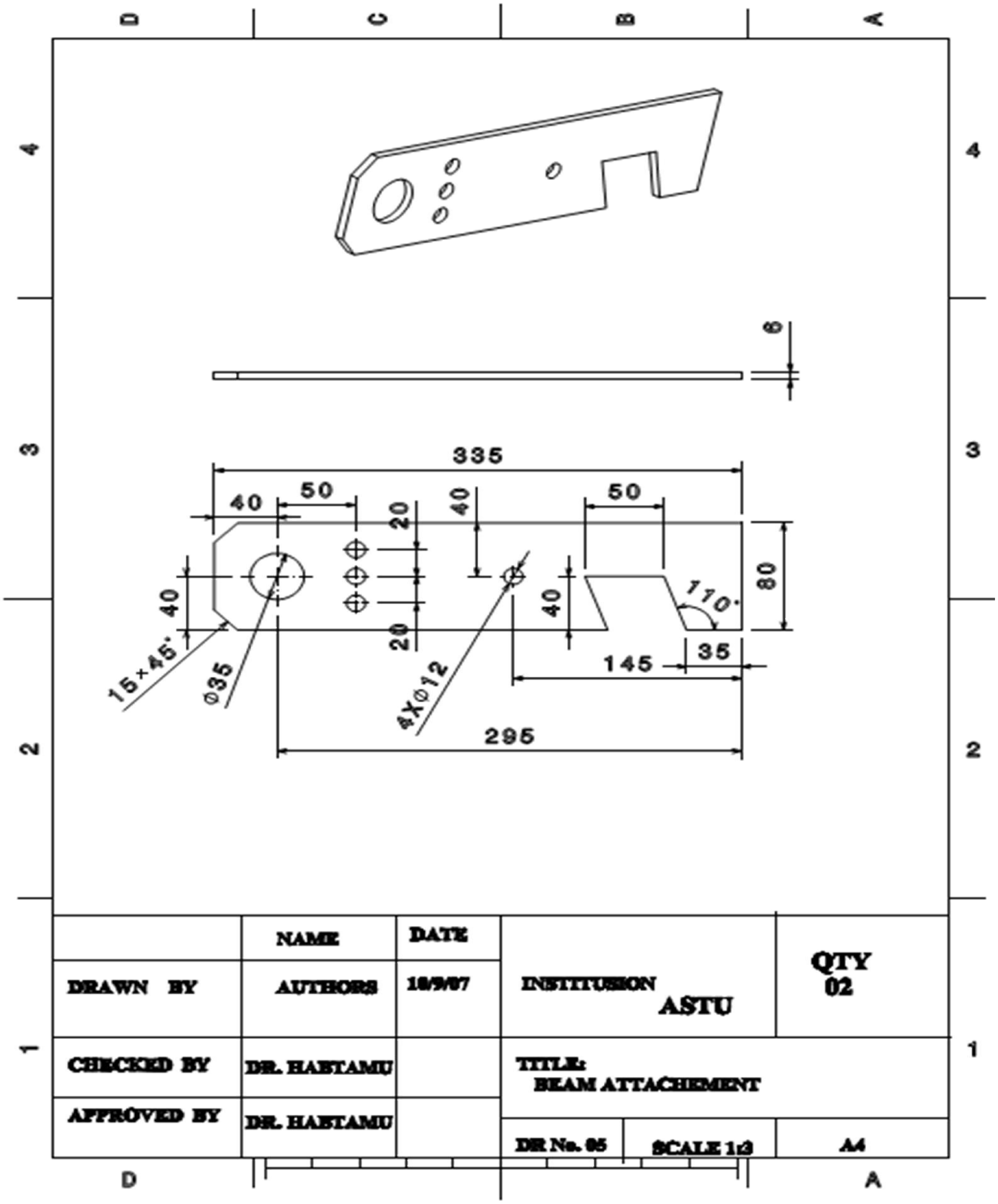
APPROVED BY	DR. HABTAMU		DR No. 04	SCALE 1:9	A4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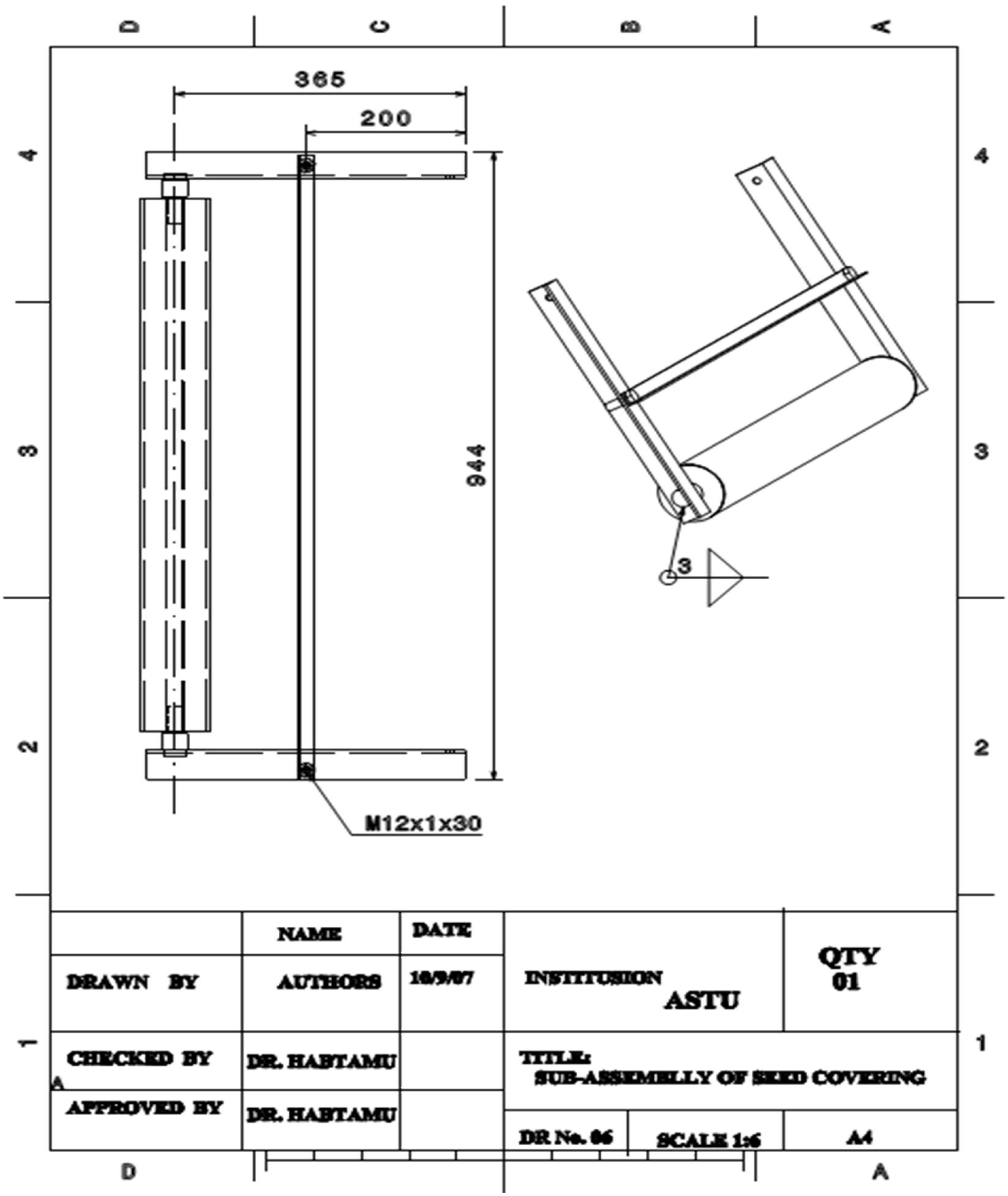
50
20
40
50
80
40
110°
40
20
15×45°
Φ35
4XΦ12
145
35
295
6
NAME
DATE
DRAWN BY
AUTHORS
10/9/07
INSTITUSION
ASTU
QTY
02
CHECKED BY
DR. HABTAMU
TITLE:
BEAM ATTACHEMENT
APPROVED BY
DR. HABTAMU
DR No. 05
SCALE 1:3
A4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DATE
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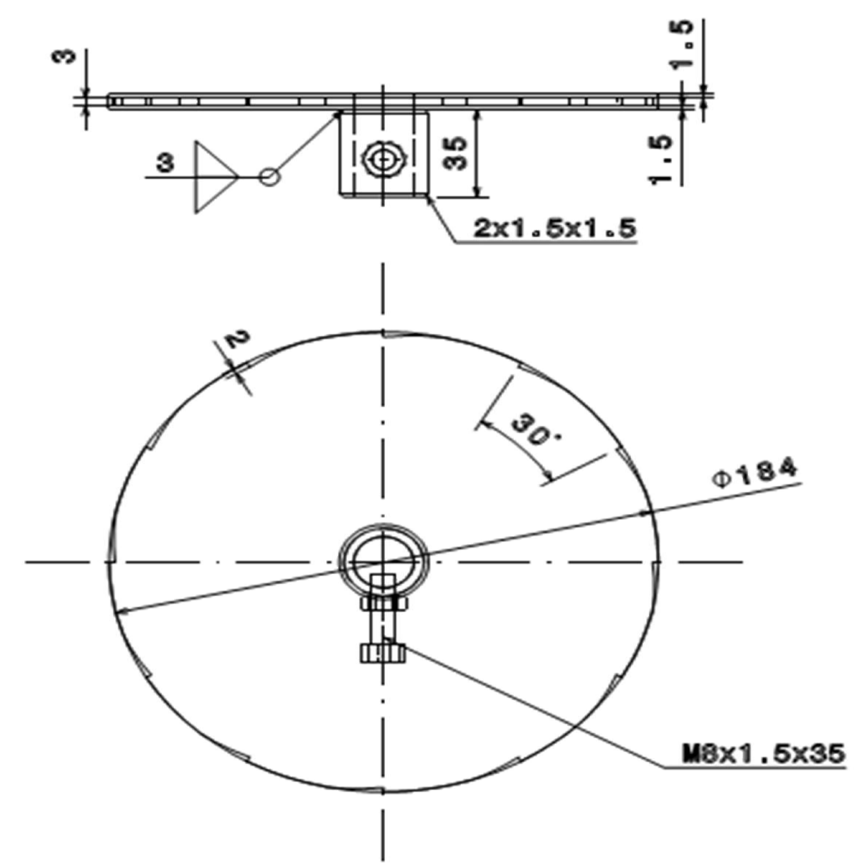
AUTHORS
10/9/07
INSTITUSION
ASTU
QTY
01
CHECKED BY
DR. HABTAMU
TITLE:
SUB-ASSEMBLLY OF SEED COVERING
APPROVED BY
DR. HABTAMU
DR No. 06
SCALE 1:6
A4



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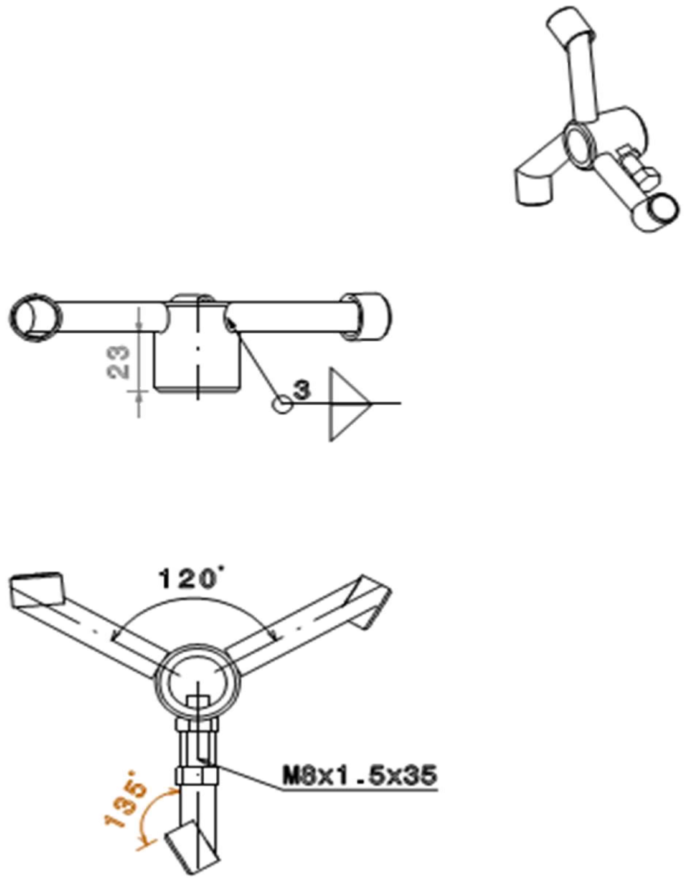
APPROVED BY	DR. HABTAMU		DR No. 07	SCALE 1:2	A4



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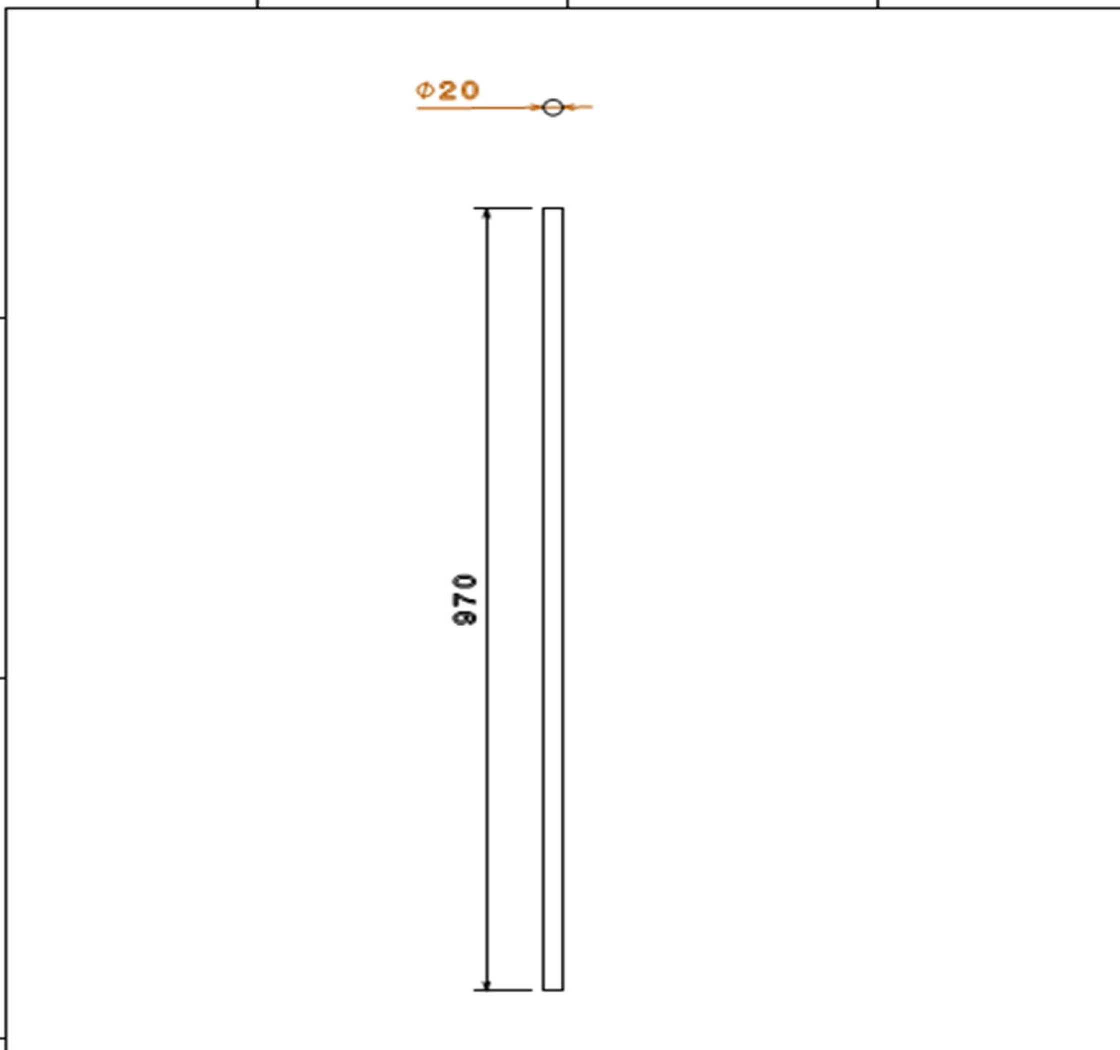
APPROVED BY	DR. HABTAMU		DR No. 06	SCALE 1:8	A4



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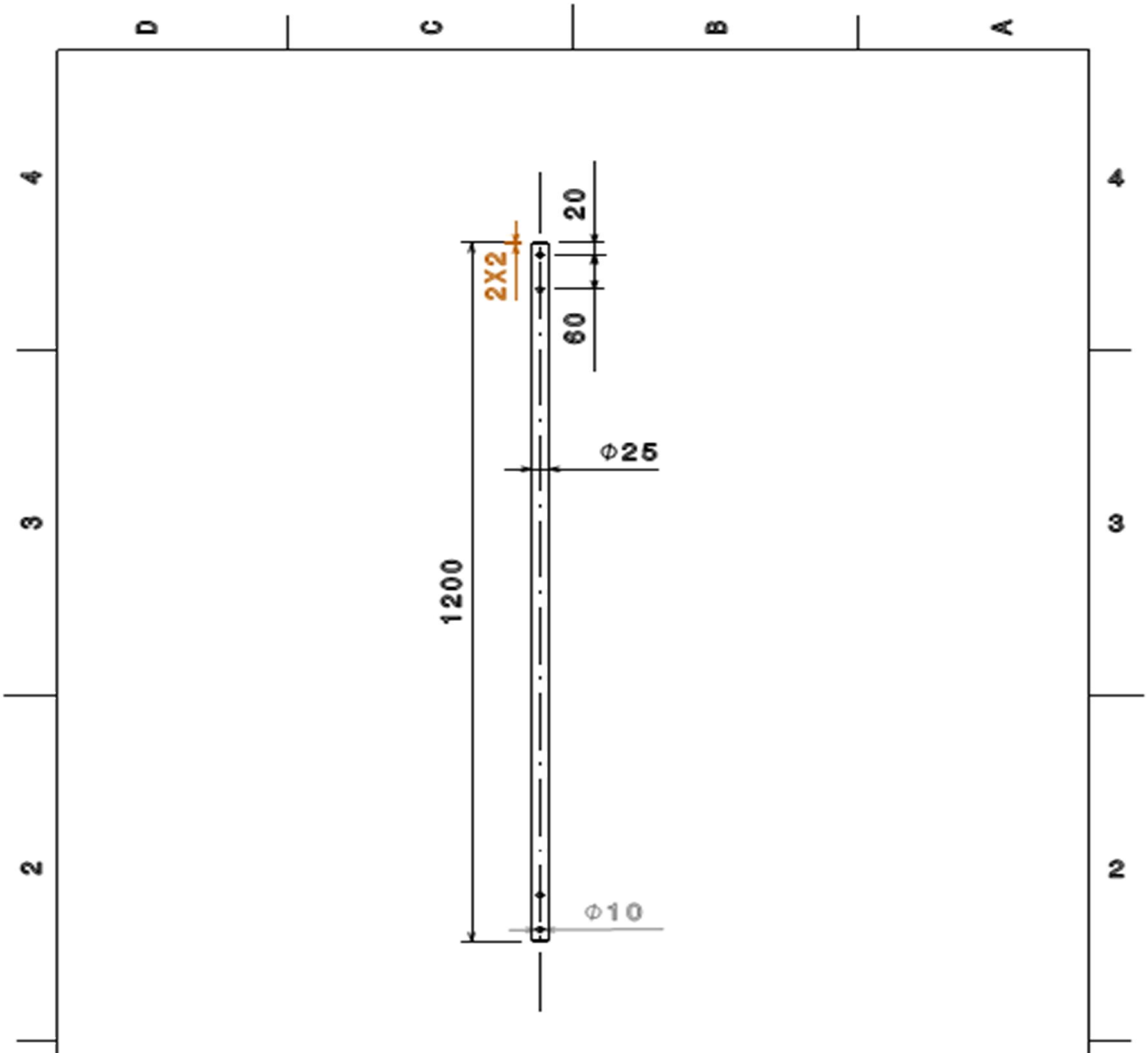
APPROVED BY	DR. HABTAMU		DR No. 10	SCALE 1:6	A4



	NAME	DATE		
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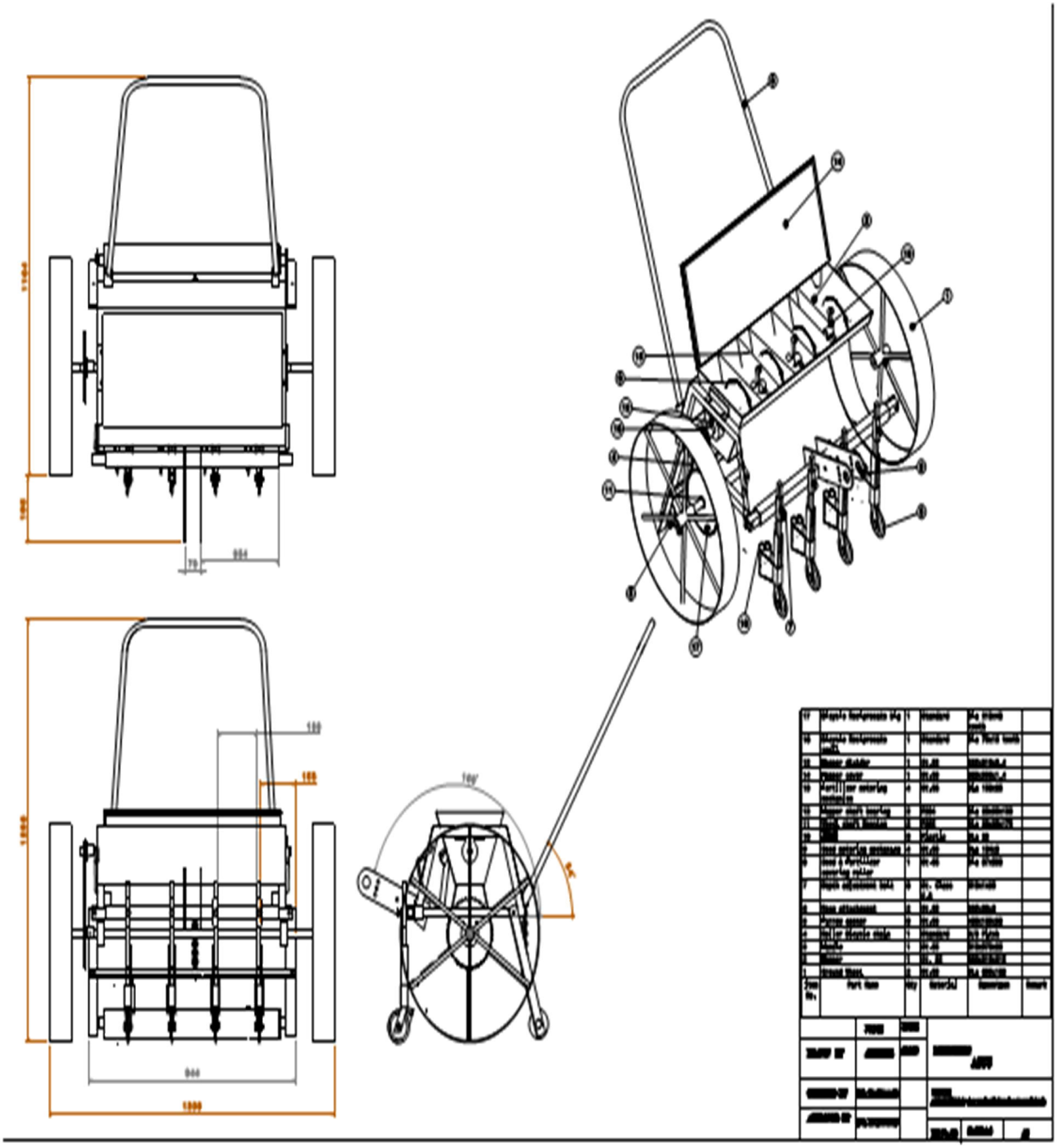

APPENDIX-B
Production, area cultivated and productivity of teff

Year	Area(ha)	% change	Production (qt)	% change	Yield (q/h)	% change
2003/2004	1,989,068	-	16,773,480	-	8.43	-
2004/2005	2,135,553	7.36	20,255,214	20.76	9.48	12.45
2005/2006	2,246,017	5.17	21,755,976	7.41	9.69	2.22
2006/2007	2,404,674	7.06	24,377,494	12.05	10.14	4.64
2007/2008	2,565,155	6.67	29,929,235	22.77	11.67	15.09
2008/2009	2,481,333	-3.27	30,280,181	1.17	12.20	4.54
2009/2010	2,588,661	4.33	31,793,743	5.00	12.28	0.66
2010/2011	2,761,190	6.66	34,834,826	9.57	12.62	2.77
Average	2,396,456	4.85	26,250,019	11.28	10.81	6.05

Source: CSA (various years): Estimates of Meher season Area, Production and Yield of teff [1].

APPENDIX- C

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

English Questionnaires

Dear participant:

This questionnaire is distributed to gather information about need assessment and to study the feasibility of designing and manufacturing teff row Planter machine as part of the final project for a master's degree graduating class at Adama Science and Technology University. For the ideas that you will give us genuine information about the demand and importance of this machine we would like to thank you in advance.

Direction

Tick (√ or x) in the given box.

I. Personal characteristics (Demography)

You do not need to write your name.

1. Sex: Male ☐ Female ☐
2. Age: 15 -20 ☐ 21 – 30 ☐ 31 – 40 ☐ Above 40 ☐
3. Educational qualification level:_________________

Part-I Questionnaires

I. For the questions in the table below, read and if you agree with the statement thick (√ or x) this sign under Yes and if you do not agree with it thick (√ or x) under No.

No.	Questions	Yes	No
1.	Are you currently using traditional hand broadcasting method?		
2.	Have you ever a chance to used teff row Planter machines?		
3.	Are you interesting to buy if teff row Planter machine will be made at Adama Science and Technology University with reasonable cost?		
4.	At this time, is there a need teff row Planter machine?		
5.	When you need to buy teff row Planter machine, is that available in the market in available cost teff?		

Part-I Questionnaires

1. Have you ever taken training on row planting method?__________________________

2. What amount of teff you use during hand broad casting method?(kg)

3.What problems do you see with traditional sawing method?

4. To improve the yield of teff which method you prefer?

5. How much amount of (in quintal) teff you collect from one hector by traditional broad casting method?

6. If you have any other comment, please indicate below

መጠይቅ

የመጠይቁ አላማ ስለ ጤፍ በመስመር መዝሪያ ማሽን የማስተር የመመረቅያ ፕሮጀክት ድዛይን አድርገን ልናመርት ስለሆነ በዚህ ዙርያ ስለማሽኑ ጥቅምና ተፈላጊነት ላይ ያተኮረ ጥናት እያደረግን ስለሆነ የበኩልዎን ለሚሰጡን ትክክለኛ መረጃ በቅድሚያ እናመሰግናለን፡፡

ክፍል አንድ

የ √ ምልክት ያድርጉ ፡

ጾታ ፡ ወንድ ☐ ሴት ☐

እድሜ ፡15-20 ☐ 21-30 ☐ 31-40 ☐ ከ 40 በላይ ☐

የትምህርት ደረጃ ፡ ____________________

ክፍል ሁለት

ከዚህ በታች በቀረበዉ ሰንጠረዠ ዉስጥ ያሉትን ጥያቄዎች አንብበዉ መልሱ ትክክል ከሆነና በሃሳቡ ከተስማሙ 'አዎ' ወይም ለማይስማሙት ሃሳብ 'አይ' በማለት በእያንዳንዱ ጥያቄ ትይዩ የ √ ምልክት የድርጉ፡፡

ተ.ቁ	ጥያቄዎች	አዎ	አይ
1	በአሁኑ ጊዜ በባህላዊ መንገድ በእጅ ነው እየዘሩ ያሉት ?		
2	የጤፍ መዝሪያ ማሽን መጠቀም እድሉ አግኝተው ያውቃሉ?		
3	የጤፍ መዝሪያ ማሽን በአዳማ ዩንቨርስቲ ቢመረት ይገዛሉ ?		
4	በአሁኑ ጊዘ የጤፍ መዝሪያ ማሽን ቢመረት የመግዛት ፍላጎት አልዎት ?		
5	የጤፍ መዝሪያ ማሽን ለመጠቀም ከፈለጉ በተመጣ ዋጋ ያገኛሉ		

ክፍል ሶስት

1. ጤፍ በመስመር ስለ መዝራት ስልጠና ወስደው ያውቃሉ ?

____

____

2. በባህላዊ በእጅ ሲዘሩ ምን ያክል ኪሎ ግራም ጤፍ ይጠቀማሉ ?

____

____

3. በባህላዊ መንገድ ጤፍ ሲዘሩ ምን ዓይነት ችግር ያጋጥሞታል ?

____

____

4. የጤፍ ምርት ለመጨመር ምን አይነት የአዘራር መንገድ ይመርጣሉ?

____

____

5. በባህላዊ መንገድ ጤፍ ሲዘሩ የሚያጋጥሞት ችግር ካለ ?

____

____

6. ያልተገለጸ ቀረ የሚሉት ሃሳብ ካለ ይጥቀሱ፡

____

____

APPENDIX-D

Life of bearings for various types of machines.

No.	Application of bearing	Life of bearing, in hours
1	Instruments and apparatus that are rarely used (a) Demonstration apparatus, mechanism for operating sliding doors	500
	(b) Aircraft engines	
2	Machines used for short periods or intermittently and whose breakdown would not have serious consequences e.g. hand tools, lifting tackle in workshops, and operated machines, agricultural machines, cranes in erecting shops, domestic machines.	4000 – 8000
3	Machines working intermittently whose breakdown would have serious consequences e.g. auxiliary machinery in power stations, conveyor plant for flow production, lifts, cranes for piece goods, machine tools used frequently.	8000 – 12 000

APPENDIX -E

Principal dimensions for radial ball bearings.

Bearing No.	Bore (mm)	Outside diameter	Width (mm)
200	10	30	9
300		35	11
201	12	32	10
301		37	12
202	15	35	11
302		42	13
203	17	40	12
303		47	14
403		62	17
204	20	47	14
304		52	14
404		72	19

APPENDIX-F

Particle true densities and diameter coefficients for different fertilizers. A, B, and D identify the origin of the fertilizer

Fertilizer	Source	True Density, kg/m^3	Diameter Coefficient q
Ammonium nitrate (B)	7	1890	0.8
CAN 27N (A)	17	1820	0.88
CAN 27N (B)	17	1850	0.87
CAN 27N (D)	17	1830	0.83
CAN 27N	24	1860	0.88
CAN 22N+7MgO prills (B)	17	2000	0.97
Diammoniumphosphate (D)	17	1930	0.72
NP 23-23 (B)	17	1710	0.82
NP 26-14 (A)	17	1740	0.85
NP 26-7 (A)	17	1890	0.8
NPK 12-10-18	24	2090	0.76
NPK 12-10-18 (B)	17	1960	0.81
NPK 17-17-17 (B)	17	1780	0.82
Potassium 60	24	2030	0.63
Potassium Sulphate (D)	17	2230	0.74
Superphosphate (45%) (D)	17	2010	0.71
Triple Superphosphate (B)	17	2120	0.8
Urea granules (2.9 mm) (B)	17	1260	0.95
Urea granules (5–8 mm) (B)	17	1260	0.82
Urea prills (B)	17	1310	0.89

APPENDIX-G
Values of service factor (KS).

No	Type of service	Service factor (KS) for radial ball bearings
1	Uniform and steady load	1.0
2	Light shock load	1.5
3	Moderate shock load	2.0
4	Heavy shock load	2.5
5	Extreme shock load	3

APPENDIX-H
Basic static and dynamic capacities of various types of radial ball bearings.

Bearing No	Basic capacities in kN			
	Single row deep groove ball bearing		Single row angular contact ball bearing	
	Static	Dynamic	Static	Dynamic
200	2.24	4	-	-
300	3.6	6.3	-	-
204	6.55	10	6.55	10.4
304	7.65	12.5	8.3	13.7
205	7.1	11	7.8	11.6
305	10.4	16.6	12.5	19.3