MODIFICATION OF MECHANIZED SOYBEAN TRANSPLANTER

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DEPARTMENT OF AGRICULTURAL TECHNOLOGY

FACULTY OF AGRICULTURE

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ABSTRACT

BAHRUM TILAS (G041181313). Modification of mechanical soybean planting equipment. *Supervised by*: ABDUL AZIS *and* SUPRATOMO.

Increasing the yield of soybean production requires agricultural tools and machinery so that farmers are not too overwhelmed in the process of cultivating soybean plants because some farmers still use the manual planting method using conventional technology by using a tugal. The purpose of this research is to develop a soybean planting tool by utilizing a gasoline motor as the main driving force of the tool. Where the previous tool still has deficiencies in several components such as a hopper which still has a small capacity to accommodate seeds, does not yet have a clutch as a tool advance regulator and auxiliary wheels as the main mover in rotating the metering device through over gear transmission as a spacing regulator. So that from the planting tool the development of components such as hoppers, couplings, metering devices and over gears is carried out. Where previously the planting tool only used 2 hoppers and then it was developed into 4 hoppers with a capacity of 3.5 kg. Metering device that functions to drop seeds from the hopper into the groove opening channel. The clutch which functions to disconnect the main power source from the engine to the wheel axle to make it easier to control the planting tool is run, especially when the tool turns so that the seeds are not wasted and the over gear acts as a spacing regulator with the auxiliary wheel as the prime mover in rotating the metering device shaft.

Keywords: *Hopper, Metering device, Gasoline Motor*.

LIFE CIRCUMSTANCES

Bahrum Tilas, born in Palopo December 06, 1999, to Mr. Nasirung and Mrs. Rita, the third of 5 children. The formal education levels that have been passed are:

1. Starting education at Bayangkari Kindergarten in 2005-2006
2. Continuing education at SD Negeri 23 Batara, in 2006-2012.
3. Continuing education at the junior high school level at SMP Negeri 2 Palopo in 2012-2015.
4. Continuing education at the senior high school level at SMA Negeri 3 Palopo, in 2015-2018.
5. Continuing education at Hasanuddin University Makassar, Faculty of Agriculture, Department of Agricultural Technology, Agricultural Engineering Study Program in 2018.

While studying in the world of lectures, the author was active in campus organizations, namely as an administrator in the Hasanuddin University Agricultural Technology Student Association (HIMATEPA UH) for the 2020/2021 period.

TABLE OF CONTENTS

FIGURE LIST

TABLE LIST

LIST OF ATTACHMENTS

1. INTRODUCTION

1.1 Background

Increasing the production of soybean plants requires extra care and processing so that farmers are often overwhelmed in the process of cultivating soybean plants because some farmers still use manual planting using conventional technology. In addition, planting soybeans manually by punching holes in the soil using pointed objects such as wood (tugal) can affect health, reduce work productivity, so it is necessary to innovate and utilise appropriate technology in cultivating soybean plants.

One of the efforts that can be made to reduce production costs is by using agricultural mechanisation. Currently, there are many types of seeder tools that have been made and mass-produced and have been widely used by farmers such as the ATB1-2R model mechanical planting tool (Hendriadi., 2007), q-dros (quick drop seeder) (Surfani I., 2015), Corn Planting and Fertiliser Machine Integrated with Groove Land Processing (sitorus., 2015) and Direct Seed Planting Tool Model Paddy Seeder Drum Type 12 Row Hand-Drawn System for Paddy Fields (Budiman DA., 2016). The tool before modification is a corn seed planting tool, where modifications are made to 5 components such as, increasing the capacity and number of hoppers with a capacity of 1.5 kg with 2 hoppers, over gear which is connected directly to the shaft of the driving wheel (tyre), the auxiliary wheel is used for the pedestal of the tool on the back to be balanced, the metering device used for corn plants with 1 hole on each side of the metering device circle, the clutch in the tool uses a manual clutch type so that when the tool runs the seeds will still fall.

Modification of the planting tool (Seeder) by utilising power from a petrol motor as the main drive on the wheel shaft and seed rationing (metering device), increasing the capacity of the existing hopper by adding the dimensions of the hopper where previously only 2 pieces and will be developed into 4 hoppers, developing a metering davice as a seed meter by increasing the number of slit holes which previously only 1 to 3 holes, a clutch that functions as a breaker and power forwarder from a petrol motor with a drive wheel shaft (tire) and a metering device on the tool then developed with an auxiliary ronda as the main drive so that the metering device functions on the planting path. So that when the tool turns, the seeds will not be wasted and the tool remains on the planting path. There is a setting of the number of seeds regulated by the metering device component with a distance that can be adjusted between holes by the over gear component without involving human labour. In addition, this planting tool is expected to make the time used in the planting process shorter so that less labour is used and save costs incurred by farmers.

Based on the above problems, the role of technology in the process of cultivating soybean plants is needed so that it is necessary to modify some components of mechanical soybean planting tools that are expected to be a solution for farmers in the process of cultivating soybean plants.

1.2 Problem Formulation

The problem formulations in this study are:

1. How is the clutch able to disconnect and pass the rotation power through the petrol motor engine to the main drive wheel?
2. How can the over gear adjust or vary the spacing?
3. How can the metering device drop soybean seeds with the desired number of seeds?

1.3 Problem Limitation

The problem restrictions in this study are:

1. This research modified the seeder planting tool for soybean planting?
2. This research only reached the functional test stage?

1.4 Purpose and Usefulness

The purpose of this research is to modify the soybean planting tool with a petrol motor drive as a metering device to facilitate the process of soybean seeding and the use of this research to make it easier for farmers in the process of planting soybean seeds.

2. LITERATURE REVIEW

2.1 Soybeans

Soybeans as a commodity is very useful because it contains vegetable protein that can improve nutrition and is good for health, increasing population growth causes the need for soybeans to also increase, because soybeans are usually used as raw materials for processed food industries such as tempeh, soy sauce, tofu, milk, tauco, soybeans, soy flour, and others (Siregar ddk., 2017).

Soybean plants are cultivated as monoculture crops or by intercropping with other crops such as corn, oil palm, banana, sugar cane and other crops. Soybeans are round, ovoid and slightly flat, in each pod there are 2-3 soybean seeds with very diverse sizes, ranging from small ones around 7-9 g/100 seeds, medium size 10-13 g/100 seeds and large size >13 g/100 seeds. Indonesia has a tropical climate that soybean plants need to support their growth. Soybean plants will grow well in areas with rainfall of around 100-400 mm/month and require temperatures of around 21-30^{o} C. The spacing that is usually used in soybean planting is 25 cm x 25 cm or 20 cm x 25 cm, soybean plants have a taproot system and fibrous secondary roots with a root length of around 30-50 cm (Bacin, 2016).

Soybean is a food crop that originated in Northern China and began to be cultivated in Indonesia in the 7th century as food and green fertilizer. Soybean plants are annual plants with a growing age of about 72-90 days. The growth phase of soybean plants consists of vegetative and generative phases, where the vegetative phase starts from the growth of the plant until the first flower appears on the main stem. The generative phase starts from flowering plants to mature pods or until harvest time (Burhanuddin, 2021).

According to Girsang (2020), the classification of soybean plants is as follows: *Kingdom: Plantae, Divisiono: Spermatophyta, Subdivo: Angiospermeae, Class: Dicotyledoneae, Order: Leguminales, Family: Papilonaceae, Genus: Glycine, Species: Glycine Max L. Me'rrill.*

The bushy soybean plant has a stem height ranging from 30-100 cm, each soybean plant stem can form 3 to 6 branches. Currently, soybeans can be used to fulfill vegetable protein needs. Soybean crop production continues to be carried out but the increase in crop yields has not been significant (Waliyansyah, 2018).

Figure 1: Kedalai seeds
(Source: Waliyansyah, 2018).

2.2 Soybean Planting

Soybean planters carried out by farmers still use simple tools which are divided into two types as follows:

1.2.1 *Conventional*

The traditional planting system is commonly called tugal or header. In the form of wood tapered at the end, soybean planting is carried out on land with makeshift conditions by tillage by hoeing so that the soil is still in the form of large chunks and cleaned of grass on the land. The use of tugal still requires a lot of time and labor and costs so that the traditional tugal is modified into a semi-mechanical tugal which has a working mechanism using a spring, with the working principle when the tugal eye enters the soil the soil surface will press up the dispensing regulator. Then push the spring stalk which causes the seed hole to open so that the seeds fall to the ground (Jamaluddin et al., 2019).

At present, the production of soybean crops per hectare has not reached the maximum, the productivity of soybean crops is very low while the need for soybeans is increasing to be able to increase crop productivity, adequate planting equipment is needed and easy to operate, so it is necessary to develop and design planting tools as an effort to increase agricultural productivity (Syaiful, 2014).

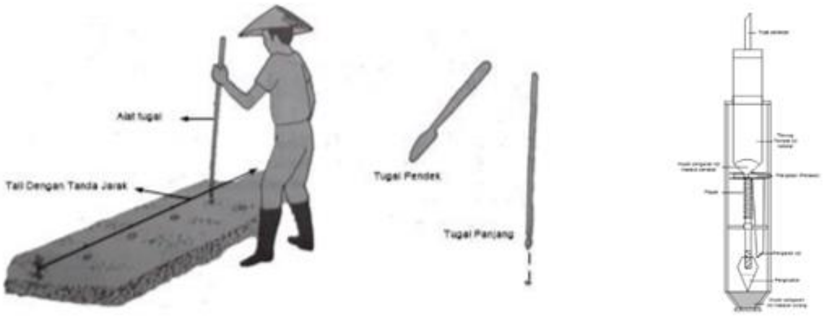

Figure 2: Traditional and Semi-Mechanized Tugal
(Source: Jamaluddin et al, 2019).

2.2.2 *Seeder*

Seeders or grain planting machines are useful for placing seeds in the form of grains such as soybeans, peanuts, corn and others that will be planted at a certain distance and depth. Physical properties of seeds such as shape, size and resistance to pressure and friction can affect the planting machine (Jamaluddin et al., 2019).

Seed planter is a planting tool designed for planting seeds with a certain distance in a planting area. *Seed planter* is operated using human propulsion and can be used effectively. The working principle is to make holes with a distance between holes according to what is set, then the seeds fall and close the hole again (Syaiful, 2014).

Seeder is a type of agricultural tool and machine used to place seeds to be planted with a certain amount and depth and relatively high uniformity. The physical properties of seeds that can affect planting tools include shape, size, density/volume and so on.

According to Jamaluddin et al (2019), that based on the planting method, the grain *seeder is* divided into 5 types, namely:

1. *Broadcasting* is a planting machine that works by randomly spreading seeds on the soil surface.
2. *Drill seeding* is a planting machine that works by randomly dropping seeds in the furrow and then simultaneously closing the seeds.
3. *Precision drilling* is a planting machine that works by placing a seed at the same distance in the row.

4. *Hill dropping* is a planting machine that works by placing a group of seeds in the soil at the same distance in the row.
5. *Check row planting* is a planting machine that works by placing a group of seeds in a row of plants so as to produce rows of plants that are perpendicular to each other.

2.3 Construction of the *Seeder*

According to Jamaluddin et al (2019), the grain planter machine has several main components, which are as follows:

2.3.1 *Seeding metering* device

A tool component that divides seeds in a certain amount based on what is needed by plant growth. This component has a variety of forms depending on the desired planting distance and the nature or characteristics of the seeds. The *metering device* functions as a regulator of the number of seeds to be planted according to needs. The *metering device is* made of cylindrical iron and is equipped with circular fins.

The metering device or seed rationing device functions as a regulator of seed dropping with a certain amount and at a certain planting distance. The seed rationing mechanism can be done using the principle of *variable orifice* and *fluted wheel,* to regulate seed rationing based on volume. For precision rationing, it is done through a per-seed rationing mechanism with the principle of *finger pickup planter* based on the dimensions of the seeds to be rationed, while *pressure disk planter* and *vacuum disk metering are* based on air pressure. The types of seed rationing *metering devices are* as follows:

a. *The star wheel feed* rationer is where the material to be distributed is placed between the star wheels and then falls into the dispensing tube by gravity. Setting the material dispensing capacity is done by adjusting the height of the input hole at the top of the star wheel.

b. *The rotating bottom* rationer serves to ration the material in rows. The rationer consists of a stationary rake that separates the fertilizer from the rotating disk below the fertilizer tank to the side channel of the fertilizer bowl.
c. Thread *rationer (auger)*, this rationer consists of loose and tight thread rationers.
d. The *edge cell is* mounted at the required distance along the *hopper* and rotated along a rectangular shaft. The width of the gap is about 6 to 32 mm which serves as a place for the attachment of seeds and fertilizers.
e. The rotating belt rationer *(*belt *type)* functions for large amounts of fertilizer, the belt material is made of rubberized cloth or wire.
f. This type of *fluted* roller rationer consists of a *fluted* rotor at the top of the dispensing door that can be adjusted by a drive wheel.

2.3.2 Delivery tube

It functions as a seed distributor into the *furrow* made by the *furrow opener*. The length, shape and roughness of the tool affect the flow of seeds. The delivery tube is made from a rubberized hose pipe so that the pipe is flexible and easy to bend and easy to disassemble.

2.3.3 *Furrow opener*

Has a function to open the planting groove that will be passed by the seeds. The way to optimize plant growth is determined by certain planting depths. The type of groove used depends on several factors such as the type of plant, soil moisture content, soil temperature and others.

2.3.4 Groove closing tool

It has a function to cover the seeds that have been inserted into moist soil. Soil cover must be done so that the plants can still grow well. Furrow covers are usually like *drag chains*, cover shovels with wheel pressure, cover plates, cover plates.

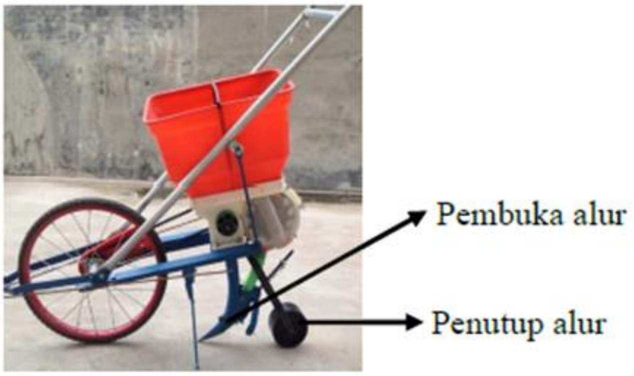

Figure 3. Opening and Closing Grooves
(Source: Jamaluddin et al., 2018).

2.3.5 *Hopper*

The first container of a material that will be processed to the next stage. The calculation of the volume and capacity of a *Hopper* can use the following formula:

V *Hopper* Total = *Hopper* + V Upper Tube + V Output Tube + V Tube + Output Tilt

The explanation of the formula is:

1) V *Hopper*

$$V\ Hopper = \pi \times \frac{h}{12} \times (D^2 + D.d + d^2) \quad (1)$$

2) V Top Tub

$$V\ Tabung\ Atas = \pi \times r^2 \times t_1 \quad (2)$$

3) V Output Tube

$$V\ Tabung\ Output = \pi \times r^2 \times t_2 \quad (3) \quad (3)$$

4) V Tilt Output Tube

$$Tabung\ Output\ Kemiringan = \pi \times r^2 \times t_3 \quad (4)$$

Description:

h: overall height of the *hopper* (cm)

t_1 *: hopper* top tube height (cm)

t_2 *: hopper* bottom tube height (cm)

t_3 : height of the sloping side of the *hopper* (cm)

D: *hopper* top tube diameter (cm)

d^2 *: hopper output* tube diameter (cm)

The hopper is designed and made of plate iron with a width, top length and height that adjusts the capacity that will be needed by looking at the strength of the previous tool frame. The angle of inclination of the *Hopper* against the *metering device* with a bulk angle or *anggle of repose* is 45^o . This angle is the optimal angle for abrasion materials that affect the weight of fertilizer against the placement of fertilizer into the *screw conveyor*. The hopper is designed to be made of acrylic material with a thickness of 3 mm, with the aim that the box is not easily damaged, not easily corroded and lightweight (Adhar et al., 2016).

Figure 4. *Hopper*
(Source: Adhar et al., 2016).

The seed *hopper* is part of the planting machine component which is used as a seed container before the seeds are planted on the ground. *Hopper* plays an important role in the seed planting process so that the design of the *hopper* needs to be done properly so that there is no accumulation of seeds that will hinder the planting process (Ahmad, 2015).

2.4 Clutch

The types of couplings consist of:

1. Mechanical Clutch

Mechanical Clutch is a clutch with a working principle that is regulated by a clutch *handle*, the release is done by means of a clutch *handle* on the steering rod being pulled.

2. Automatic Clutch

The automatic clutch has a way of working that is regulated by low or high engine speed, the release is carried out automatically at low speed.

2.5 Transmission System

The transmission system functions in the *power* transfer system *(power train)* on a machine that is useful for forwarding power or engine rotation from the clutch to the *propeller* shaft and changing the moment generated by the engine to suit needs such as road conditions and engine loads (Ahmad, 2015).

According to Zulfirman (2015), there are parts of the transmission system consisting of:

1. *Pulleys are* generally made of steel or iron with varying shapes and have strengths derived from parts such as radius strength, naf strength (shaft neck diameter) and the strength of the rim used.
2. *V-belt* can facilitate rotation, easy to disassemble and gampanng operated with pulleys that cause vibration.
3. Chain *sprockets* are generally made of carbon steel for small sizes and steel or cast iron for large sizes. The contact angle between the *sprocket* and the chain should be more than 120^{o} .
4. Power transmission chains can be used when the shaft distance is greater than gear transmission but shorter than in belt transmission, The function of the

chain is that it can forward large power because of the large force and does not require initial power and small wear on the bearings.

5. Bearing is one of the elements in the machine that supports the loaded shaft so that the rotation and reciprocating motion that occurs can take place smoothly and safely that rotates with the stationary part.

2.6 Gasoline Motor

Gasoline motor is a fuel motor made from gasoline, where gasoline itself is a fuel that is classified as flammable and can experience evaporation. In addition, gasoline combustion motors can also be used as power plants through a process where gasoline fuel is converted into heat power and finally turns into mechanical power. The constituent components of a gasoline motor are the *cylinder block*, piston, cylinder *head*, *camshaft* piston rod, *crankshaft*, and *valve mechanic*. The workings of a gasoline motor are divided into two, namely a two-stroke gasoline motor and a four-stroke gasoline motor (Susilo, 2015).

The combustion process in combustion motors is divided into 2, namely there is complete combustion if at the time of combustion all elements in the fuel can burn completely and there is no remaining material and forms H2O gas and CO2 gas. The stages of perfect combustion begin when there is a jump in electric sparks and spark plugs, then the air fuel mixture burns out. The mixture that has experienced combustion will suppress the fuel mixture that has not occurred. So that there is an increase in temperature in the fuel mixture that has not been burned (Wiratmaja, 2010).

3. RESEARCH METHODS

3.1 Time and Place

This research was conducted from May 2022 to December 2022. Located at the Agricultural Engineering Workshop Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, Makassar.

3.2 Research Tools and Materials

The tools that will be used in this research are workshop equipment, measuring instruments (tachometer), *software* (*solid works*) and couplings. The materials used in this research are electrodes, bolts, nuts, chains, iron plates, cylinder pipes and acrylic.

3.3 Research Procedures

The research procedure consists of several stages, namely:

3.3.1 Design Stages

Modification Section

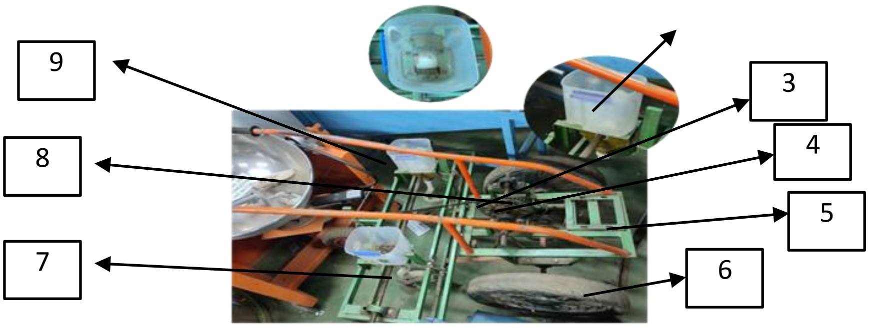

Figure 5. The modified planting tool.

Description:

1. *Metering Device* functions as a regulator of the amount of soybean seeds released
2. *Hopper* serves as an entry point as well as seed storage
3. *Over gear* serves to adjust the speed of the *metering device* shaft
4. The transmission system functions to forward power from the fuel motor drive engine
5. The main frame serves to unite other components
6. Wheels function to support the weight of the tool
7. The groove opener serves to open the seed drop groove

8. The Distributor Chain serves to connect the power from the combustion motor to the axle.
9. The steering wheel serves to control or control the direction of the tool

The following is the development part of the soybean *seeder.*

Table 1. Modified Parts

No.	Component	Reason	Modification Plan
1.	*Hopper*	*Hopper* capacity that is still unknown	Adding *hopper* capacity with larger dimensions
2.	*Metering device*	Rationer for maize seed	Creating soybean seed drop uniformity
3.	Clutch	No clutch	Adding to the main shaft of the engine to make it easier for the tool to turn.
4.	Rotation source (auxiliary wheel)	The rotation of the *metering device* on the wheel shaft rotates so that the process of falling soybean seeds continuously under the conditions when the tool turns.	Adding auxiliary wheels to the shaft of the *metering device* so that in the process of turning the tool the seeds will not fall so that the seeds are not wasted.
5.	Over *Gear*	The rotation of the over *gear* shaft is sourced from the main drive tire wheel	Transferring the rotation of the over *gear* drive to the auxiliary wheel as the prime mover

3.3.2 Functional Design

The design of the soybean *seeder is* designed using *software* (*Solid Work)*, where the parts designed are the *hopper*, *metering device*, clutch and gasoline motor. The main function of the soybean *seeder* with a fuel motor is to plant soybean seeds that will be planted in the field quickly because it uses a *metering device* of 4 pieces located under the *hopper*.

The hopper is expected to function as a place to accommodate soybean seeds that will be directed to the *metering device and* then dropped to the ground. The *metering device* is expected to function as a place to release seeds into the soil that have entered or been stored by the *hopper*. The designed *metering device is* expected to speed up the planting process carried out by farmers.

Clutch is a power transfer unit that functions as a connector and breaker of rotation and power from the *engine* to the transmission. The clutch is expected to function as a *seeder* tool drive. Gasoline motor is the main driving force in the power transmission which is channeled through a chain that is forwarded to the *metering device* shaft.

Table 2. Component Functions of the Soybean *Sedeer* to be modified

No.	Component	Function
1.	*Hopper*	Accommodate soybean seeds that will be planted
2.	*Metering Device*	Dispense the desired amount of soybean seeds
3.	Clutch	Disconnecting and connecting the power transfer from the combustion motor to the wheel axle
4.	Auxiliary wheel	As the main drive for the rotation of the *metering device*
5.	Over gear	As a soybean seed spacer

3.3.3 Structural Design

Structural design in the design of the *seeder* machine is done by determining the dimensions of each component to be used. The identification of each component will complement each other so that the soybean *seeder* machine can work properly. The *hopper* that will be designed in this study uses acrylic material with a thickness of 2 mm. Based on the design criteria that have been applied, the *hopper* must be enlarged in size or dimension in order to accommodate more seeds. Because the *metering device* that you want to develop becomes 4 pieces. Where the *metering device* on the previous tool was only 2 pieces. Determination of the shape of the *hopper* dimensions is done by considering the *hopper* capacity for one filling and the *angle of repose* of soybean seeds.

To determine the dimensions of the *hopper* use the following equation:

$$A = V \times \rho \times P \times lJ \times m \quad (5)$$

Description:
V : seed box volume (cm)^3
A: land area once filling the *hopper* (m)^2
J : number of soybean seeds per planting hole (seeds)
ρ : seed density (kg/m)^3
P : distance between planting furrows (cm)
L: distance between planting holes (cm)
M : seed mass (kg/grain)

The dimensions of the seed *hopper are* planned with the inclination of the seed *hopper* section of 30^o by making the angle of inclination of the *hopper* greater than the bulk angle so that the seeds that fall into the output channel are smoother. Determination of the bulk angle is done by the *anggle of repose* method as shown in the figure.

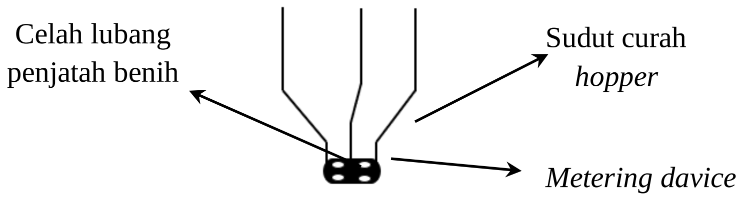

Figure 6. *Hopper* shape

The type of *metering device* to be used is the *edge cell* type, which is mounted at the required distance along the *hopper* and rotated along the axis of the *metering device.* For this reason, there are several things that are the basis for designing the *matering davice* as follows:

1. The material of the *metering device* must be resistant to rust so acrylic is used.
2. The number of *metering devices* that Unknown Developed is 4 pieces with the same shape and dimensions so that 4 planting lanes are obtained for one pass.
3. The dimensions of the *metering device are* determined based on the dimensions of the dispensing hole of the *hopper* and the gap between the edge of the *hopper* hole and the *metering device*.
4. The expected seed output is 2-3 seeds per hole. So that the dimensions of the *metering device* gap are determined based on the average dimensions of soybean seeds and can accommodate the expected number of seeds.

To determine the gap distance of the *metering device* based on the planting distance and the desired tool forward speed. So it can be approached with the equation:

$$Jc = Jtb(\pi \times D)(1+5\%)G2G1 \quad (6)$$

Description:
JC: number of gaps in the *metering device* (pieces)
G1: number of *sprocket* teeth on the shaft (pieces)
G2: number of *sprocket* teeth on the *metering device* (pieces)
D: wheel diameter (cm)
Jtr: wheel rotation distance after adding 5% wheel jam (cm).
Jtb : seed spacing (cm)

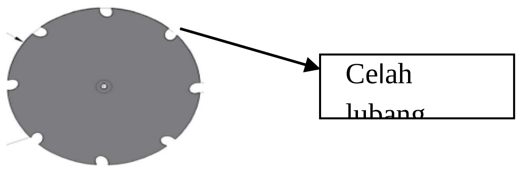

Figure 7. *Metering Device*

The clutch is a transfer link or power breaker from the gasoline motor with the *metering device* shaft pressing the clutch lever on the handle stand of the *seeder* designed to facilitate the control of the seed *rationing* process by the *metering device*.

The mechanical clutch type is a clutch that has a way of working regulated by the clutch *handle*, where the release is done by pulling the clutch *handle* on the steering rod. The clutch is used when you want to stop the rate of the tool by pulling the clutch *handle* located on the steering stand. However, if the clutch is already in the *off* position then the *metering device* shaft rate does not stop, it is Unknown due to the clutch adjustment is not good or the helper setting on the clutch is not too pressing. But when the rate of the tool has stopped then do the gas adjustment by lowering the gas (*idle*) slowly. Where if the clutch has not been there before on the soybean planting tool that will be Unknown Develop will cause the rotation of the fuel motor as the main drive will continue to rotate forwarding the power to the shaft *metering device* that drops the seeds will result in when the tool turns the seeds will fall continuously and the seeds fall Asked in a place that is not supposed to fall. (Ministry of Agriculture, Agricultural Extension and Human Resources Development Agency, 2015).

To calculate the dimensions of the *pully,* the following equation can be used:

$$N1R1=N2R2 \quad (7)$$

Therefore, to find the value of N_2 , the equation can be used:

$$N2=N1R1R1 \quad (8)$$

Where

R_1 : First *pully* radius (cm)
R_2 : Second *pully* radius (cm)
N_1 : First *pully* rotation (rpm)
N_2 : Second *pully* rotation (rpm)

3.3.4 Manufacturing Stage

Manufacture of *hoppers* and *metering devices* where the manufacturing process is:

a. *Hopper*

1. Create a *hopper* design using *solid* work application
2. Preparing *hopper* tools and materials
3. Make the size of the *hopper* that has been Asked to be determined on acrylic material
4. Shaping the *hopper* by cutting with a grinder and heating the acrylic material using fire so that it is easy to shape.
5. Unite each side of the *hopper* that has been formed by gluing each side using glue so that it can be fused on each side of the *hopper* so that it can form according to the size that has been Asked Set.

b. *Metering device*

1. Create a *metering device* design using *solid work* application
2. Prepare *metering device* tools and materials
3. Make the size of the *metering device* that has been determined on *polytelin* palstic material
4. Shaping the *metering device* using a hand drill to make a slit hole and cutting the *metering device* using a grinder to the size that has been determined.
5. Installing the *metering device* on the axle of the *metering device* that has been made.

3.3.5 Functional Test of Soybean Planting Equipment

Functional testing is carried out to ensure that the developed components can function properly. So that testing of components that are Unknown Developed where the tool is run at an average speed of people walking (0.5 m / sec). Then observed the condition of the *hopper*, *metering device*, auxiliary wheel, over *gear* and clutch to ensure the following:

1. Ensure that the *hopper* can accommodate maximum material by putting soybean seeds in each *hopper* with a total capacity of 3.5 kg by looking at the

durability of the *hopper to be* able to accommodate soybean seeds optimally if there are no soybean seeds that fall when the tool is operating and soybean seeds can fall well on the *metering device.*

2. Ensure that the *metering davice* (seed rationer) can rotate and remove soybean seeds smoothly without any friction and blockage constraints. In the operation of the tool where the *metering device* is connected to the auxiliary wheel shaft as the main driving force in rotating the *metering device there* are no obstacles. So that the rotation generated to rotate the metering *device* can drop soybean seeds in the amount of 2-3 seeds per hole made by the groove opener.
3. Ensuring the clutch can disconnect and connect power from the combustion motor shaft to the wheel shaft (tire) without the constraints of excessive friction and slip on the clutch shaft.
4. Ensure that the auxiliary wheel can rotate and forward the rotation to the *gear metering device* shaft through the chain transmission as a link by looking at the rotation generated by the auxiliary wheel in forwarding the rotation to the *gear metering device* shaft so that it can drop soybean seeds.
5. Ensure that the over *gear* as a plant spacer can rotate properly with the chain as a connecting transmission on the *gear metering device* shaft by looking at the rotation generated by the over *gear* forwarding the rotation to the *gear metering device.*

3.3.6 Evaluation Stage

The evaluation stage of the soybean *seeder* is carried out to ensure that the components of the soybean seeder development results, especially the *hopper, metering device,* over *gear,* auxiliary wheels and clutch components, are aligned between the design and function that Unknownehend with the reality that occurs in the implementation of the tool. This stage will identify whether the function of each component is functioning properly.

3.4 Flow Chart

The flow chart of this research is as follows:

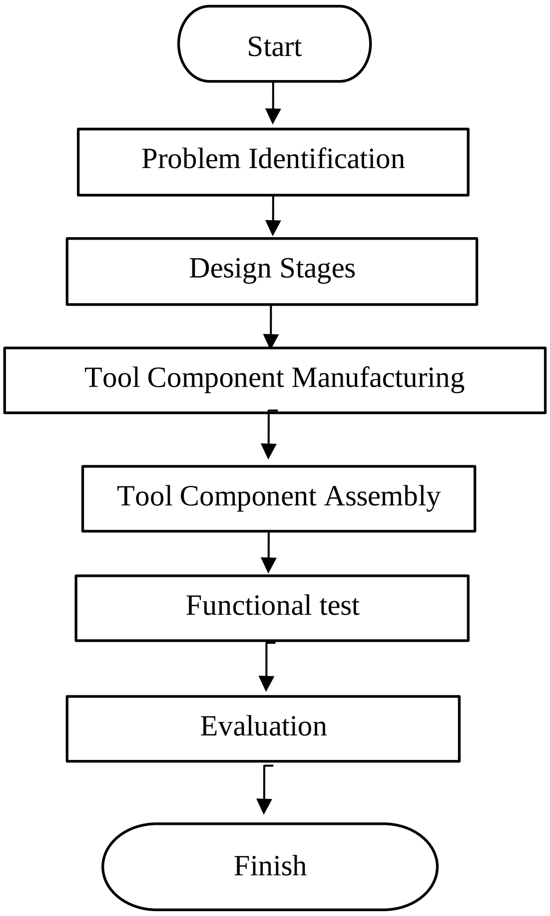

Figure 8. Research Flowchart.

4. RESULTS AND DISCUSSION

4.1 Overview of Modified Tools

Planting equipment is an agricultural machine tool used by farmers to facilitate the process of planting seeds, especially in soybean crops. The planting tool (seeder) for soybean plants is the development of a tool that was previously used as a corn planting tool. The following is a picture of the tool before development and after development as follows:

Figure 9. Planting tool before modification.

Figure 10. Modified Planting Tool.

Modifications were made to 5 components, such as hoppers, namely the addition of capacity and the number of hoppers which previously had a capacity of 1.5 kg with 2 hoppers to 4 hoppers with a capacity of 3.5 kg each, over gear which was previously connected directly to the shaft of the driving wheel (tyre) then developed as a soybean seed spacer, the auxiliary wheel was previously used to support the tool on the back to be balanced then modified to become the main driver in driving the metering device shaft, The metering device previously used for corn crops with 1 hole on each side of the metering device circle was then developed for soybean crops with 3 holes in each circle of the metering device which functioned to drop seeds from the hopper into the groove opening channel and the clutch in the previous tool did not exist then a clutch was installed which functioned to disconnect the main power source from the engine to the wheel shaft to facilitate control when the planting tool was run.

4.1.1 Seed container *(hopper)*

Hopper is a component of soybean planting equipment that functions as a seed container. The soya seed container was developed into 4 pieces which were previously only 2 hoppers. The area of land planted for 1 planting is used as the basis for the capacity of the *hopper* to be designed at 350 m2 so that the capacity that can be accommodated is 3.5 kg, so that the overall volume of the hopper is 5,133 cm^3.

The basis for determining the dimensions of the hopper size with some consideration is the weight of soybeans that can be loaded by a soybean planting tool (seeder) with 4 hoppers with a soybean density of 0.6 kg/l. Determination of the sloping side of the hopper is done using the angle of repose. The seed container (hopper) is made of acrylic plastic with a thickness of 2 mm. The dimensions of the hopper can be seen in the following table:

Table 3. Dimensions *Hopper*

Parts hoppers Dimensions	Length (cm)	Width (cm)	Height (cm)	Length of The Hypotenuse (cm)
Top	20	15	10,23	-
Bottom	4,5	5	17,11	34,22

Figuge 11. Hopper and Hopper Design on Tools.

4.1.2 *Metering device* (seed rationing)

The seed rationer is a component of the planting tool that functions to regulate the dropping of seeds in a certain amount and the desired planting distance. The type of metering device used is the type of flawed wheel rationer (edge cell) in the form of a circle with material from polytelin plastic. Where the type of metering device is very suitable for the tool developed especially in the previous tool also uses a blemished type.

Determination of the basic dimensions of the metering davice is to take the initial dimensions of the pre-existing metering device with a diameter of 4.5 cm and a length of 5 cm as the initial basis for designing the dimensions as well as the size of the metering device. Then it is mounted on the hopper shaft and rotates along the shaft of the metering device with a hole gap width of 0.6 cm with a depth of 0.10 cm by making 3 holes on the curved side of the inner circle of the metering device, where each 1 hole is filled with 1 soybean seed, so that the function of each 1 metering device is able to remove 3 soybean seeds at once.

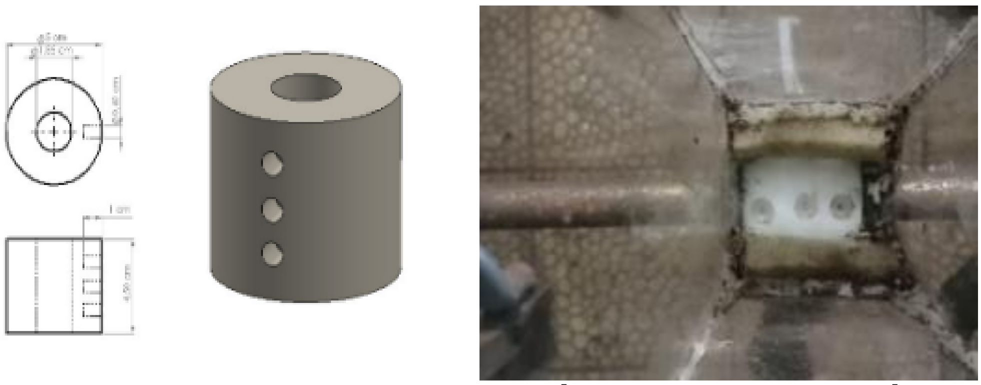

Figure 12. Metering Device Design and Metering Device on Tools.

4.1.3 Transmission

Soyabean seed planting tool (sedeer) with the transmission used is a chain and sprocket transmission system. The petrol motor as the main driving force is connected to a centrifugal type clutch with the number of sprocket teeth, namely 14 teeth and the rotation power is forwarded to the gear box and then forwarded to the drive wheel shaft with the number of sprocket teeth, namely 49 in turning the drive wheel. With a walking speed of 0.5 m / sec. Then the rear auxiliary wheel as the main drive that functions to forward the rotation on the metering device shaft with the help of an over gear as a successor to the rotating power of the auxiliary wheel. The transmission system is divided into 2, namely the transmission system of the drive wheel (tyre) and the metering device as follows:

Figure 13. Clutch Transmission Design and Clutch Transmission in Tools.

4.1.3.1 Drive Wheel Transmission

Clutch transmission is one component of a tool that functions to disconnect and connect the rotation power of a petrol motorbike engine. Where the type of clutch is divided into two types, namely automatic clutch and mechanical clutch. The type of centrifugal clutch used to connect the source of rotation on the clutch shaft to the gear box uses a chain as a transmission link.

The chain as a transmission link has a low slip, so it is very well used in soya planting tools, moreover it has good resistance in pulling loads and rotating the clutch. The advantages of the clutch are that it is easy to obtain, has a strong material which is made of stainless steel which has been equipped with sprocket teeth and is practical in mounting on a combustion motor. The centrifugal type clutch functions to forward and disconnect the driving rotation power from the engine to the drive wheels. The gear box functions to reduce rotation which has a ratio of 1:50 rotation. Therefore, the clutch sprocket teeth and the gear box output are 14 teeth. The wheel shaft gear sprocket tooth totals 49, so the drive wheel speed is obtained at 16.8 rpm. Based on the calculation results, the reduction speed 1 is obtained with the ratio of the number of input and output sprocket teeth in the gear box of 142.8 times. Furthermore, the 2nd reduction with the ratio of the number of gear box output sprocket teeth and wheel shaft sprocket teeth is 2.9 times. So it is known in the operating speed of the tool starting from the clutch gear shaft to the drive wheel shaft with the ratio of sprocket teeth that need to be used, namely 14 at the output of the gear box and 40 teeth on the wheel shaft sprocket. This is different from that used in the developed soya planting tool. Where the sprockets on the wheel shaft gear are 49 teeth. In determining the sprocket on the wheel shaft on the tool based on the availability of materials on the market with the number 40 sprocket teeth are only produced for certain needs and are very rarely produced in general. To approach the desired number of sprocket teeth so use 49 sprocket teeth that have been found in the soybean planting tool (seeder).

Table 4. Transmission reduction result

Transmission	Reduction (kali)	Speed *(input)*	Speed (*output*)
Machine to clutch	1	2400 Rpm	2400 Rpm
Clutch to fear box	50	2400 Rpm	48 Rpm
Gear box to wheel axle	142,8	48 Rpm	16,8 Rpm

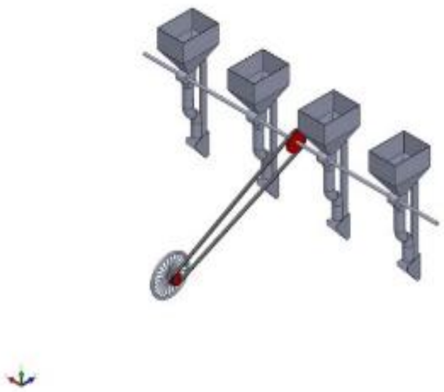


Figure 14. Matering Device Design and Metering Device on Tools.

4.1.3.2 Transmisi *metering device* (seed rationer)

Metering davice using an auxiliary wheel that serves to channel the main source of rotation to the metering davice shaft. The transmission used is over gear as a variation of the planting distance to the metering davice gear shaft and chain as a transmission link. The over gear transmission is equipped with 6 gears as a tool component in adjusting the planting distance used on the auxiliary wheel with a serrated rubber outer tyre to reduce slip on the auxiliary wheel. The speed of the auxiliary wheel depends on the forward speed and the ratio between the diameter of the drive tyre wheel and the diameter of the auxiliary wheel. The speed of the metering device shaft depends on the speed of the auxiliary wheel with the ratio of the sprocket over gear teeth loading the table as follows:

Table 5. Speed sprocket metering device

Gear	Number of over gear sprocket teeth (seed)	Number of metering device sprocket teeth (seed)	Shaft speed of the metering device (Rpm)
1	28	49	13,71
2	22	49	10,77
3	21	49	10,28
4	19	49	9,30
5	17	49	8,32
6	14	49	7,83

So it can be seen that the planting distance produced by comparing the gear input ratio of the wheel with the gear output of the metering device is a ratio of 28: 49 which requires 1.75 turns to produce 1 rotation of the metering device output gear. As known gear speed 1 is 21.91 cm / sec. So that the speed multiplied by 1.75 turns results in a planting distance of 38.34 cm in gear 1, so the fewer the teeth of the sprocket, the greater the planting distance produced.

4.2 Test Results

Soybean planting tools (seeder) with a motorbike drive can be seen the level of success based on the amount of uniformity of soybean seeds that come out of the hopper, planting distance, and processing time.

4.2.1 Functional test

Functional tests are carried out to determine whether the components or modified parts of the soybean planting tool (seeder) can function properly. Based on the test results show that all components and parts of the machine have functioned properly. As the most important part of the tool is the motorbike engine, metering device, hopper and clutch.

Table 6. Functional Test Results

No	Component	Parameters	Performance
1.	Motorbike engine	• • Engine power	5,5 Hp
		• • Cylinder volume	163 cc
		• • Maximum speed	3600 Rpm
		• • Maximum torque	2500 Rpm
2.	*Hopper*	• • Capacity	3,5 kg
		• • Hopper top volume	3.076 cm^3
		• • Hopper bottom volume	2.307 cm^3
		• • Total volume of the hopper	5.383 cm^3
3.	*Metering device*	• • Number of seeds	2 - 4 benih
		• • Number of hole slots	4 lubang
		• • Number of hole slots per row	3 lubang
		• • Planting distance	30 - 60 cm
		• • Plant spacing in rows	25 cm
4.	Clutch	• • Clutch speed when the tool is stationary	244 ≤ 2300Rpm
		• • Clutch speed when the tool is operating	2400 rpm

Table 7. Tool Speed Measurement at 10 m Distance

Description	No-load tool	Tools with auxiliary wheels	Tools with groove-opening weights and auxiliary wheels
	28,24 s	28,32 s	39,46 s
	26,33 s	26,79 s	32,67 s

	25,18 s	26,90 s	30,58 s
Average speed	26 s	27 s	34 s
Road tool speed	0,5 m/s	0,5 m/s	0,5 m/s

Table 8. Relationship of Seed Spacing to Over Gear Stability with Depth of Groove Opening

Gear	Tool Mileage (m)	Number of Holes	Distance Between Seeds (cm)	Interior Groove Opener (cm)
1	10	33	30	3
2	10	28	36	3
3	10	25	40	3
4	10	21	47	2
5	10	19	53	2
6	10	17	60	2

Table 9. Testing Results of Soybean Planting Equipment (Seeder)

Test Parameters	Test Results of Soybean Planting Equipment (*seeder*)
Working speed (m/detik)	0,5
Land area (m^2)	350
Inter-row spacing (cm)	25
Plant spacing in rows (cm)	30-60
Planting depth (cm)	2-3
Number of seeds per hole (seeds)	2 – 4
Distance travelled by the tool during testing (m)	10
Tool travelling time during the test (seconds)	34

4.3 Evaluation Stage

At the evaluation stage of the modified soybean planting tool (sedeer) modification while checking and evaluating several tool components such as Hopper, Metering device, over gear, auxiliary wheels and clutches that have been done at the analysis and development stage. The evaluation stage of the tool components is as follows:

4.3.1 *Hopper*

The evaluation stage of the hopper component aims to determine whether the results of the design or design that has been made are good, so testing is carried out by inserting soybean seeds with a capacity of 3.5 kg whether there are seeds that come out or not and can accommodate seeds properly or not. Based on the test results, the hopper used is classified as good because there are no seeds that come out when the hopper is filled and the material used is acrylic plastic.

1.3.1 *Metering device* (seed rationing)

The evaluation stage of the metering device component aims to determine whether the results of the design or design that has been made are good, can drop soybean seeds in the amount ranging from 2-4 soybean seeds per hole. From the test results it is also obtained that the metering device is classified as good because there are no obstacles and friction constraints when soybean seeds are removed from the hopper exhaust channel.

1.3.2 Clutch

The evaluation stage of the clutch component aims to determine whether the installation results are good. The results of the test have been carried out by starting the combustion motor engine with a state of rotation of 244 ≤ 2,300 rpm when the clutch position has not forwarded the rotation to the drive wheel shaft (tyre). When the gas lever is raised with a clutch rotation of 2,400 rpm, the clutch will continue the rotation power from the combustion motor engine to the drive wheel shaft (tyre) properly, based on the results obtained, the clutch works well.

4.3.3 Over *gear*

The evaluation stage of the over gear component aims to determine whether the installation results are good. Where the function of the over gear is to forward the rotational power from the auxiliary wheel to the shaft of the metering device with a multilevel gear ranging from small to large gears totalling 6 pieces and a chain as a penguhung transmission. The test results have been carried out by looking at the over gear is able to forward the rotation power to the axle of the metering device so that it can produce a planting distance that varies according to the gear level so that the planting distance is obtained between 30-60 cm. based on the results obtained, it is classified as good.

4.3.5 Auxiliary wheel

The evaluation stage of the auxiliary wheel component aims to determine whether the installation results are good. The auxiliary wheel functions as the main drive on the axle shaft of the metering device without any friction constraints on other components when rotating. The auxiliary wheel was previously used as the rear drive wheel as well as to support the weight of the tool. From the test results obtained that the auxiliary wheel that has been installed is classified as good.

4.3.6 Tool Permormance

Performance testing of the tool is carried out to determine how the performance system of various components of the soybean planting tool (seeder) when operating such as, hopper, metering device, clutch, auxiliary wheel, over gear and groove opener Based on the results of testing the tool it can be seen that the hopper can accommodate 3.5 kg of soybean seeds, then the seeds from the hopper will be forwarded to the metering device which functions to drop soybean seeds as much as 2-4 seeds per hole. Clutch as a breaker and forward the main power from the motorbike engine with a clutch speed of 2400 rpm with a centrifugal clutch type.

At this speed the clutch will function so as to drive the driving wheels through the chain as a transmission link to the gear box then the gear box to the main driving wheel. The tool operates at a walking speed of 0.5 m / sec. The auxiliary wheel will start rotating to rotate the metering device with the chain as a transmission link between the auxiliary wheel shaft gear through the over gear to the metering device shaft gear. Furthermore, the groove opener serves to open the soil so that soybean seeds can enter the soil with a depth of 2-3 cm so that the seeds will fall through the exhaust channel made of plastic hose with a size of 1 inch connected to the groove opener channel. The size of the tool test field with a track length of 10 m with a test time of 34 seconds with a planting hole distance between seeds based on the over gear level and the distance in the seed row is 25 cm. So that the theoretical field capacity is 0.135 Ha / hour, the effective field capacity is 0.095 Ha / hour and the planting field efficiency is 70.3%.

5. CLOSING

Conclusion

Based on the research on the modification of mechanical planting tools, it can be concluded that:

1. The soybean planting tool has successfully worked in accordance with the function of each component developed such as, hopper, metering device, over gear, auxiliary wheel and clutch.
2. The test results show that the soybean seeds released by the metering device work well with the number of 2-4 seeds and the petrol motor as the main driver on the soybean planting tool (sedeer) in the operation of the tool does not fully use human power. Able to plant 4 planting furrows at once so as to streamline work time for farmers.

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APPENDIX

Appendix 1. *Hopper* dimension calculation

1. Initial determination of *hopper* volume

Description: A = 350 m^2

J = 3

l = 25 cm 0,25 m

ρ = 0.65 kg/l 0.65 kg/dm^3 600 kg/m^3

m = 22 grams 0.22 kg

p = 30 cm 0,3 m

Asked: V_a ....?

Completion:

cm^3

V = 5.133 cm^3 m = ×5133

m 3.3 kg

So, the capacity obtained from the results of the calculation is 3.3 kg, before adding dimensions to the top of the *hopper* with a size of 2 cm upwards so that the full capacity of the *hopper* is 3.5 kg per *hopper*.

Description:

V = seed box volume (cm $)^3$

A = land area once filling the *hopper* (m $)^2$

J = number of soybean seeds per planting hole (seeds)

ρ = seed density (kg/m $)^3$

p = distance between planting furrows (cm)

l = distance between planting holes (cm)

m = seed mass (kg/seed)

2. Determination of *metering* device spacing

Unknown: J_c = 4 pieces

G_1 = 28 seeds

G_2 = 49 seeds

D = 39 cm

Asked: $J_{tb.}$ ....?

Completion:

Description:

= number of gaps in the *metering device* (cm)

= number of *sprocket* teeth on the shaft (pieces)

= number of *sprocket* teeth on the *metering device* (pieces)

D = wheel diameter (cm)

= wheel rotation distance after adding 5% wheel jam (cm)

= seed spacing (cm)

3. *Angle of Repose Size*

Def: h = 12.7 cm

D_1 = 42 cm

D_2 = 43.5 cm

Asked: ......?

Completion:

cm

4. Determining *Hopper* Volume

Based on the results obtained regarding the density of soybeans, the *hopper* capacity is 3.5 kg. Where to determine the value of P = 20 cm, taken from the spacing distance of the *metering device,* with a size of 100 cm, then divided by the *hopper* with a spacing distance of 5 cm per *hopper* to avoid collisions and to find out L = 15 cm is taken from the number of spaces per *hopper* on the lid. The position of the *hopper* can be seen in the picture:

Unknown: $Kh = 3.5$ kg → $m_1 + m_2$ → 2 kg + 1.5 kg

$\rho = 0.65$ kg/l

L = 15 cm

Asked: a. V over *hopper*.........?

a. V bottom *hopper*......?

b. *Hopper height*..........?

Solution:

Description:

m_1 = top *hopper* capacity (kg)

m_2 = bottom *hopper* capacity (kg)

P = distance of each bottom *hopper* (cm)

L = top *hopper* width (cm)

ρ = density of soybean (kg/l)

5. Determining the Leaning Side of the *Hopper*

Unknown: *Angle of repos* → *30°*

Dimension of *metering device* → $P_m = 5$ cm

$L_m = 4.5$ cm

Hopper dimension → $P_h = 20$ cm

$L_h = 15$ cm

Asked: Hypotenuse....?

Completion:

$A_1 = P \times L = 5cm \times 4.5cm = 22.5cm^2$

$A_2 = P \times L = 20cm \times 15cm = 300\ cm^2$

Description:

P_m = Length of *metering device* (cm)

L_m = Width of *metering device* (cm)

P_h = *Hopper* length (cm)

L_h = *Hopper* width (cm)

Appendix 2. Calculation of transmission of drive wheel rotation

1. Determining drive wheel rotation

Unknown: D_1 = 58 cm → r = 29 cm

V_1 = 0.5 m/sec

Id: Wheel circumference and wheel rotation.......?

Completion:

1 rps = 1 wheel circumference/second

Description:

D_1 = Tire wheel diameter (cm)

V_1 = Tool operating speed (m/sec)

r = tire wheel radius (cm)

2. Determining rotation reduction

Unknown: motor rpm = 2400 rpm

Gear box ratio = 1:50

Wheel rotation = 16.8 rpm

Asked: Reduction 1 and reduction 2 ....?

Completion:

Reduction 1 → *gear* box ratio = 1:50

Where the reduction speed of 1 with the ratio of the number of teeth of the input *gear* box *sprocket* and the number of teeth of the *output gear* box *sprocket* can be known by calculation:

Where the reduction speed is 2 with the ratio of the number of teeth of the *gear* box *output sprocket* and the number of teeth of the wheel shaft *gear sprocket*.

Appendix 3. *Metering Device* Transmission Calculation

Table 10. Comparison of *Metering Device Sprocket Gear* Ratio

Speed	Teeth	Ratio
1	28/49	0,57
2	22/49	0,44
3	20/49	0,40
4	19/49	0,38
5	17/49	0,34
6	14/49	0,28

1. Determine the speed of the auxiliary wheel

   Unknown: D_r = 39 cm → r = 19.5 cm

   V_1 = 0.5 m/sec

   Def: a. Circumference of the auxiliary wheel...?

   4 Auxiliary wheel speed.....?

   Completion:

   Where 1 rps = 1 wheel circumference/second

Description:

D_r = auxiliary wheel diameter (cm)

V_1 = tool operating speed (m/sec)

2. Determine the circumference of the *metering device* shaft *gear*

   Unknown: D_g = 190 mm → 19 cm

   r = 8 cm

   Asked: *Gear circumference*.....?

   Solution:

Description:

D_g = diameter of gear *metering device* (cm)

r = radius of gear *metering device* (cm)

3. Determines the reduction of auxiliary wheel rotation to the *metering device gear* shaft

Unknown: auxiliary wheel rpm = 24 rpm

Output diameter of *metering device gear* = 19 cm → r = 8 cm

Sprocket gear metering device output = 49 gears

Input gear sprocket = 14 teeth

Asked: *Output gear speed*......?

Solution:

a. Speed reduction in *gear* 1

Where, *gear* speed 1 = 2 × π × f × r

= 2 × 3,14 × 0,43 × 8

= 21 cm/sec

b. Speed reduction in *gear* 2

Where, *gear* speed 2 = 2 × π × f × r

= 2 × 3,14 × 0,34 × 8

= 17.08 cm/sec

c. Speed reduction in *gear* 3

Where, *gear* speed 3 = 2 × π × f × r

= 2 × 3,14 × 0,32 × 8

= 16.43 cm/sec

d. Speed reduction in *gear* 4

Where, *gear* 4 speed = 2 × π × f × r

= 2 × 3,14 × 0,29 × 8

= 14.56 cm/sec

e. Speed reduction in *gear* 5

Where, *gear* speed 5 = 2 × π × f × r

= 2 × 3,14 × 0,26 × 8

= 13.06 cm/sec

f. Speed reduction in *gear* 6

Where, *gear* speed 6 = 2 × π × f × r

= 2 × 3,14 × 0,24 × 8

= 12.52 cm/sec

So to determine the planting distance on the *metering device* component can be seen from the rotational speed of the auxiliary wheel input gear with the ratio of the input and *output gear* with a ratio of 28: 49, which requires a rotation of 1.75 to be able to produce 1 rotation of the *metering device output gear* with input level 1 *gear* speed = 21.91 cm / sec, so with a distance of 21.91 cm × 1.75 turns, so the resulting distance is 38.34 cm at the 1st *level sprocket* position and so on until the *gear* at level 6, so the more *sprocket* teeth the closer the resulting planting distance.

Appendix 4. Calculation of Tool Planting Efficiency

a. Theoretical Field Capacity

Known : Wt = 75 cm → 0,75 m

Vt = 0,5 m/sec

Asked : KLT……..?

Solution:

KLT = Wt × Vt

= 0,75 × 0,5

= 0,375m^2 /second → 0,135 Ha/hour

Description:

KLT = Theoretical Field Capacity (Ha/hour)

Wt = Theoretical Working Width (m)

Vt = Theoretical Constant Working Speed (m/sec)

b. Effective Field Capacity

Known : L = 10×10 m → 100 m^2 → 0,01 Ha

Wk = 6,3 minutes → $0{,}105\ hour$

Asked : KLE………?

Solution:

$$KLE = \frac{L}{WK}$$

$$= \frac{0{,}01}{0{,}105}$$

= 0,095 Ha/Jam

Description :

KLE = Effective Field Capacity (Ha/H)

L = Operating Land Area (Hectares)

Wk = Working Time (Hour)

c. Field Efficiency

Known : KLE = 0,095 Ha/Jam

KLT = 0,135 Ha/Jam

Asked : EL…………?

Description :

$$EL = \frac{KLE}{KLT} \times 100\%$$

$$= \frac{0{,}095}{0{,}135} \times 100\%$$

= 70,3 %

Description:

EL = Planting field efficiency (%)

KLT = Theoretical Field Capacity (Ha/H)

KLE = Effective Field Capacity (Ha/H)

Appendix 5. Clutch Drawings and Specifications

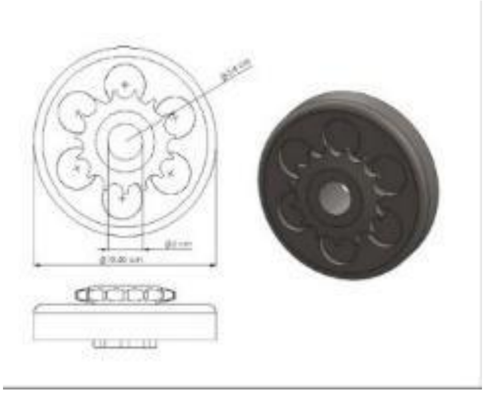


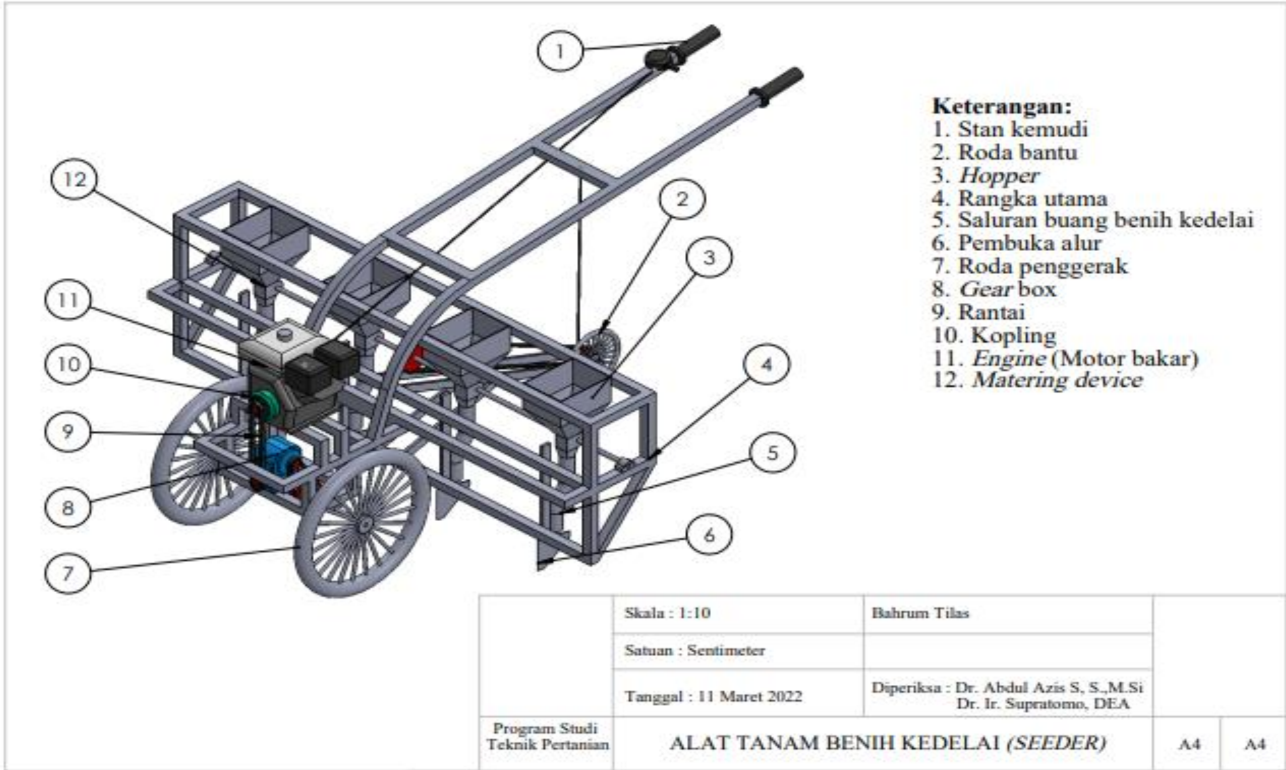
Figure 15: Clutch and Coupling Design of the Tool.

Table 11: Specifications of Automatic Clutch Assy 420-14T

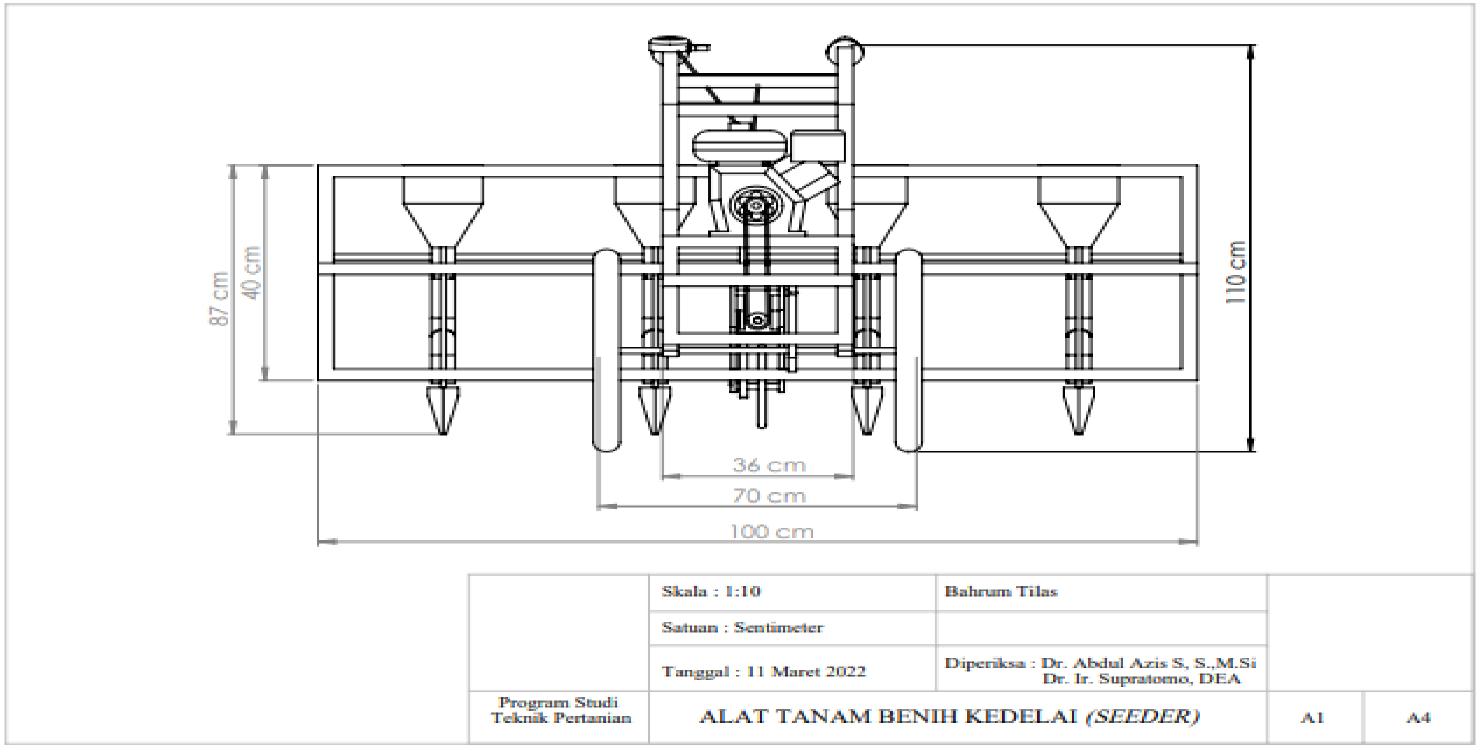
Specifications	Size
Hole diameter	19 mm
Diameter *sprocket*	28,5 mm
Outside diameter	107 mm
Number of sprocket teeth	14 seeds

Appendix 6. Tool Design

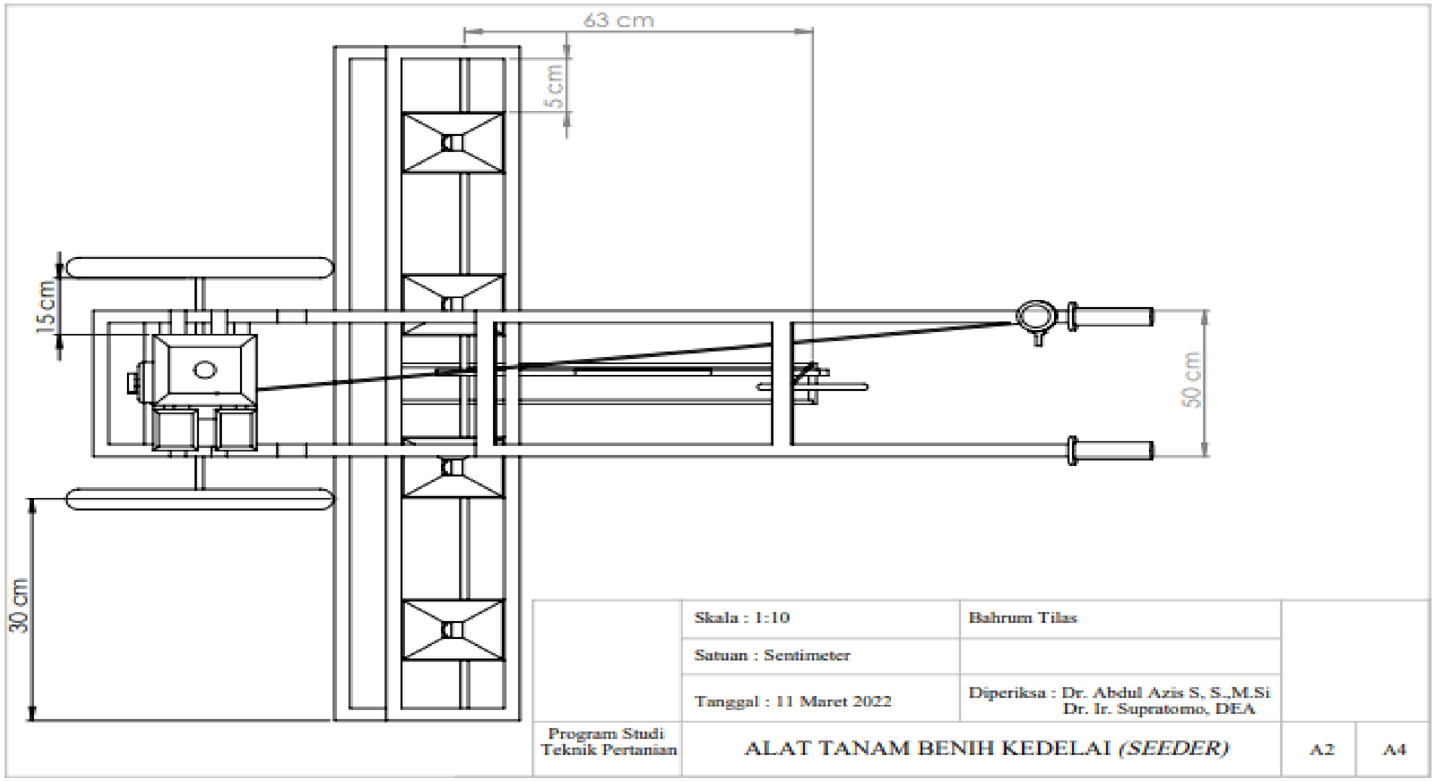
1. **3-Dimensional Design Drawing (Sedeer Soybean Seed Planting Tool)**



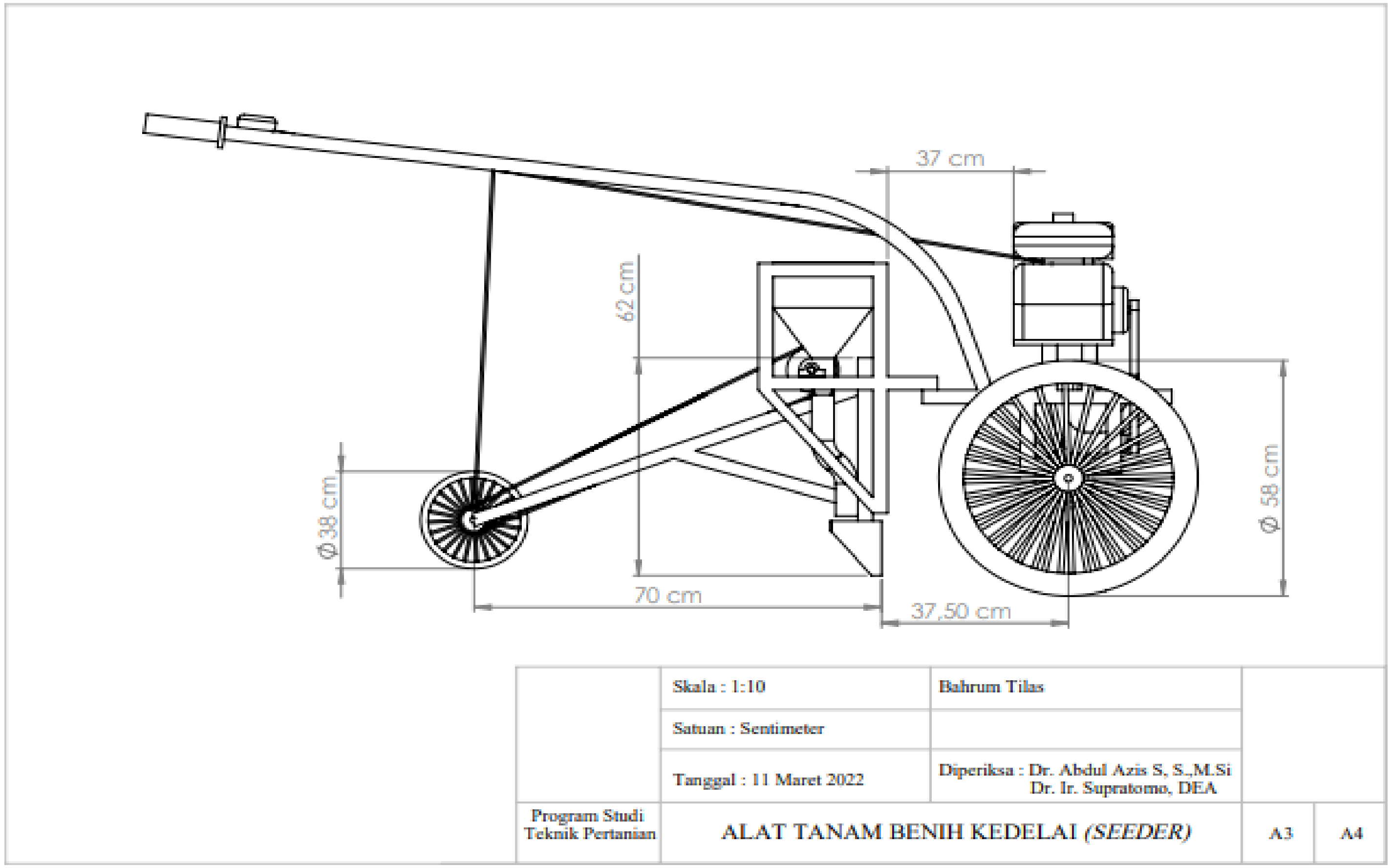
2. Front View Design Drawing (Sedeer Soybean Seed Planting Tool)



3. Top View Design Drawing (Sedeer Soybean Seed Planting Tool)



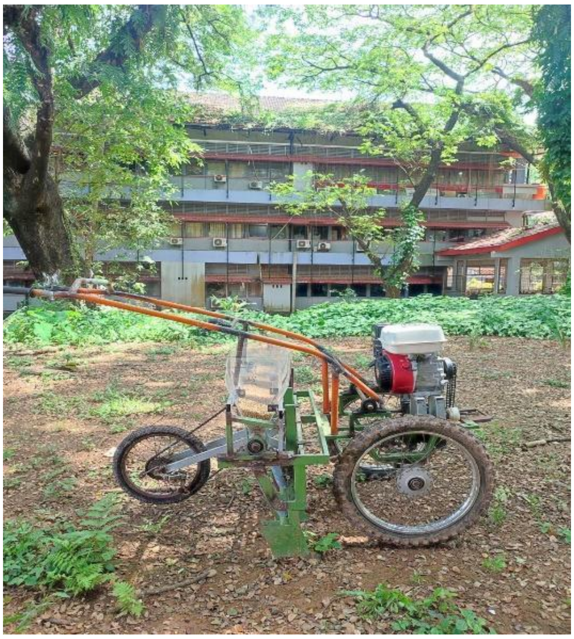
4. Side View Design Drawing (Sedeer Soybean Seed Planting Tool)



Appendix 7. Research Documentation

1. **Picture of the tool before modification**

2. **Picture of the Tool after modification**



3. Picture of Tool Testing Result