DESIGN AND FABRICATION OF MULTIFUNCTIONAL TILLING MACHINE FOR PRECISION AGRICULTURE

A PROJECT REPORT

Submitted by

SWASTHI K (8115U23ME053)

in partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

K. RAMAKRISHNAN COLLEGE OF ENGINEERING
(AUTONOMOUS)
SAMAYAPURAM, TRICHY

ANNA UNIVERSITY

CHENNAI 600 025

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Mr.S. NANDHA GOPAN

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BONAFIDE CERTIFICATE

Certified that this project report titled "**DESIGN AND FABRICATION OF MULTIFUNCTIONAL TILLING MACHINE FOR PRECISION AGRICULTURE "is** the bonafide work of **SWASTHI K (8115U23ME053)** who carried out the work under my supervision.

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(AUTONOMOUS

Under
ANNA UNIVERSITY, CHENNAI

DECLARATION BY THE CANDITATE

I declare that to the best of my knowledge the work reported here in has been composed solely by myself and that it has not been in whole or in part in any previous application for a degree.

Submitted for the project Viva- Voce held at K. Ramakrishnan College of Engineering on __________

SIGNATURE OF THE CANDITATE

SWASTHI K

ACKNOWLEDGMENT

We thank the almighty god without his blessing it would not have been possible for us to complete this project.

At this moment of having successfully completed our project, we wish to convey our sincere thanks and gratitude to our management of our college and our beloved chairman **Dr.K. RAMAKRISHNAN, B.E., Ph.D., who** provide all the facilities to us.

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Dr**. S. KUPPUSAMY, M.B.A., Ph.D**., for forwarding us to do our project and offering adequate duration in completing our project.

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ABSTRACT

India's agriculture is the back bone of the nation, and efficient soil preparation plays a crucial role in improving crop yield. This project focuses on the development of a fully mechanical tilling system powered by a wheel-driven mechanism. The system transmits motion through chain sprockets to drive the tilling blades, while a ploughing tool at the front initiates soil turnover. By combining ploughing and tilling into a single operation, this system reduces the time and effort required for soil preparation, making it more efficient and less labor-intensive. Its simple, durable, and low-maintenance design is tailored for agricultural use, providing a cost-effective and sustainable solution for farmers.

KeyWords:Peeling,tiresome,extraction,fatigue

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CHAPTER 1

INTRODUCTION

Agriculture plays a crucial role in India's economy, contributing significantly to the GDP and serving as the primary livelihood for nearly two-thirds of the population. Covering 33% of the country's geographical area, agriculture remains the backbone of rural socio-economic development. Soil preparation is a fundamental step in farming, directly influencing crop health and productivity. Proper tilling and ploughing improve soil aeration, nutrient availability, and water retention, creating the ideal environment for crop growth. However, traditional soil preparation methods can belabor-intensive, time-consuming, and less efficient, highlighting the need for innovative solutions.

India's agricultural diversity necessitates modern tools to meet the demands of different crop cultivation. Farmers often rely on equipment that combines efficiency with affordability. This project aims to develop a fully mechanical tilling system designed to streamline soil preparation. Unlike conventional methods, this system incorporates a wheel-driven mechanism that transmits motion through chain sprockets to drive the tilling blades. Additionally, a front-mounted ploughing tool initiates soil turnover, ensuring a comprehensive approach to soil preparation. By integrating ploughing and tilling into a single process, the system minimizes manual effort and time consumption.

The fully mechanical tilling system offers a robust design that prioritizes durability and ease of use. Its low-maintenance structure makes it ideal for small-scale and large-scale farming operations, ensuring reliability in varying agricultural conditions. By addressing the challenges of traditional tilling methods, the system provides a practical and sustainable solution for Indian farmers, who often face resource constraints and high labor costs. The use of simple mechanical components like chain sprockets and mild steel further ensures affordability and accessibility.

In addition to reducing the physical strain on farmers, the system promotes consistency in soil preparation, which is essential for improved crop yields. The combination of ploughing and tilling enhances soil texture, reduces clumps, and allows better water penetration. This not only improves planting conditions but also supports the long-term sustainability of the land. The project's focus on efficiency and simplicity aligns with the growing need for agricultural innovation in India.

Through extensive literature reviews, market surveys, and prototype development, this project endeavors to create a tool that not only meets the practical needs of farmers but also addresses the limitations of traditional methods. By combining efficiency with ease of use, the fully mechanical tilling system represents a significant step toward modernizing soil preparation techniques, ultimately contributing to India’s agricultural growth.

CHAPTER 2

LITERATURE REVIEW

The current research work on this particular topic was broadly studied by referring to the research work carried out by numerous research scholars, and their findings were thoroughly examined to arrive at the main objective of the research work. The following research studies were reviewed before finalizing the objectives of our project.

A.R. Patel et al.[1] worked on the development of a manual soil tilling machine. This study addressed the challenges of manual soil preparation in small-scale farming. The research focused on designing a mechanism that incorporates ploughing and tilling in a single operation. The machine, powered manually, included a plough blade at the front and a rotary blade mechanism at the rear. The research concluded that the design was effective for small agricultural plots, reducing manual labor and time.

S.K. Sharma and M.K. Gupta[2] conducted research on a tractor-mounted rotary tiller. The primary objective of their work was to enhance soil aeration and nutrient absorption. The rotary tiller, driven by a tractor PTO (Power Take-Off), was equipped with a chain and sprocket mechanism to power the rotary blades. Their findings demonstrated that this system significantly improved soil preparation efficiency and reduced the labor required compared to traditional methods.

D. Vishnu and R. Kumar[3] explored the design of a wheel-driven soil tiller with a focus on compact and cost-effective solutions for farmers. Their research highlighted the use of a chain and sprocket transmission system to drive the rotary tiller blades. A simple ploughing tool was integrated at the front, enabling dual functionality in a single pass. Their prototype showed promise in reducing soil preparation time and improving uniformity in soil tilth.

T.S. Rajesh et al.[4] worked on developing an automated ploughing and tilling system for sustainable farming. The study proposed a machine powered by renewable energy sources such as solar panels. The design used a combination of belt and pulley mechanisms and a crank-slider system control the tilling blades. The research could to concluded that this eco-friendly be a game-changer in reducing solution dependency on fuel-powered machines.

A.K. Singh et al.[5] proposed a simplified soil preparation system for marginal farmers. Their research introduced a manually operated tilling device with a lightweight frame constructed using mild steel. The machine utilized a bearing system to ensure smooth operation of the rotary tiller blades. The study demonstrated that such low-cost designs could help farmers in rural areas improve productivity without incurring high costs.

Through a thorough review of the above studies, it was observed that while significant progress has been made in soil preparation technologies, there is a lack of simple, low-cost, and efficient solutions tailored for small-scale and marginal farmers. This necessitated the development of a fully mechanical tilling system, combining ploughing and tilling into a single efficient operation, to address these gaps effectively.

CHAPTER 3

PROBLEM IDENTIFICATION

Labor-Intensive Process: Traditional manual soil tilling is physically demanding and time-consuming, requiring significant effort and manpower. The process reduces efficiency, particularly for small-scale farmers who often lack access to advanced machinery.

Ineffectiveness on Uneven or Hard Soil: Existing tilling machines often struggle to perform on uneven or hard soil, resulting in inconsistent tilling depth and suboptimalsoil preparation. This can adversely impact crop growth and yield.

Precision and Safety: Current methods can lack precision, potentially damaging soil structure or leaving portions insufficiently tilled. Additionally, safety features are often inadequate, posing risks to operators.

Adaptability to Varied Soil Conditions: Soils differ in texture and hardness across regions, and many tilling machines are not adaptable enough to handle these variations effectively, further limiting their usability.

Durability and Maintenance: Machines used for soil preparation tend to have high maintenance requirements, leading to frequent downtime and increased operational costs for farmers.

User-Friendliness: Many tilling machines require significant expertise to operate efficiently, creating a barrier for less-experienced farmers and limiting widespread adoption.

Cost-Effectiveness: High equipment costs discourage adoption by small and marginal farmers, making it necessary to develop affordable solutions without compromising functionality.

Environmental Impact: Consideration must be given to energy consumption and potential environmental effects, ensuring that the tilling process remains sustainable while minimizing emissions or waste.

Integration with Farming Practices: A lack of integration between tilling machines and other farming processes leads to workflow inefficiencies. Machines must be designed to seamlessly complement other agricultural operations, ensuring streamlined soil preparation.

CHAPTER 4

OBJECTIVES

Efficiency in Tilling: The machine should perform efficient soil preparation by combining ploughing and tilling into a single operation. This approach aims to save time and effort while enhancing productivity compared to traditional farming methods.

User-Friendly Operation and Safety: The design should ensure simple and intuitive operation, requiring minimal training for farmers. Safety features should be incorporated to protect operators during use, promoting ease of handling and reliability.

Adaptability and Sustainability: The system must be adaptable to various soil types, including hard and uneven terrain, ensuring consistent tilling depth and quality. Additionally, the design should focus on sustainable practices by minimizing energy consumption and reducing environmental impact.

Durability and Cost-Effectiveness: Built with robust materials, the machine should be durable and require low maintenance, reducing downtime and operational costs. The system should also be affordable, making it accessible to small-scale farmers, thereby maximizing its utility and adoption in rural farming communities.

CHAPTER 5

SELECTION OF MATERIALS

CHAIN SPROCKETS

PRINCIPLE OF CHAIN SPROCKETS

Chain sprockets are fundamental components in power transmission systems, commonly used in agricultural machinery to transfer motion between rotating shafts. They operate on the principle of interlocking teeth on a sprocket wheel with the links of a chain to transmit rotational motion efficiently.

WORKING OF CHAIN SPROCKETS

As shown in the Figure 5.1 When the sprocket is connected to a driving source such as a motor, the rotation of the sprocket engages with the chain's links, driving the attached load. The chain's tension and the precise alignment of sprockets ensure smooth motion transfer. Chain sprockets are robust and ideal for high-torque applications in tilling machinery, where they efficiently transmit power to the workingtools.

Figure 5.1 CHAIN SPROCKETS

TILLING BLADE

PURPOSE OF TILLING BLADES

Tilling blades are the primary tools for breaking and loosening soil, crucial for soil preparation before planting. They are designed with sharp edges and specific angles to penetrate and churn the soil effectively

WORKING OF TILLING BLADES

As the tilling blades rotate, powered by the machine's drive system, they cut into the soil and create a fine tilth, promoting aeration and improving soil texture. Their shape and arrangement ensure minimal energy consumption while maximizing coverage and efficiency, making them suitable for small-scale and large-scale agricultural activities.

WHEEL

FUNCTION OF WHEEL

Wheels are essential components in agricultural machinery that provide mobility and support. They help in transporting the machine over various terrains, ensuring smooth movement and stability during operation. The wheels are designed to handle the weight of the machine and ensure consistent performance across different soil conditions. They also aid in the overall efficiency ofthe machine by ensuring the tilling and ploughing tools function optimally without hindrance from the ground.

WORKING OF WHEEL

The wheels are attached to the frame of the machine and rotate as the machine is pushed forward. As the wheels rotate, they drive the chain sprockets, which in turn power the tilling blades and ploughing tools. The wheels are designed to maintain traction and stability, even in challenging soil conditions. This allows the machine to maintain consistent speed and efficiency while performing tasks such as tilling and ploughing. The durable material and robust design of the wheels ensure that they can withstand wear and tear, ensuring a long operationallife for the machine.

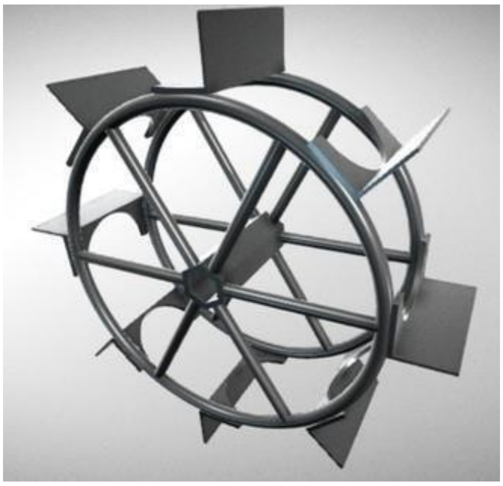
Figure 5.2 WHEEL

Talking about power transmission, a belt is the cheapest form. It’s a loop of flexible material used to link two or more rotating shafts mechanically,As shown in the Figure 5.2 it is often in a parallel form. These belts may be used as a source of motion as it transmits power more efficiently.

Definition of Wheel

A wheel is a circular component designed to rotate on
an axle. It is an essential part of most machines and vehicles, used to reduce friction, facilitate motion, and support the movement of objects. The wheel transmits mechanical power by providing rolling motion, which is efficient in various mechanical applications. In the case of your project, the wheel helps in providing the necessary traction for the movement of the machine.

Functions of Wheel

The primary function of the wheel is to facilitate
movement by minimizing friction between the machine and the ground. The wheel's rotation allows for easy and efficient movement across the field. It supports the machine’s structure and plays a crucial role in distributing the weight of the machine, thus ensuring smooth operation. Wheels are vital in applications requiring mobility, such as in agricultural machinery, where the wheel assists in the movement of tilling and ploughing tools.

Applications of Wheel

Wheels are integral to the movement of various machines, from vehicles to agricultural equipment. In your project, the wheels help the tilling machine move across the field, enabling it to till and plough efficiently. They are also used in:

- **Vehicles:** Cars, trucks, and other transportation machines rely on wheels for movement.
- **Agricultural machinery:** Tractors and tillers depend on wheels to provide mobility and maneuverability.
- **Heavy-duty machinery:** Forklifts, cranes, and construction vehicles rely on wheels to move large loads efficiently.

MILD STEEL FRAME

Mild steel, also known as plain-carbon steel, is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications, more so than iron. Low-carbon steel contains approximately 0.05–0.320% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased through carburizing. It is often used when large quantities of steel are needed, for example as structural steel. The density of mild steel is approximately 7.85g/cm3 (7850 kg/m3 or 0.284 lb/in3) and the Young's modulus is 210 GPa (30,000,000psi).

Low-carbon steels suffer from yield-point run out where the material has two yield points. The first yield point (or upper yield point) is higher than the second and the yield drops dramatically after the upper yield point. If a low-carbon steel is only stressed to some point between the upper and lower yield point then the surface may develop Lüder bands. Low-carbon steels contain less carbon than other steels and are easier to cold-form, making them easier to handle. Mild steel is one of the most commonly used construction materials. It is very strong and can be made from readily available natural materials. It is known as mild steel because of its relatively low carboncontent.

Mild steel usually contains 40 points of carbon at most. One carbon point is .01 percent of carbon in the steel. This means that it has at most .4 percent carbon. Most steels have other alloying elements other than carbon to give them certain desirable mechanical properties. 1018 steel, a common type of mild steel, contains approximately .6 percent to .9 percent manganese, up to .04 percent phosphorus, and up to .05 percent sulphur. Varying these chemicals affects properties such as corrosion resistance and strength. Mild steel is very strong due to the low amount of carbon it contains. In materials science, strength is a complicated term. Mild steel has a high resistance to breakage.

Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms. Mild steel is especially desirable for construction due to its weldability and machinability. Because of its high strength and malleability, it is quite soft. This means that it can be easily machined compared to harder steels. It is also easy to weld, both to itself and to other types of steel. It takes on a nice finish and is polishable. However, it cannot be hardened through heat treatment processes, as higher carbon steels can. This is not entirely a bad thing, because harder steels are not as strong, making them a poor choice for construction projects.

PLOUGHING TOOL

FUNCTION OF PLOUGHING TOOLS

Ploughing tools are specialized implements used for initial soil breaking and turning. They play a vital role in mixing organic matter and breaking compacted soil layers, essential for crop cultivation.

WORKING OF PLOUGHING TOOLS

Attached to the frame of the machine, the ploughing tool penetrates the soil surface and turns it over as the machine moves forward. Its sharp, curved structure ensures uniform soil turnover and reduces manual labor. This process improves soil drainage, aeration, and root penetration, forming the foundation for healthy crop growth.

CHAPTER 6

DESIGN AND FABRICATION

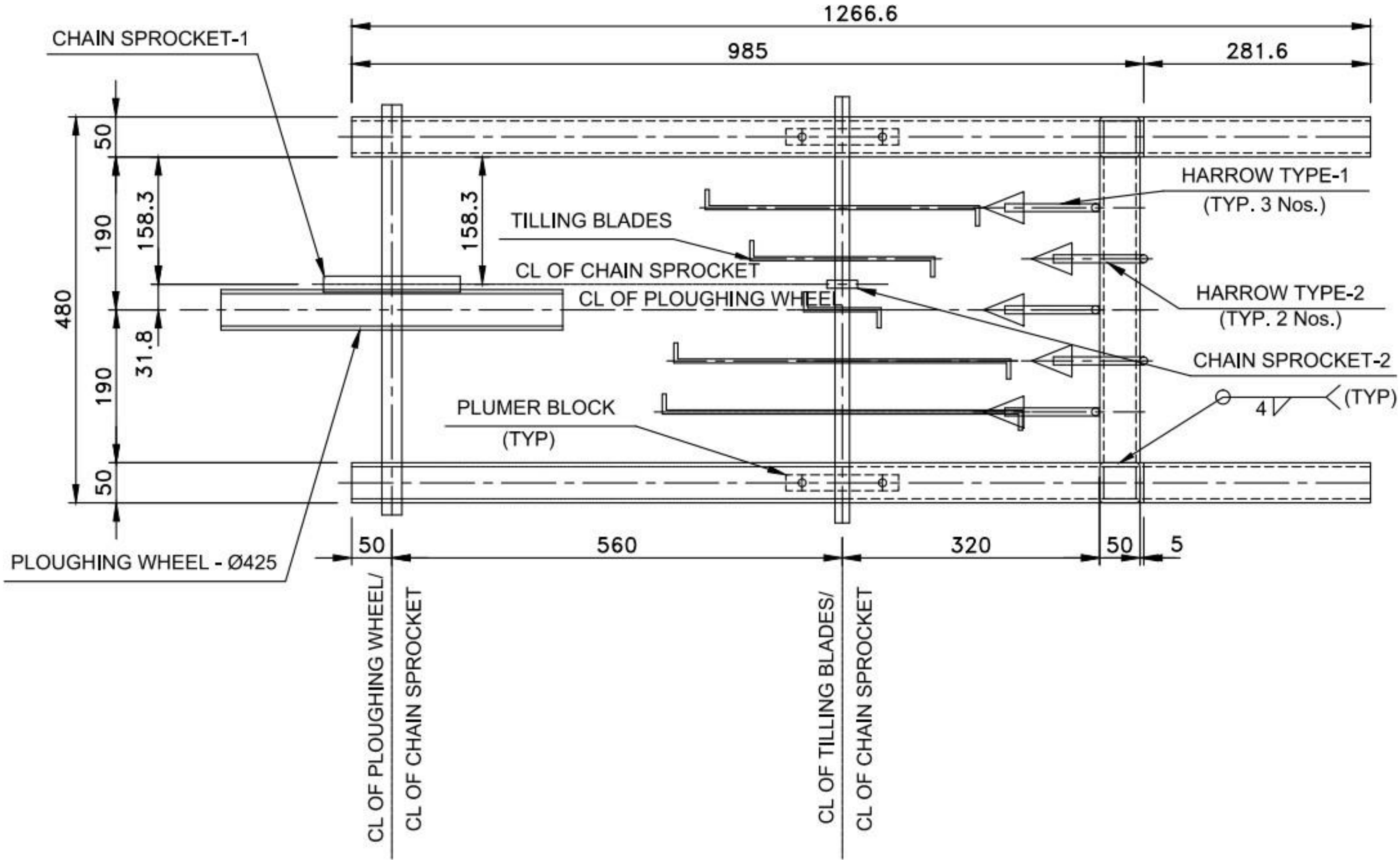

Figure 6.1

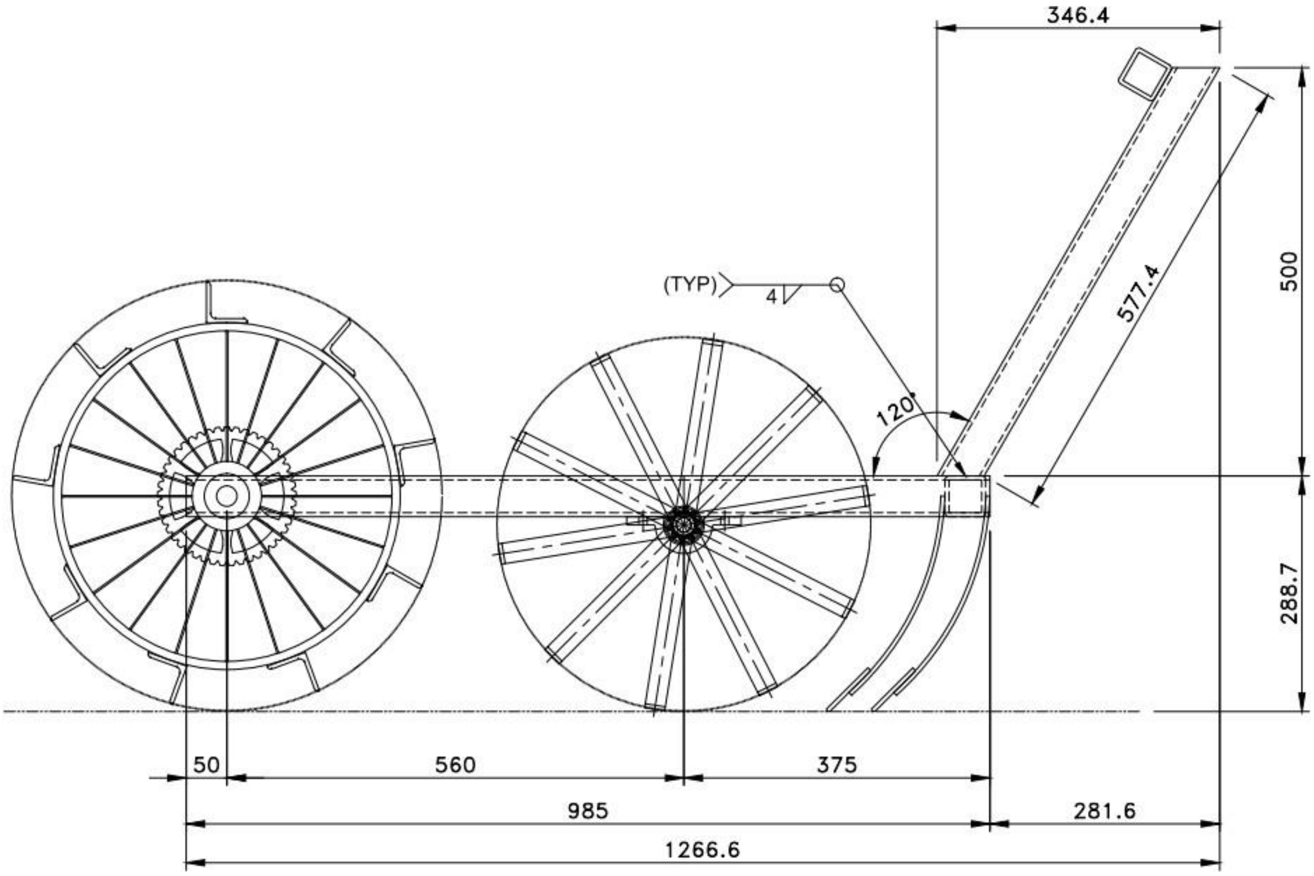

Figure 6.2

MULTIFUNCTIONAL TILLING MACHINE GENERAL ARRANGEMENT

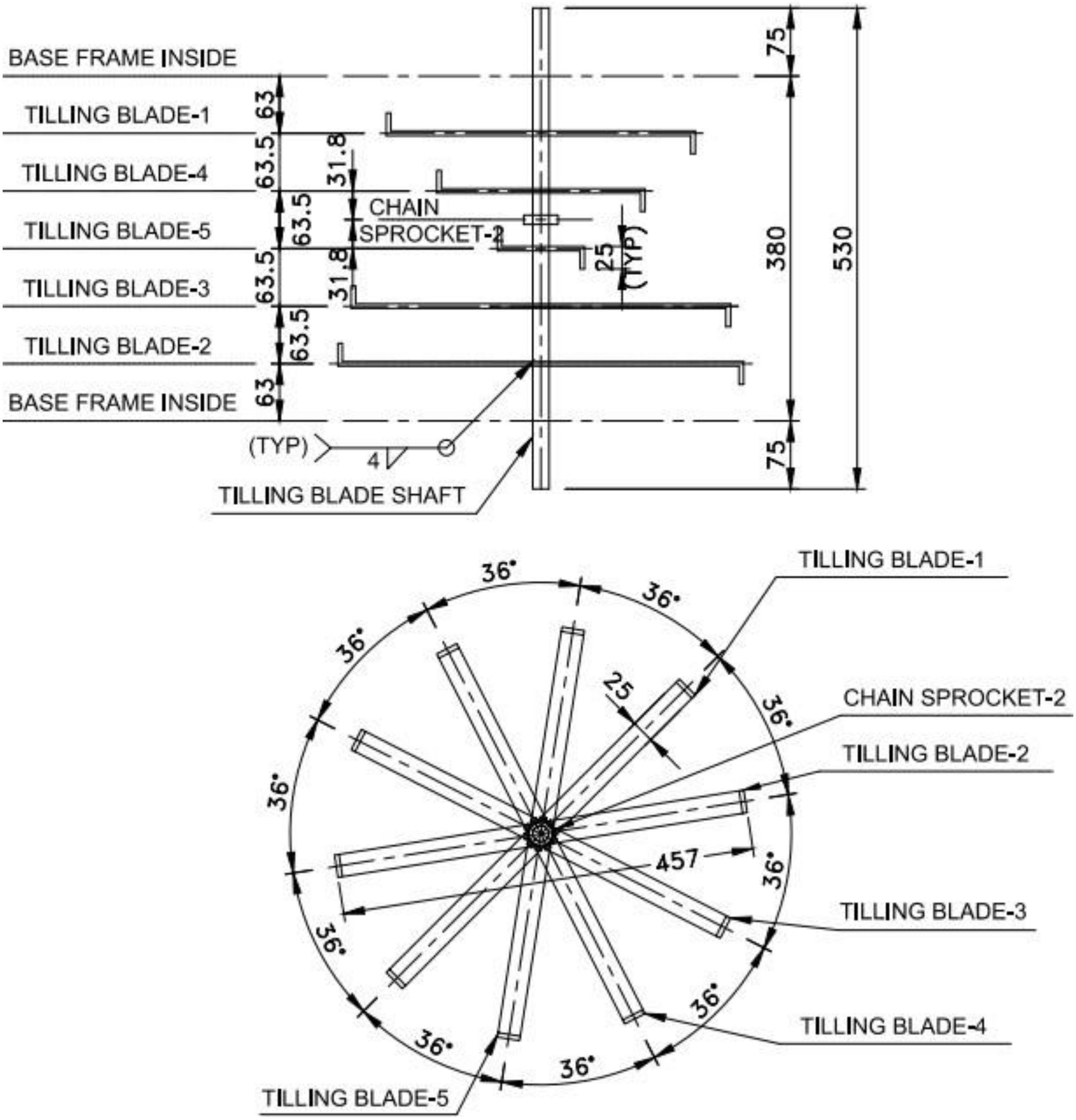

Figure 6.3

TILLING BLADES WITH SPROCKET ARRANGEMENT DETAIL

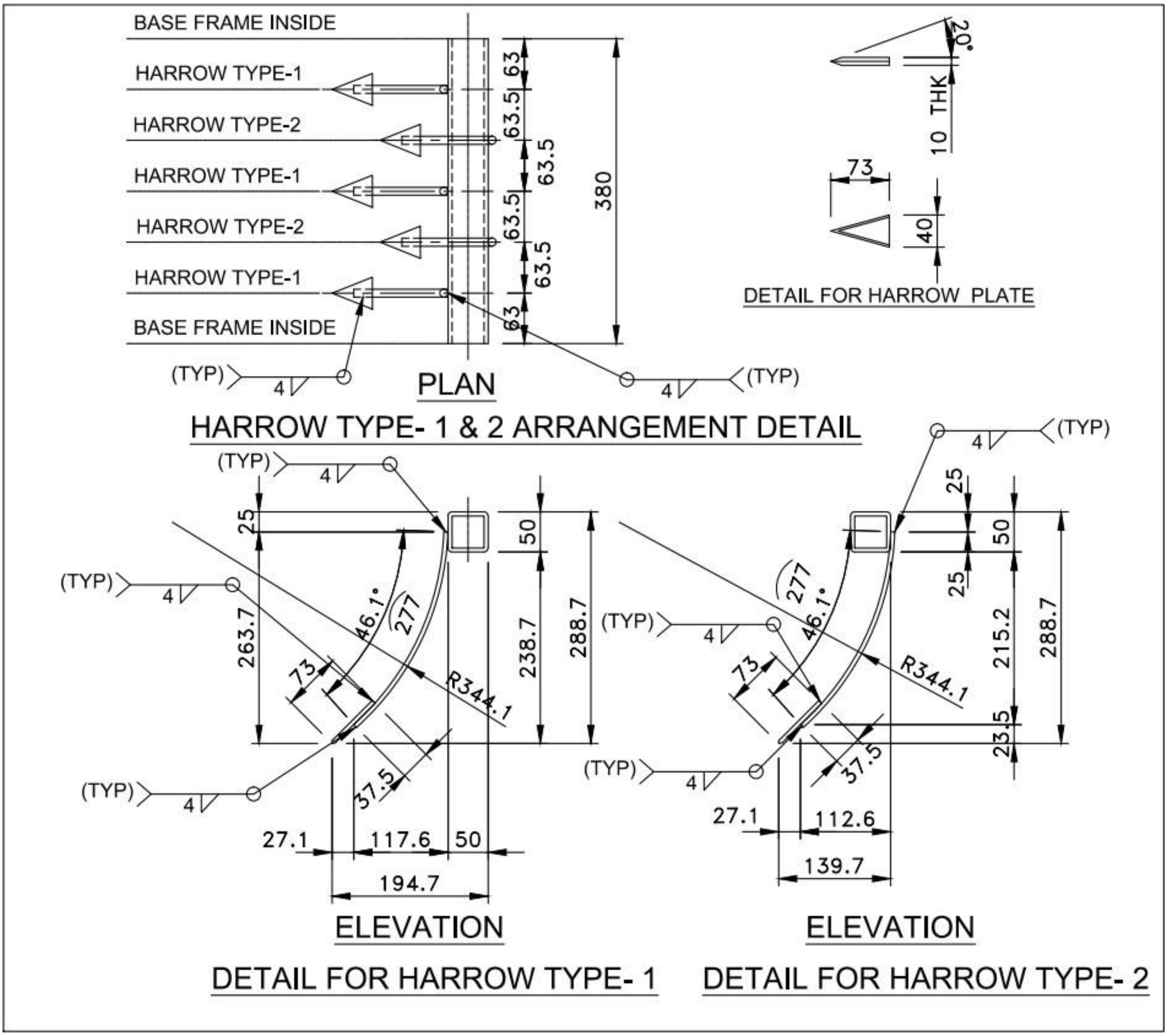
BASE FRAME INSIDE
HARROW TYPE-1
HARROW TYPE-2
HARROW TYPE-1
HARROW TYPE-2
HARROW TYPE-1
BASE FRAME INSIDE
63
63.5
63.5
63.5
63.5
63
380
(TYP)
4
PLAN
HARROW TYPE- 1 & 2 ARRANGEMENT DETAIL
20°
10 THK
73
40
DETAIL FOR HARROW PLATE
25
50
263.7
46.1°
277
73
R344.1
238.7
288.7
37.5
27.1
117.6
50
194.7
ELEVATION
DETAIL FOR HARROW TYPE- 1
25
50
25
215.2
288.7
23.5
37.5
27.1
112.6
139.7
ELEVATION
DETAIL FOR HARROW TYPE- 2

Figure 6.4

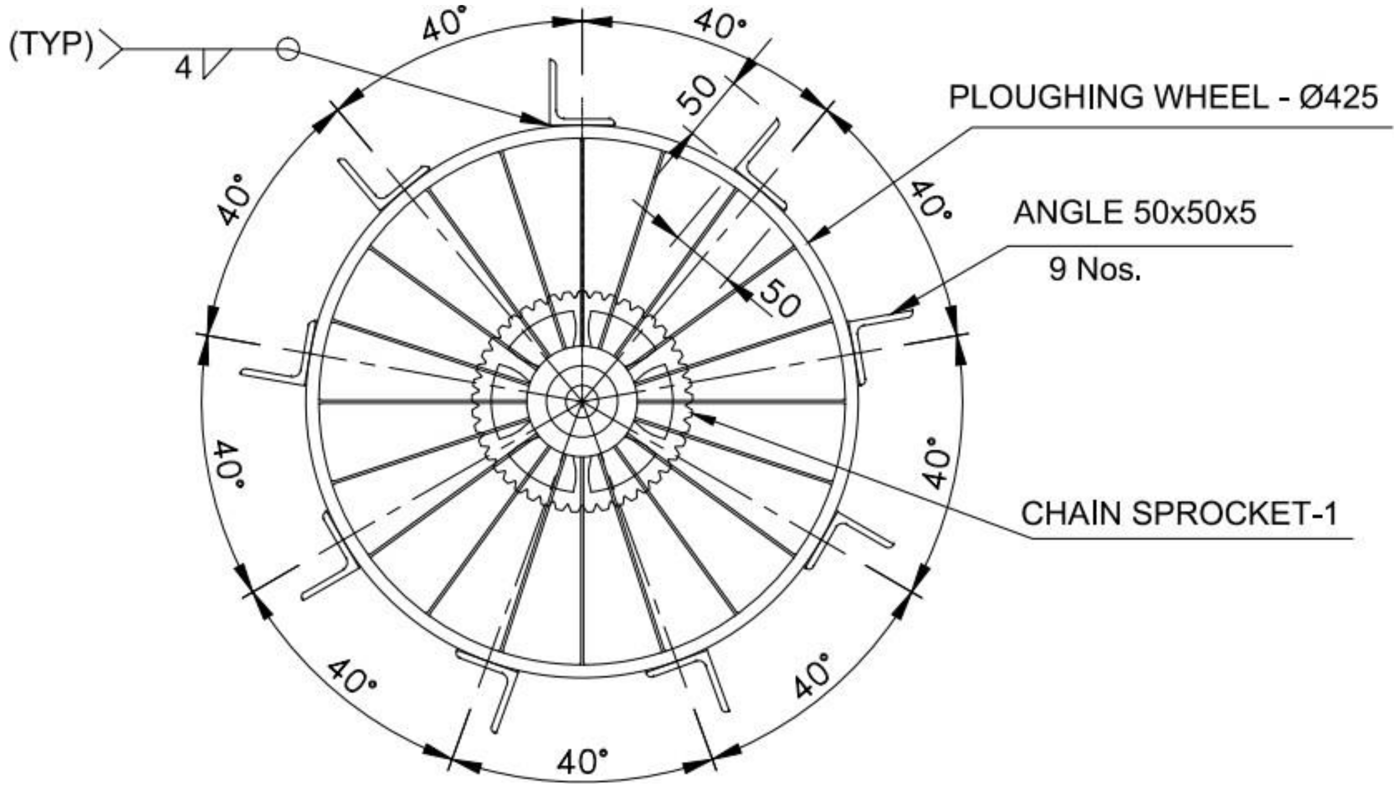

Figure 6.5

PLOUGHING WHEEL WITH SPROCKET ARRANGEMENT DETAIL

Figure 6.6

Figure 6.7

Figure 6.8

Figure 6.9

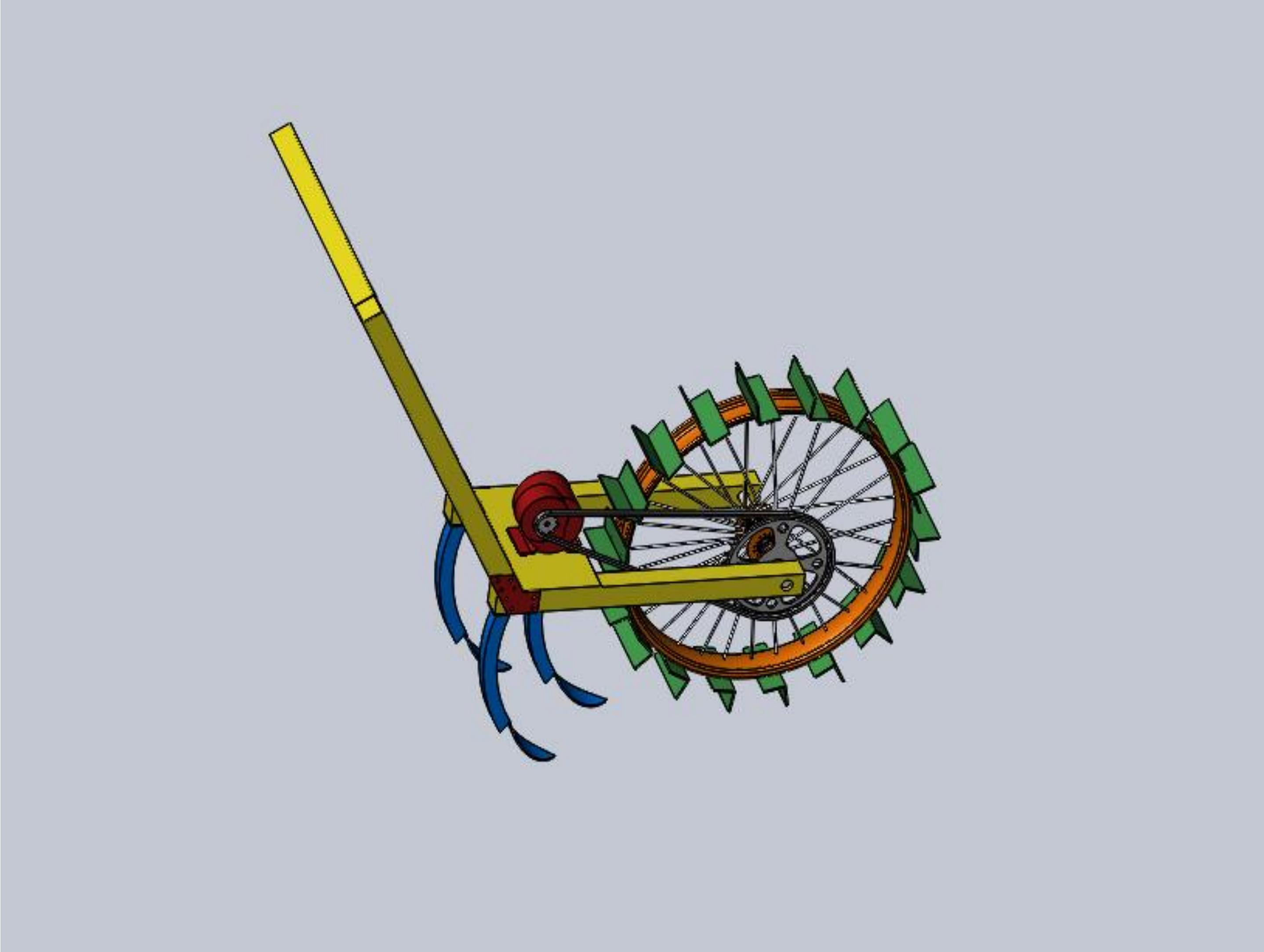

Figure 6.10

CHAPTER 7

DESIGN AND CALCULATION

GIVEN DATA

Wheel Diameter (D): 42.5 cm = 0.425 m

Chain Sprocket Diameter: 17 cm = 0.17 m

Mini Chain Sprocket Diameter: 7.5 cm = 0.075 m

Tilling Blade Length: 15 cm = 0.15 m

Base Bar Length: 77 cm = 0.77 m

Distance from Edge to Tilling Rod: 49.02 cm = 0.4902 m

Distance from Edge to Wheel Rod: 3.14 cm = 0.0314 m

Distance Between Wheel and Tilling Rods: 45.89 cm = 0.4589 m

STEP 1: SPEED RATIO

The speed ratio (I) is determined by the diameters of the chain sprockets:

I=Chain Sprocket Diameter / Mini Chain Sprocket Diameter

= 0.17 / 0.075 = 2.27

STEP-2: OUTPUT SPEED

Assume manual pushing generates a wheel speed of 30 rpm .The mini chain sprocket speed is:

NMini Sprocket = NWheel ×I = 30rpm × 2.27 = 68.1rpm

STEP:3 TILLING BLADE SPEED

The tilling blade rotates directly with the mini chain sprocket. Therefore:

NTilling Blade = NMini Sprocket = 68.1 rpm

STEP:4 LINEAR VELOCITY OF WHEEL

The linear velocity of the wheel is calculated using:

$V_{Wheel} = \pi \times D_{Wheel} \times N_{Wheel} / 60$

$V_{Wheel} = \pi \times 0.425m \times 6030 = 0.667m/s$

STEP:5 TILLING BLADE CUTTING SPEED

The tip speed of the tilling blade is:

$V_{Tilling\ Blade} = \pi \times D_{Tilling\ Blade} \times N_{Tilling\ Blade} / 60$

$V_{Tilling\ Blade} = \pi \times 0.15m \times 6068.1 = 0.534m/s$

STEP:6 POWER TRANSMISSION

Assuming a manual force of 50 N applied at the handle and a wheel torque:

$T_{Wheel} = F \times r_{Wheel} = 50N \times 0.2125m = 10.625Nm$

Power input to the system:

$P_{Input} = T_{Wheel} \times \omega_{Wheel} = 10.625Nm \times 602\pi \times 30 = 33.41W$

STEP:7 LENGTH OF CHAIN

The chain length depends on the center distance (CCC) between sprockets and their diameters:

$L = 2C + \pi((D_{Chain\ Sprocket}+D_{Mini\ Chain\ Sprocket})/ 2) + (((D_{Chain\ Sprocket} - D_{Mini\ Chain\ Sprocket})) / 4C)^2$

CHAPTER 8

COST ESTIMATION

SL NO	**PARTICLES**	**AMOUNT (RS).**
1	OTHER ALLOWANCES	500
2	MANUFACTURING COST	1000
3	DRILLING	500
4	WELDING	1000
5	POWER HAND SAW	500
6	GAS CUTTING COST	1000
7	OVERHEAD CHARGES	500
8	MATERIAL COST	1000
	TOTAL COST	6000

CHAPTER 9

WORKING PRINCIPLES

The machine operates on a fully mechanical push mechanism. When the operator pushes the machine, the wheels start to rotate. These wheels are welded to a chain sprocket, which is connected via a chain to another sprocket. The second sprocket is fixed to the rod that drives the tilling blades.

As the wheels rotate, they transfer motion through the chain and sprockets, causing the tilling blades to rotate. The rotating tilling blades effectively loosen and aerate the soil.
Behind the tilling blades, a ploughing tool is attached. This tool ensures additional soil turnover, making the machine suitable for preparing fields for various types of crops.

The simple chain sprocket mechanism eliminates the need for complex motorized systems, ensuring durability, ease of operation, and low maintenance. This design is optimized for efficient soil preparation in small to medium-scale agricultural operations.

CHAPTER 10

RESULT

This research aims to design, fabricate, and test a multifunctional tilling machine to enhance the mechanization of soil preparation for precision agriculture. The developed machine consists of a robust frame, a chain sprocket-driven mechanism, rotating tilling blades, and an attached ploughing tool. This push-driven machine eliminates the need for motorized systems, relying solely on mechanical power transmission.

The machine is designed to save time, reduce manual effort, and minimize costs associated with traditional soil preparation methods. Its simple and efficient mechanism ensures that farmers can achieve better productivity and soil preparation quality with ease and reliability.

CHAPTER 11

CONCLUSION

- At the end of extensive research, design, fabrication, and testing, a multifunctional tilling machine for precision agriculture was successfully developed using cost- effective and readily available materials and manufacturing techniques. The push- driven mechanism, utilizing a wheel and chain sprocket system, ensures efficient power transfer to the tilling blades while the attached ploughing tool aids in simultaneous soil turnover.

- **Enhanced Efficiency:** The machine streamlines soil preparation, traditionally a labor-intensive process. Its dual functionality of tilling and ploughing accelerates field preparation, leading to time savings, improved efficiency, and reduced operational costs.

- **Labor Savings:** The fully mechanical design eliminates the need for electric or motorized systems, significantly reducing manual labor while maintaining high performance. This makes it ideal for small-scale and resource-constrained farming environments.

- **Improved Ergonomics and Safety:** By replacing labor-intensive soil preparation methods, the machine minimizes physical strain and fatigue for farmers, promoting safer and more ergonomic working conditions.

- **Consistency and Quality:** The machine ensures uniform soil preparation, improving seedbed quality and supporting optimal crop growth. Its design caters to both dryland and wetland farming scenarios.

- **Adaptability:** The machine is versatile, suitable for a wide range of farming applications, including horticulture, landscaping, and organic farming, making it adaptable to diverse agricultural needs and terrains.

- **Cost-Effectiveness:** The simple, durable, and low-maintenance design ensures affordability, making it accessible for farmers. Its efficiency and versatility outweigh initial fabrication costs, offering long-term economic benefits.

- **Potential Challenges:** As with any new agricultural equipment, adoption might face resistance from traditional practices or operational challenges in diverse field conditions. Proper training, demonstration, and support will help mitigate these barriers.

- In conclusion, the multifunctional tilling machine presents an innovative and practical solution for precision agriculture. It enhances productivity, reduces labor demands, and promotes sustainable farming practices, benefiting farmers and contributing to the agricultural sector's growth.

- By alleviating the labor-intensive process of soil preparation, the multifunctional tilling machine contributes to the sustainable growth of agriculture and enhances the economic well-being of farmers and stakeholders.

CHAPTER 13

BIBLIOGRAPHY