DEVELOPMENT AND TESTING OF A TREE LOPPING MACHINE AS AN ATTACHMENT TO THE POWER TILLER

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PROJECT REPORT

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Tavanur - 679 573 Malappuram

1997

DECLARATION

We hereby declare that this project report entitled " **Development and Testing of a Tree Lopping Machine as an Attachment to the Power Tiller** "is a bonafide record of project work done by us and that this work has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title to us, of any other university or society.

Tavanur

31st May 1997

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CERTIFICATE

Certified that this project report, entitled **"Development and Testing of a Tree Lopping Machine as an Attachment to the Power Tiller "** is a bonafide record of project work done jointly by Jyothiraj C R, Naushad A and Sujith George under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to them.

31.5.97

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Jyothiraj CR

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SYMBOLS & ABBREVIATIONS

cm	- Centimetre(s)
dia	- diameter
Dept.	- Department
Engg	- Engineering
et al.	- and others
Fig	- Figure(s)
FIM	- Farm Implements and Machinery
FPME	- Farm Power Machinery and Energy
GI	- Galvanized Iron
g	- gram(s)
ha	- hectare
hp	- horse power
hr	- hour(s)
i.e.	- that is
I.S.I	- Indian Standard Institutions
J.	- Journal
K.A.U.	- Kerala Agricultural University
K.C.A.E.T.	- Kelappaji College of Agricultural Engineering and Technology
kg	- kilogram
kmph	- kilometre per hour
m	- metre(s)

min	- minute(s)
mm	- millimetre
MS	- Mild Steel
No.	- Number(s)
Pp	- Page
PTO	- Power Take Off
rpm	- revolutions per minute
Rs	- rupees
s	- second(s)
sec	- second(s)
Viz.	- namely
vs	- versus
&	- and
@	- at the rate of
/	- per
%	- percentage

CHAPTER I

INTRODUCTION

Trees constitute a major part of the earth's green carpet and serve a wide variety of purposes. The farmer can derive innumerable benefits from trees on his farm. The value of trees in a farming environment depends on the inherent potential of that environment, the range of types suited to the area, the genetic material available and the use or value of the tree or its products. The purposes and needs for which trees are grown are of primary importance.

Trees can be commercial crops which provides economic stability in the long term. Forestry products have a wide range of uses such as timber, chemical products and fruit. Many countries still rely upon wood as a major source of fuel. The additional use of incoming energy and water by trees can complement crop or livestock production in what is called stratified production.

Fodder trees have a role in semiarid environment with their ability to produce out of season feed from fruit crops. Shade, shelter for livestock, soil and water conservation, control of landslides, salt encroachment etc. are positive functions of trees on farms. Trees for beautification and appeal in rural as well as urban environments is a real purpose set by farmers, communities and local governments.

Trees can also provide excellent green manure to crops. Green manure has been used in farms from time immemorial. But over the years there has been a shift from the use of organic manure to the use of chemical fertilizers as they yield quick and impressive results. This is mainly as a result of very low availability of green manure even with a high production potential. The use of green manure in farming is always recommended for enrichment of the soil because of its many advantages and absence of any ill effects. The capability of bio mass production in our country is 270 tonnes per hectare per year. But we are able to produce only 30 tonnes per hectare per year. Kerala being an area receiving very good rainfall (3000 mm per year) the growth of green manure is high and profuse. But farmers face a grave situation: the greatest problem associated with green manure collection has been the shortage of labour for climbing the trees and cutting the branches, as well as high labour wages.

Trees when grown for a purpose or even otherwise require quite a number of manual or mechanical operations to be performed upon them for their proper growth and efficient utilization. The lopping of trees is one such practice, which is highly labour intensive and yet, is inevitable for most of the purposes which trees serve. Also, it is recommended that lopping of branches is necessary for obtaining a good growth of the trees. Pruning of branches is a common practice in parks, orchards, gardens etc. from an aesthetic point of view. In the case of trees like teak, rosewood etc. lopping is recommended for obtaining elongated circumferential timber for wood works. Cutting of branches is also essential for obtaining wood for fuel. Trees with branches which periliously hang over roads or grow close to electric supply cables pose great nuisance to public and are a few examples, where lopping is inevitable.

In all the above cases, the large height of the branches makes difficult the process of lopping. This, coupled with acute shortage of labour in the farm, makes tree lopping a problem to be surmounted indeed.

Considering the socio economic gravity of the problem, it was felt necessary to develop a suitable machine for the lopping of trees. Hence, a project entitled, "Development and Testing of a Tree Lopping Machine as an Attachment to the Power Tiller" was undertaken with the following objectives:

1 Estimation of the green manure requirement in the state of Kerala.
2 Development of a tree lopping machine as an attachment to the power tiller.
3 Field evaluation of the machine, and incorporation of suitable modifications to eliminate problems encountered during field operations.

CHAPTER II

REVIEW OF LITERATURE

In this chapter, a brief review of different wood cutting equipments, tree pruners and previous works done on the development of tree lopping machines and other relevant works have been presented.

The equipments for the tree looping could be classified as small scale hand tools, small scale tree pruners and power driven tree pruning machines, depending upon their mode of use and source of power.

2.1 Small Scale hand tools for branch cutting

Small scale branch cutting tools are handled manually and they include the traditional felling knife, wood cutters axe, bill-hook, broad axe etc. These are hand tools and the operator needs to climb up the trees to use them to cut branches.

2.1.1 The traditional felling knife.

The traditional felling knife is locally known as "Vakkathi" . It consists of a sharp blade of tempered steel provided with a wooden handle.

2.1.2 Wood-cutter's Axe

It consists of a wedge shaped blade with a curved edge. The blade is made of high grade steel, shaped and heat-treated. Handles are made of straight grain wood, about 18" long.

2.1.3 Bill hook

The bill hook is similar to the traditional felling knife, except that the blade is longer (about 50 cm) and made of light weight hardened steel blade. A hard wood handle is provided. It is some times called a 'brush cutter'.

2.1.4 Broad Axe

The broad axe is similar to the wood cutter's axe except that the edge of the blade is longer (10" long). It is used for squaring rough timbers into posts and beams.

2.1.5 Machetes

Machetes come in various shapes and sizes. A common feature to all of them is a long sword like blade (12" to 24" in length) and a short wooden or plastic handle. They are ideal tools for clearing and cutting heavy weed growth, brush, vines, grass and shrubs.

2.2 Small scale tree-pruners

The small scale tree-pruners include the curved pruning saw head, heavy duty top down trimmer head, hand chain saw etc. These implements are used along with long light weight poles with or without telescopic arrangements and / or nylon cords with full handle, which enable the operator to lop branches at greater heights from the ground itself.

2.2.1 Curved pruning saw head

It has a 20" long curved blade with 6-8 teeth per inch used along with poles to reach higher limbs.

2.2.2 Heavy duty-top down trimmer head.

It consists of a spring loaded shearing blade mounted on the end of a long pole, with a 3.5 m long nylon cord and a pull handle, which can conveniently top branches up to 3 cm thick and upto approximately 5 m height. It is so designed that a force of 20 times the pull on the rope is exerted on the branch.

2.2.3 Hand chain saw.

The hand chain saw consists of a 48" cutting chain (blade mounted chain) with control ropes from both ends and a small weight at the end of one of the ropes. The weight is tossed over the branch to be cut after positioning the cutting chain, The control ropes are pulled at alternatively. The cutting chain can saw through a branch upto 25 cm in dia metre and about 9 m high.

2.3 Power driven tree pruning / felling machines

This section deals with power driven machines for lopping of branches. They include chain saw, power pruner, power tiller operated felling machines etc.

2.3.1 Chain saw

The chain saw or power saw, is a light, portable saw normally designed to be used by one person. Cutting is done by a endless chain fitted with cutters which run around a flat plate called the guide bar. The drive links of the chain run in a groove machined in the edge of the guide bar and they are pulled along by the teeth of a sprocket. The sprocket is driven by a small two stroke petrol engine, or less commonly by an electric motor.

2.3.2 Power pruner

The power pruner consists of a chain saw cutting head, driven by a 3.5m long aluminium shaft and driven by a two-stroke petrol engine. The 3/8" pitch cutting chain can cut through 25 cm branches.

2.3.3 Power-tiller operated tree-felling machine.

Varsheny and Narang (1994) developed a front mounted power tiller operated tree felling machine. A 45 cm diameter serrated disc saw was provided to cut trees upto 20 cm diameter. The machine could fell 300 trees / day and the cost of operation was worked out to be Rs. 36/hr and Rs. 96 per 100 trees.

2.3.4 Solar powered wood-cutter

Panday , Sing and Aich (1988) developed a solar - powered bunch wood - cutter, consisting of a solar photo voltaic module which supplies power to a DC motor attached circular blade. It could cut a 3.5 cm thick log in 150 sec.

CHAPTER III

MATERIALS AND METHODS

In this chapter the materials used and the procedure adopted for the fabrication and testing of the tree lopping machine are discussed.

3.1 Estimation of the green manure requirement in Kerala.

The total annual green manure requirement in Kerala was estimated as follows. The total areas under cultivation of some of the major crops in Kerala were obtained from the 'Farm guide 96'. The green manure requirement per plant or per unit area and the spacing of each of this crops were obtained from the 'Package of Practices Recommendations, Crops 93'. The green manure required per unit area of crop when multiplied by the total area under cultivation of that crop gives its annual green manure requirement. Thus the total requirement was obtained by adding the requirements for all the crops. The results are discussed in the next chapter.

3.2 Selection of Prime mover.

The choice of the prime mover is based on its capacity to meet the power requirements for lopping of branches , the speed of operation, fuel on which it is operating , repair and maintenance etc to match with the functional requirements.

On the basis of the above considerations the power tiller was chosen as an ideal prime mover. The power tiller being compact and small in size can move on narrow terrains, has better stability due to low centre of gravity, provides small turning radius and is a versatile source of power. The use of power tiller satisfies the portability requirement of the lopping machine. It was envisaged that the tree lopping machine could be operated as an auxiliary mounting on the power tiller. The specification of the Mitsubishi Shakti power tiller is shown on Appendix III.

3.3 Cutting unit

A circular saw served as the cutting unit. Two blades 20 cm (Fig. 3.1) and 25 cm (Fig. 3.2) in diameters were tested for their performance. The blades were made of 1.5 mm thick high carbon steel plate with 100 number of teeth on their circumference. The depth of the teeth in the two blades were 3mm and 4mm respectively for the smaller and larger blades. The disc saw was fixed on to the hub at the end of power transmission shaft, with the help of nuts and plate washers on either side of the blade (Plate 3.1).

3.4 Power transmission.

Power was taken directly from the crankshaft of the engine and through a flexible shaft upto the cutting blade.

3.4.1 Power transmission shaft.

The operation of the machine involved frequent change of the orientation of the machine. In order to lop branches at various positions relative to the ground, a 15mm flexible shaft was used to transmit power from the engine to the blade. The flexibility of the shaft eliminated the use of bevel gears or flexible coupling which should have been provided otherwise. This provision thus enabled easy manoeuvrability and frequent change of direction and angle of power transmission without significant losses in speed and power (Plate 3.2).

The length of the shaft from engine to blade was 7 m. Due to non-availability of a single shaft of the length required , the shaft was formed of three lengths of shafts, one 3m in length and others 2 m long. These shafts were brazed together end to end. The shaft was connected to the engine crankshaft with the help of a coupling unit (Fig 3.3).The unit was externally threaded on the end to which the bottom end of the shaft was connected and other end was internally threaded so that it could be tightened on to the threaded end of the crank shaft which was extended beyond the engine pulley. The coupling unit was hexagonally faced so that it could be tightened by a 32 mm spanner.

The top end of the shaft was threaded on to the hub of the blade. About 70 Cm from the bottom end of the shaft, a cotter joint was provided to serve as a safety device to the shaft against excessive load.

3.5 Frame.

The frame to support the shaft was constructed of 1" G.I. Pipes and MS Flats as shown in the Fig. 3.4. The frame was 5.03 m long from its base to the hub of the blade. The flexible shaft from the engine passed through the pipe frame and extended right upto the point of cutting. The plane of the disk saw was required to be parallel with the axis of the frame for proper cutting to take place. This meant that the drive had to take a 90 ° turn at the top of the frame(Plate 3.2). The flexibility of the shaft was taken advantage of in providing a smooth bend of G.I. Pipe at the top, welded on to the top of the frame to achieve the change of direction of drive.

The hub of the blade was supported on the bend portion of the pipe by two 1" ball bearings. The bottom part of the frame was made to serve as a handle for handling the machine during operation. For the smooth handling of the frame and for attaining a balance of weight on either side of the point of support of the frame, a counter balance of 15 kg was provided. The part of the shaft between the engine pulley and the bottom end of the frame was enclosed in a 1" dia flexible plastic hose to ensure protection to the operator.

3.6 Stand: mounting on the power tiller.

The frame of the machine was mounted on the power tiller with the help of a stand (Fig. 3.5). It was primarily constructed of two 3" GI pipes joined by a thrust bearing assembly. The bearing was formed of two circular M S plates with a rivetted coupling in between and provided with smooth balls in a groove between the plates. This assembly enabled the rotation of the frame along a horizontal plane which was an essential requirement of the tree lopping machine. The top end of the pipe was welded with a pair of mild steel flats serving as simple supports to the frame, which had a 1.2" dia sleeve to enable resting of the frame on the stand. The bottom of the pipe was welded onto a M S structure (Plate 3.3) specially made to be bolted on to the chassis of the power tiller. The dimensions of the stand and its components are given in Fig. 3.5. The fully assembled Tree Lopping machine mounted on the tiller is shown in Fig. 3.6 as well as in Plate 3.4.

3.7 Minimum power requirement for lopping.

The method for the determination of minimum power requirement for lopping is shown in Appendix V.

3.8 Field testing and performance evaluation of the tree lopping machine.

The tree lopping machine was tested for its field capacity, optimum rpm., cost of operation etc. Also an attempt was made to select the most suitable blade from among the two types tested.

3.8.1 Machine capacity determination.

The machine capacity of the tree lopping machine was defined as the total cross sectional area of all branches which the machine can cut in a unit period of time. The time taken (including the time between successive loppings) to lop a few different branches in a randomly selected area with trees was noted and the capacity of the machine was determined after measuring the diameter of the cut branches. The above evaluation was repeated for three separate runs, and the average value was taken.

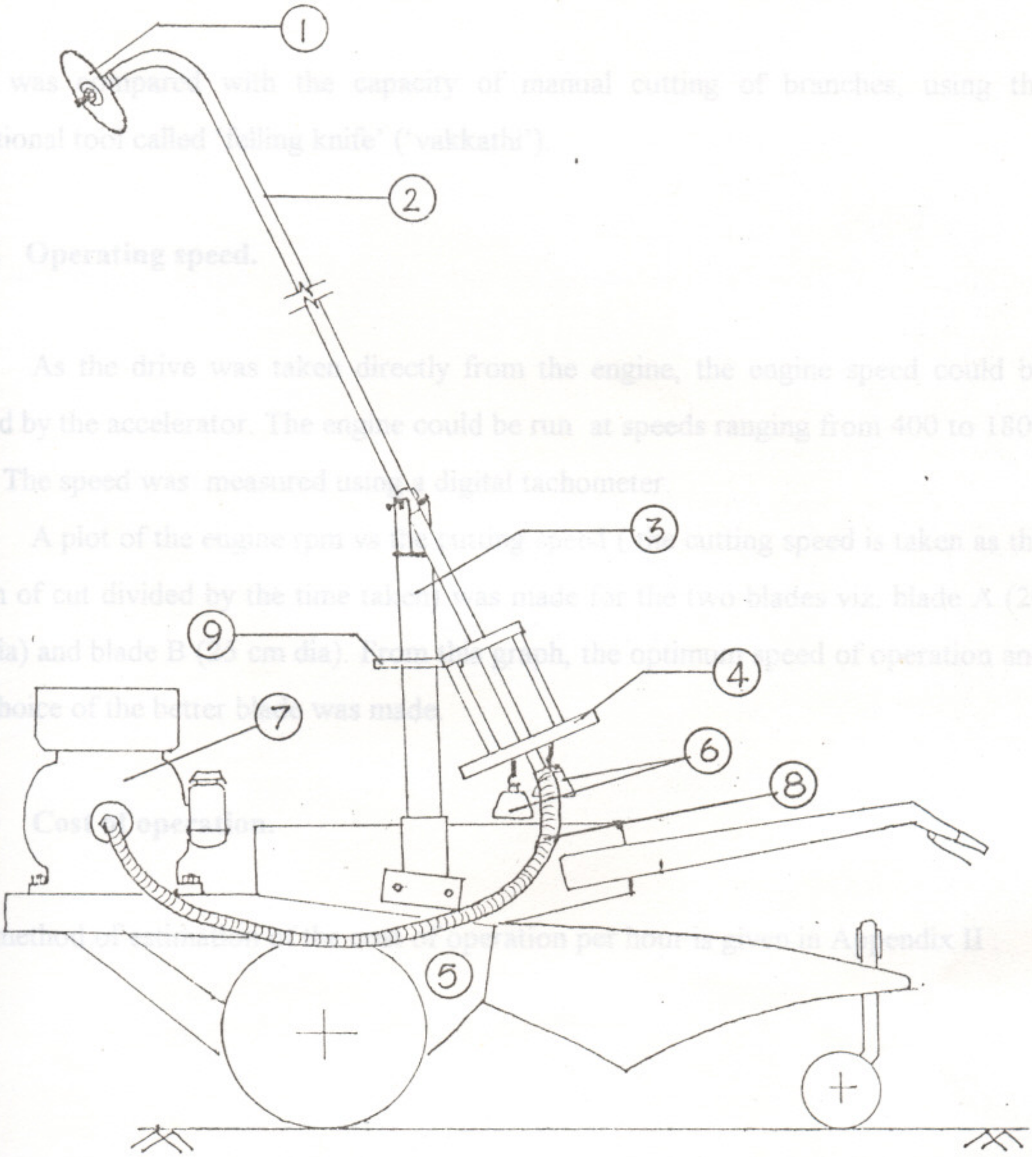


Fig.3.6. Tree Lopping Machine Mounted on the Power Tiller

1) Blade 2) Frame 3) Supporting Stand
4) Handle 5) Power Tiller 6) Counter Balance Weights
7) Engine 8) Flexible hose 9) Bearing

This was compared with the capacity of manual cutting of branches, using the traditional tool called 'felling knife' ('vakkathi').

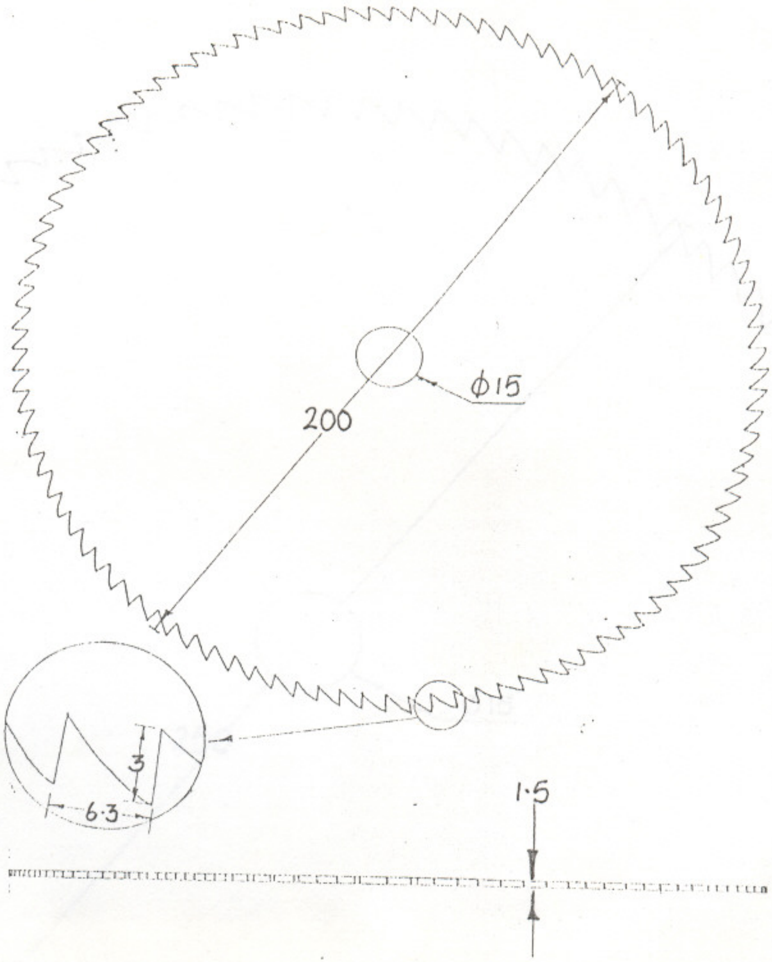
3.8.2 Operating speed.

As the drive was taken directly from the engine, the engine speed could be varied by the accelerator. The engine could be run at speeds ranging from 400 to 1800 rpm. The speed was measured using a digital tachometer.

A plot of the engine rpm vs the cutting speed (the cutting speed is taken as the depth of cut divided by the time taken) was made for the two blades viz. blade A (20 cm dia) and blade B (25 cm dia). From this graph, the optimum speed of operation and the choice of the better blade was made.

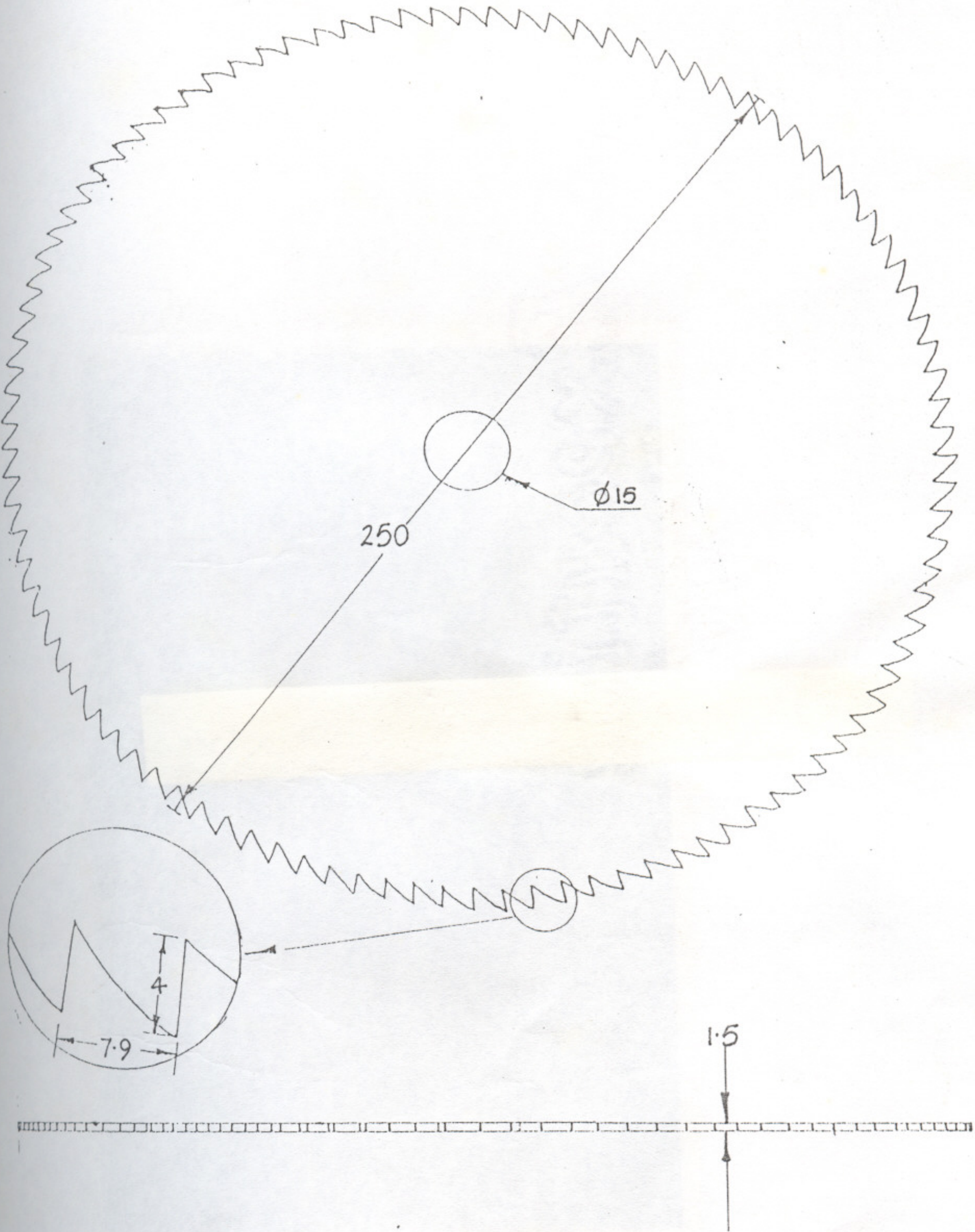
3.8.3 Cost of operation.

The method of estimation of the cost of operation per hour is given in Appendix II .



ALL DIMENSIONS IN mm

Fig.3.1. Specifications of Cutting Blade A



ALL DIMENSIONS IN mm

Fig.3.2. Specifications of Cutting Blade B

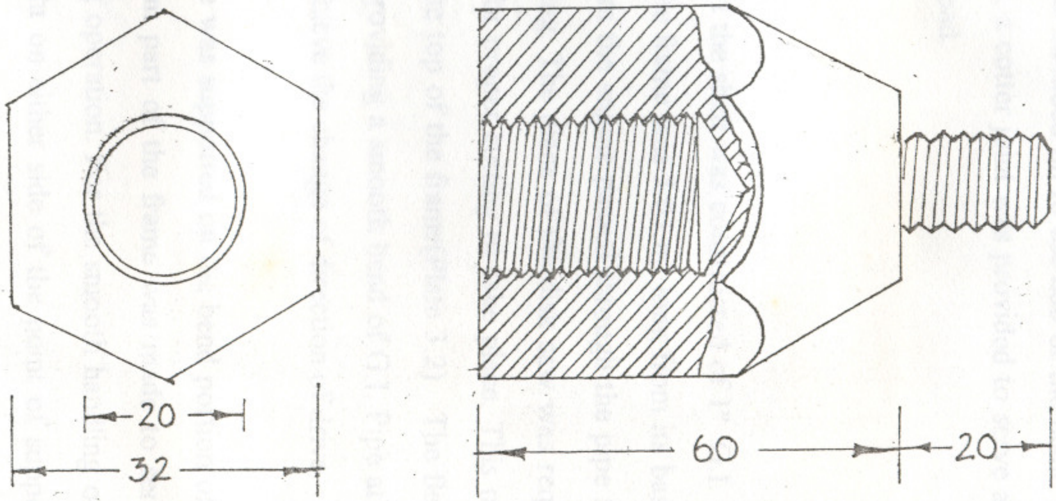


Fig.3.3. Coupling Unit Between Shaft and Engine

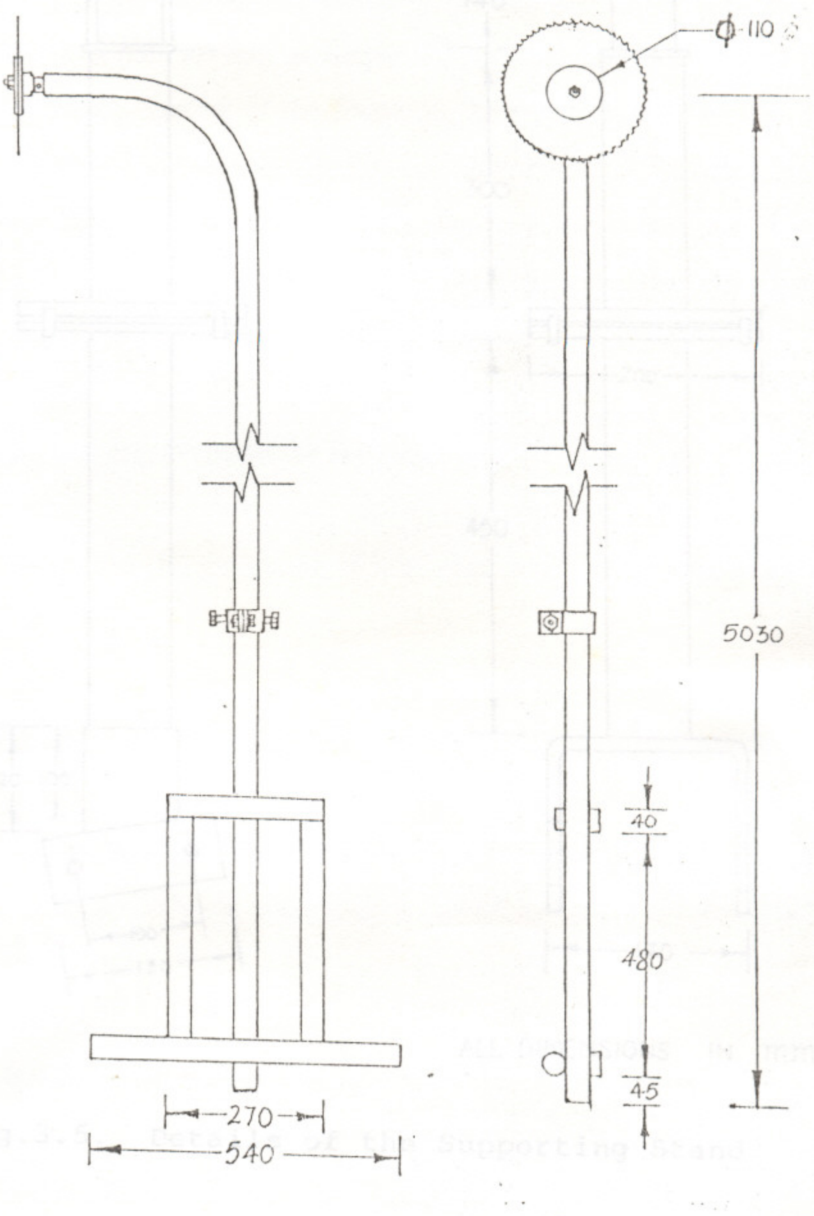


Fig.3.4. Supporting Frame of the Power Transmission Unit with Blade

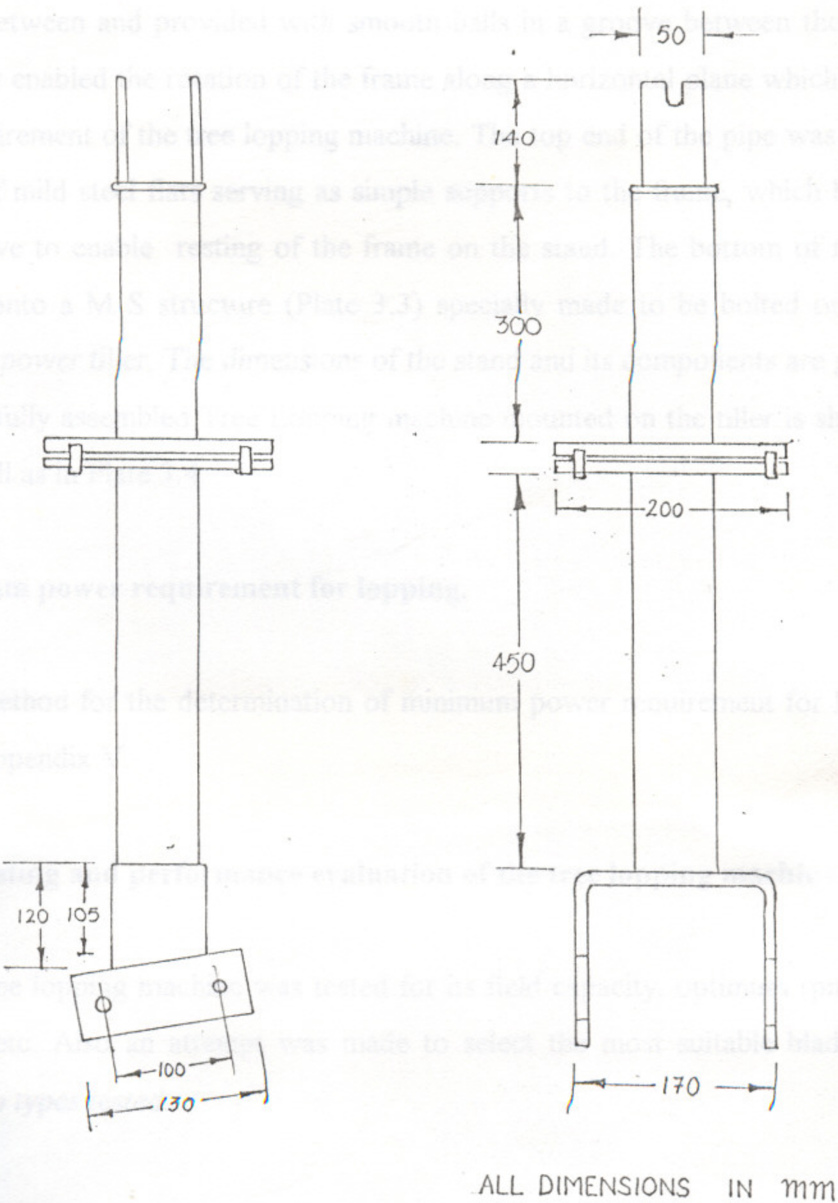
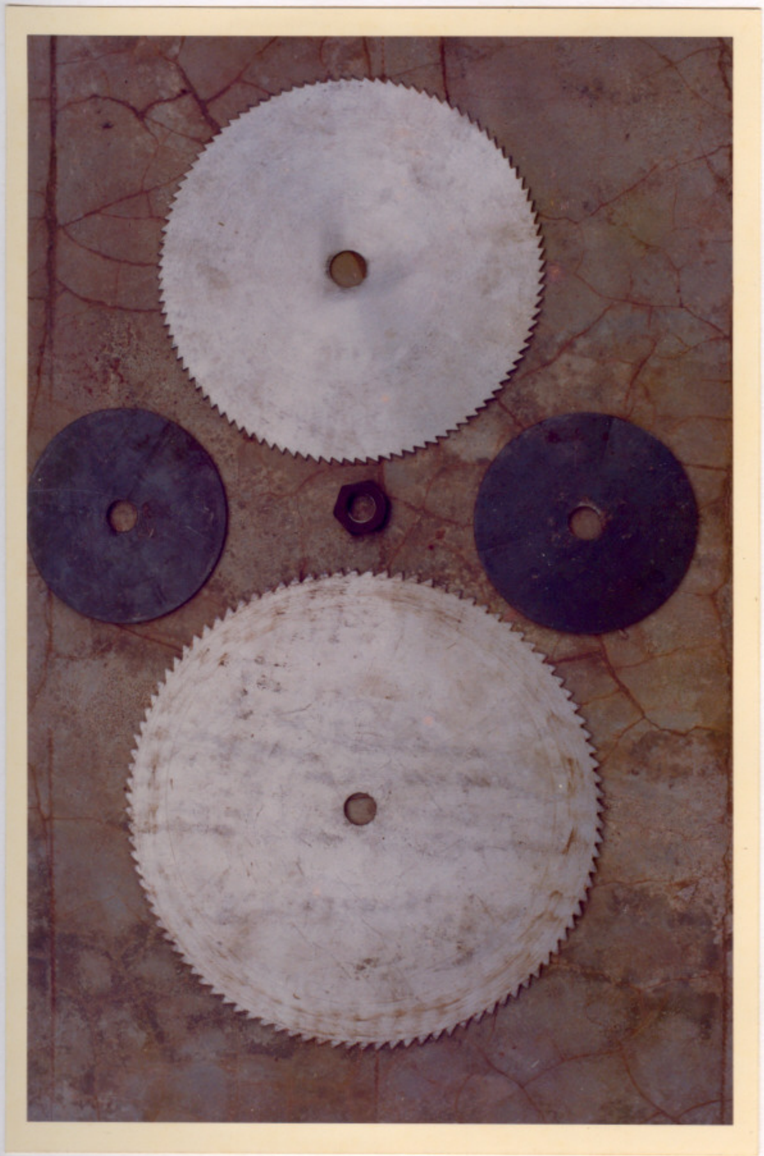


Fig.3.5. Details of the Supporting Stand



CHAPTER IV

RESULTS AND DISCUSSION.

This chapter deals with the results of the experiments conducted in the field to evaluate the performance and economics of the newly developed tree lopping machine as an attachment to the power tiller.

4. 1 Estimation of green manure requirement in Kerala.

An attempt was made to estimate the total requirement of green or farm yard manure in Kerala state. The results are tabulated in Appendix I. The table indicates the total requirement of green manure to be 217.4 lakh tonnes per year. But less than one percentage of the requirement is satisfied due to the reasons such as shortage of labour to climb trees and to cut branches, high labour wages (upto Rs. 25/hr),laborers being reluctant to climb trees due to the risk involved and a bundle of green manure costs Rs.150 as a result of which farmers tend to go for application of chemical fertilizers which are more easily and cheaply available.

It is shown in the subsequent pages of this chapter that the use of the tree lopping machine can overcome all the above mentioned problems and to a great extent reduce the wide gap that exists between the requirement and the availability of green manure in our farms.

4.2 Power tiller as Prime mover to the Tree Lopping Machine

The use of the power tiller as the prime mover to the tree lopping machine proved to be advantageous for a wide variety of the reasons like, the power tiller being compact and small in size could move on narrow terrains. It ensured the portability requirement of the machine. The non availability of electric power was not a hindrance to the operation of the machine. Speed of operation could be varied by the use of the accelerator. The machine could employ the power of tiller for off season work or otherwise the power tiller would have to remain idle for major part of the year. It is very easy to attach and detach the machine from the power tiller and causes no modification to the power tiller at all. Thus farmers without power tiller can also hire tillers for operating the tree loping machine.

There was one major problem encountered during the operation. The power was taken directly from the crank shaft and the shaft was threaded on to the crankshaft through a coupling unit. There was no clutch assembly, whatsoever provided between the engine and the power transmission shaft. As a result of this , the machine had to be kept in operation or otherwise the shaft had to be detached from the crankshaft, whenever the power tiller was in forward motion. This lead to valuable time being lost between successive lopping between trees.

4.3 Cutting Unit

The blades used proved to be excellent for cutting branches. The cutting unit in operation is exhibited in Plate 4.1. The selection of the more suitable blade frame among the two tested is given in section 4.8.2.

4.4 Power Transmission

The power transmission was smooth except for a little vibration of the portion of the shaft between the engine pulley and the base of the frame which was enclosed in a flexible plastic hose of 1" diameter. This could be overcome by providing a flexible outer covering of metal for this portion of the shaft so that the shaft does not sag too much as there was a tendency of the shaft to twine up during operation.

The provision of the safety pin proved to be vital , because on a few occasions, the pin yielded to the excessive load on the shaft resulting from brief blockages of the blade in the wood, thus protecting the shaft from taking the overload.

4.5 Frame

The frame which was made of G.I was found to be strong enough to withstand the weight of the shaft and all other forces which would act upon it during operation of the machine. The provision of the sleeve along the pipe enable easy sliding of the frame to vary the height of operation. The 5.03 m long frame facilitated a maximum cutting height of 5.4 metre above the ground surface.

4.6 Stand: Mounting on the Power Tiller

The stand was mounted on the tiller at a very safe and convenient position providing enough stability and weight balance to the entire assembly even while the tiller was in motion. The height of the stand (0.9 m) was just sufficient from an ergonomical point of view. The bearing unit in the stand provided easy orientation in a horizontal plane and holes provided in it facilitate locking of the stand in any desirable position.

4.7 Power Requirement for Lopping

The power required for lopping considering all kinds of losses in transmission, worked out to be 5.5 hp. As an 8 hp engine of the tiller was used as the prime mover, the prime mover was more than enough to supply the maximum power required for lopping of branches.

4.8 Field Testing and Performance Evaluation of the Lopping Machine.

The tree lopping was tested for its capacity, optimum rpm etc and the results are shown in Tables 4.1,4.2 and 4.3. The cost of operation of the unit is shown in Appendix II.

4.8.1 Machine Capacity Determination.

The machine capacity of the tree lopping machine was defined as the total cross sectional area (cm^2) of all branches which the machine can cut in a unit period of time . It included the time taken between successive lopping. An area covered with various kinds of trees was randomly selected and the machine was operated for three difference runs of around 15 minutes each. The total cross sectional area of the branches lopped were measured and this divided by the time taken for each run was taken as the machine capacity. The average value for the three runs was adopted as the machine capacity . To compare the performance of the machine with the manual lopping of branches, an average man was made to climb and cut branches for about 15 minutes and the capacity of manual labour also was determined. The results are tabulated in Table 4.1.

Table 4.1 Determination of the Tree Lopping Machine Capacity

	Total Cross-sectional area of cut (cm^2)	Time for cutting alone (sec)	Time between cutting (sec)	Total time (sec)	Machine Capacity (m^2/hr.)
Run #1 of Machine	988.9	407	475	882	0.404
Run #2 of Machine	463.96	228	248	476	0.351
Run #3 of Machine	757.15	309	385	694	0.393
Manual labour	364.53	776	1546	2322	0.057

The above table shows that the average capacity of the Machine is 0.383 m^2/hr. which is significantly higher than the capacity of manual labour (0.057). Also the man was found to tire easily due to repeated climbing of trees. The results indicate that on an average, the machine can cut 312 numbers of branches in an hour if all the cut branches were of 4 cm. diameter.

4.8.2 Selection of blade and operating speed.

The cutting speed(depth of cut made per unit time) noted for different engine rpm for both the blades and the results are tabulated in Table 4.2 and Table 4.3 . A graph of the engine speed Vs the cutting was plotted for 2 runs , one using blade A *(20 cm dia) and the other using blade B (25 cm dia). This is shown in (fig 4.1 and fig* 4.2) . The figure shows that for both blades the cutting speed increase with the engine rpm. For a particular rpm, the cutting speed was greater for the blade A. This was because of the smaller diameter and therefore lesser values of pitch and depth of teeth of blade A so lesser power is required for blade A at a given rpm.

It is also seen that the cutting speed varies more smoothly with engine rpm for blade A than blade B. So under the given condition, blade A is selected as more suitable for lopping than blade B but its use is theoretically limited to lopping of branches of a maximum size of 4.5 Cm. [radius of blade (10cm) minus radius of washer (5.5cm)]. So in the case of slightly thicker branches upto 7 cm dia , blade B is recommended and in every other case, blade A may be adopted .

As seen from the fig 4.1 and fig 4.2 the cutting speed was maximum at 180 rpm (for blade A) and 1790 rpm for blade B. The decrease in cutting speeds at higher rpm may be because of excessive vibration of the machine at such high speeds and the inability of the blade to remain straight in the cut made on the branch. Thus a value of 1800 rpm was adopted as being optimum for the lopping of branches.

Since the cut was made from above the branch, there was no much possibility of the blade being blocked as the weight of the branch being cut caused the groove to grow wider as the cutting proceeded and thus prevented the wedging of the blade.

Table 4.2 Cutting Speed for Blade A (20 cm dia.)

Sl: No.	Engine RPM	Diameter of Cut branch (cm)	Time taken (sec)	Cutting Speed (mm/min)
1	505	2.50	19	80
2	796	1.50	5	180
3	1200	3.3 0	9	220
4	1390	4.5	12	225
5	1805	5.00	13	231

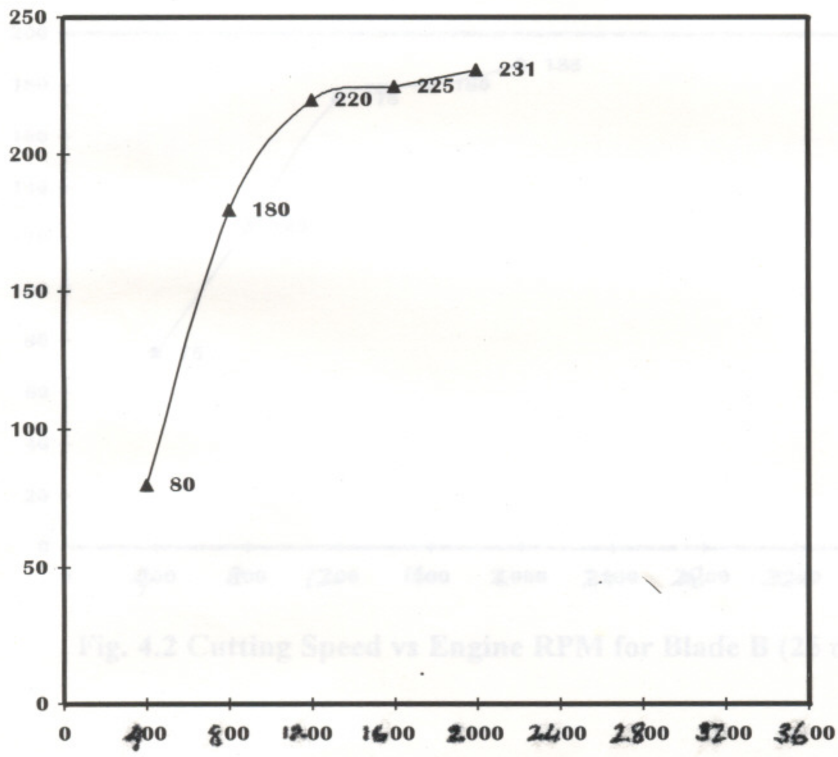


Fig. 4.1 Cutting Speed vs Engine RPM for Blade A (20 cm dia.)

Table 4.3 Cutting Speed for Blade B (25 cm dia.)

Sl: No.	Engine RPM	Diameter of Cut branch (cm)	Time taken (sec)	Cutting Speed (mm/min)
1	492	2.00	16	75
2	812	1.70	8	125
3	1210	1.5 0	5	175
4	1400	3.30	11	180
5	1790	4.40	14	188

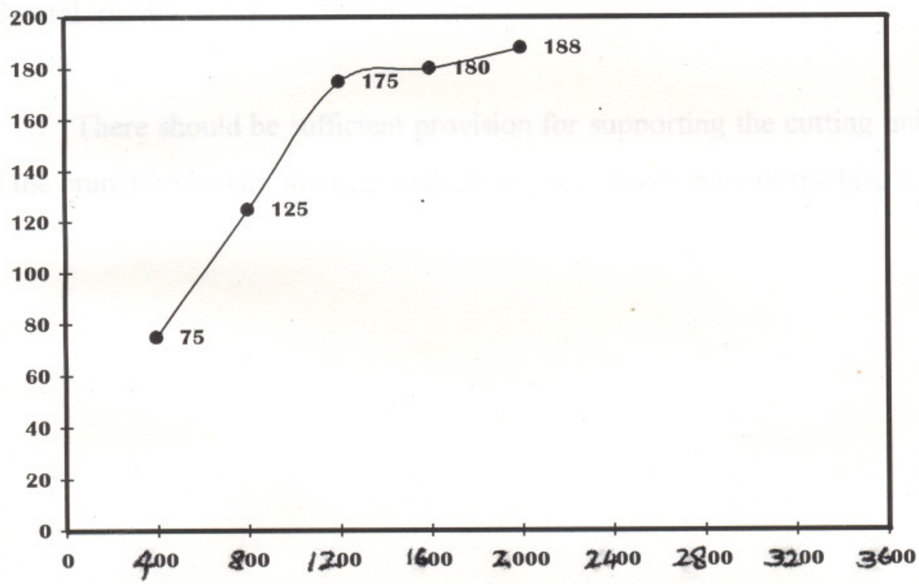


Fig. 4.2 Cutting Speed vs Engine RPM for Blade B (25 cm dia.)

4.8.3 Cost of operation

The estimation of the cost of operation per hour of the machine was carried out and the method followed is explained in Appendix II . The result show that the cost of operation of the tree lopping machine is Rs. 52.70 per hr

4.8.4 Suggestions for Modifications

Following modifications on the existing tree lopping machine are suggested, to overcome certain draw backs experienced during its operation:

1. A clutch assembly could be provided between the engine pulley and the transmission shaft which would facilitate engaging or disengaging the power at the will of the operator.
2. The portion of the flexible shaft between the pulley and base of the frame which had a tendency to sag and thereby twist , could be enclosed in a flexible outer covering of metal, rigidly.
3. There should be sufficient provision for supporting the cutting unit on one side of the branch to be cut, in order to facilitate easy positioning of the blade.

CHAPTER V

SUMMARY AND CONCLUSION

Trees form a indispensable part of any farming system. Besides providing food, fibre, fuel, timber etc., trees are also depended upon for their shade, shelter, foods, chemical products and aesthetic purposes . In addition to the above, trees also provide excellent green manure to crops.

The vast and inherent potential of trees with respect to their various uses are being under utilized due to acute shortage of labour and high labour cost whether it is the procurement of green manure or of fodder, fuel or timber or the lopping of trees is an important and highly labour intensive operation which is faced with innumerable limitations . The great height at which the branches grow, the risk and difficulties involved in cutting them and the shortage of labour involved , are some of the problems that have led to a very low utilisation of green manure, which is so abundantly available from trees in an agrarian state like Kerala.

A project work entitled, "Development and Testing of a tree lopping machine as an attachment to the power tiller was under taken to overcome the problems associated with lopping of branches".

An estimate of the total green manure requirement in the state of Kerala was made based on the total area under cultivation and the recommended application rates of green manure for each crop, to highlight the usefulness of the machine in bridging the gap between the green manure requirement and its actual supply. The total annual green manure requirement worked out to be 217.47 lakh tonnes less than 1.0 % of which was the actual supply.

The machine developed basically consisted of a circular saw driven by the engine of the power tiller through a flexible shaft. The use of the power tiller supplied the power and portability requirements of the tree lopping machine. The cutting unit and transmission shaft were mounted on a GI pipe frame which was mounted on to the power tiller by a stand. The stand possessed a bearing assembly to achieve orientation of the machine in a horizontal plane.

The drive was directly taken from the engine pulley and the speed of operation could be varied with the help of the accelerator of the engine.

Two blades of diametres 20 cm and 25cm were used . The machine was tested for its machine capacity and optimum operating speed and also an attempt was made to select the more suitable blade from among the two used.

The machine had a capacity of 0.382 m^2 of branches (cross sectional area of cut) per hour as against 0.057 m^2 /hr for manual lopping.

The cost of operation of the machine along with the power tiller amounted to Rs. 52.70 / hr and Rs 137.9/m^2 area of branch cut as against Rs. 438.6/m^2 for manual lopping. This indicates a higher efficiency of the machine as compared to manual labour, and if modified, could result in still higher efficiency.

From the studies it was evident that the power tiller mounted tree lopping machine was technically and economically suitable for tree lopping in farms.

REFERENCES

Agarwala, V.P. (1985). *Trees in India*. Oxford and IBH publishing Co. New Delhi. Pp - 17-24

Baylis, R. (1961). *Carpentry and Jointery* . Hutchinson Educational Ltd, London, Pp 1,21-23, Pp 163-176

Brett Peter. (1985). *Carpentry and jointery for advanced craft students*. Hutchinson & company Pub. Ltd . London. Pp 77-89

Farm Information Burea, Govt. of Kerala (1996). *Farm guide*. Kerala Books and Publication Society. Kochi. Pp - 7-16

Hawker, H.F.J and Keenlyside, J.F. (1985). *Horticultural Machinery* . Longman, London .Pp 160-164.

Howes, K.M.W and Rummery. (1984). *Integrating Agriculture and Forestry*. Natraj Publishers, Dehradun.

K.A.U (1993) . *Package of Practices and Recommentations for Crops*. Director of extension, Mannuthy

Klenin N.I, Popov, I.F and Sakum, V.A (1985), *Agricultural Machines*. Amerind Publishing Co. Pvt.Ltd., New Delhi.

Krutz, G, Thompson, L and Claar,P.(1984). *Design of Agricultural Machinery* John Wiley and Sons. New York.

Pandey, M.C. , Singh, B and Aich, J.C. (1988). *Solar powered wood cutter - a practical proposition*, Invention Intelligence. **23**(8), Pp 230-234

Varshney, A.C.and Narang S.(1994).*Power tiller operator tree felling machine*. Invention Intelligence. **29**(2), Pp 89-96

APPENDIX I

Green Manure Requirement Of Crops In Kerala

Sl. No.	Crop	Area Under Cultivation (ha.)	Average Green manure Required (t/ha-yr)	Total Green manure Required for Crop (t/yr.)
1	Arecanut	63929	16	1022864
2	Banana	23667	20	473340
3	Cardamom	43386	15	650790
4	Cashew	109035	15	1635525
5	Cereals(others)	10269	12	123228
6	Clove	741	4	2964
7	Cocoa	9315	15	139725
8	Coconut	877012	5	4385060
9	Coffee	84000	—	—
10	*Cotton*	*12253*	*12.5*	*153162.5*
11	Drumstick	18058	6	108348
12	Fodder grass	1664	5	8320
13	Fruits(others)	6968	5	34840
14	Ginger	13937	30	418110
15	Ground nut	15535	2	31070
16	Jack	70850	3	212550
17	Mango	75462	3	226386
18	Nutmeg	3653	8	29224
19	Papaya	12108	20	242160
20	Oil Palm	1782	2	3564
21	Pepper	183478	12	2201736

22	Pine apple	5033	25	125825
23	Plulses	23123	20	462460
24	Rice	537608	10	5376080
25	Sesamum	8012	5	40060
26	Rubber	444096	2.5	1110240
27	Sugarcane	6100	10	61000
28	Tapioca	135033	12.5	1687912.5
29	Tea	34488	—	—
30	Tuber Crops	33549	10	335490
31	Turmeric	2938	40	117520
32	Vegetables	21866	15	327990

Total = 21747544.0 tonnes

(Source : Farm Guide '95) **$\simeq$ 217.475 lakh tonnes**

APPENDIX II

Cost of Operation of the Tree Lopping Machine

(a) Tiller - Mitsubishi Shakti

Assuming

1.	Initial cost (C)	=	Rs. 75000.00
2.	Useful life period	=	10 Years
3.	Annual working hours	=	1000
4.	Salvage value(S)	=	10 % of initial cost
5.	Interest on Initial cost (I)	=	15% annually
6.	Repairs and maintenance	=	10 % of initial cost
7.	Housing, Insurance and Tax	=	1 % of Initial cost
8.	Fuel consumption	=	1.5 lit/hr
9.	Fuel cost	=	Rs. 8.00 per litre
10.	Labour wages	=	Rs. 100/day of 8 hrs.
11.	Lubrication charges	=	20 % of fuel cost

Fixed Cost.

$$\text{Depreciation} = \frac{C-S}{L} = \frac{75000-7500}{10} = \text{Rs.}6750.00$$

$$\text{Interest} = \frac{C+S}{2}\times I = \frac{75000+7500}{2}\times\frac{15}{100} = \text{Rs.}6187.50$$

$$\text{Housing} = 75000\times\frac{1}{100} = \text{Rs. }750.00$$

$$\text{Taxes} = 75000\times\frac{1}{100} = \text{Rs. }750.00$$

$$\text{Insurance} = 75000\times\frac{1}{100} = \text{Rs. }750.00$$

Total fixed cost = 6750.00+ 6187.50+750.00+750.00+750.00 = 15187.50/year.

Variable Cost

Fuel charges = $1000 \times 1.5 \times 8$ = Rs. 12000.00

Repairs and Maintenance = $75000 \times \frac{10}{100}$ = Rs. 7500.00

Lubrication Charges = $12000 \times \frac{20}{100}$ = Rs. 2400.00

Labour Charges = $\frac{100 \times 1000}{8}$ = Rs. 12500.00

Variable Cost = 12000.00 + 7500.00 + 2400.00 + 12500.00 = Rs. 34400.00

Total cost of operation of tiller per hour

= (Fixed cost + variable cost)

= 15187.50 + 34400.00

= Rs.49.59/hr.

(b) Tree lopping machine

Assuming

1). Initial cost, C = Rs. 3500.00

2). Useful life of machine, L = 12 years

3). Salvage value of machine, S = 10% of initial cost

4). Interest on investment = 15% annually

5). Annual working hours = 200 hrs

Fixed Cost

Depreciation = $\frac{C-S}{L}$ = $\frac{3500-350}{12}$ = Rs. 262.50

Interest = $\frac{(C+S)}{2} \times I$ = $\frac{3500+350}{2} \times \frac{15}{100}$ = Rs. 288.75

Extra charges (including repair) = 2% of initial cost

= $3500 \times \frac{2}{100}$ = Rs. 70.00

Total cost per hr = 262.50 + 288.75 + 70

= Rs. 3.11/hr.

Total cost of operation of tree lopping machine as an attachment to the Power Tiller in one hour.

= Rs. 49.59+Rs.3.11

= Rs. 52.70

APPENDIX III

SPECIFICATIONS OF THE MITSUBISHI SHAKTI POWER TILLER

POWER TILLER - Model CT 85

Type	: Side - drive rotary tilling
Dimensions	: L 2360 mm W 890 mm H 1200 mm
Weight	: Power tiller with AD 8V engine 393 Kgs.
Oil	: Grade SAE 90
Tilling Width	: 540 mm
Travel Speeds	: Maximum for tilling 3.6 Kmph
	: Minimum for hauling 1.2 Kmph
Master Clutch	: Dry-multi Disc friction
Tyre Size	: 6.00 - 12 Pnumatic wheel
Track	: Adjustable maximum. 100 Cms., Minimum - 65 Cms.

ENGINE - Model AD 8V

Continous Output	: 8 h.p. 1500 rpm
Compression ratio	: 20:1
Total Displacement	: 452 c.c
Engine Weight	: 125 Kgs.(dry)
Oil	: Grade SAE 30 or SAE (Heavy Duty)
Fuel	: Diesel oil (H.S.D)
Fuel Tank Capacity	: 8 litres
In-Built Dynamo Capacity	: 12V - 35 Watts.

OTHER FEATURES:

* Six forward and two reverse speeds
* Service brake directly coupled to master clutch,which doubles as parking brake
* 0.5 litre capacity oil and fuel filters
* Double oil sealed axle and bearing

APPENDIX IV

SPECIFICATIONS OF THE TREE LOPPING MACHINE

Function	: Lopping of tree branches upto a height of 5.4m from the ground level.
Specifications	
Overall length	: Length of cutting unit = 5.03m
	: Height of frame from ground level =1.5m
Height	: Maximum height achieved =5.4m
Weight	: Weight of the cutting unit =40 Kg
Power Transmission Shaft	: Flexible Shaft : Diameter= 15mm
	: Length = 7m
	: Material of Shaft- Mild Steel.
Coupling Unit	: 32mm hexagonal unit threaded internally to connect to the end of engine crank shaft.
Blades	: Blade - 1 : 20cm dia.; 100 numbers of teeth, 1.5mm thickness. Pitch - 6.3mm
	: Blade - 2 : 25cm dia.; 100 numbers of teeth, 1.5mm thickness. Pitch = 7.9mm.
	: Material used - High Carbon Steel .
Supporting Unit	
Stand	: G.I. Pipe 3" dia. with thrust bearing assembly and locking unit.
Frame	: G.I. Pipe 1" dia., 5.03m length with a handle and blade attaching unit.
Other Details	
Transportation	: By the Power Tiller.
Power Source	: Directly coupled to the crank shaft of the Power Tiller Engine
Labour Requirement	: 2 Persons
Machine Capacity	: 0 .383 sq.meter /hr.
Height of Cut	: 5.4m above the ground level.
Optimum rpm	: 1800
Investment Cost	: Rs. 3500.
Operating Cost	: Rs. 52.70 / hr.

APPENDIX V

POWER REQUIREMENT FOR LOPPING

The Power requirement for lopping is computed as follows:

Due to the non availability of sufficient data, a very large value of the cutting resistance (160 kg/cm^2) for wood is assumed, with a high factor of safety.

Assuming that the engine runs at its maximum rpm of 1800 and that the larger blade (25 cm dia.) is used

Area of cut of the tooth of the blade = depth of cut $\times$ thickness of blade

$$= 0.4 cm \times 0.15 cm$$

$$= 0.06 cm^2$$

$\therefore$ Total cutting force required at the edge of the blade, F

$$= 160 kg/cm^2 \times 0.06 cm^2$$

$$= 9.6 kg$$

$\therefore$ Torque required, $T = F \times$ Radius of the blade

$$= 9.6 kg. \times 0.125 m$$

$$= 1.2 kg.m$$

$\therefore$ Horse Power

$$= \frac{2 \pi NT}{4500}$$

$$= \frac{2 \pi \times 1800 \times 1.2}{4500}$$

$$= 3.02$$

Assuming a transmission efficiency of 60% for the flexible shaft,

Power required = 5.5 hp

DEVELOPMENT AND TESTING OF A TREE LOPPING MACHINE AS AN ATTACHMENT TO THE POWER TILLER

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ABSTRACT OF THE PROJECT REPORT

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ABSTRACT

Lopping of trees has been identified as a highly labour intensive and difficult task to be performed in farms. As a solution to the problem associated with lopping of tall branches for procurement of green manure, fodder, fuel etc, the development of a power tiller mounted tree lopping machine was undertaken in K.C.A.E.T, Tavanur. The total annual green manure requirement in Kerala was estimated to be 217.47 lakh tonnes, which was far above the existing supply. The machine developed was expected to bridge the gap between the supply and demand of green manure. The machine basically consisted of a circlular saw as cutting unit, a flexible shaft as power transmission unit, a G.I.pipe frame to support the shaft and a stand as the mounting unit on the power tiller. Power was taken directly from the engine pulley. The machine when tested, had an optimum operating speed of 1800rpm. It could cut branches upto 5 cm. thick at a maximum hight of 5.4 m from the ground. The highest cutting speed attained was 231 mm./min. The machine whose cost of operation was Rs. 52.70 per hour, proved to be technically and economically suitable for lopping of trees in farms. With few modifications, the machine could be made available for commercial production.