KFRI Research Report 170

DEVELOPMENT OF APPROPRIATE TOOLS FOR HARVESTING REED BAMBOOS

K.V. Bhat
R.C. Pandalai

KERALA FOREST RESEARCH INSTITUTE
PEECHI, THRISSUR

August 1999

Pages: 10

CONTENTS

ABSTRACT

The gradual depletion of reed resources in the forests of Kerala has been causing concern to the forestry and reed-based industrial sectors in the State. This has led to a search for better management strategies involving both replenishment and sustained utilisation of these resources. % presently followed haruesting method using bill hook is rather wasteful as considerable amount of fibrous material is left out in the field as stumps, lops and tops. In this context, improvement of the present harvesting practices has become a necessity to minimise the wastage of usable reed material This project was undertaken with a view to develop some alternative toolsfor cutting reeds more conveniently and, at the same time. avoid excessive wastage of culm material as tall stumps in the field. The attempt has led to design and fabrication of three different prototypes of reed cutting tools. AU the three prototypes are designed for making a slanting cut at the culm base and the user can operate the tool with single hand, standing in an erect posture. Three different knife edge profiles that are compatible with these prototypes were also tested. The tool appeared quite promising since it showed appreciable success during field testing: however; it has both advantages as well as limitations. The major advantage is its capability to reach the base of any single culm of a clump without destroying the surrounding culms. Secondly, the tool makes use of the rigid base of the culm to be cut,for its support, hence making it mandatory for the user to limit his cuts to the basal part of the culms. The main limitation of the tool is its unsuitability for detopping and cleaning of culms. Thus the present study has succeeded in contributing certain innovative ideas of design for developing a reed cutting tool. However; the prototypes need further refinement before commercial use.

Introduction

In Kerala. reed bamboos constitute an important raw material for pulp and paper industry. besides being used in traditional cottage industries such as basket and mat-weaving.The resource has been a means of employment and subsistence, mainly for the underprivileged sections of the society. It is estimated that there are about 15,000 families engaged in this traditional industry (Chand Basha, 1991).However, during the past three decades, the pulp and paper sector in the State has grown as the major consumer of reed resources, and the inadequacy of the existing resources to meet its long-term demand is increasingly being felt. Besides, the depletion and degradation of reed habitats. due to a variety of reasons, have also been causing a great concern to the forestry sector. Therefore, some of the recent publications on reed resource management have emphasised the need for adopting a scientific approach for the optimum use of the valuable resources: augmenting the depleted areas, increasing productivity. minimisation ofharvest wastage, etc. are some of the measures proposed in this regard [Chand Basha. 1991).

Wastage of pulpable reed material with the existing extraction practices is reported to be as high as 23% of the total culm weight (Asari,1978).Usually. the reed cutters leave out 2 to 3 internode length of stump besides the inextricable top portion of culms during extraction, and collect only the remaining part. A recent study shows that the total harvest wastage resulting from such cutting practices is as high as 30% in terms of green weight and 23% in terms of air dry slivers. The actual wastage in terms of weight from bottom end of culms is more than twice as that from the top end (Gnanaharan and Mohanan, 1996). Since the basal part of reed culms has thicker walls and greater diameter which contribute to higher volume of fibre. wastage of even half a metre length from this part can be equal to discarding 5 to 6 metre length from the top. Obviously, loss of material from the bottom end of culms becomes the target in any attempts to curtail the harvest wastage of reeds.

Present reed harvesting technique

Reed harvesting is done in Kerala by professional reed cutters who arc traditionally well trained in this job. They make use of a very sharp bill hook for cutting and cleaning the culms. The maturity of harvestible culms is judged from the sound while tapping the culm with the tool. The first cut is made at the basal part above 2 to 3 lower internodes usually leaving a stump of 0.7 to 1.3 m height from the ground level (Gnanaharan and Mohanan. 1996). In doing so the reed cutters not only avoid bending their body. but also get rid of the lower heavier portion of culms which is usually curved and problematic while bundling. After pulling down the culms and clearing the branches, they chop the top at a convenient height level so as to maintain a definite length for the bundle. Quite naturally, the reed cutter's interest is easier and speedy operation and collection of maximum number of culms in a shorter time. The bill hook is a convenient tool for this kind of job: it is simple. versatile and easy to operate.

Need for alternative methods

From the foregoing paragraphs it is clear that there is a need to look for ways and means that can reduce the harvest wastage. Development of alternative techniques/tools that can improve harvesting methodology gains importance in this context. Thus the present project aimed at testing the possibility of developing some new designs of cutting tools for harvesting reed bamboos. The objectives of the project were:

a. to design and fabricate prototypes of a few reed cutting tools and

b. to test their cutting performance by field trials and make further improvements in the design

Thus it was envisaged to test 2 or 3 different designs of hand-operated cutting tools and an equal number of knife-edge profiles in order to evaluate the efficiency of different combinations of blade and tool.

Simple, lever-operated tools were chosen for fabrication and testing as they are more suitable than powered machines for the type of work and local situations. Reed harvesting is a selective cutting of culms unlike crop harvesting which is generally a clear-cutting operation. Therefore, highly mechanised harvesting systems are not appropriate for the purpose. The hilly terrain of reed forest may pose a further problem to such machines. The portable powered tools, on the other hand, are not likely to be more productive than the existing methods. Their cost may be a hurdle and the weight may be an additional burden to the reed worker particularly, while carrying the headload of harvested culms downhill. Thus, use of some simple mechanical tools seems to be a more effective means for improving the reed harvesting technology..

Criteria followed in designing the tool

Since there can be many possible conceptual designs for a cutting tool, each with its own merits and limitations, the following set ofcriteria were laid down arbitrarily in order to choose more promising designs. The main requisites expected in the prospective design were that:

1. The tool should enable the user to cut the reed culms at their base at an optimum level without having to bend down:
2. It should allow its operation with one hand leaving the other hand free:
3. It should be easy and quick to operate and reasonably light to carry;
4. It should allow picking out any culm from a compact clump and reach the culm base without destroying or disturbing the surrounding culms:
5. It should be simple enough to be fabricated locally, easily reparable and should be reasonably cheap.

Two conceptual designs of reed cutting tools (RCTs) which satisfied all the requirements listed above were chosen initially for fabrication. The prototypes were fabricated in mild steel (MS) as well as stainless steel (SS) at some local engineering workshops. Both the models were designed for making slanting cut on the culm axis as in the traditional cutting, since oblique plane offers relatively low resistance to knife penetration as compared to transverse plane. Further, each design made use of the stiff base of the culm for its support during operation; the tool was unsuitable for cutting beyond this level since the culm rigidity normally declines with increasing distance from the ground. Hence, the designs chosen were also helpful to make it mandatory for the user to restrict the cuts to the basal part of the culm. The possibility to vary the position of cuts, within certain limits. was another advantage which facilitated precise placement of cuts uniformly above the second intact node as prescribed in felling rules. The prototypes were field-tested and further improved in their design: subsequently, a third prototype which combined the positive features of both the earlier models was also fabricated.

Prototype RCT1

As shown in Fig. 1 the prototype has a very simple design. It has a 'C' shaped frame to grip the culm during cutting. The diamond-shaped knife blade is pivoted on the mid-part of the frame on its outer side in such a way that it is free to move in a circular path parallel to the flat face of the latter. The distal corner of the knife blade is fastened to the lever. The bevelled. 'V' shaped cutting edge of the blade is meant to jab the culm and ultimately sever it with the advance of the lever. Two thick spikes projecting perpendicularly in opposite directions from the frame secure the culm in position during operation of the lever. One of the spikes is mounted on the frame directly. and the other, on a curved arm overlying the flat face of the blade. The inner face of the frame is provided with rough striations for providing a strong grip on the culm while cutting.

Fig. 1. Prototype of reed cutting tool RCT 1; portion showing the cutting head. Fig.2. Operation of prototype RCT1 in the Reld.

During operation, the tool is stretched forward and hooked on to the selected culm and then slipped downwards along the culm axis to the required position. It is then turned through 90° and pushed towards upright position as far as possible so that the culm is held tightly. In this position (Fig. 2) the lever is pulled so that the knife blade pierces the culm ultimately making an oblique cut on the latter. The entire sequence of operation would be instantaneous and would normally take not more than 3-5 seconds.

Prototype RCT2

Fig. 3 shows the design of a second prototype of reed cutting tool which provides for a linear, sliding movement of the knife blade unlike in RCT1 . The different components of the tool are located on a framework formed of a pail-of 'L' shaped bars connected parallel to each other. The knife blade is located in grooves between the horizontal arms of the frame and is free to slide along its track. A pair of spring locks are mounted on the front end of these arms to secure the culm that is slipped into the gap for cutting. For proper centralised positioning of culms in the gap there is a short downward extension of the frame contoured into a 'V' shaped face. The lever is connected to the knife via a double drive pivoted at the top end of the frame.

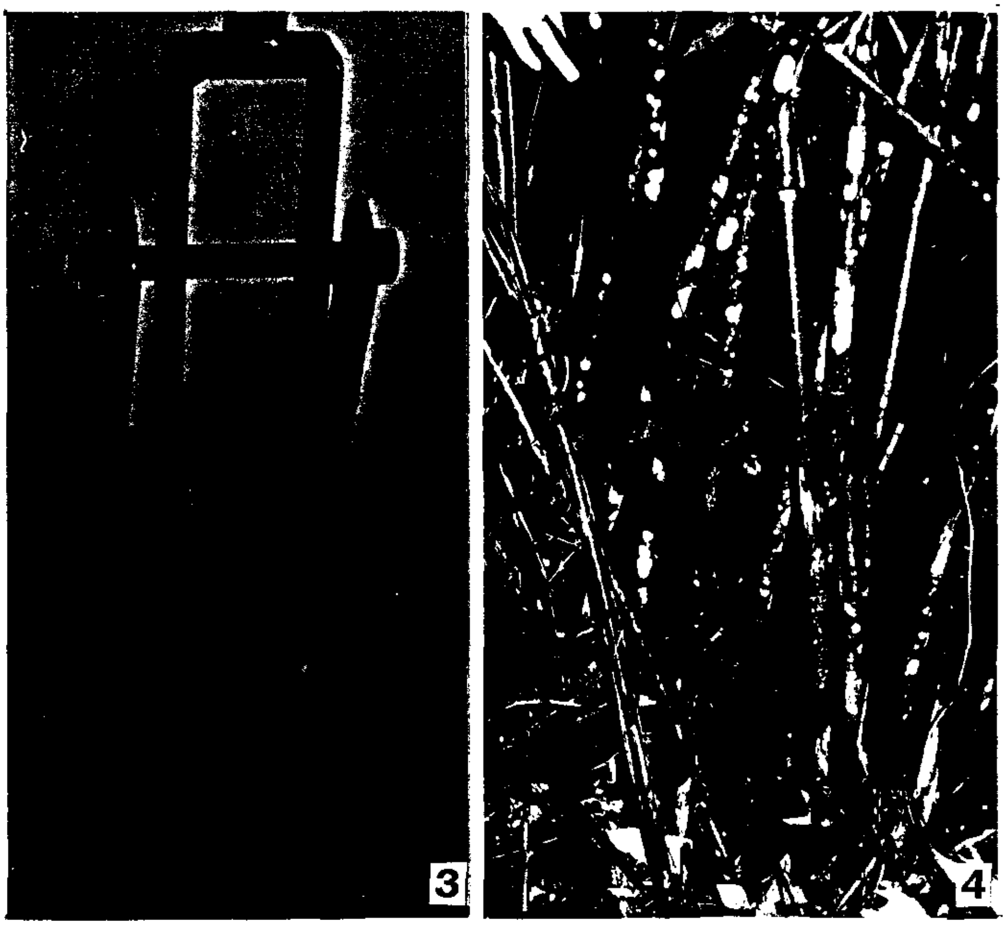


Fig.3. Prototype of reed cutting tool RCT2: portion showing the cutting head. Fig. 4. Operation of prototype RCT2 in the field.

For operation the tool is held by one hand almost vertically and thrust on to the culm to force the spring locks open: this allows the culm to squeeze in Into the gap between the slide track. The tool is then slipped downwards along the culm axis to the required position. As the lever is pulled backwards (Fig.4) to a slanting position, not only the grip on the culm tightens, but also the knife slides forward to pierce the culm and proceed further to make a slanting cut. Thus, the operation of this prototype is much quicker in comparison to RCTl.

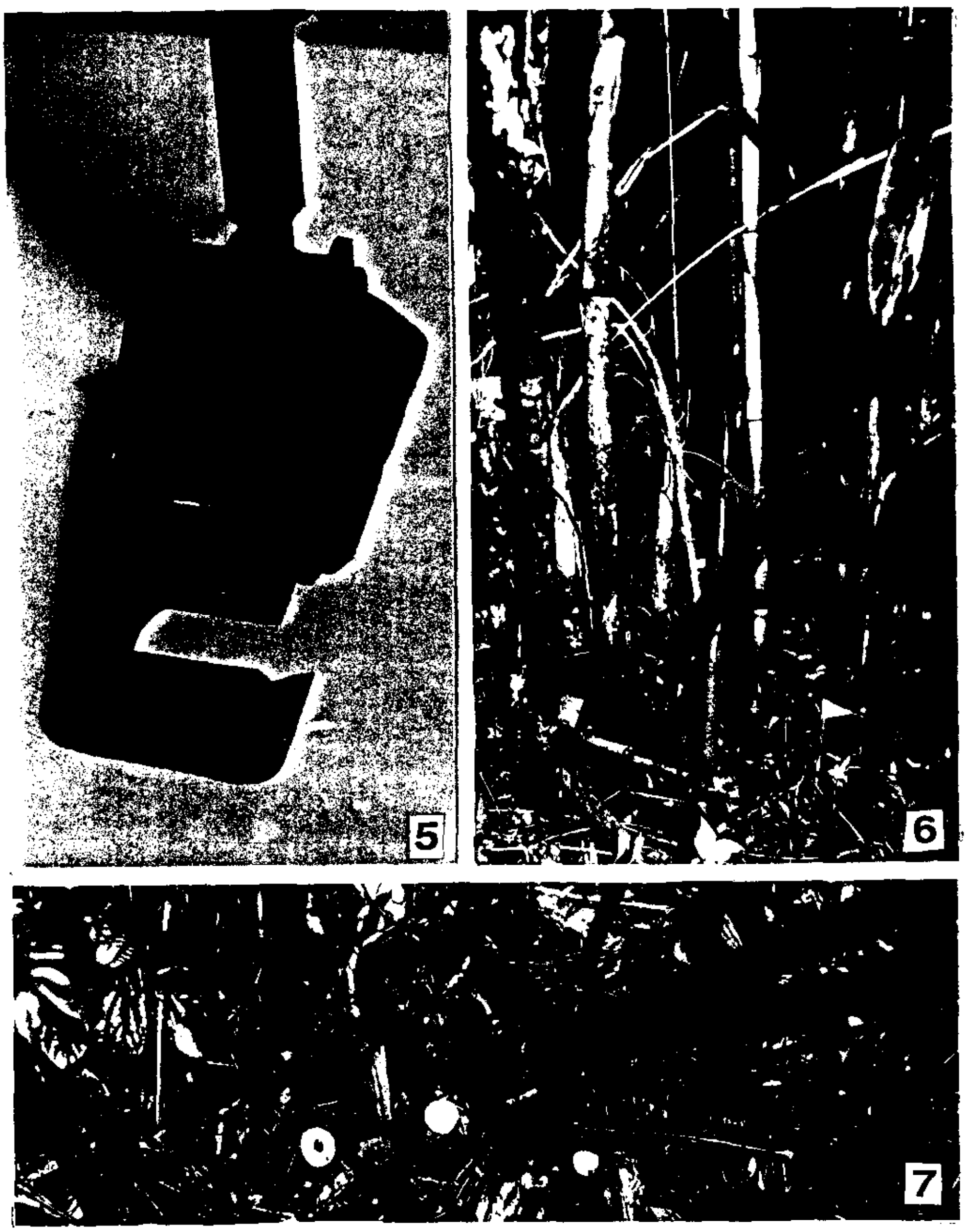


Fig.5. Prototype of the reed cutting tool RCT3: portion showing the cutting head. Fig6 Operation of prototype RCT3 in the field. Fig.7. Overhead view showing culm bases left after cutting reeds using

Prototype RCT3

After repeated field testing with various modifications of the above-said designs. a third prototype, RCT3 was evolved combining the positive features of RCT1 andRCT2.The number of movable parts and complexities of RCT1 and RCT2 have been minimised in designing this prototype. The framework of RCT3 is almost boot-shaped, but fully open from the top (Fig. 5).The gap for entry of culm is provided on the lateral side: in doing so, the locking mechanism is eliminated. The knife is designed for a sliding movement along the surface of the bottom plate, thus eliminating the need for any grooves. In essence, the design has been simplified considerably to achieve a trouble-fret, operation. The working of the tool is similar to that of RCT2. The chosen standing culm is inserted through the gap in the frame (Fig. 5).The alignment of the passage prevents slippage of the culm while the lever is operated. As in the earlier prototypes, the lever is pulled backwards (Fig. 6) to force knife blade to slide and cut the culm along an oblique plane (Fig. 7).

Knife edge profiles

The three different types of knife edge profiles tested for their effectiveness are shown in Fig. 8. These profiles were tested in combination mainly with

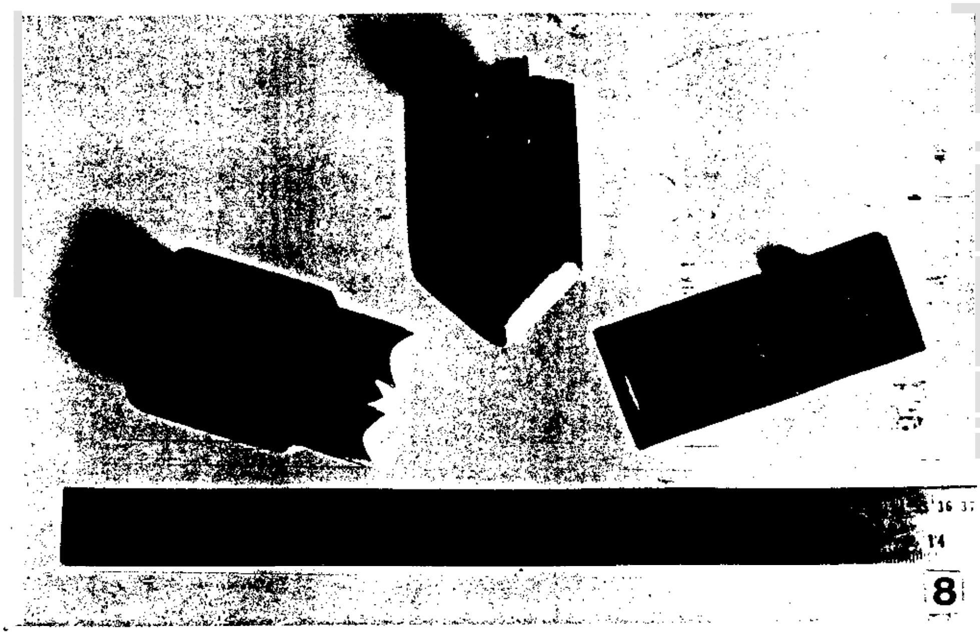


Fig. 8. Dilfcrent knife edge profiles rested in cornbinallon wlth the reed cutting tools

RCT2 and RCT3: with RCT1 however, only 'V 'proffle was feasible. A knife blade with a straight bevelled edge was easier to make and sharpen. However, the effort requirement was greater while using this profile. The penetration was also not satisfactory in most of the trials. The 3-teeth proffle with two lateral teeth and one median sunken tooth was designed with a view to overcome this problem. It was envisaged that the two lateral teeth of this profile would incise the two sides of the culm first and the third tooth which follows immediately would complete the cut by piercing the remaining parts of the culm wall. However, this design did not give the expected level of success. The main problem was in grinding and shaping the proffle to the desired extent of accuracy or sharpness. The third type of profile tested was a 'V 'shaped cutting edge with an angle of $\leq 90^{o}$. This profile gave considerable success, particularly in combination with RCT2. Hence, this proffle was used in most of the modified versions of RCT2.

Comparative evaluation of different designs

The notable feature of all the three prototypes described above is their suitability for 'singlehand operation'. The culm that is being cut provides the necessary support for the tool operation and this allows the user to hold the culm with one hand, if necessary, during cutting. The capability to reach the base of any culm without destroying the surrounding culms is the major advantage over the traditional harvesting knives. However, since the tool is designed specifically for the basal cut, it cannot be employed for detopping or cleaning the culms during harvesting.

Among the three prototypes tested RCT1 has the advantage of being simpler and compact in design with comparatively lower weight and better leverage. The problem encountered during operation was the frequent failure due to slippage of culm during cutting. The major limitation of this prototype is the excessive requirement of lever displacement for producing a complete inci sion. On the other hand, the design of RCT2 was found to be more quicker and successful with respect to cutting. Its main drawbacks are its complex design, rather bulky working head and possibility of frequent mechanical failures. RCT3 is similar to RCT2 in several respects like size, weight, etc. but its design is considerably simplified. made more sturdy: thus the possibility of breakdowns is minimised.

Main Findings

The present study has attempted to evolve and test some new devices for reed cutting. This has led to the development of a few prototypes embodying certain innovative ideas of design which can be further modified or improved for optimum results. It was found from trials that cutting of reeds generates considerable force on the tool components and to overcome this a sturdy design and construction is essential. It was also observed that bevelled 'V' profile of knife edge was more efficient in cutting. Thinness of knife blade and smaller bevel angle were other factors helpful for successful cutting.

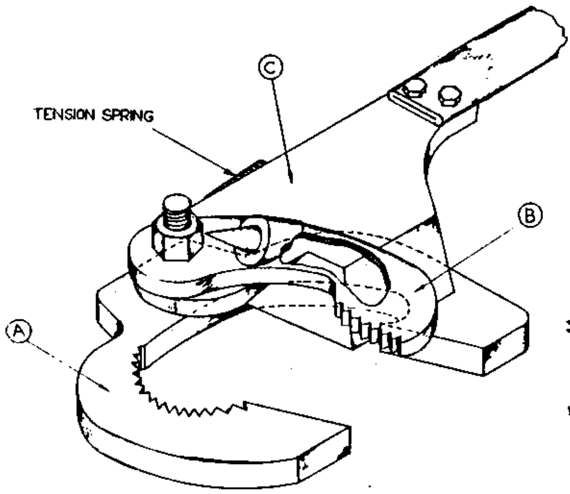
REFERENCES

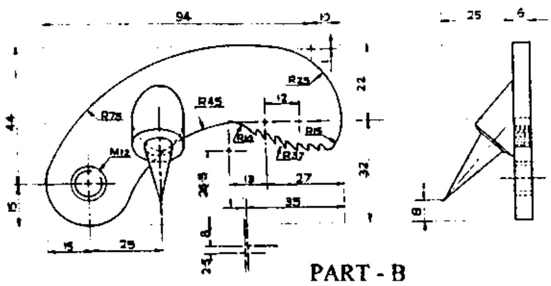
Asari. P.K.S. 1978. Industry-Oriented Management Plan for Reeds 1977-78 to 1991 92. Kerala Forest Department. 348 p.

Chand Basha. S. 1991. Ochlandra (Bamboo reed) - a vanishing asset of forests of Kerala, South India. Proc. Fourth International Bamboo Workshop. Chiangmai. Thailand. Nov. 27-30, 1991: 18-26.

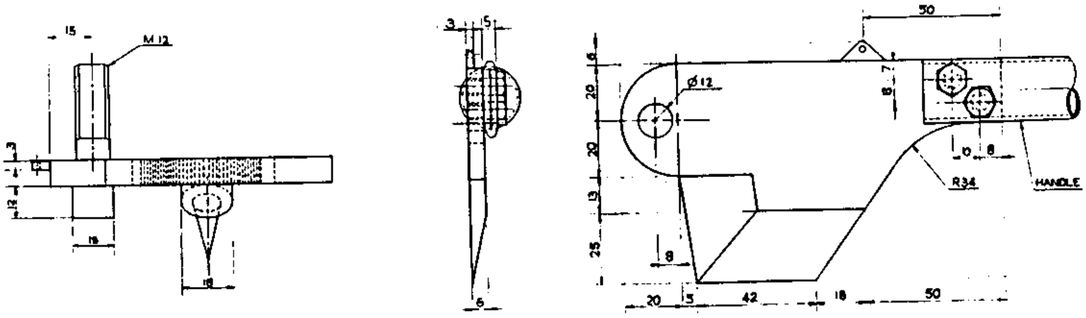
Gnanaharan. R. and Mohanan. C. 1996. Ways to minimise harvest wastage of Ochlandra travancorica. Proc. National Seminar on Bamboo, Bangalore. Nov. 28-29, 1996: 125-126.

PROTOTYPE - RCT1



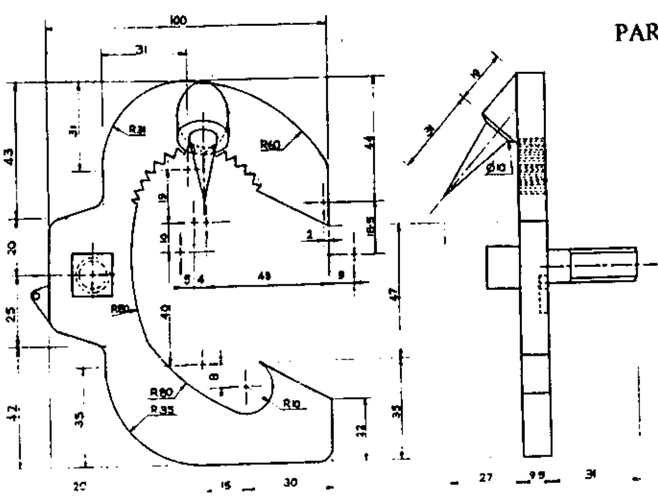


PART - B



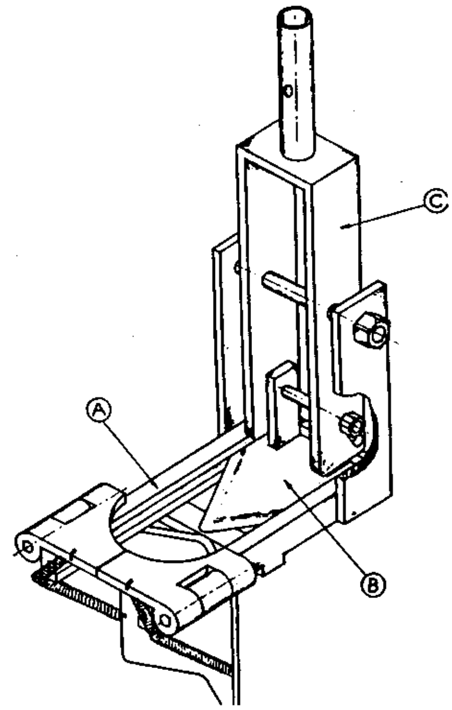
PART - C

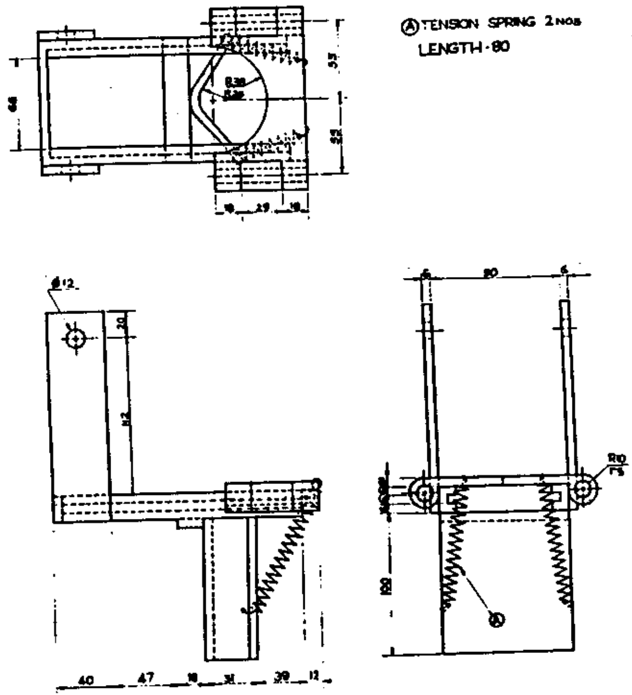
UNIT : MM



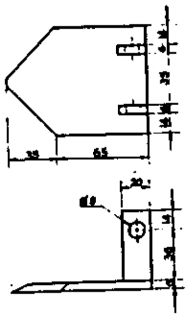
PART - A

PROTOTYPE - RCT2

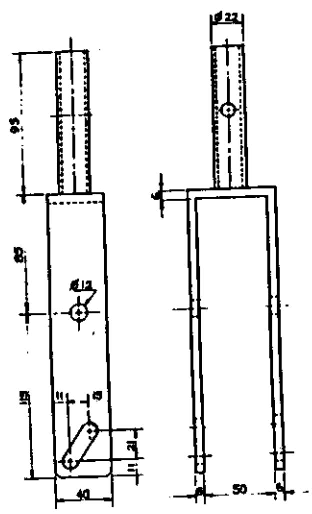




PART - A



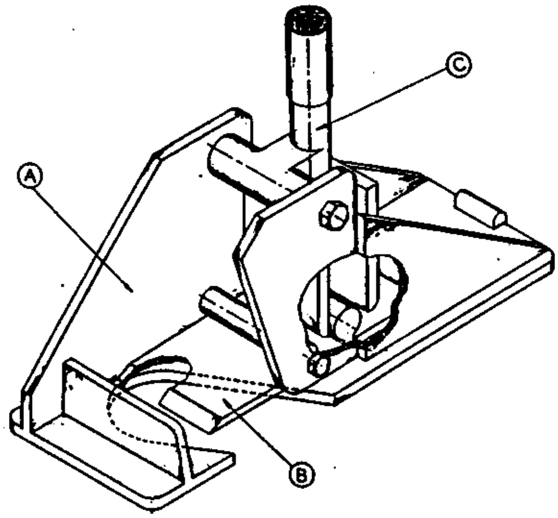
PART - B

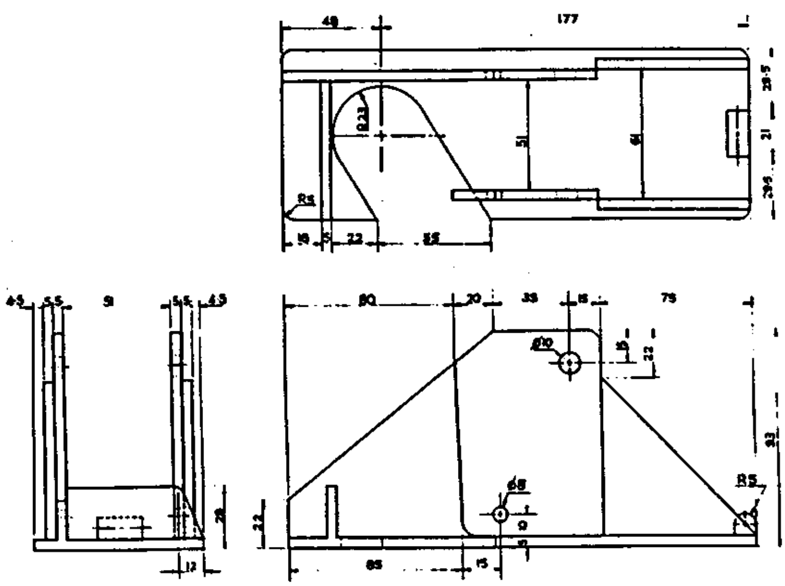


PART - C

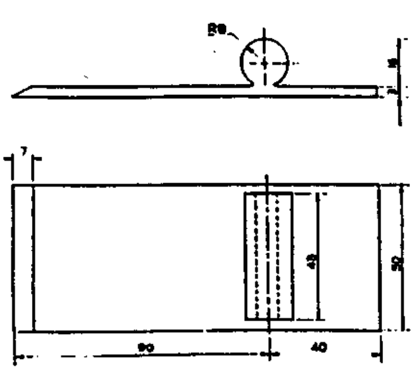
UNIT : MM

PROTOTYPE - RCT3

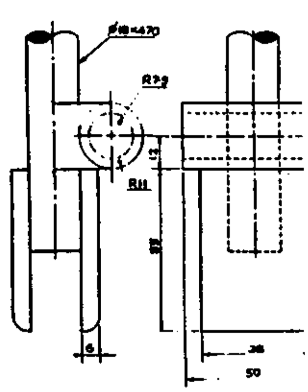




PART - A



PART - B



PART - C

UNIT : MM