DEVELOPMENT AND TESTING OF A MODIFIED ARECANUT HARVESTER - CUM - SPRAYER

By

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PROJECT REPORT

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KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

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KERALA

1998

DECLARATION

I hereby declare that this project entitled " **Development and Testing of Modified Arecanut Harvester - cum - Sprayer"** is a bonafide record of project work done by me and that this work has not previously formed the basis for the award of any degree,diploma, associateship, fellowship or other similar title to me, of any other university or society.

Tavanur,

23 - 11 - 1998

Kingsling Das J

CERTIFICATE

Certified that this project report, entitled "**Development and Testing of a Modified Arecanut Harvester - cum - Sprayer**" is a bonafide record of project work done by Kingsling Das J 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 him.

Tavanur,

23 - 11 - 1998

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SYMBOLS & ABBREVIATIONS

Al	-	aluminium
BHC	-	benzene hexa chloride
C	-	inital cost
cm	-	centimeter(s)
CPCRI	-	Central Plantation Crop Research Institute
$CuSO_4$	-	copper sulphate
Dia	-	diameter
Dept.	-	Department
Engg	-	Engineering
et al.	-	and others
Fig.	-	figure(s)
FPME	-	Farm Power, Machinery, and Energy
G I	-	galvanized iron
g	-	acceleration due to gravity
ha	-	hectare
H	-	annual working hours
h	-	hour(s)
IDE	-	Irrigation and Drainage Engineering
i.e.	-	that is
J.	-	journal
K.A.U.	-	Kerala Agricultural University
K.C.A.E.T.	-	Kelappaji College of Agricultural Engineering and Technology
kg	-	kilogram
kgf/cm^2	-	kilogram force per square centimetre
l	-	litre
L	-	*useful life period*
m	-	metre(s)

min	-	minute(s)
mm	-	millimetre
MS	-	mild steel
No.	-	number(s)
pp	-	page
rpm	-	revolutions per minute
Rs	-	rupees
S	-	salvage value
sec	-	second(s)
TNAU	-	Tamil Nadu Agricultural University
Viz.	-	namely
VMD	-	volume mean diameter
Vs	-	versus
W	-	weight
Yrs	-	years
&	-	and
μ	-	micron
/	-	per
%	-	percentage
ρ	-	density
ϕ	-	diameter

INTRODUCTION

Arecanut palm *(Areca catechu Linn)* well known for its multifarious uses is a major plantation crop grown in India. Thoug it is concentrated in the south-western and north-eastern regions of the country, arecanut in tender, ripe or process form is chewed by all kinds of people, young and old, men and women all over the country. In addition arecanut cultivation which is a profitable venture provides a source of livelihood for nearly six million people.

Arecanut palm is one of the important plantation crops grown largely in the states of Kerala, Karnataka, Assam, and Meghalaya. Arecanut products in it's varied forms find numerous use. The effectiveness of arecanut in treating coughs, fits, anaemia, etc. are acclaimed the world over. Commercially arecanut tannins and husk fibres are used in the manufacture of dyes and fabrics respectively. The use of betel nuts during religious ceremonies is in vogue in most of the households. In addition, the use of scented supari made from processed betelnuts is a favored delicacy for most people.

The most valuable product from areca tree is the valuable nuts. The production of scented supari and gutka spread over the length and breadth of the country with small and attractive sachets even in the petty shops brought popualrity for masticatory item such as areca. The prohibition slogans of tobacco products like cigarette and beer added feather to the prices in areca. Data collected from the Directorate of Economics and Statistics, Thiruvananthapuram shows a production capacity of 17,466 million nuts in an year from an area of 71676 hectares in Kerala during 1994-'95 (**Table 2.1 and Table 2.2**).

The average number of arecanut palms grown in an acre of land is about thousand with a spacing of 2m X 2m. In India the production of arecanut during 1995-96 was 2,75000 tones per year. The net area grow in the country was about 2,37,800 hectre during the period. In Kerala, arecanut was cultivated in an area of 76,000 hectre, the average production was estimated as 1102 kg/hectre (Agricultural hand book, 1998).

The altitude at which the arecanut palm can be successfully grown varies to some extent according to the latitude of the place. Though it grows at altitudes upto 1000 m above the sea level, at higher altitudes it is not at all productive. Based on the yield levels obtained, the fertile valley soils surrounded by hillocks and with an adjacent forest ecosystem is ideal for the areca plams growth and yield well in open textured and well drained laterite, sandy loam and sandy clay loam soils having higher organic matter content. Good monsoon rains, high humidity and assisted irrigation during summer months are necessary for obtaining high yields. Exposed table lands, ill drained marshes, eroded sloppy lands, soils with rocky substrata should be avoided. The cultivation is mostly confined to 28° north and south of the equator. It is unable to withstand extreme temperature and wide diurnal variations. The range of temperature at which it can flourish is from 15° to 38° C. The spacing of the area areca trees in a form in recommended as per the package of the practices, KAU, (1997) is about 2.7 x 2.7m.

Cultivation practices for arecanut are varied throughout the year. During January to March, irrigation may be adopted once in 3 to 5 days. Sparying against mites attack is also necessary as a plant protection measure. Harvesting and curing of tender nuts, planting new seedlings, cleaning and deepening of drainage channels and plant protection are the important operations to be taken up during the period of April to October and digging taken up before the end of November. Harvesting and drying of ripe nuts may commence then. Incidence of mites and spindle bug on palms of all ages must be prevented by spraying. The pre-bearing age of the the palm ranges from 5 to 8 years. The colour of the fruit during its growth changes from green to different shades of yellow and red during ripening. In some places, tender nuts are harvested whereas in other regions, only mature nuts are harvested. Both immature and mature nuts are harvested in some other places.Areca is a monocotyledon tree. However, the real break through in agricultural production was effected through the introduction of high-yielding dwarf varieties. A very popular semi-tall early-bearing variety has been released by the Central Variety Release Committee under the name 'Mangala' yielding about 70% more than the local variety. Climbing palms is necessary for harvesting nuts and plant protection measures. By and large, it is done by professional climbers who get trained from their younger days. Since it is a strenous and risky job, and with the changed socio-cultural outlook, fewer young men are taking it up and this has caused a scarcity of palm climbers. Timely harvesting can be as assured by the availability of skilled labourers. The number of people available is dwindling day by day and labour charge is also high. The main intercrops like pepper and betel vines increase the difficulty in the climbing of the palm. Several pests attacking areca tree has been reported, (**Appendix I**) of which 'Mahali' is the most baneful disease that causes fruit rot. The conventional method of plant protection done against'Mahali' is by applying bordeaux mixture manualy with the help of rocker sprayer. Spraying has to be done just before and after the monsoon as a precautionary measure. It is very difficult to apply chemicals on the fruit bunches of areca tree because it is unusually tall compared to other crops. The spraying is done using a rocker sprayer involving two persons, one operating the sprayer from the ground and the other climbing the tree with the boom with nozzle. But this method is very tedious, time consuming and uneconomic. Above all, skilled labourers are required to do this operation and they are exposed to the chemical they apply. Of late, high labour costs and frequent pest's attacks have posted hindrances to the productivity of the crop.

This project aims at tackling these problems with a view to increase the profitability in arecanut cultivation. In order to eliminate the drudgery involved in harvesting and spraying for arecanut palms, an attempt was undertaken at Kelappaji College of Agricultural Engineering and Technology with the following objectives:

1. Preliminary investigations on harvesting and spraying methods of areacanut.
2. To develop an arecanut harvester cum sprayer.
3. To test the device for the field conditions
4. To modify the developed machine based on the results of the performance evaluation
5. To compare the performance of the modified harvester cum sprayer with that of the parent machine and manual harvesting and spraying.

REVIEW OF LITERATURE

This chapter deals with the statistics of cultivation of arecanut in Kerala state, small scale hand tools for branch cutting, harvesting and spraying methods for plantation crops- especially the areacanut plams is briefly reviewed underneath.

2.1. Arecanut Cultivation - Area and Production:

It is known that Phillippines is the place of origin of arecanut. India is the largest producer and consumer of arecanut in the world. Trends in area and production of arecanuts in Kerala is presented in **Table 2.1. and Table 2.2** respectively. The total aracanut area has expanded rapidly since 1956-57 from 94,800 ha to 2,20,400 ha in 1991-'92. For the country as a whole, there was a three fold increase in production.(74.7 thousand tonnes in 1956-57 to 243.2 thousand tonnes in 1991-92). Till 1971 to 1972 the increase in production of arecanut was mainly due to a rapid increase in area whereas in yield further increase was significantly contributed by the increase in yield levels of areca plantations. Gross area of arecanut under irrigation is shown in **Table 2.3**. Statewise area and yield of arecanut cultivation is presented in **Table 2.4**. Nearly 95% of the arecanut area is accounted by the three principal area growing states namely Karnataka, Kerala and Assam. Area wise Kerala was the leading state in the beginning and now it has gone to third position both in area and production. Karnataka has come on the top in area and production since the very beginning. Other areca growing states are Maharastra, Goa, West Bengal, Meghalaya, Tripura, Andhrapredesh, Tamil nadu and Andaman which together account only about 5% of the total area of the country. Trends in area, production and productivity of arecanut in India is shown in **Table 2.5.**

2.1.1 Import and export

Arecanut import and export statistics is presented in **Table 2.6**. India was importing large quantities of arecanut in 1950's and 1960's mainly from Singapore, Malaysia and Sri Lanka. The quantity of imports came down gradually from 90 tonnes to 36 thousand tonnes by 1971-72 and since then our country is only exporting arecanut. Exports showed a rising trend from 1976-77 with about 603 tonnes to aboutt 800 tonnes currently. However the export of arecanut is not ble 2.1 AREA UNDER ARECANUT (ha)

DISTRICT	86-'87	87 - '88	88-'89	89 - '90	91 - '92	92 - '93	94-' 95
Trivandrum	2865	2311	2511	2119	1674	1640	1315
Quilon	2823	2235	2156	1986	1929	2024	1846
Pathanamthitta	1360	1520	1613	1467	1207	1126	1128
Alleppey	2133	1900	1799	1652	1704	1622	1703
Kottayam	2145	1768	1772	1665	1307	1272	946
Idukky	2333	1974	2029	1898	1695	1745	2054
Ernakulam	5259	4485	4785	4251	3475	3148	2741
Trichur	5982	6569	6023	5420	5421	5721	6637
Palaghat	2090	2369	2370	2614	2578	2777	2948
Malappuram	8865	9941	10420	11398	12214	11485	12635
Kozhikode	5288	5110	5349	5629	6156	5996	8364
Wayanad	1243	1516	1546	1428	1785	2084	2667
Kannur	6441	8708	9121	9895	11252	12028	13375
Kasargod	8907	10127	10978	11407	11140	11261	13317
State	**57734**	**60535**	**62472**	**63179**	**63437**	**63929**	**71676**

Source : Department of Economics and Statistics Publications , Trivandrum)

Table 2 .2 PRODUCTION OF ARECANUTS (million nuts)

DISTRICT	86 '87	87 - '88	88-'89	89 - '90	91 - '92	92 - '93	94 - ' 95
Trivandrum	430	305	271	276	214	187	139
Quilon	481	351	356	383	339	353	313
Pathanamthitta	378	338	295	298	332	274	307
Alleppey	422	264	128	132	209	188	236
Kottayam	361	304	230	256	191	175	143
Idukky	319	321	545	459	498	540	645
Emakulam	1323	1111	912	828	603	527	516
Trichur	1178	1340	1250	1092	1475	1400	1982
Palaghat	237	226	273	321	338	364	447
Malappuram	1374	1371	1751	1924	2341	2426	2479
Kozhikode	1009	840	966	1084	1045	239	2299
Wayanad	286	324	297	278	343	460	475
Kannur	1096	1558	1974	2263	2651	2788	3272
Kasargod	1669	2012	2212	2370	2537	2722	4213
State	**10563**	**10665**	**11450**	**11964**	**13116**	**13643**	**17466**

(Source : Department of Economics & Statistics Publications , Trivandrum)

Table 2.3 GROSS AREA OF ARECANUT UNDER IRRIGATION (ha)

DISTRICT	86 '87	87 - '88	88-'89	89 - '90	91 - '92	92 - '93
Trivandrum	1	1	4	4	22	14
Quilon	9	1	3	2	64	8
Pathanamthitta	2	1	2	1	3	32
Alleppey	49	37	43	37	277	263
Kottayam	-	-	-	40	7	2
Idukky	2	2	2	1	1	1
Ernakulam	688	735	705	681	753	1024
Trichur	2670	3613	4427	3787	3179	4460
Palaghat	1849	1868	1903	1813	1982	1921
Malappuram	1972	2684	3291	2910	3717	3899
Kozhikode	119	62	87	100	271	244
Wayanad	4	5	5	3	7	20
Kannur	318	820	1216	1399	2843	2916
Kasargod	8986	5754	8952	6650	7761	7591
State	**11669**	**15583**	**20690**	**17428**	**20887**	**22395**

(Source : Department of Economics & Statistics Publications, Trivandrum)

Table 2 .4 STATE WISE PRODUCTION OF AREACANUT IN INDIA (1994 - 1995)

STATE	AREA ('000ha)	YIELD('000 tonnes)
Andhra pradesh	0.2	0.2
Assam	70.3	71.2
Goa, Daman &Diu	1.3	1.5
Karnataka	77	103.3
Kerala	63.9	70.3
Maharashtra	1.9	3.6
Meghalaya	8.8	8.8
Mizoram	0.1	0.1
Pondicherry	0.1	0.2
Tamil Nadu	4	4
Tripura	1.2	2.2
West Bengal	5.3	7

(Source : Economics & Statistics Advisor, New Delhi)

Table 2.5 TRENDS IN AREA PRODUCTION AND PRODUCTIVITY OF AREACANUT IN INDIA (AT FIVE YEARLY INTERVELS SINCE 1956-'57 TO 1994-'95)

YEAR	AREA (ha)	PRODUCTION (tonnes)	PRODUCTIVITY (kg/ha.)
1956 - '57	94,800	74,700	789
1961 -'62	1,16,830	95,170	816
1966 -'67	1,42,100	1,30,100	916
1971 -'72	1,73,800	1,47,100	846
1976 -'77	1,70,700	1,65,100	967
1981 - '82	1,82,600	1,93,800	1061
1986 -87	1,76,300	2,09,400	1188
1991 - '92	2,20,400	2,43,200	1103
1992 - 93	2,22,300	2,48,400	1117
1993 - 94	2,35,500	2,75,100	1168
1994 - '95	2,35,500	2,72,400	1156

(Source : CPCRI, Kasargod)

Table 2.6 TRENDS IN IMPORT AND EXPORT OF ARECANUT IN INDIA.

YEAR	IMPORT (tonnes)	EXPORT (tonnes)
1946 - 47	36,762	675
1951 -52	45,397	170
1956 - 57	39,879	227
1961 - 62	10,041	123
1966- 67	597	219
1971 - 72	90	292
1976- 77	-	603
1981-82	-	579
1982-83	-	695
1983 -84	-	535
1984-85	-	783
1988-89	-	669
1992-93	-	629
1993-94	-	640
1994 -95		800

(Source : CPCRI, Kasargod)

significantly to cast any change in the production target and to expand the area under arecanut.

2.2 Fruit Harvesters

Various methods of detachment employed are either hand or mechanical harvesting. These generally involve cutting, pinching, pulling, bending or snapping, twisting or some combination of these actions. Machines that shake the plant, develop detachment forces as a result of inertia. Bending and twisting as well as a direct pull may be induced by the shaking. Harvesting methods which donot necessarily involve direct contact between removal device and the fruit or stem are often referred to as man-harvest systems.

Tractor mounted cable shakers, fixed stroke boom shakes, and boom type impact knockers were originally developed for nuts. Impact knockers are still used to a considerable extent on old almond trees because these trees are large and relatively rigid. An impact knocker delivers discrete axial impacts or impulses by mechanical, pneumatic or hydraulic means, rather that having a continous oscillating motion. Inertia type shakers have largely replaced fixed-stroke shakers except in large nut trees. With an inertia shaker, the exciting force is derived from the accelaration of a reciprocating man or two opposite rotating, eccentric masses. An inertia shaker is attached to the supporting structure through flexible mounts or hangers, thereby isolating the vibration. Hydraulic motor drives are employed. These shakers may be attached to the trunk to shake only a portion of the tree at a time. Trunk shakers are faster than limb shakers because attachment is easier and is needed at only one place per tree. In a shake-catch harvesting system catching units have low-profile collection surfaces that extend under the tree. Stationary surfaces are usually sloped towards a belt or draper-type conveyor, but some units have pans that are mechanically dumped onto the conveyor. Another arrangement, requiring a minimum of vertical clearence but more labour, has roll-out canvas sheets that are retracted towards the conveyor when loaded. Effective packing of all hard collection surfaces and deflector panels are necessary to avoid excessive damage to easily bruised fruits apples, citruis etc. (Srivasthava, 1990)

Another mass harvest concept that has been investigated for citrus is the use of an oscillating air blast to shake the foliage. In one arrangement, air at

160 kmph is discharged from two side-by-side outlets 254 mm wide and 6.1 m high, directed toward one side of the tree as the machine moves down the row at about 0.4 kmph mechanically moved deflectors in the outlets change the air direction at a frequency of 60 to 70 cycles per minute. Fruit removal percentage ranges from 60-90% with some leaf damage. (Srivasthava, 1990)

The traditional method of harvesting of mango is time and labour intensive. To overcome these difficulties three models of improved mango fruit harvestor, impact, shear type, and impact cum shear type have been developed by Sapovadia and Patel (1995). The main parts of the mango harvester are handle, cutting tool, and conveying net. The handle was fabricated from conduit pipe. To attach the conveying net to the handle a ring of appropriate size was provided. The performance parameters were compared with that of the local harvester. Impact type model was found to be the best among all.

A jack fruit harvester was developed at K.C.A.E.T Tavanur (Mohammed, 1996). The harvester was a manually operated one. A special feature of the product was that two men harvest a jack fruit in 4-5 minutes from the ground. The harvester consist of a long telescopic handle with a hook knife at the top. A basket of net type is there to bring down the jackfruit safely. The operation is so simple that a layman can harvest the jackfruit easily.

2. 3 Traditional Harvesting Methods.

There are expert professionals who can scale tall trunks even without using ankle rings or waist rings. The labourer climbs up through one stem to reach the crown of a palm and swings it horizontally to reach the crown of the neighbouring palm.

In Cuba, the difficult to climb royal palm (Oreodoxa regia) is shinned by certain professional climbers who used two rope rings (Hodge, 1958).

In Ivory Coast,(Anon.1963,1966) for climbing oil palms, spiked boots, and flexible steel around the body of the climber and tree are used.

Corner (1966) has given drawing of climbers in action in different countries using ankle and/or waist rings.

For climbing palmyrah palms (Anon.1967) a ladder type device was developed for harvesting palms.

2. 3.1 Macaque for harvesting palms

In parts of Malaysia, Indonesia and Thailand, monkeys, the most common species being *Mecaca nemestrina* are used for harvesting areca palms (Aziz, 1980). While climbing, the primate is provided with a long chain through which the trainer conveys instructions as to which bunch the monkey has to harvest and which not to pluck. Harvesting is done either by kicking the fruits or twisting them off the spikes. A monkey is capable of harvesting over 60 palms per day.

2.4 Improved Palm Climbing Devices :

Swamy and patil (1975) developed a much simpler device which consists of movable supports for legs and hands and lifted alternatively while the other one is gripped for climbing cocunut.

The palm bicycle used for coconut palm (Davis, 1977) in its simplest form consist of an an angle iron frame work with a wooden platform on which the operator rides, while friction rollers pressed against the trunk of the palm by his weight carry him to the top when he turns the handle.

Improved oval rings have been used for scaling tall forest trees in Czechoslovakia, Poland, Soviet Union and Germeny (Davis, 1977).

Dwivedi (1977) developed a manually operated portable device that can be used to climb on palms. It consists of 4 concentric rectangular pipes made of aluminium (**Fig.2.1**). It was designed so as to raise the man standing on the platform to a desired height above 5 m. The hand-winch is operated by another man. Leaving apart the skill this could not solve the scarcity of labourers. More over the device should support the weight of a man.

At TNAU, Coimbatore also attempts were made towards developing the bicycle for climbing coconut.

Annamalai (1982) developed an improved device for climbing of palms. (**Fig. 2.2**) The device comprises three major parts, namely (i) Upper clutch around the trunk with handle and with independent clutching mechanism (ii) Lower clutch with platforms for foot rest having arrangement for clutching with the trunk and (iii) the body with collapsible lever mechanism connecting the top and bottom ring. The device will work on the principle of alternate clutching of upper and lower clutches and lifting of the device with the help of collapsible lever mechanism.

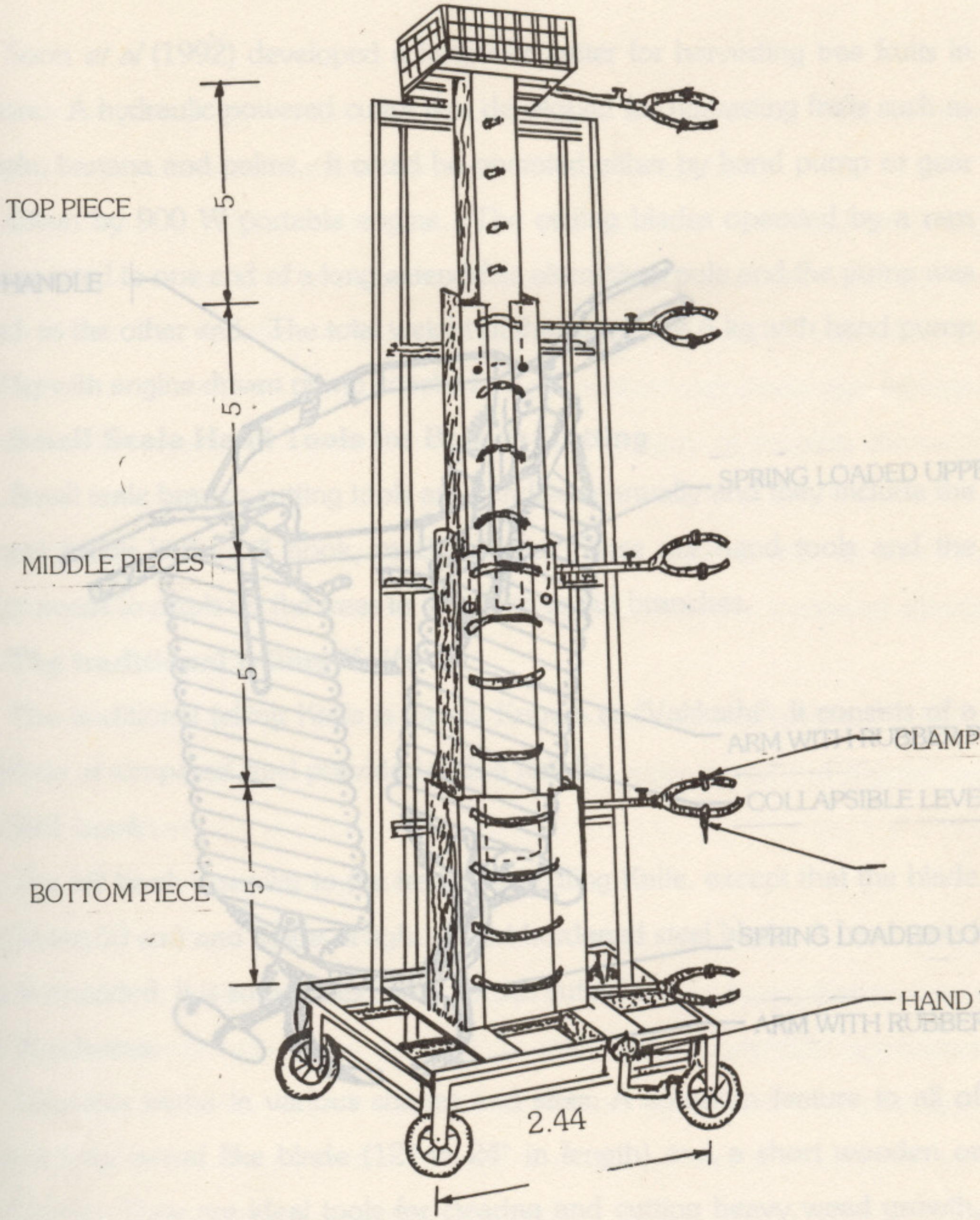


Fig. 2.1 MANUALLY OPERATED PALM CLIMBING DEVICE DESIGNED BY DWIVEDI AT C PCRI.

ALL DIMENSIONS IN M

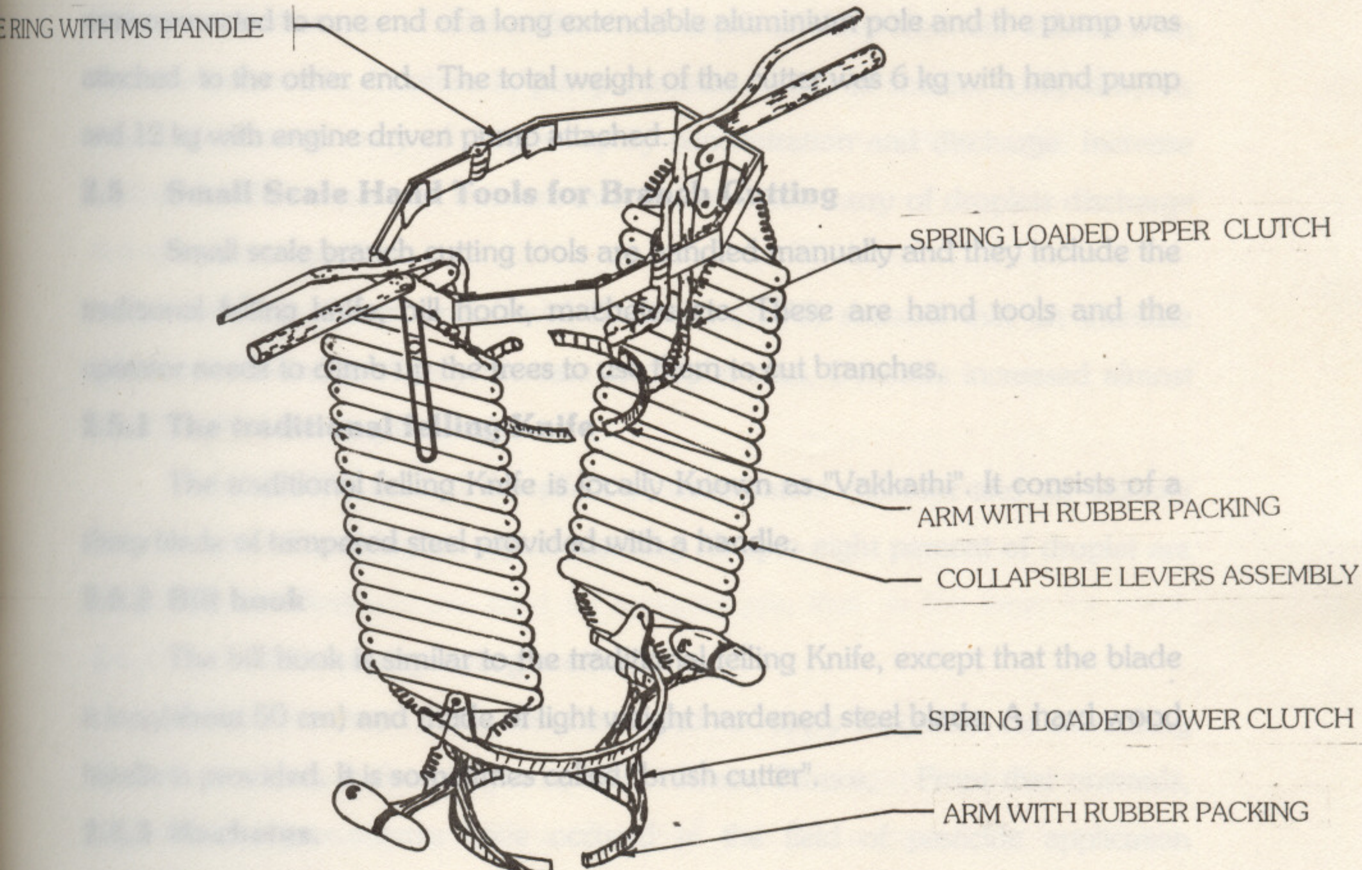


Fig. 2.2 ARECANUT PALM CLIMBING DEVICE DESIGNED BY ANNAMALAI AT CPCRI.

Soon *et al* (1992) developed a hydraulic cutter for harvesting tree fruits in Singapore. A hydraulic powered cutter was developed for harvesting fruits such as Pineapple, banana and palms. It could be operated either by hand pump or gear pump driven by 900 W portable engine. The cutting blades operated by a ram were connected to one end of a long extendable aluminium pole and the pump was attached to the other end. The total weight of the cutter was 6 kg with hand pump and 12 kg with engine driven pump attached.

2.5 Small Scale Hand Tools for Branch Cutting

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

2.5.1 The traditional felling Knife

The traditional felling Knife is locally Known as "Vakkathi". It consists of a sharp blade of tampered steel provided with a handle.

2.5.2 Bill hook

The bill hook is similar to the traditional felling Knife, except that the blade is long(about 50 cm) and made of light weight hardened steel blade. A hard wood handle is provided. It is sometimes called "brush cutter".

2.5.3 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, vires, grass and shrubs.

2.6 Plant Protection Measures

All toxic chemicals used for plant protection are called pesticides (Latin '*peste*' meaning infection and '*caedo*' meaning kill) Chemical preparation used for control and destruction of weeds are known as herbicides ('*Herba*' meaning grass). Those used for combating plant desease caused by fungi as fungicides and other for protection against bacteria infection as bactericides.

Most chemicals used for plant protection against organism and weeds are hazardous to human health. Entering through skin, mouth or respiratory tract may lead to severe poisoning or even death. Depending upon area of infection and stage of growth various plant protection methods can be applied.

Bindea O. S (1971) stated that factor like measure in increase in pump pressure and diameter of dike orifice and depth of eddy chamber influence on operation of nozzle. Increase in pump pressure results in smaller spray droplets increased pressure carry of droplets spray concentration and discharge. Increase in disc of orifice results in increase in size of droplets carry of droplets discharge and spray concentration.

Hario W. Strom and David B. Smith (1976) showed that an increase inflow rate tended to slightly increase in droplet sizes. Densities increased almost linearly with increasing flow rate.

Heidt (1979) studied the effect of temperature different and an velocity between ground and higher region resulting lift upto eight percent of droplet are lost due to this effort.

2.6.1 Modern spraying methods

Sprayers were probably first developed to apply fungicides for controlling diseases of grapes in the vineyards, of Bordeaux, France. From that onwards, tremendous improvements have occured in the field of pesticide application equipments and methods. Improvement of application equipments and techniques to permit the effective use of smaller dosages of chemicals and to reduce drift and harmful residues has become increasingly important as one means of minimizing pollution caused by chemical pesticides. (Sreevastava, 1990)

Bronson and Anderson (1952) defined the function of sprayer as to break the liquid into droplets of effective size and distribute them uniformly over the surface or space to be protected. Another function is to regulate the amount of insecticide to avoid excessive application to prevent wastage and pollution.

United states department of agriculture classifies present day sprayers as Hydrraulic Sprayers Hydropnuematic Sprayers, Blower Sprayers and Aerosol Generators.

2.6.1.1 Hydraulic sprayer

In hydraulic sprayerspraying action is due to the direct action of pump on the liquid spray material. The pressure developed by the pump break the spraying fluid in to proper size droplets and disperse them. The essential parts of hydraulic sprayers are pump, tank, frame work for mounting the sprayer, relief valves, strainers, distribution system and power source.

Hydraulic sprayers are further classified as Multipurpose sprayer, Small general use sprayer, High pressure high volume sprayer, Low pressure low volume sprayer & Self-propelled high clearence sprayer.

2.6.1.2 Multipurpose sprayer

This is versatile to meet the spraying needs on diversified forms

2.6.1.3 Small general purpose sprayer

This type sprayers are used for spraying job, that is too large for hand equipments.

2.6.1.4 High pressure high volume sprayers

These are used for complete spray coverage of high growing fruit and shade trees. Pressures ranging from 27 to 69 kg/cm^2 with discharge ranging from 30 to 225 1/min could be developed using these sprayers. Rocker sprayers & foot sprayers are some examples of these sprayers.

Rocker sprayer consists of a pump assembly, a plat form, an operating lever, a pressure chamber, a suction hose with strainer, a delivery hose and spray nozzle. The rocking motions develops required pressure. Usual range of pressure developed varies from 14 to 18 kg/cm^2 and if may go upto 36 kg/cm^2.

Foot sprayer is similar in construction to rocker sprayer except that the rocking arm is replaced by a foot pedal. Pressure is built up, by the action of foot pedal and a pressure ranging from 17 to 21 kg/cm^2 could be developed.

2.6.1.5 Low pressure low volume sprayer

These are designed for low volume field sparying.

2.6.1.6 Self propelled high clearance sprayer

This is a special purpose machine to spray field and row crops which are too high for conventional sprayer.

2.6.1.7 Hydropnuematic sprayer

Here air compressor is used to develop spraying pressure. It is a low pressure low volume sprayer.

2.6.1.8 Blower sprayer

Also known as mist or concentrated sprayer, is used to apply pesticide in concentrated form. these sprayers are economical due to reduction in labour and due to reduced run off from foliage. But wind velocity and direction may cause drift of spray.

2.6.1.9 Aerosol generators

These machines disperse the spray material in the fine droplets in the range of 1-50 M.

2.7 Sprayer Nozzles

Nozzles are atomizing devices for disintegration of spray fluid into fine spray. For efficient distribution of spray fluid at the crown of areca tree, selection of appropriate nozzle is very important. Droplet sizes and spray drift are two major factors affecting the application efficiency. A nozzle capable of giving satisfactory performance is to be selected. Following types of nozzles are available in the market, at present.

2.7.1 Hydraulic energy nozzle

These types of nozzles break up fluid coming at high pressure into fine droplets of high velocity. Based on spray pattern, they can be classified into jet nozzle, impact nozzle, flat fan nozzle, swirl nozzle & tripple action nozzles. Jet and impact nozzles produce coarse droplets. Fan nozzle have a fan shaped spray pattern, where swirl nozzles produce cone shaped spray pattern. In triple action nozzles, jet as well as cone shaped spray pattern can be produced.

2.7.2 Gaseous energy nozzles

For producing spray droplets, air or other gas is made use of.

2.7.3 Centrifugal energy nozzle

These are also called spinning disc or rotary nozzle. Which are used for producing fine sprayers, mists or aerosol sized droplets. Here, spray fluid is fed centrally to a rotating disc, which force out due to the centrifugal force towards the periphery.

2.8 Sprayer Performance

The basic principles underlying the pesticide application are coverage of target area, deposition efficiency and uniformity of deposition. To achieve the efficiency aimed to obtain from spraying, it has to meet certain specific requirements. Many research workers have under taken detailed studies about the general performance requirement needed for efficient spraying. A brief description to these works, with special reference to areca tree spraying is described below.

The spray distribtion (Number of droplets per unit area), the diameter of droplets and the active ingredient (the amount of pesticide) are all important. Atomization influences distribution of the spray and the loss due to evaporation, drift and convection. Accurate measurement of spray atomization is essential for assessing equipment and methods of application and for developing the spray equipment for specific sizes of droplets.

Kepner *et al.* (1987) recomended that nozzle distribution pattern can be determined in laboratary by spray and surface that consist of a series of adjacent spraying v-trough and measuring, liquid collected from each trough. The drift can also be reduced by using hoods or shields.

2.9 Arecanut Sprayers

Abraham (1975) had developed an applicator for placing pesticide granules inthe leaf axils of an arecanut palm from a position just below the crown. However this applcator is suited only for young palms of height not more than 5 m. So this had only limited application.

Udupa (1991) developed an areca sprayer. The lifting mechanism utilized the principle of telescopic tubes with external rope mechanism. The spray fluid is being pressurised by a rocker sprayer can cover upto a height of 16 m.

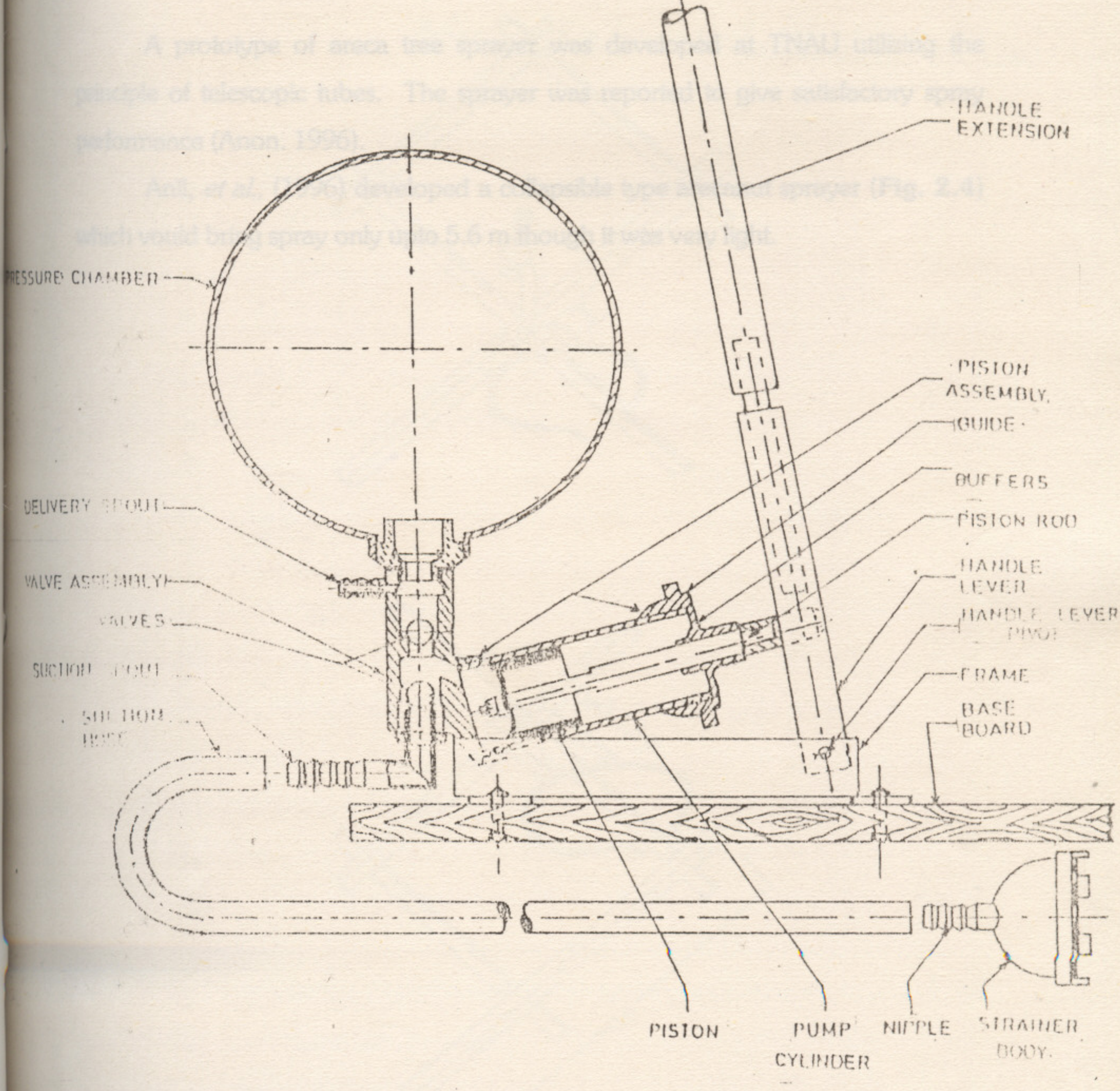


Fig. 2.3 ROCKER SPRAYER

A prototype of areca tree sprayer was developed at TNAU utilizing the principle of telescopic tubes. The sprayer was reported to give satisfactory spray performance (Anon. 1996).

Anil, *et al.,* (1996) developed a collapsible type arecanut sprayer (**Fig. 2.4**) which vould bring spray only upto 5.6 m though it was very light.

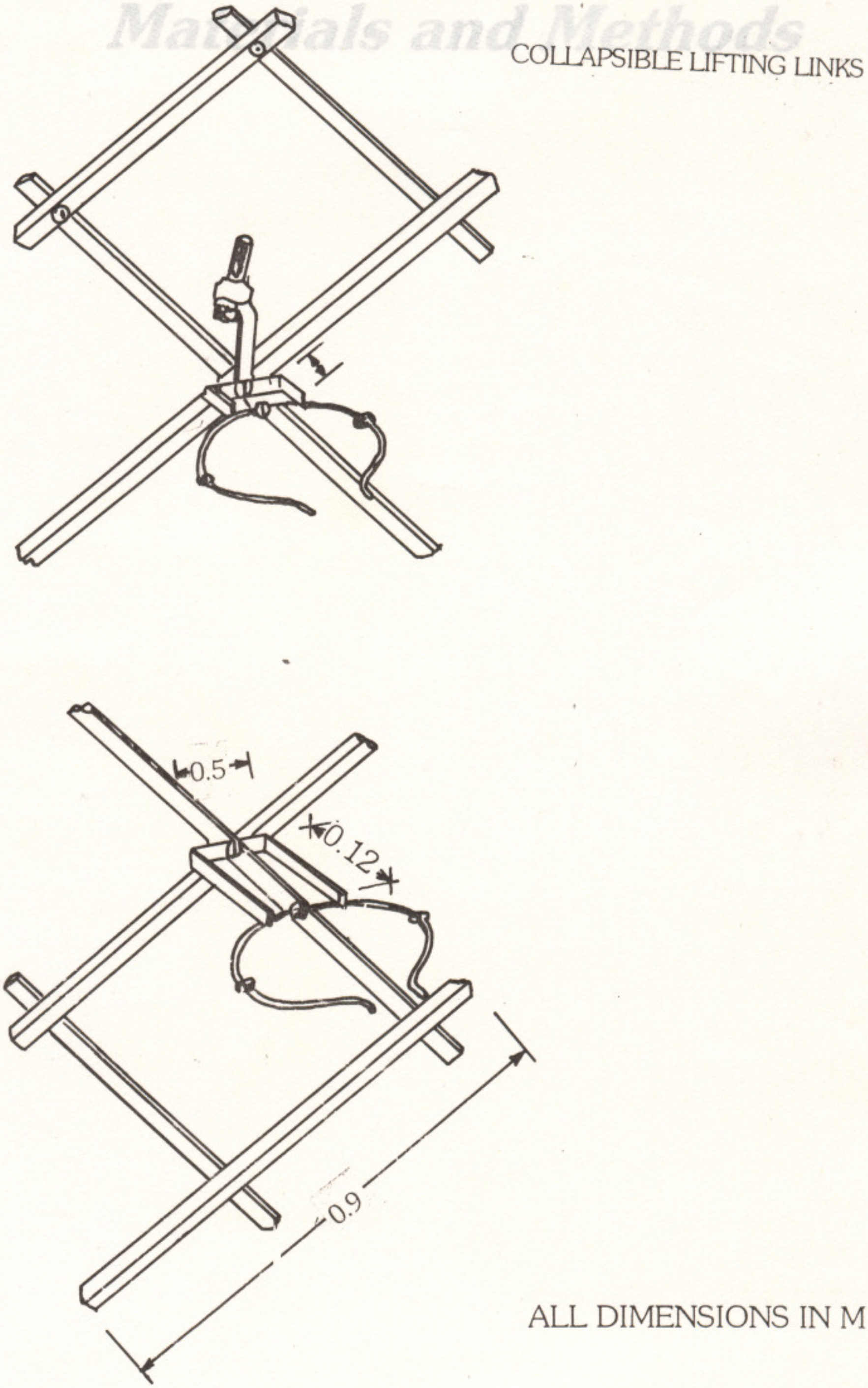


Fig. 2.4 LIFTING DEVICE OF ARECANUT SPRAYER DEVELOPED AT KAU.

MATERIALS AND METHODS

This chapter deals with the preliminary investigation conducted and the materials used and the procedure adopted for the fabrication and testing of original and modified models of the arecanut harvester cum sprayer are discussed.

3.1 Preliminary Investigations

Before developing the equipment some preliminary investigations like, tree characteristics, nut location on tree, nut characteristics and anthropometrical observations were taken for deciding appropriate size, shape, strength and capacity of differen components of the equipment.

3.1.1 Tree characteristics

It is a mono *cotyledon plant grown at altitudes up to 1000 m above the sea level. It is* having fibrous root system. The height of the tree varies from 5 to 15m, depending upon the variety. The diameter of the trunk is approximately 15 cm.

3.1.2 Nut location on the tree

The nuts are located at the end of leafsheath. So their harvesting is not obstructed by the canopy.

3.1.3 Nut characteristics

The nuts are attached to a common peduncle whereby it facilitate easy cutting of the bunch at its end.

3.1.4 Anthropometrical observations

According to anthropometric data for farm equipment design collected by Gite and Yadav, olecranon height is in the range of 99-104.1 cm. Olecranon height was taken into consideration while fixing the reel assembly.

3.2 Development of Model of the lifting mechanism

It was found that telescopic arrangement of pipes was more erect and sturdy. Two models were fabricated in order to study its feasibility.

3.2.1 Model I - External rope system

It consistes of 3 concentric G.I pipes of diameters 38.1mm, 25.4mm and 12.7mm, each of 50 cm length coupled together by reducers (**Fig. 3.1**). In the bottom most pipe, a slot of ¾ th of its length leaving 1/8 th of its length as clearance

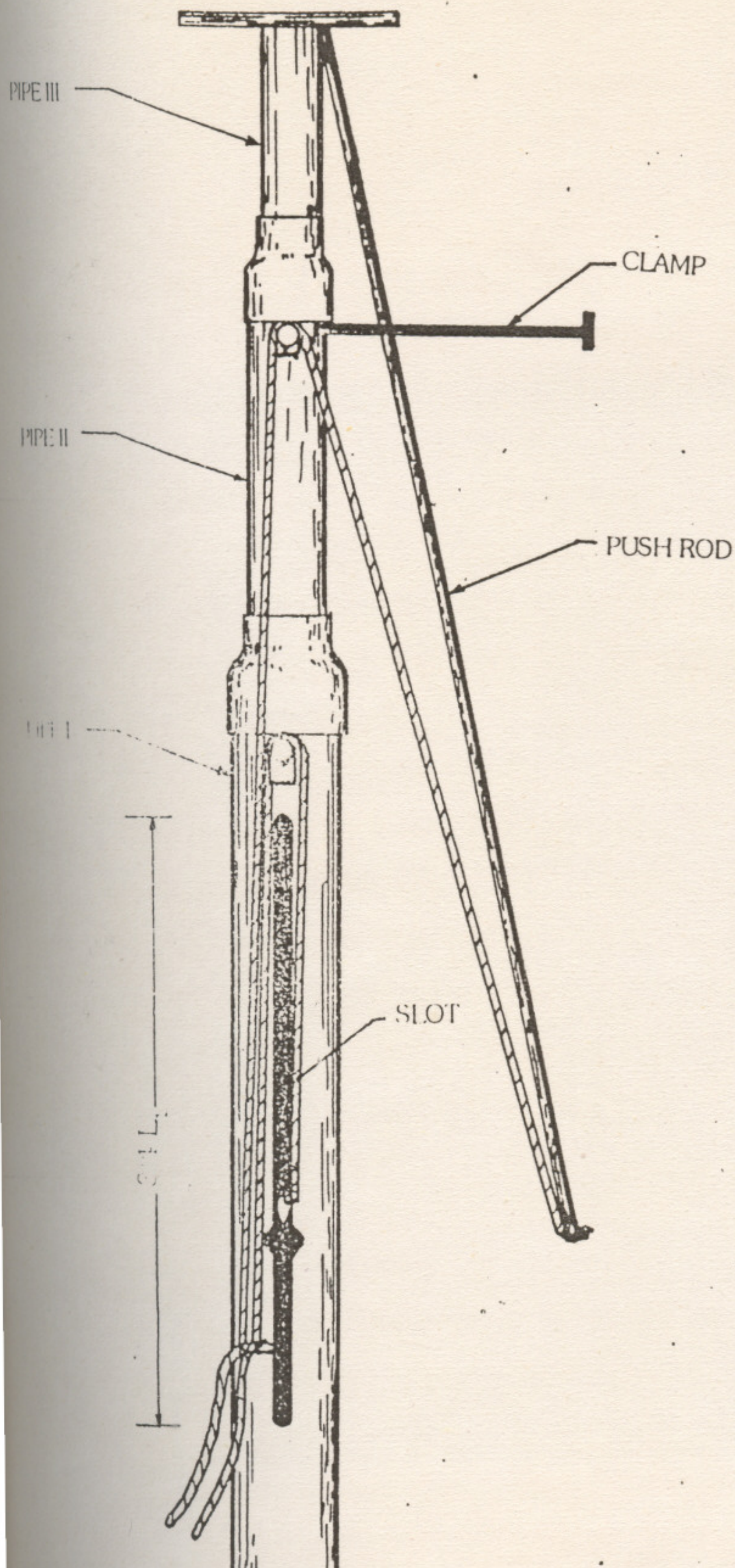


Fig. 3.1 EXTERNAL ROPE SYSTEM-MODEL I.

at each end was provided. This facilitates the movement of second pipe by rope and pulley mechanism tied to the block attached at the bottom of the second pipe. The upper pipe was lifted with the help of a push rod by rope and pulley mechanism tied to the end of the push rod, **Plate 3.1**.

The system has many advantages as this lifting mechanism consisted of external rope system this is easily repairable without dismantling the entire system. Since there is very less wear and tear in the rope, nylon rope can be used which is economical. The disadvantages of the system includes in its inticate design and as the rope system provided is not continuous it is laborious to operate also as the slot is provided along the whole length of the bottom most pipe it reduces the strength of the pipe.

3.2.2 Model II - Internal rope system.

It consistes of 3 concentric G.I. pipes of diameters 38.1mm, 25.4mm and 12.7mm, each of 50 cm length (**Fig 3.2**) coupled together by sockets having rope way drilled in it.

The continuous rope system was wound on a reel which was operated by a handle. This is shown in **Plate 3.2**.

The advantages of the system are its simplicity in construction, easiness in operation and less time consumption. Disadvantages are difficulty in repairing and high cost.

3.3 Arecanut Harvester - Original Model

Since the second model was found to be easier to operate, it was selected as the original model of the lifting mechanism of the arecanut harvester-cum-sprayer. It consists of pipes, reel assembly, pully, metal rope, socket, fork shaped clamp, hold head, etc. The specification of the original model of the arecanut harvester-cum-sprayer is shown in **Appendix III**.

3.3.1 Pipe

Three aluminium pipes of 50.8mm, 38.1mm, and 25.4mm diameters and 3.6 m length were used to make the mainframe of the unit. Aluminium pipe was preferred because of its low weight and high strength. 12.7mm diameter aluminium pipe was discarded because of its less wall thickness was not sufficient to meet the requirement of threading.

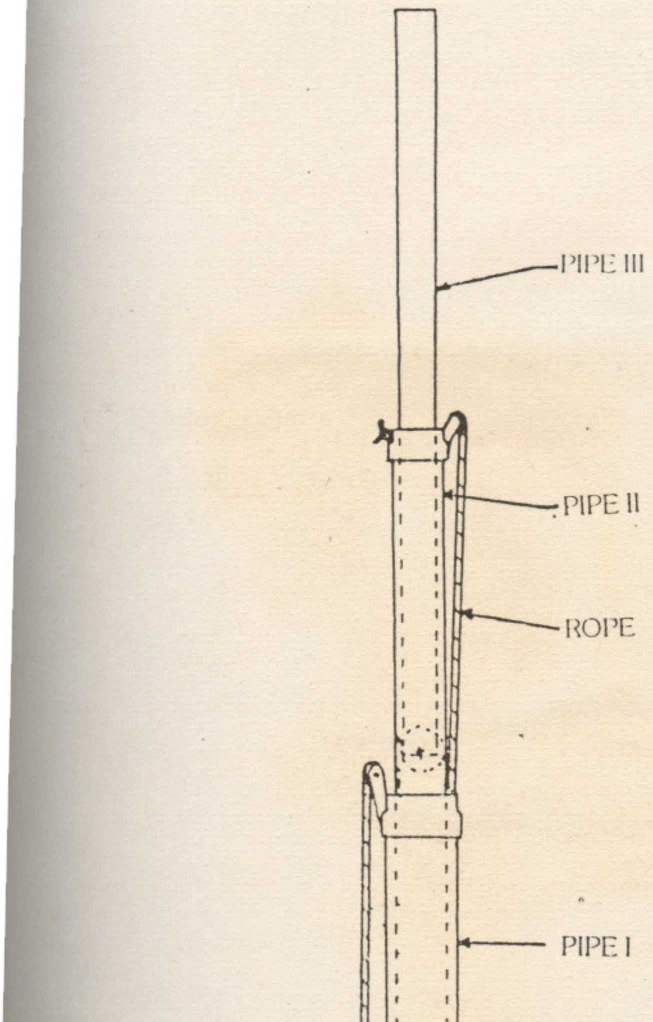


Fig. 3.2 INTERNAL ROPE SYSTEM-MODEL II.

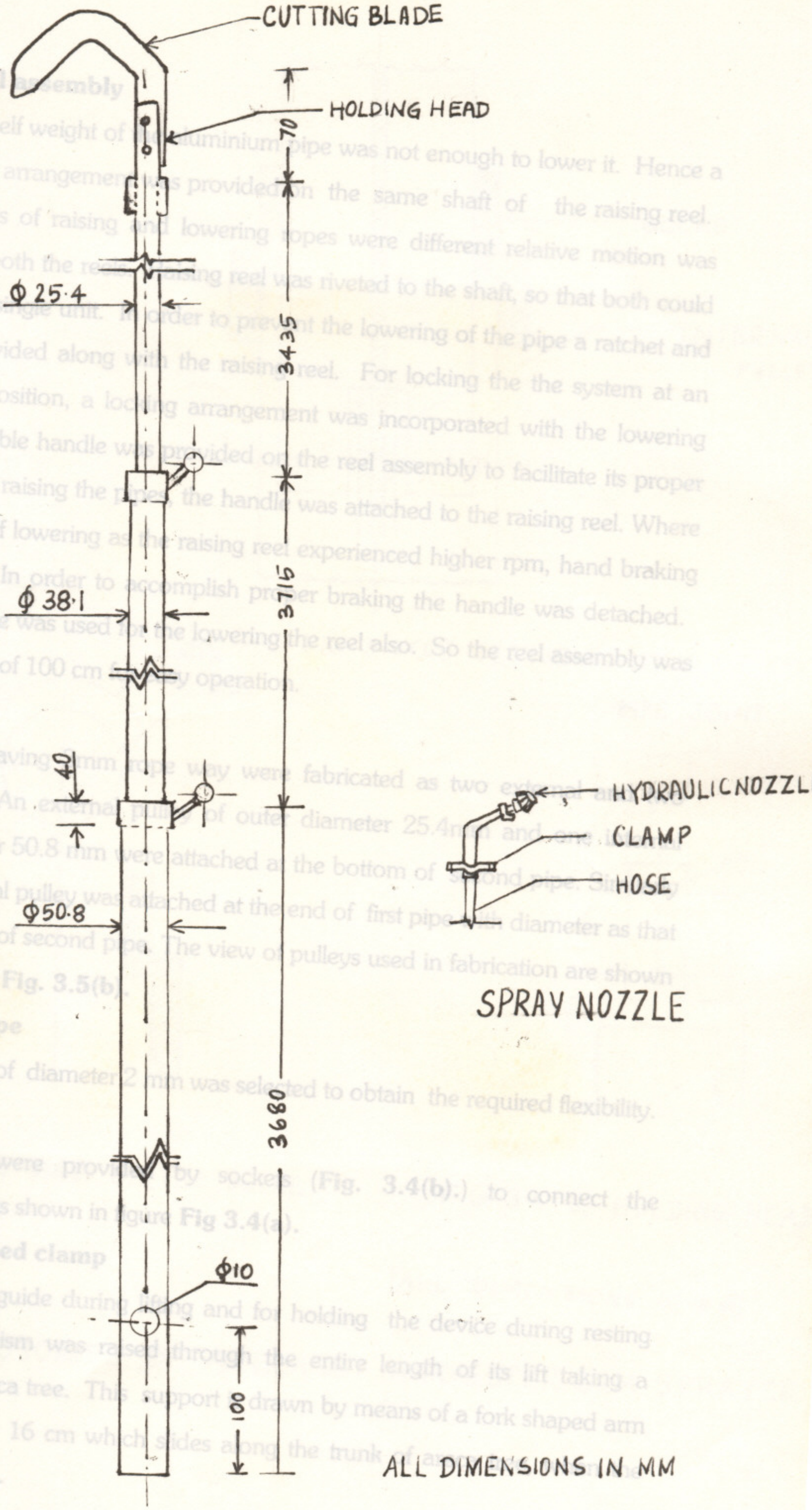


Fig.3.3 LINE DIAGRAM OF MODIFIED ARECANUT HARVESTER CUM SPRAYER

3.3.2 Reel assembly

The self weight of the aluminium pipe was not enough to lower it. Hence a rope and reel arrangement was provided on the same shaft of the raising reel. As the lengths of raising and lowering ropes were different relative motion was provided for both the reels. Raising reel was riveted to the shaft, so that both could rotate as a single unit. In order to prevent the lowering of the pipe a ratchet and pawl was provided along with the raising reel. For locking the the system at an intermediate position, a locking arrangement was incorporated with the lowering reel. A detachable handle was provided on the reel assembly to facilitate its proper working. While raising the pipes, the handle was attached to the raising reel. Where as at the time of lowering as the raising reel experienced higher rpm, hand braking was provided. In order to accomplish proper braking the handle was detached. The same handle was used for the lowering the reel also. So the reel assembly was fixed at a height of 100 cm for easy operation.

3.3.3 Pulley

Pulleys having 3mm rope way were fabricated as two external and two internal pulleys. An external pulley of outer diameter 25.4mm and one internal pulley of diameter 50.8 mm were attached at the bottom of second pipe. Similarly the second internal pulley was attached at the end of first pipe with diameter as that of inner diameter of second pipe. The view of pulleys used in fabrication are shown in **Fig 3.5(a)**.and **Fig. 3.5(b).**

3.3.4 Metal rope

Metal rope of diameter 2 mm was selected to obtain the required flexibility.

3.3.5 Socket

Couplings were provided by sockets (**Fig. 3.4(b).**) to connect the consecutive pipes, as shown in figure **Fig 3.4(a).**

3.3.6 Fork shaped clamp

To act as a guide during lifting and for holding the device during resting period, the mechanism was raised through the entire length of its lift taking a support from the areca tree. This support is drawn by means of a fork shaped arm of internal diameter 16 cm which slides along the trunk of areca tree, when the mechanism was lifted.

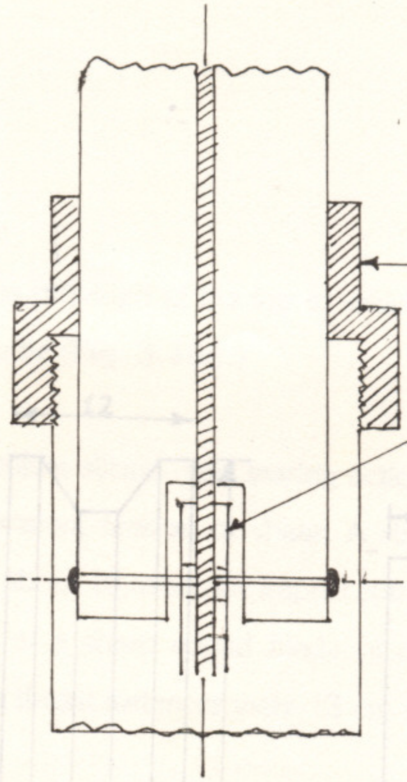
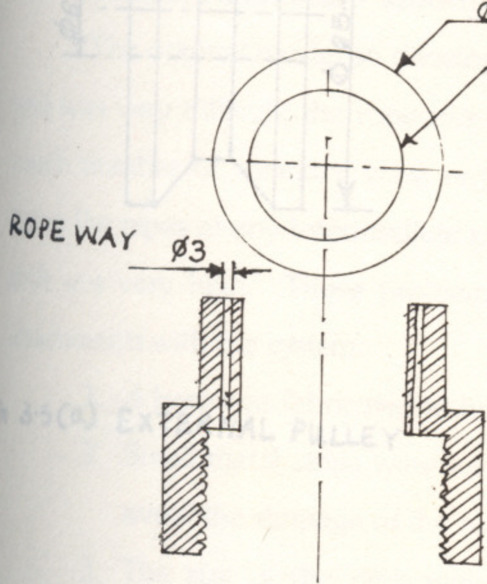
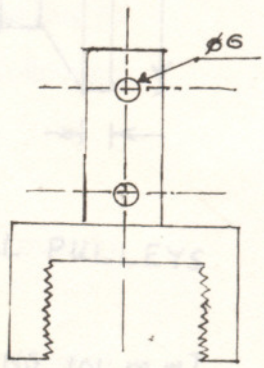


FIG 3.4(a) SECTIONAL VIEW OF THE PIPE JOINT





G 3.4(b) SECTIONAL VIEW OF THE SOCKET

FIG 3.4(b) HOLDING HEAD

[ALL DIMENSIONS IN mm]

FIG 3.4 ACCESSORIES OF ARECANUT HARVESTER CUM SPRAYER

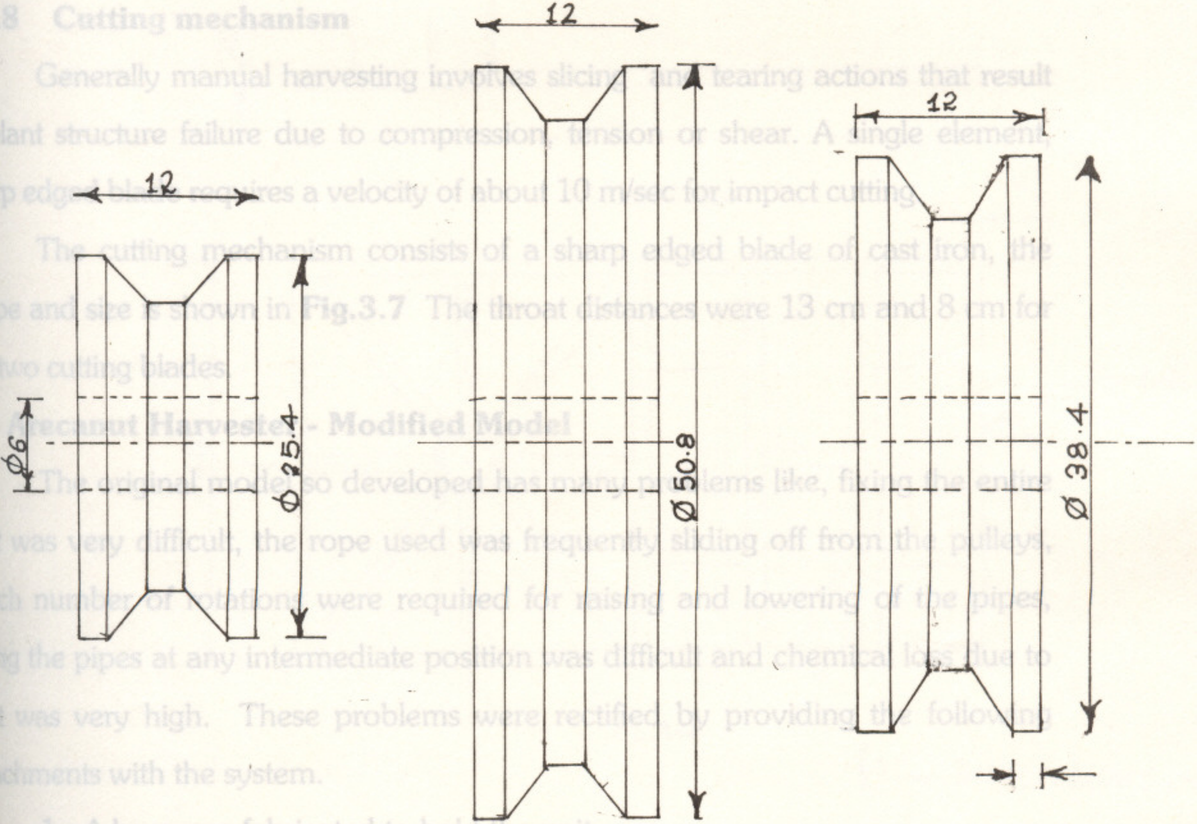


FIG 3.5(a) EXTERNAL PULLEY

FIG 3.5(b) INTERNAL PULLEYS

[ALL DIMENSIONS IN mm]

FIG 3.5 FRONT VIEW OF THE PULLEYS

3.3.7 Holding head

A detachable holding head was provided at the top to which the knife or the nozzle can be bolted as the case may be (**Fig 3.4(c).**)

3.3.8 Cutting mechanism

Generally manual harvesting involves slicing and tearing actions that result in plant structure failure due to compression, tension or shear. A single element, sharp edged blade requires a velocity of about 10 m/sec for impact cutting.

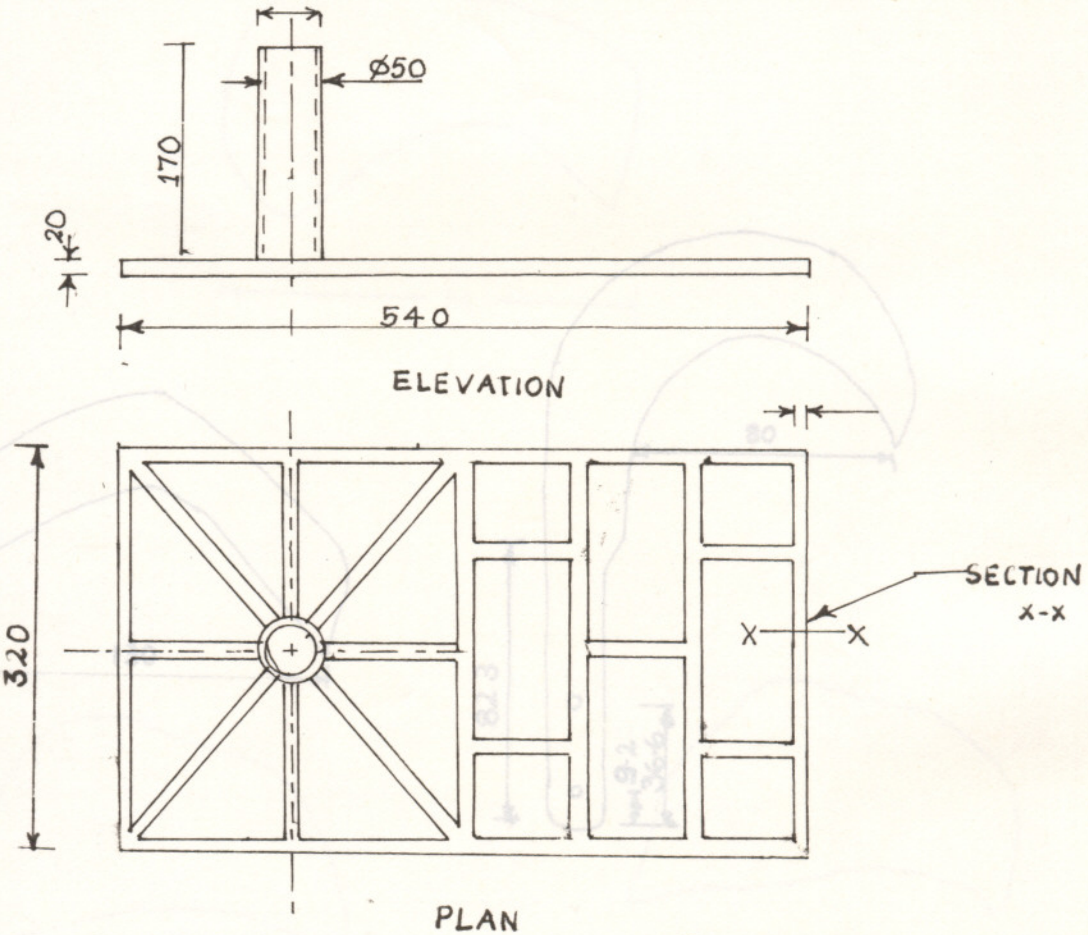
The cutting mechanism consists of a sharp edged blade of cast iron, the shape and size is shown in **Fig.3.7** The throat distances were 13 cm and 8 cm for the two cutting blades.

3.4 Arecanut Harvester - Modified Model

The original model so developed has many problems like, fixing the entire unit was very difficult, the rope used was frequently sliding off from the pulleys, much number of rotations were required for raising and lowering of the pipes, fixing the pipes at any intermediate position was difficult and chemical loss due to drift was very high. These problems were rectified by providing the following attachments with the system.

1. A base was fabricated to hold the unit.
2. Small metal strips were welded on the pulleys as a protective cover to avoid the slippage of the rope from the grooves.
3. The size of the reels were enlarged in order to avoid the repeated rotation of the reel during lifting and lowering.
4. A protective hood made of aluminium sheet was attached with the nozzle head to protect the worker from dripping of chemicals.
5. An automatic lock system was fabricated and attached with the revolving reel to operate the requirement more efficiently and smoothly.

The specification of the modified arecanut harvester-cum- sprayer is shown in **Appendix IV.**



[ALL DIMENSIONS IN mm]

FIG. 3.6 ORTHOGRAPHIC VIEWS OF THE BASE WITH HOLD [MODIFIED]

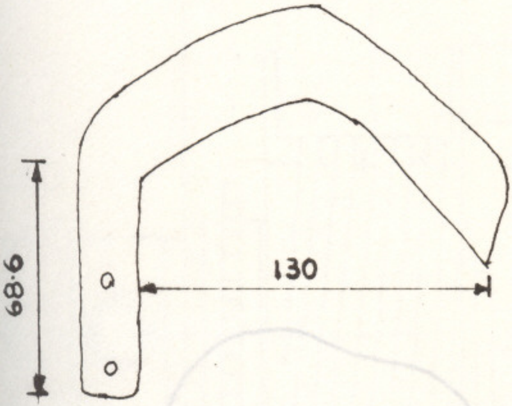


FIG 3·7(a) KNIFE (A)

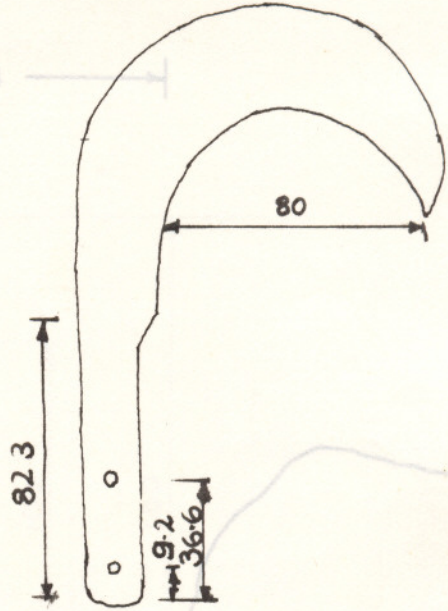


FIG. 3·7(b) KNIFE (B)

[ALL DIMENSIONS IN mm]

FIG 3·7 CUTTING BLADES

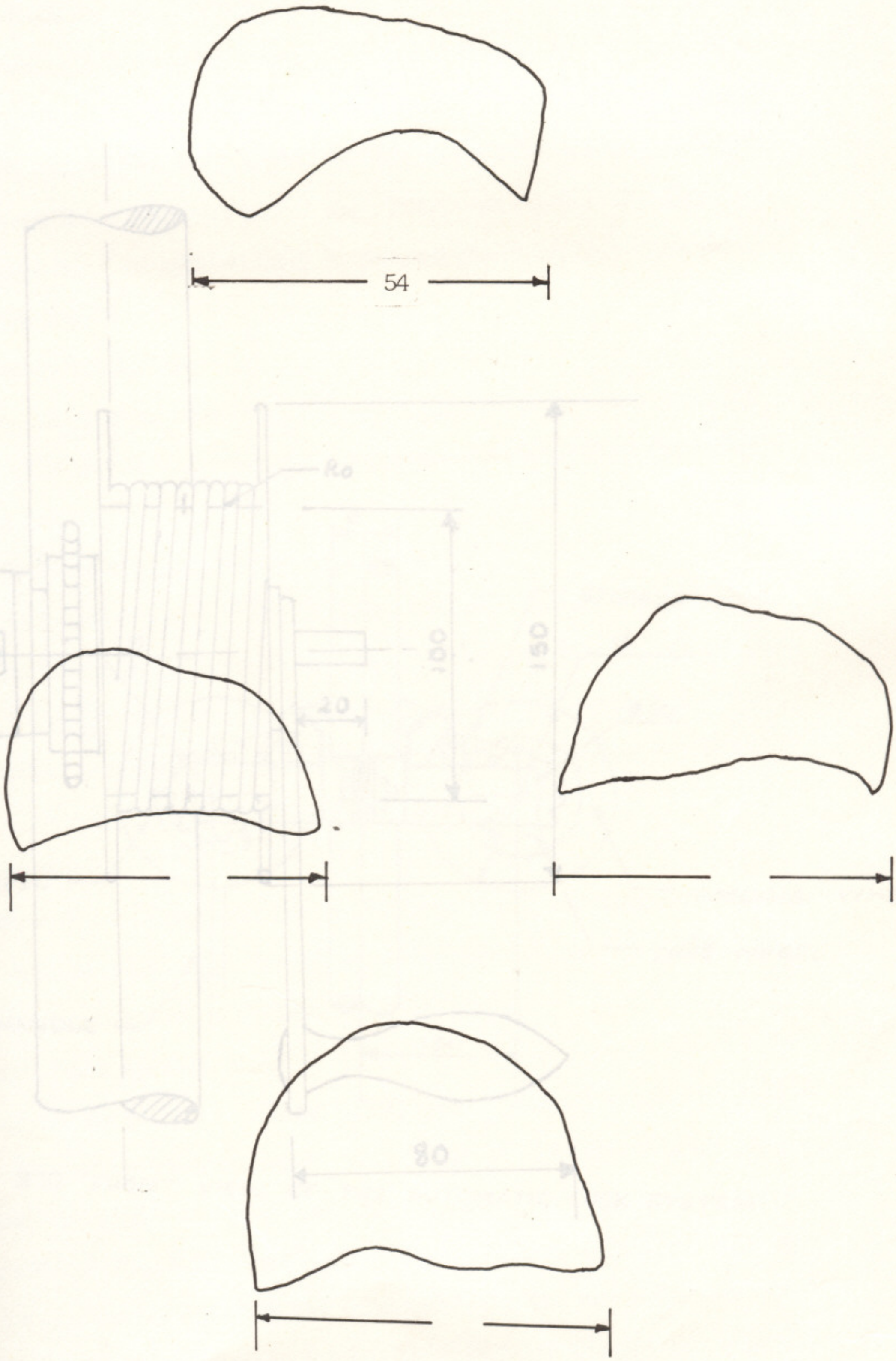


Fig. 3.8 PEDUNCLE CROSS-SECTION.

ALL DIMENSIONS IN MM

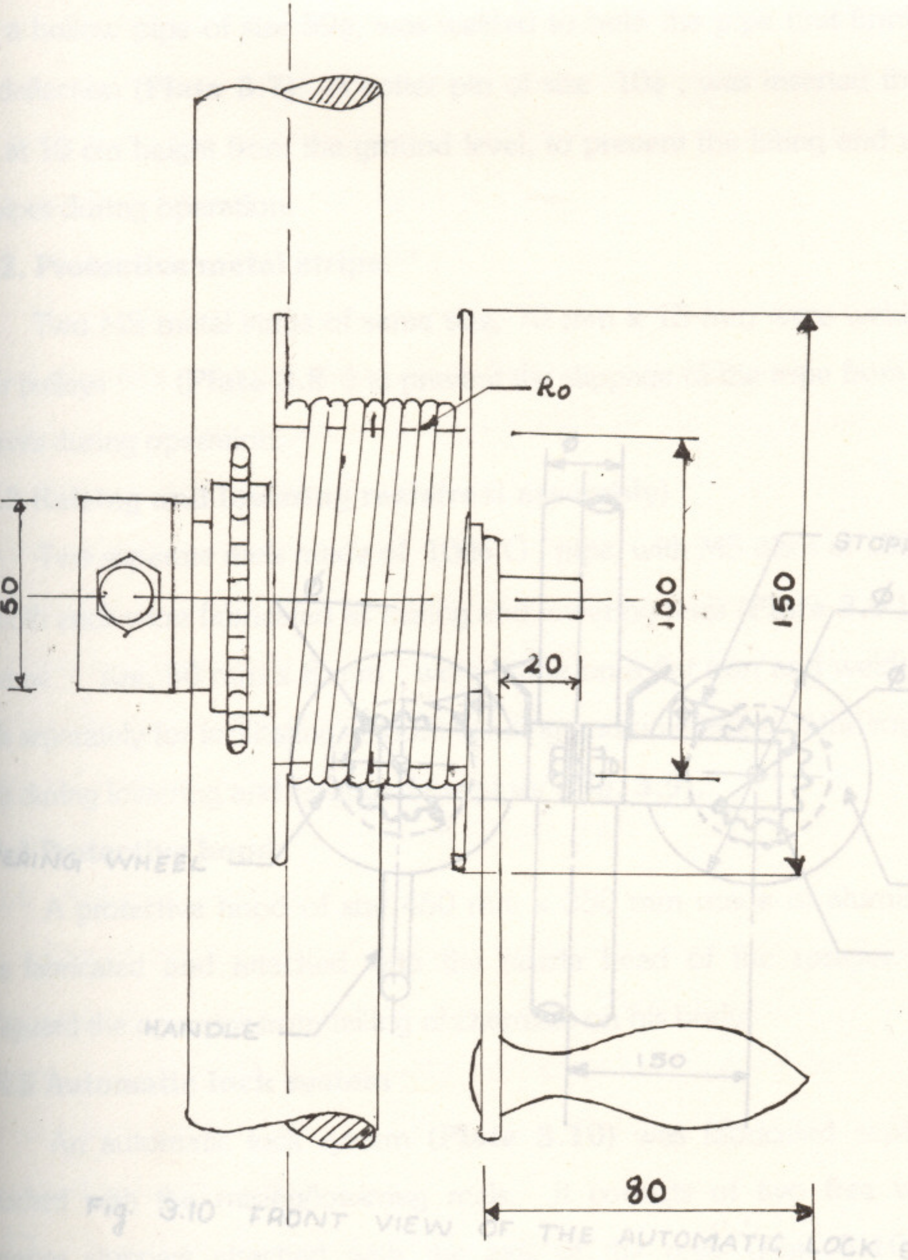


FIG 3.9 FRONT VIEW OF RAISING OR LOWERING WHEEL

[ALL DIMENSIONS IN MM]

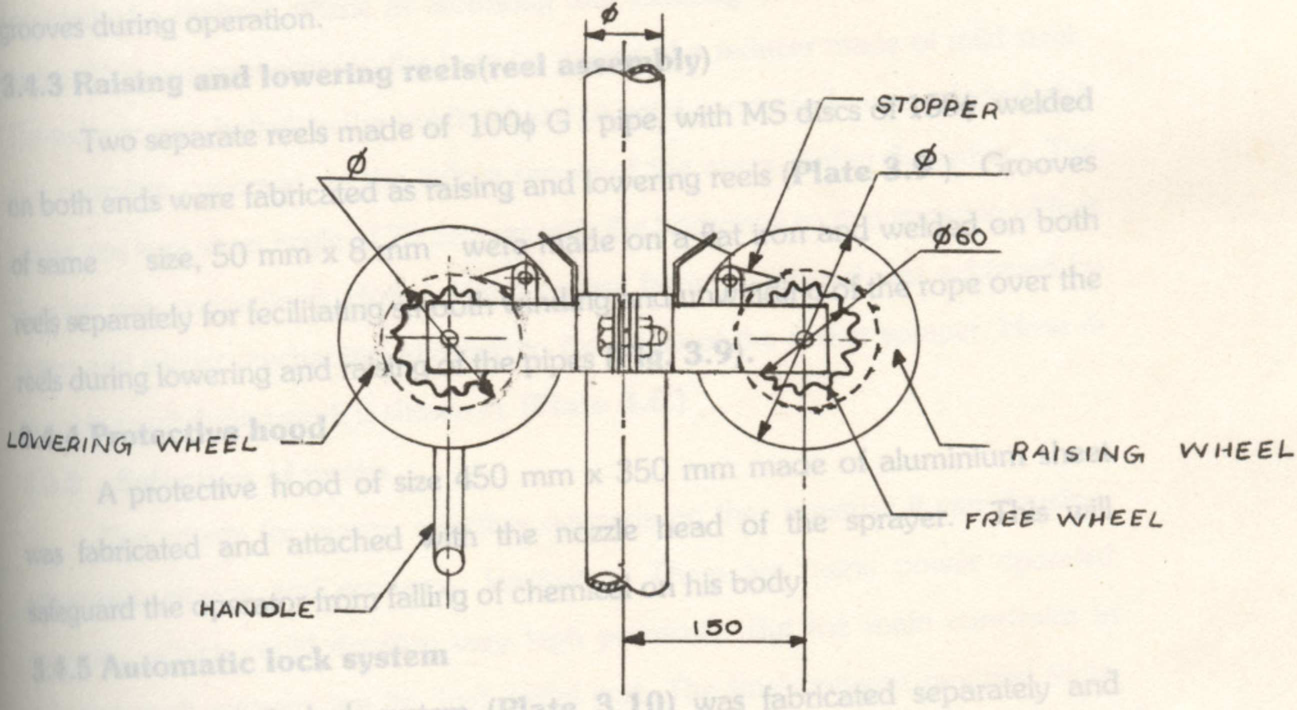


Fig. 3.10 FRONT VIEW OF THE AUTOMATIC LOCK SYSTEM

3.4.1 Base with hold

A base made of MS channel sections of size 200 mm X 100 mm as a rectangular frame 540 mm X 320 mm in size are shown in **(Fig. 3.6).** At its left side, a hollow pipe of size 59ϕ, was welded to hold the pipe unit firmly without any deflection (**Plate 3.7**). A cotter pin of size 10ϕ , was inserted through the pipe at 10 cm height from the ground level, to prevent the lifting and rotation of the pipes during operation.

3.4.2. Protective metal strips.

Two MS metal strips of same size, 70 mm x 15 mm were welded on the outer pulleys **(Plate 3.8**) to prevent the slippage of the rope from the pulley grooves during operation.

3.4.3 Raising and lowering reels(reel assembly)

Two separate reels made of 100ϕ G I pipe, with MS discs of 150ϕ welded on both ends were fabricated as raising and lowering reels (**Plate 3.9**). Grooves of same size, 50 mm x 8 mm were made on a flat iron and welded on both reels separately for fecilitating smooth winding and unwinding of the rope over the reels during lowering and raising of the pipes **(Fig. 3.9).**

3.4.4 Protective hood

A protective hood of size 450 mm x 350 mm made of aluminium sheet was fabricated and attached with the nozzle head of the sprayer. This will safeguard the operator from falling of chemical on his body.

3.4.5 Automatic lock system

An automatic lock system **(Plate 3.10)** was fabricated separately and attached with the raising/lowering reels. It consists of two free wheels with separate stoppers attached with the axis of the reels **(Fig. 3.10).** During raising/lowering of the pipe, both free wheels rotate in opposite directions. During raising of the pipes, lock the lowering free wheel with the stopper and rotate the raising reel in anti-clock wise direction. If it has to be stopped at any intermediate position, put the stopper in the lowering free wheel. Similarly the lowering of the pipes was done in viceversa.

3.5 Areacanut Sprayer

Rocker sprayer, foot sprayer, knapsack sprayer etc. are some of the manually operated sprayers available in market. Rocker sprayer can develop higher pressure compared to foot sprayer. Rocker sprayer develops a pressure ranging from 14 to 18 kg/cm^2, which was greater than the required pressure for areca farm spraying. Also its compact size and long rocker arm made it ergonomically sound. Hence rocker sprayer is selected for this particular study.

3.5.1 Atomizing unit and hose

Hose selected for connecting rocker sprayer and atomizing device was 1 cm internal diameter. It was about 20 m length. The atomizing unit essentially consisted of a hydralic nozzle as atomizing unit tomizing device and a connecting device. This was connected to the hose by means of a reducer made of mild steel. The reducer was bolted to the holding head. A solid cone nozzle was selected as it give complete coverage on the inflore secure of the areca during flowering. The nozzle was kept at an angle of 70 degrees with the horizontal so that spraying of fruit bunches was conveniently done. Hand control from the ground was achieved by boom and trigger mechanism attached to the outlet of the rocker sprayer. Hose & atomizing unit during work is shown in (**Plate 3.6**.)

3.5.2 Selection of pump

The criteria for pump selection depends on the pressure it can develop, ergonomic aspects and economic feasibility. There are many power operated sprayers, which could develop very high pressure. But the main constraint in adopting such sprayers are its high initial cost. The total pressure required to be developed is shown in **Appendix II**

3.5.3 Operation procedure of the sprayer.

The hose of the sprayer was bolted to the holding head. The section hose of the rocker sprayer was dipped in a bucket. Bordeaux mixture of one percent was used for testing the arecanut sprayer. The procedure for preparation of the bordeaux mixture is shown in **Appendix V**. The holding head with nozzle was lifted manually until required hight was covered. Thus with this mechanism, the delivery hose with nozzle at its tip was raised to the top.

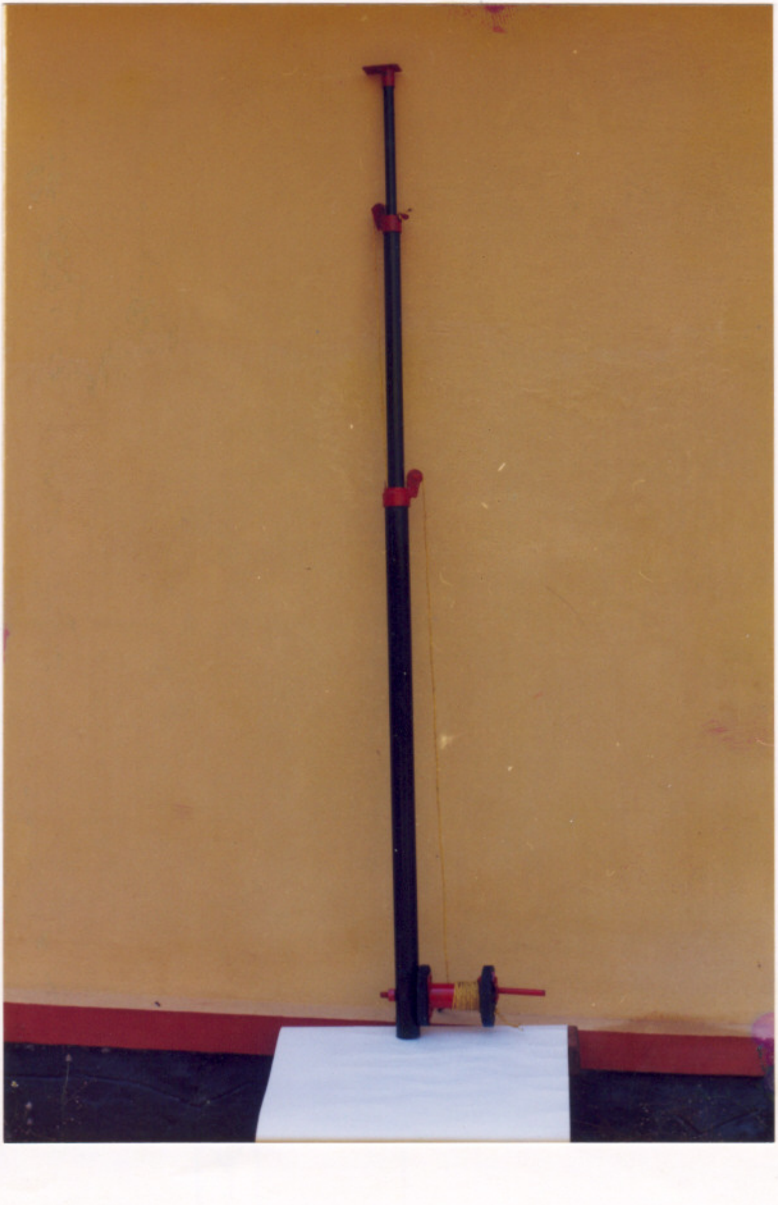
By the reciprocating motion of the rocker arm, sufficient pressure to atomize the spray fluid developed inside the rocker sprayer and hence spraying was done at the top of areca tree.

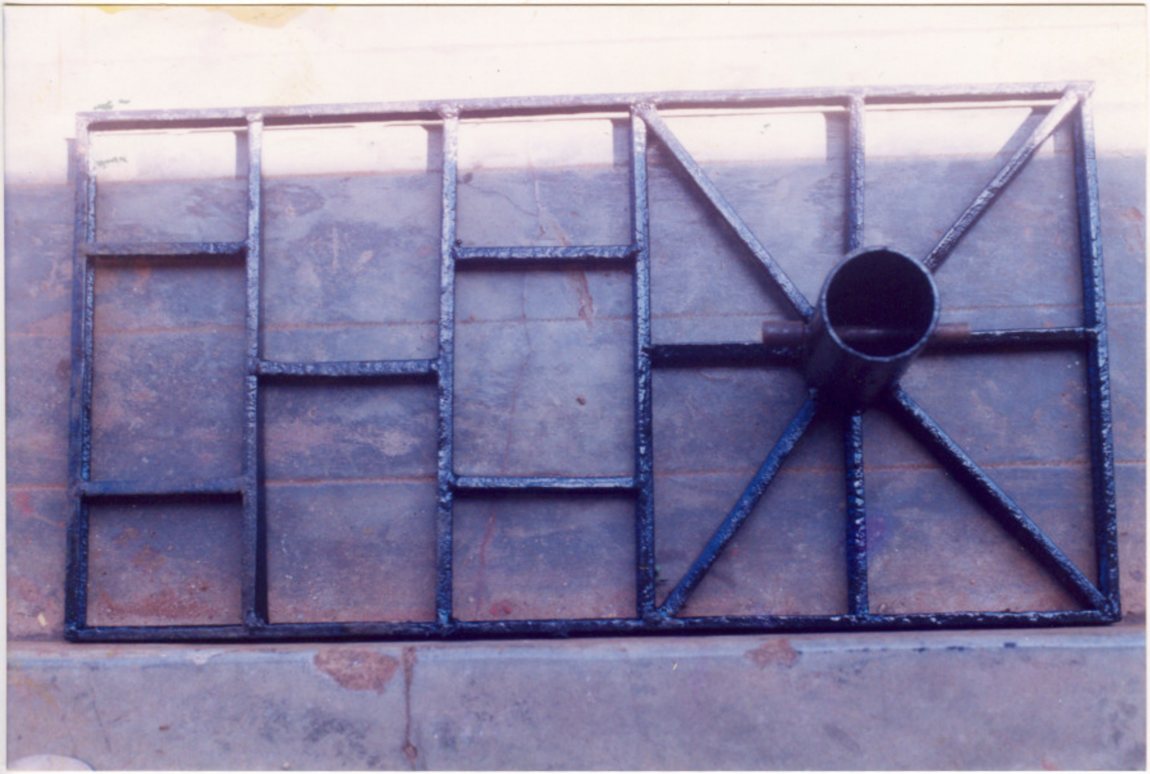
3.6 Field Testing and Performance Evaluation

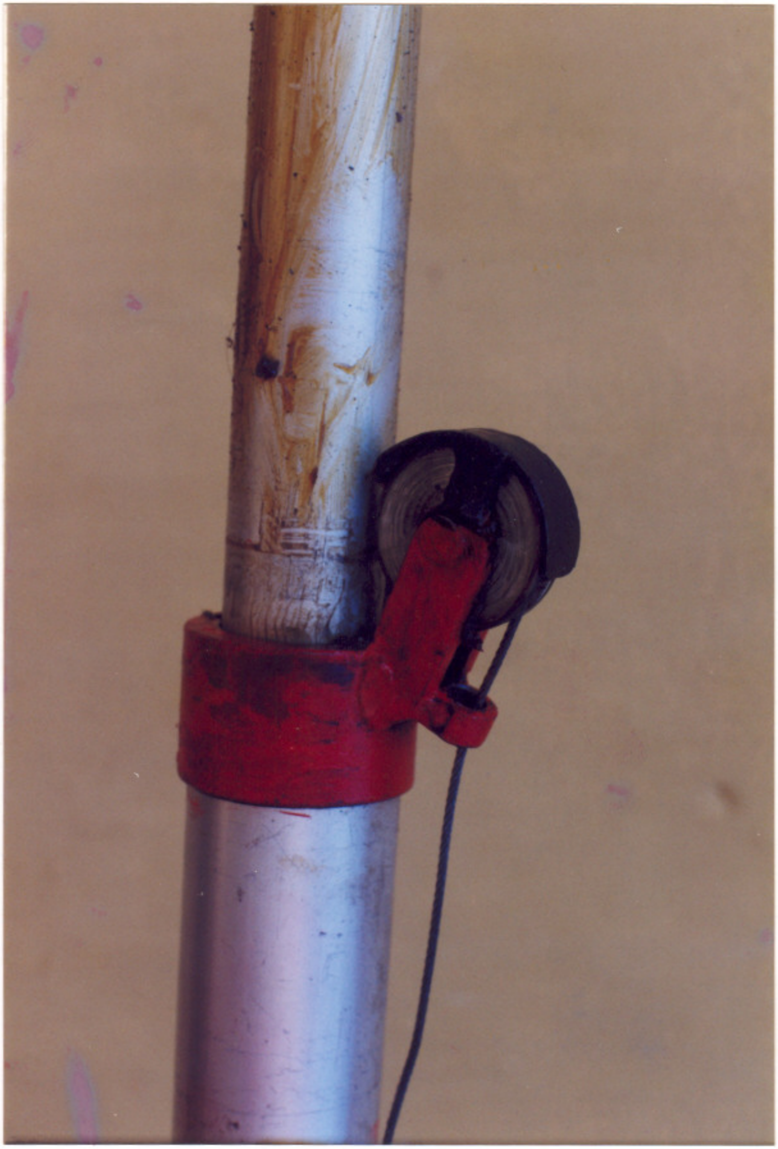
The performance of the arecanut harvester cum sprayer was tested for various field conditions in an arecanut farm of a local farmer in Tavanur. Major parameters considered were lifting capacity of the lifting mechanism, maximum height at which it can cover, performance efficiency during harvesting, selection of suitable knife among the two types tested, performance efficiency during spraying, and cost of operation.

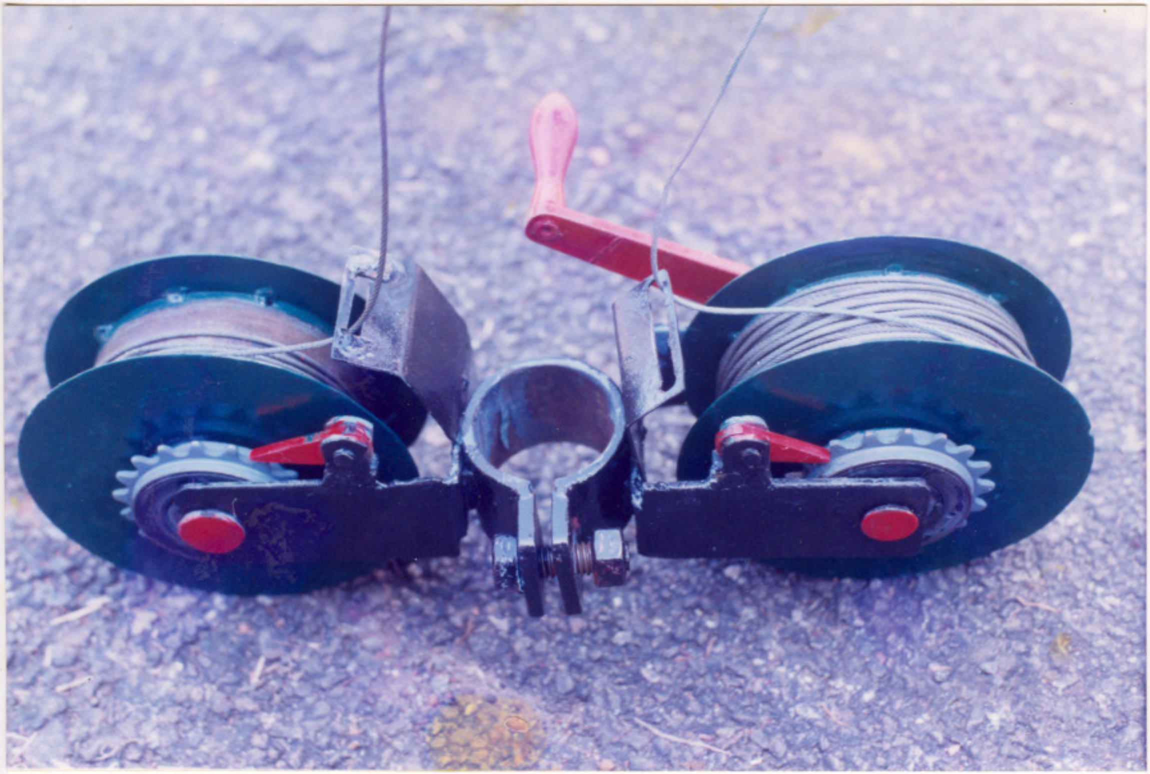
3.7 Cost of Operation

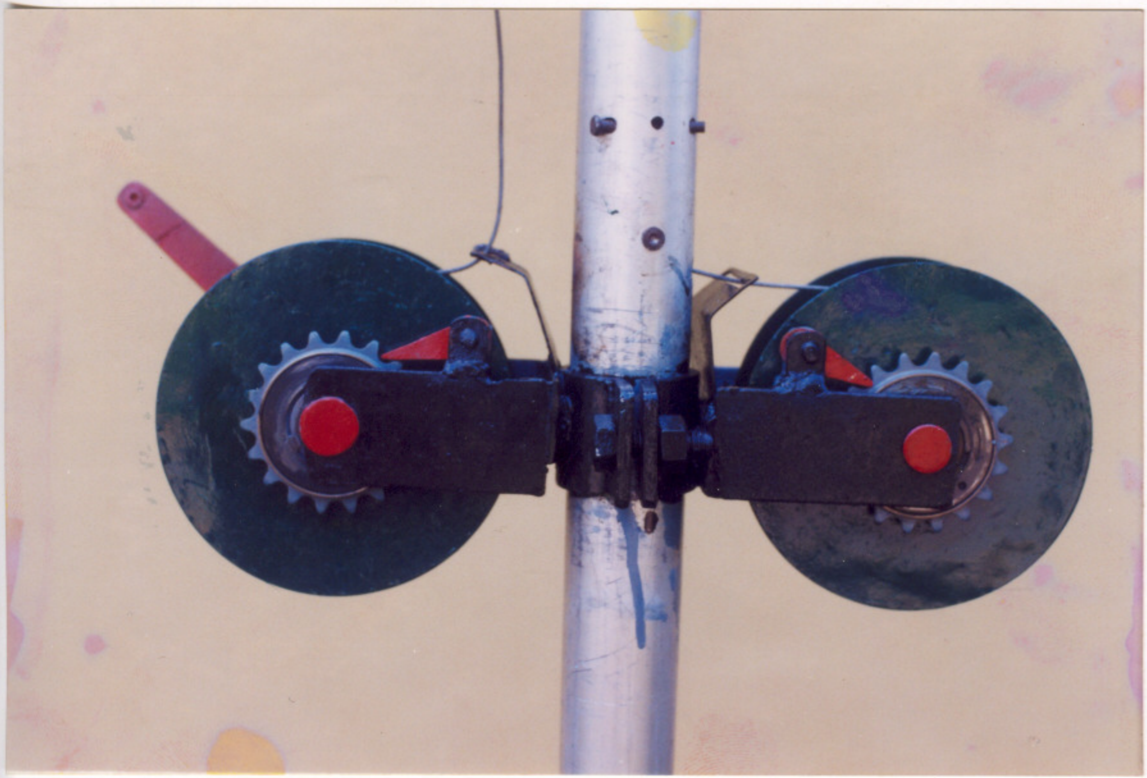
Cost of operation for the harvesting and spraying in both mechanical and mannual method is seperately shown in **Appendix VI and VII.**











RESULTS AND DISCUSSION

This chapter deals with the results of experiments conducted to evaluate the performance of the original and modified models of the harvester cum sprayer and its comparative performance with the manual method.

The non availabilty of the skilled labourers being a serious constraint for the arecanut cultivators, an arecanut harvester cum sprayer was fabricated and tested. This equipment was evaluated to find whether it accomplish the cultivators goal.

In this chapter, results obtained while testing the performance of newly developed equipment for areca harvesting and spraying is provided. Various parameters, which were under study while testing were maximum height attained by the lifting mechanism, deflection of the lifting mechanism, ease of operation, selection of suitable knife for harvesting, spraying efficiency and economic aspects.

4.1 Maximum Height

The maximum height refers to the fetch of the equipment upto which it can be operated . It was found to be 10.9 m . The compacted height was 5m . Hence it could be uesd for trees up to a height of 10 m. If necessary, more numbers of concentric pipes can be used to increase the height.

4.2 Selection of Suitable Knife.

From the **Fig 3.7(a)** it is clear that knife of throat clearance of 13 cm was easy to cut . The size and shape of cross section of the arecanut penducle is shown in **Fig 3.8**. The cross section of peduncle almost resemble the knife A. Hence knife (A) was selected.

4.3 Deflection

The equipment in compacted position has no deflection at all. Since lifting was done by supporting against areca tree using a clamp, there was no deflection during the operation.

4.4 Ease of Operation

To study the ease of operation, the time taken for raising, locking, harvesting/ spraying , lowering and transport were noted for the original model shown in **Table 4.1** and **Table 4.2.** Average time for harvesting was found to be 131 sec and for spraying was 170 sec.

During raising and lowering, whole equipment was supported by ground . It was done by raising /lowering each pipe one after another using a reel assembly. Since the material used for pipe being aluminium the entire system was very light ie, only 10 kg . Hence the equipment could be easily carried by a single man.

4.5 Effects Due to Modifications

By attaching a base with the pipe system, it become more easy to hold the entire unit both in use and resting times. By firmly putting one of the leg of the operator on the base, the raising and lowering will also become easy.

By providing the metal strips over the outer pulleys, the fear of sliding off the rope from the grooves was totally eliminated. Also the raising and lowering can be accomplished very smoothly.

As the sizes of the raising and lowering reels were enlarged, it requires less number of revolutions during raising and lowering the pipes. Because of the grooves specially drilled on the flat iron, there was a gradual winding and unwinding of the rope over the reels. This will further facilitate easy operation.

For the protection of the operator during spraying, a hood was provided with the nozzle head. This provision helped the operator from falling of spray chemicals due to drift.

A special type automatic locking system was fabricated and attached with the real axis. Its major advantage is that by any means, if the pipes slides down due to its own weight it can be locked by just putting the stopper on the lowering free wheel. Also, it helps for locking at any intermediate position of the pipes. Thus, due to these modifications, the system efficiency become increased.

The time taken for raising and lowering of pipes during harvesting/spraying was very much reduced due to these modifications, the results obtained during field tsting are given in **table 4.3** and **4.4**

Table 4.1 Time Taken for Harvesting (original model)

No. of Trees	No. of Bunches	Time for Raising (Sec)	Time for Locking(Sec)	Time for harvesting(Sec)	Time for Lowering(Sec)	Time for Transport(Sec)	Total Time (Sec)
1	2	40	3	3	35	50	131
2	3	78	6	6	70	100	260
3	5	118	8	8	105	150	389
4	7	157	11	10	143	200	521
5	8	196	13	13	182	250	654

Table 4.2 Time Taken for Spraying (original model)

No. of Trees	No. of Bunches	Time for Raising (Sec)	Time for Locking (Sec)	Time for Spraying (Sec)	Time for Lowering (Sec)	Time for Transport (Sec)	Total Time (Sec)
1	1	46	3	40	35	50	174
2	1	78	6	82	70	100	336
3	1	118	8	120	105	150	501
4	1	157	11	160	143	200	671
5	1	196	13	210	182	250	851

Table 4.3 Time Taken for Harvesting (Modified model)

No. of Trees	No. of Bunches	Time for Raising (Sec)	Time for harvesting(Sec)	Time for Lowering(Sec)	Time for Transport(Sec)	Total Time (Sec)
1	2	15	3	13	47	78
2	3	28	6	25	92	151
3	5	42	8	37	131	218
4	7	56	10	48	174	288
5	8	70	13	60	221	364

Table 4.4 Time Taken for Spraying (Modified Model)

No. of Trees	No. of Bunches	Time for Raising (Sec)	Time for Spraying(Sec)	Time for Lowering(Sec)	Time for Transport(Sec)	Total Time (Sec)
1	1	15	40	13	45	113
2	1	28	82	25	87	222
3	1	42	120	37	133	332
4	1	56	160	48	173	437
5	1	70	210	60	216	556

4.6 Economic Aspects

Cost for harvesing and spraying for both modern and traditional method is given in **Appendix VI** and **VII.** The major difference in cost between traditional and modern method is mainly due to high wages of the skilled labourer.

SUMMARY AND CONCLUSION

Need of an efficient arecanut harvester cum sprayer was aggrevated by the lack of efficient labours in time. This prompted the scientists to develop many models of arecanut harvester cum sprayer of which none could be that much effective to meet allthe requirements of the farmers. Hence to overcome the limitation of existing models a new device was developed. An estimate shows that Kerala produces about 17466 million nuts from an area of 71676 ha (**Table 2.1 and Table 2.2**) in the year '94 -'95

The device developed basically consist of three concentric aluminium pipes attached by sockets. Raising and lowering of the pipes is facilitated by rope and pulley mechanism, which is driven manually through a reel assembly. Cutting blades was bolted to the holding head for harvesting and hydraulic nozzle connected to a hose was bolted to the holding head for spraying. A rocker sprayer has been selected for spraying pesticide.

From the field trials, it was revealed that the lifting mechanism properly functioned upto a height of 10.9 m without any problem of deflection. Its maximum extended height was found to be 10.9 m and compacted height was about 5.095 m. As it was made of aluminium pipes, it was light in weight, simple in construction, easy to operate and required only one operator for harvesting and spraying. The total weight of the equipment was only 10 kg .The device can harvest 1 bunch in 78 sec and spraying of 1 tree can be done in a time period of 113 sec. The cost of operation for harvesting is Rs. 1070/ha and for spraying is Rs. 1512/ ha.

In the original model there were some difficulties with its operation during harvesting and spraying. The major problems were with fixing the pipe system at a particular location, the slippage of the rope from the pulleys, more number of times the raising or lowering reels has to be rotated for raising and lowering the pipes, falling of chemicals over the operator during spraying, sliding down the top pipes by its own weight during operation etc. These difficulties were rectified by promptly equipping the original model with certain modifications like, attaching a base with hold, welding metal strips on the pulleys, enlarging the diameters of the raising/lowering reels, providing a protective hood with spray nozzle head and incorporating an automatic lock system with the raising and lowering reels respectively. These modifications helped to operate the equipment more smoothly and conveniently.

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APPENDIX - I

Common Diseases and Pests affecting arecanut palms

Diseases and Pests	Symptoms	Remedy
Mahali (Koleroga or Fruit rot)	Fallen nuts discoloured and with a whitish felt	Spraying of 1% Bordeaux mixture two times, before and after monsoon
Stem Bleeding	A reddish brown ooze from the stem cracks. Large cavities are formed inside stem	Scooping out the diseased tissues; sterilizing the open wound with burning torch
Foot rot	Stem cracks giving out dark brown ooze	Sulphur is deposited on ground around the tree
Leaf rot	Burnt appearance of leaves	1% Bordaux mixture is used
Scale insects and mealy bugs	It will affect the vitality of plant adversly	Spray 0.4% Diazinon of DDVF
Aphid	-do-	-do-
Arecanut beetle	Feed on the leaves and ripening fruits	Spray 0.2% BHC
Mites	Devitalize the tender plant parts	Dust Sulphur
Spindle bug	Dark brown patches appear on the leaves	50 % BHC is applied
Tirathalia Mundella (Pukkula puzhu)	Flowers are destroyed	Malathayon is applied
Leukofilis Lepedphora (Vella puzhu)	Tender roots are destroyed	Aldrin or clorden are added to ground

(Source : Hand Book of Agriculture, ICAR, New Delhi, 1992)

APPENDIX II

PRESSURE CALCULATIONS

Pressure required at nozzle for proper atomization = $2.812\ kg/cm^2$.

Atmospheric pressure = $1 kgf/cm^2$

Pressure required to reach cropheight upto 10 m = $1 kgf/cm^2$

(Assuming density of spary fluid is same as water)

$$Friction\ loss\ in\ hose = \frac{4flv^2}{2gd} = \frac{4\,x\,.02\,x\,20\,x\,(.0955)^2}{2\,x\,9.81\,x\,.01}$$

$$= .07x10^{-4}\ kgf/cm^2$$

Total pressure required to be developed = $2.812+1+1+.000007$

= $4.812\ kgf/cm^2$

The sprayer must be capable of developing a pressure equal to or greater than $4.812\ kgf/cm^2$

APPENDIX III

SPECIFICATIONS OF ARECANUT HARVESTER CUM SPRAYER

(original model)

ITEMS	SPECIFICATIONS
Maximum height attained	: 10 m
Compacted height	: 4 m
Weight	: 9.2 kg
Coupling unit	: Socket
Cutting blade	: A cast iron blade having throat clearance 130 mm
Supporting unit	
Frame	: Aluminium pipes of 50.8 mm, 38.1 mm and 25.4 mm diameters of 3.6 m length
Clamp	: U - shaped clamp of 60 cm inner diameter made of cast iron
Other details	
Reel assembly	: Separate raising and lowering reels on a shaft with ratchet and lock key
Labour requirement	
Harvesting	: One person
Spraying	: Two persons at a time
Costs/hectare	
Harvesting	: Rs. 1835.55
Spraying	: Rs. 6120

APPENDIX IV

SPECIFICATIONS OF MODIFIED ARECANUT HARVESTER CUM SPRAYER

ITEMS	SPECIFICATIONS
Maximum height attained	: 10.9 m
Compacted height	: 5.095 m
Weight (including base)	: 13.1 kg
Coupling unit	: Socket
Cutting blade	: A cast iron blade having throat clearance 130 mm
Supporting unit	
Frame	: Aluminium pipes of 50.8 mm, 38.1 mm and 25.4 mm diameters of 3.6 m length
Clamp	: U - shaped clamp of 60 cm inner diameter made of cast iron
Other details	
Raising/ Lowering reels	: Separate raising and lowering reels on a shaft with automatic lock system
Labour requirement	
Harvesting	: One person
Spraying	: One person
Pulleys	: 2 Nos. with metal strips
Spraying Unit	: Nozzile head with protective hood
Costs/hectare	
Harvesting	: Rs. 1070/ha
Spraying	: Rs. 1512/ha

APPENDIX - V

PREPARATION OF BORDEAUX MIXTURE (1 PERCENT)

One kilogram of copper sulphate ($CuSO_4$) is dissolved in 50 litre of water and another 50 litre, milk of lime, is prepared with one kilogram of quicklime. $CuSO_4$ solution is poured in milk of lime, slowly, with stirring. The vessel used must not be wooden, earthern or copper vessel. Test it before apply by dipping a polished knife in it. If it show reddish colour add more lime till blade is not stained on dipping.

APPENDIX VI

COST ANALYSIS

(for the developed model of arecanut harvester - cum - sprayer)

MODERN METHOD

For Harvesting

Initial cost of lifting mechanism	=	Rs. 1250/-
Initial cost of cutting blade	=	Rs. 50/-
Initial cost of arecanut harvester (C)	=	Rs. 1300/-
Useful life period (L)	=	10 yrs
Annual working hours (H)	=	750 hr
Salvage value (S)	=	10% of initial cost
Interest on initial cost, (I)	=	15% annually
Repairs and maintenance	=	3% of initial cost.
Labour wage	=	Rs. 150/- per person per day of 8 hr.
Lubrication charge	=	1% of initial cost.

Fixed cost

$$Depreciation = \frac{C-S}{L} = \frac{1300-130}{10} = Rs.117/-$$

$$Interest = \frac{C+S}{2} x\, I = \left(\frac{1300+130}{2}\right)\frac{15}{100} = Rs.107.25/-$$

$$Total\ fixed\ \text{cost} = Rs.224.25/yr$$

Variable Cost

$$Repairs\ and\ Maintenance = 1300 x \frac{3}{100} = Rs.39/-$$

$$Lubrication\ Charges = 1300 x \frac{1}{100} = Rs.13/-$$

$$Labour\ Charges = \frac{150 x 750}{8} = Rs.14062.5/yr$$

$$Total\ Variable\ cost = Rs.14114.5/yr$$

$$Total\ Cost\ per\ hour = \frac{14338.75}{750} = Rs.19.12/hr$$

$$Total\ Cost\ per\ day = 19.12 x 8 = Rs.152.96/day$$

Total Number of days required for operational of 1 ha

$$Total\ area = 10000 m^2$$

$$Spacing = 4 m^2$$

$$Therefore, Total\ plants = 2500$$

Average time required for one plant = 78 sec

$$Therefore, for\ 1 ha = \frac{78x2500}{3600x8} days = 7\ days$$

$$Total\ Cost\ per\ hectare = 152.96 x 7 = Rs.1070/ha$$

For Spraying

Initial cost of lifting mechanism	=	Rs. 1250/-
Initial cost of spraying mechanism	=	Rs. 1700/-
Initial cost of arecanut sprayer (C)	=	Rs. 2950/-
Useful life period (L)	=	10 yrs
Annual working hours (H)	=	750 hr
Salvage value (S)	=	10% of initial cost
Interest on initial cost (I)	=	15% annually
Repairs and maintenance rate	=	3% of initial cost
Labour charges	=	Rs. 150/- per person per day of 8hr.
Lubrication charges	=	1% of initial cost

Fixed cost

Depreciation = $\frac{C-S}{L} = \frac{2950-295}{10}$ = Rs. 265.5/-

Interest = $\left[\frac{C+S}{2}\right] I = \left[\frac{2950+295}{2}\right]\frac{15}{100}$

$$= \text{Rs. } 243.38/-$$

Total fixed cost = Rs. 508.88/ yr

Labour charge $= \frac{150 \times 750 \times 1}{8}$

= Rs. 14062.5/ yr

Repair and maintenance $= \frac{2950 \times 3}{100}$

= Rs. 88.5/-

Lubrication Charge = 2950 x 0.01 = Rs.. 29.5 /yr

Total variable cost per year = Rs. 37742.9/ yr

Total cost per year = Rs. 14180.5/ yr

Total cost per hour $= \frac{14180.5}{750}$

= Rs. 18.90/ hr

Total cost per day = 18.9 x 8 = Rs. 151.26 /day

Total number of days required for operation of one hectre

Average time required for one plant = 113 sec

Total plants in one ha = 2500

Therefore total time (in days) $= \frac{2500 \times 113}{3600 \times 8}$

= 10 days

Therefore Total cost per hectare = 151.26 x 10 = Rs. 1512/Ha

APPENDIX VII

COST ANALYSIS

(for manual harvesting and spraying)

Harvesting

1 ha			=	10,000 m^2
area per plant	=	2 x 2	=	$4m^2$
no. of trees per ha			=	2500

From experience for harvesting 1 acre time required is 4 to 5 days. (In one day, work is done for 4 hours)

2.5 acre	=	1 ha
Time for 1 ha	=	10 to 12.5 ≅ 13 days
Labour Charge	=	Rs. 150/day
Cost of harvesting one ha	=	13 x 150 = Rs. 1950/ha

Spraying

For traditional spraying of 1 acre we require 6 days (In one day, work is done for 4 hours).

Therefore ,time required for 1 ha	=	15 days
Number of labours required	=	2
Labour Charge (one skilled labour Rs. 150/day and one unskilled labour Rs. 100/day)	=	250/day
So cost of spraying 1 ha	=	*15 x 250 = Rs. 3750/ha*
Total cost of operation	=	1950+3750
	=	Rs.5700/ha

DEVELOPMENT AND TESTING OF A MODIFIED ARECANUT HARVESTER - CUM - SPRAYER

By

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ABSTRACT OF THE PROJECT REPORT

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in
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ABSTRACT

Arecanut palm *(Areca catechu Linn)* is one of the important plantation crop grown largely in Kerala. Harvesting and spraying these palms have been identified as highly labour intensive and difficult task performed in farms. The existing method of harvesting and spraying are done by manual climbing. It is laborious, time consuming, hazardous and cannot ensure the timeliness of operation. Hence a telescopic pipe arrangement with continuos internal rope system was fabricated for harvesting and spraying of areca palms upto a height of 10 m. The continuos rope was wound on reels, which was operated by a handle to raise and lower the harvesting/spraying units. The minimum time for harvesting from one tree was 78 sec and that for spraying was 113 sec. This originally developed model have been modified by providing a base for fixing the pipe system, welding metal strips on pulleys to avoid slippage of rope, enlarging the lowering/raising reels to reduce the number of revolutions, attaching with a protective hood to protect the operator from falling of spray chemicals due to drift and providing an automatic lock system with the reel assembly to facilitate intermediate locking of the pipes. The cost of operation per hectare for harvesting and spraying was Rs. 1070 and Rs. 1512 respectively. Even women can operate it easily. Due to the modifications made on the original model, the operation of the unit become so easy, even for women.