Compendium of Farm Machinery developed under the project Development of Innovative Farm Mechanization (DIFM) Package for Kerala

Prepared & edited by

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Compendium of Farm Machinery developed under the project

"Development of Innovative Farm Mechanization (DIFM) Package for Kerala"

A compilation of technologies developed under the project 'Development of Innovative Farm Mechanization (DIFM) Package for Kerala'

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FOREWORD

The progress of farm mechanization programmes has been slow in India during last few decades. The level of mechanization in agriculture in the country lags behind to that of the developed countries and many of the developing countries. Due to scarcity of labourers and high production cost, the demand for modern agricultural machines and equipment has shown an increasing trend recently. The progress of farm mechanization in terms of demand for farm machinery is estimated to be about 1.0 to 1.5 per cent per annum.

Acute shortage of labours and high wage rates are the major two challenges in agriculture production, particularly in Kerala. Hence introduction of labour saving and location specific farm implements and machinery are essential to safe guard from these challenges to sustain the agriculture in the state. The machines should be user friendly and cost effective even to use in the fragmented or homestead lands. Efforts to develop such innovative machines through local manufacturers or entrepreneurs are to be accelerated and also to be made available to the farmers through custom hiring practice or at cheaper rate. With these in view, a major research project "Development of Innovative Farm Mechanization Package for Kerala" (DIFM) was implemented by Kerala Agricultural University in collaboration with Dept. of Agriculture during 2009-14 with a financial outlay of Rs. 4.0 Crores funded by State Planning Board. The project was implemented under the Principal Investigatorship of Dr. Jayan, P. R., Assoc. Prof. & Head, Dept. of Farm Power Machinery and Energy, Kelappaji College of Agricultural Engineering and Technology, Tavanur. Around 18 machines were developed for use in the cultivation and processing of crops like paddy, coconut, pepper and vegetables, which can be operated either by manual and mechanical power sources. Many of the developed technologies were published as research/ popular articles, demonstrated in farmer's fields, filed applications for granting patent and handed over for commercial production. As an alternative to the low efficient conventional pumping system prevalent in Kole lands and Kuttanad viz.,'Petti and Para', a vertical axial flow propeller pump was modified and installed at Kadumpattupadam Kole Padavu, Karalam, Thrissur through collaborative research under the project. After successful testing, it was handed over to the famer groups for paddy cultivation. As a part of the project, a working model of Pokkali paddy harvester was also developed through public - private partenership mode, which requires further refinement for field adoption.

I am happy that the compendium of various machines developed under the project were prepared and published. I hope this will be of immense help to agricultural and technology aspirants of our State. Due to acute shortage of labourers as well as high wage rate in the state, it is essential to introduce newly developed technologies and farm machines for sustaining the agriculture and for increasing the productivity of the State. I take this opportunity to express my heartfelt thanks to the Technical Advisory Committee members who guided and monitored the DIFM project to develop the technologies useful at the field level. Also, I express our gratitude to the Govt. of Kerala for the financial support and timely orders for the successful completion of the project. I congratulate Dr. Jayan, P. R. Assoc. Prof. & Head, Dept. of Farm Power Machinery and Energy, Kelappaji College of Agricultural Engineering and Technology, Tavanur and his team for the successful completion of the project and compilation of the research outputs in a simplified manner with all the required technical details. The concepts and methods of each and every technology developed under the project are easily understandable. I wish that the farm equipments and machines developed under the project will be acceptable for large scale adoption among the farming community.

Dr. T. R. Gopalakrishnan
Director of Research
Kerala Agricultural University

Vellanikkara
31.03.2015

PREFACE

As we all know that the food grain production in our country has increased from 51 million ton in 1951 to 230 million ton in 2008 with surplus for export. The Indian Council of Agricultural Research in its Vision 2020 document has projected the demand of food grains will be about 293.6 million ton by 2020. In Kerala, the area under cultivation of various crops has been found decreasing continuously over the past decades. It is obvious that in accordance with the decreasing trend of cultivable area, the food grain demand is increasing. In order to bridge the gap between these two, the only possible way is to increase the productivity from the available cultivable land. Though we are blessed with high yielding varieties (HYV) of seeds and planting materials, good quality fertilizers, promotion through giving subsidy and insurance to the farmers etc., the productivity is not found increasing. Also, due to the increased labour cost and non-availability of labourers, farmers are reluctant to continue the existing farming activities. This ultimately causes to less agricultural production from their lands. It is reported that at present there is 64000 ha of land is lying below sea level in Kerala, of which, 40000 ha is in Kuttanad, 8500 ha is in Pokkali area, 13000 ha is in Kole land and 2500 ha is in Kaipad. Developing machines for these paddy areas for seed bed preparation, weeding, pumping of water, harvesting etc., were the major issues to be solved by the researchers. In coconut cultivation, palm climbing, large scale husking of coconut, separating of copra from shells etc., were observed as researchable issues. Vegetables, root crops and banana are other major crops cultivated by the farmers in our state. Land preparation, uprooting the tubers from the soil, clearing the land after harvest of banana, pulverizing organic manures for making potting mixture/grow bags, mulching machines for controlling weeds etc., were also considered as research problems. In order to develop innovative farm machines and equipment for the above said farm operations in paddy, coconut, vegetables and pepper, a research project "Development of Innovative Farm Mechanization Package for Kerala" (DIFM) was implemented at KCAET, Tavanur. Accordingly, several machines were developed and it is illustrated in different chapters of this compendium.

This compendium contains three chapters. Each chapter deals with the basic need of the machine with its technical and performance aspects. Also, it is illustrated with schematic and orthographic projections and photographs. Technical information is separately given at the end of the explanation of each machine. The first chapter deals with the machinery for paddy viz., Kaipad bed former as an attachment to a

tractor, green shelter for mat nursery, herbicide applicator as an attachment to a mechanical transplanter, vertical axial flow pump as an alternative to 'petti' and 'para' and Pokkali paddy harvester. The second chapter includes machinery for coconut viz., KAU coconut palm climber, power operated continuous coconut husking machine, coconut splitter, copra separator and multifunction unit. The third chapter contains the details of machinery for vegetables and spices viz., KAU bed former suitable to mini tractors, coleus harvester as an attachment to a mini tiller, coleus peeler, thorny bush uprooter, banana sucker uprooting machine as an attachment to a tractor, tractor operated mulching machine, goat faecal pellet pulverizer and pepper harvester.

I take this opportunity to express my indebtedness to all the Technical Advisory and Project Advisory Committee members for making the project a grant success. The services of all Research Associates, Research Assistants, Technicians, Skilled labourers and office staff specially appointed for implementing the project works, including this compilation of the developed machines are hereby acknowledged. My sincere thanks to the teachers and technical supervisors of the Dept. of FPME for their help rendered during the implementation of the project. Also, I thank the co-operation provided by the faculties, technical and non-technical staff and farm labourers of KCAET. I express my gratitude to M/s. Kelachandra Precision Engineers, Kottayam and M/s. Das Engineering, Karalam, Thrissur for their contractual service towards the development and testing of Pokkali paddy harvester and axial flow pump respectively. I place my sincere gratitude to the staff of KAU Press, Mannuthy for their earnest efforts in printing this compendium.

I sincerely hope that this compendium of farm machines will be a valuable reference material to students, teachers, researchers, farmers and agricultural extension workers in the field of agricultural/mechanical engineering. Also, wish that the farm machines and tools/equipments developed under the project may be useful for the farmers of our country, particular to our state.

Tavanur,
31.03.15

Jayan P. R

CONTENTS

Chapter I

MACHINERY FOR PADDY

1. Kaipad bed former as an attachment to a tractor

Kaipad area lies in Kozhikode, Kannur and Kasargod districts of Kerala with a total area of 2500 ha. Most of the Kaipad area lies in Ezhome panchayath in Kannur district. The long narrow stretch of Kaipad with saline marsh lands adjoining Kuppam-Pazhayangadi river is affected by tides. Traditional cultivation methods are adopted for extensive cultivation in these fields. Fertilizers and pesticides are not used, where a few salt resistant varieties of rice are cultivated. The system of cultivation is a traditional integrated rice-shrimp farming in the brackish water areas, affected by tidal sea water. Also it is an age old practice of growing medicinal varieties of rice in northern Kerala. Hence, rice cultivation in this region needs proper soil management, especially to control soil salinity and pH. In order to achieve these controls, conventionally, mounds are prepared manually by using long handled spades. This cultivation practice is tedious, hazardous labour and time consuming farm operation. A tractor operated Kaipad bed former (Plate 1.1) was hence developed to make ridges in this region. It consists of tractor drawn suitably designed curved tynes and forming boards, attached to the 3-point linkage of tractor. The two forming boards, made of 4 mm thick MS sheets of size 90 x 40 cm spaced at 55 cm apart were fitted on a standard frame on either side of a standard. The forming boards are curved towards top at 40 degree to get a gently smooth curve on either sides. The bottom end of the standard was made as share which actually penetrates into the soil, which was set at an angle of 45 degrees. The leveling plate welded to the forming board compact the soil on the top of the bed by pushing the soil on to the top of the heap from its sides. The weight of the attachment is 135 kg. This unit can be attached to a 3-point linkage of a light weight 4-wheel tractor of 34 hp. The orthographic views of the bed former is shown in Fig.1.1. Both salinity and pH were controlled by making ridges by this mechanical device. The field capacity of the machine was 0.20 ha. hr^{-1} with a field efficiency of 74 %. The cost of preparation of mounds can be reduced exorbitantly by using the Kaipad bed former. The average bottom width and height of the seed bed obtained were 40-60 cm and 35-43 cm. The total cost of operation with tractor operated Kaipad bed former was Rs. 1560 per ha. Scale down prototype attachable to mini tractors can be used for upland vegetable cultivation.

Plate 1.1 Kaipad bed former (tractor operated) and the field operation

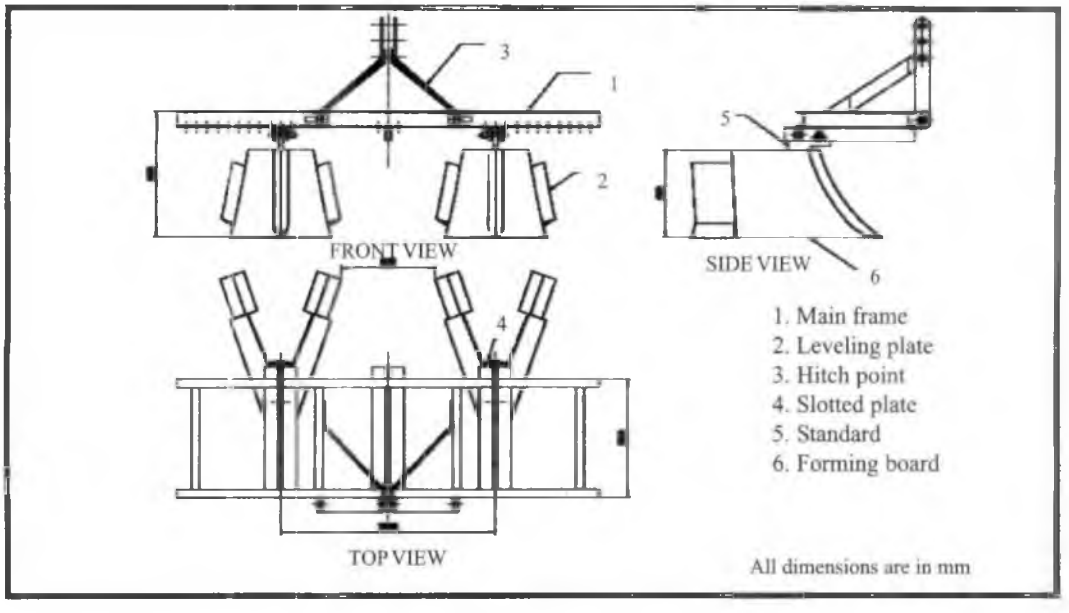

Fig. 1.1 Kaipad bed former

Technical specification:

- Mild steel main frame, two tynes (large wing type) each having two forming boards (90cm x 40cm)
- Width, height of the bed varies from 40 - 60 cm and 35 - 43 cm respectively
- Field capacity = 0.20 $ha.hr^{-1}$

2. Green shelter for mat nursery

Birds are the major cause of damage to crops, especially in rice and fruit crops. Farmers use a variety of methods to deter the birds for protecting their crops which include superficial poisoning of the crop by spraying, the use of noise alarms, shooting and trapping of birds. These types of problems are commonly associated with the

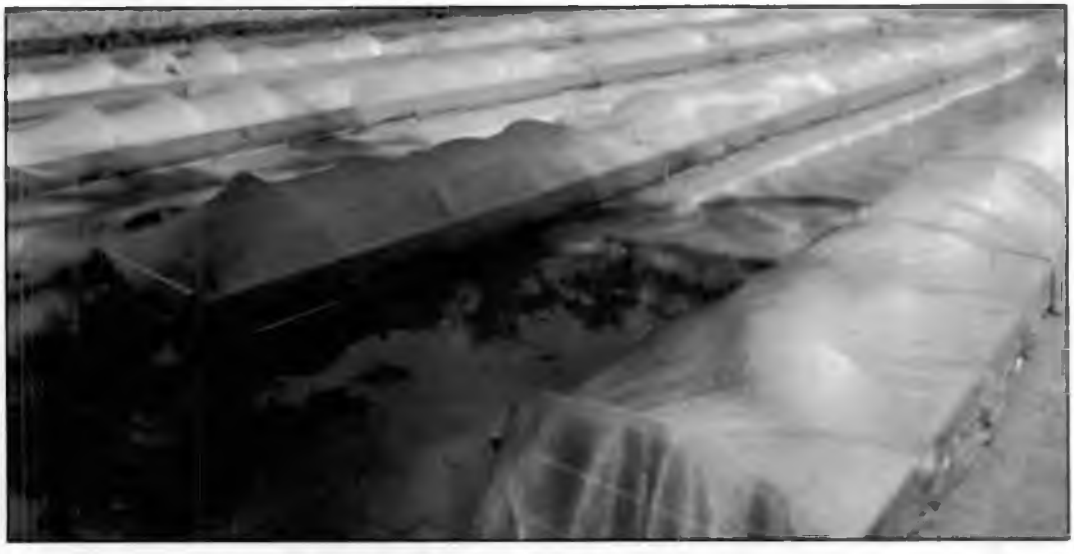

Plate 1.2. Green shelter for mat nursery

raising of mat nursery in paddy cultivation. In order to alleviate the problem, green shelters (Plate 1.2) were designed and constructed to protect the crop against birds. The shelters also protect the crops against heavy rainfall and allow the seedlings to grow in sufficient sunlight. The shelter comprises of aluminium frames of size 3.66 x 1.00 x 0.20 m and is covered by a shade net. Along the longitudinal length of the frame, GI wires at a width of 0.75 m were screwed to the aluminium frame to support the shade net. The GI wires are bent in the form of an arc so that the growth of the seedling is not affected. The details of the dimensions of the shelter are shown in Fig.1.2. The shelters are durable, economical and effective in protecting them at nursery against birds and rain fall. The cost of such a shelter is around Rs.300 per sq. m.

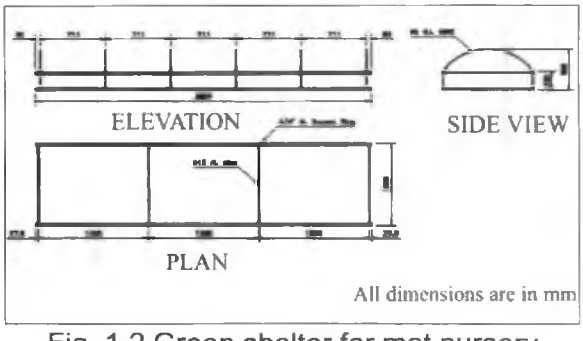

Fig. 1.2 Green shelter for mat nursery

3. Herbicide applicator as an attachment to a paddy transplanter

Weeds are the main cause of yield reduction in paddy. Conventionally, weed control in rice cultivation has mainly been carried out through a combination of water management and handweeding, but the latter is becoming less common due to shortage and high cost of labour. Herbicide use has been emerged as an alternate option for relatively cheap and efficient weed control in rice. Both direct sowing and transplanting are followed in rice cultivation, however, the latter is preferred due to high yield, though it is tedious, time consuming and more labour oriented. Mechanical transplanting alleviates these problems and assures optimum and uniform plant stand. Weeds can still be a major problem and pre-emergence herbicide application is often resorted to for its control. Manual spraying of herbicide incur additional cost and the application as an over the top treatment within 0 to 4 days after transplanting may sometimes cause phytotoxicity. A herbicide applicator which apply the herbicide only at the interspaces of planted hills at the time of transplanting itself, as an attachment to paddy transplanter was developed to overcome these problems.

Plate: 1.3 Herbicide applicator as an attachment to a paddy transplanter

The herbicide applicator (Plate 1.3) comprises of a tank, double acting positive displacement pump, spray boom with nozzles, pressure regulator and hose pipes for suction, delivery and over flow. A tank is used to store the herbicide solution of recommended dosage is fitted on a frame and placed above the transplanter seedling frame. A double acting positive displacement pump placed below the tank is directly coupled to an extended shaft of the clutch assembly unit of the paddy transplanter. A cam provided at the end of the extended main shaft converts rotary motion to reciprocating motion for the pump. Also, a clutch lever provided to engage or disengage the drive from the prime mover to the pump. While transplanting with the paddy transplanter, the clutch lever is engaged and hence the drive from the prime mover is transferred to the double acting positive displacement pump through the extended main shaft of the clutch assembly unit. Due to this, the pump receives the herbicide solution from the tank, pressurizes and delivers at the set pressure to the

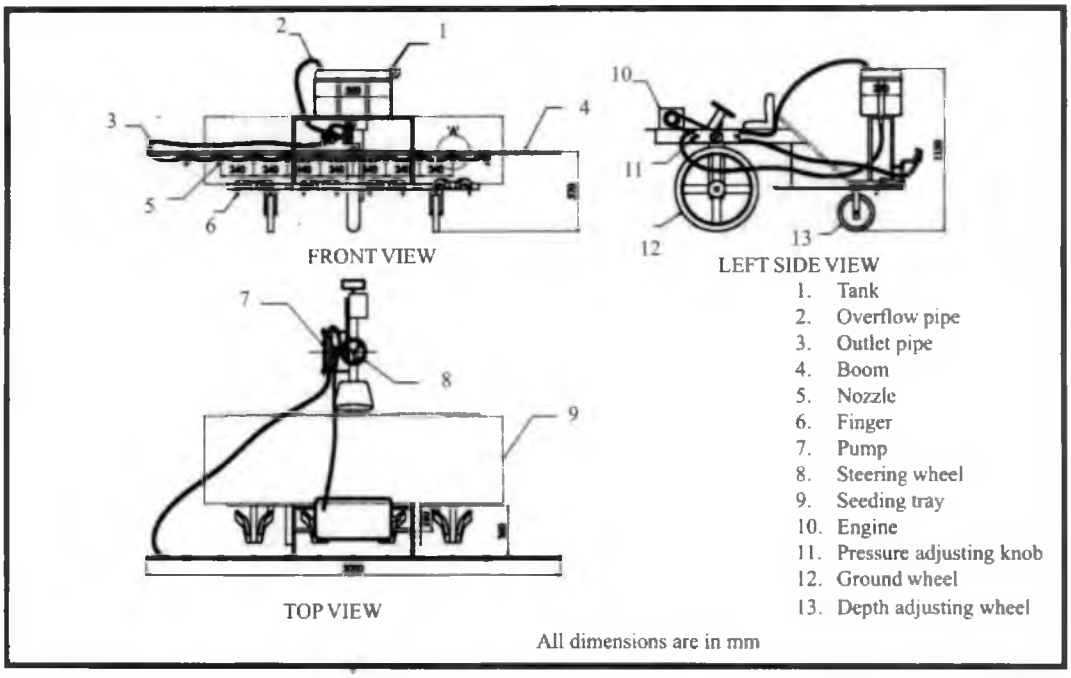

Fig. 1.3 Herbicide applicator as an attachment to a paddy transplanter

nozzles fitted in the spray boom through the delivery pipe. The nozzles of the boom are spaced in such a way that each nozzle is at the centre of the spacing between the transplanter fingers. The pressure regulator helps to discharge the herbicide solution in the form of spray at the pre-set conditions of quantity and pressure on the soil while transplanting. An over flow pipe is provided to bypass the excess herbicide to the tank. Hence, spraying and transplanting is carried out simultaneously when

operates with a paddy transplanter. Thus herbicide applicator works as an attachment to the paddy transplanter. The orthographic views of the attachment are shown in the Fig. 1.3. Patent application was filed for this attachment.

Technical specifications:

- Size and capacity of tank – 60 cm x 30 cm x 22.5 cm (40 litres)
- Height of spray – 10-20 cm
- Field capacity – 0.161 ha/hr
- Field efficiency – 61.21 %
- Operating speed (ideal) –0.5 – 1.0 kmph

4. Vertical axial flow pump as an alternative to 'petti' and 'para'

The low lands of Kerala, especially Kuttanad and Kole lands, have specific requirements for drainage and other water management practices for supporting sustainable agriculture. During monsoon, heavy rains flood the fields in these areas. Crops of low lying areas remain under submerged condition for several days due to that plants started wilting and ultimately get damaged. Dewatering the fields commences soon after the wet ploughing and for the completion of repairs of the outer bunds. Extensive area of low lying lands in Kerala is subjected to waterlogging during rainy season due to inadequate drainage facilities. Introduction of the locally made propeller pump, known as Petti and Para, had revolutionized the drainage pumping of the region in the early twentieth century. It is a traditional dewatering pumping system manufactured by local blacksmiths and carpenters. It has a special pump driven by a heavy electric motor of 50 to 100 horse power and discharges water with high flow rate, against low heads. It was originally designed by Mr. George Brendon, a British Engineer in 1918 by using locally available materials. The pump is connected to the motor using a long belt. Petti and Para has high discharge capacity under low head conditions. But its efficiency is less than 25 per cent.

Several types of pumps are available for lift irrigation and drainage under different head and discharge conditions, such as centrifugal pump, turbine pump, submersible pump, mixed flow pump and propeller pump. The centrifugal pumps are efficient for above 4 m delivery head and producing low-head discharge. Under these circumstances, propeller and submersible pumps are the options for high discharge and low head conditions to drain out water from river, canals and ponds. The scarcity of pump operators to handle the heavy and bulky 'petti and para' is also a challenging

problem, seriously faced by the kole land and Kuttanad farmers of the State. Hence more and more farmers are deviating from the agricultural works in these areas. A petty and para is normally designed to discharge the water at a height of one meter. Whenever water level in the canal rises above the discharge port of the petti, the water being lifted by the para, would not be able to discharge against the head of water raised in the canal. In such situations, the motor will keep running for hours continuously without producing even 25 per cent of its indented service, there by wasting huge amount of electricity annually. To overcome such situations, the petti and para will be fitted at a higher level and as the water level lowers down, the equipment will again dismantled and lowered then allow the pump to run. Also, operating a petty and para pumping system is very unsafe, hazardous and crude manner with long flat belt and other improper wooden support. This is crude and laborious methods always tend to suffer damages to the equipment as well as life of the operator working on it, beside financial burdens and time loses. Its efficiency is very low i.e., 20- 22 per cent, when it is newly connected. On continuous use, it become obsolete due to its own nature of manufacturing defects also deformation take place which further contribute for considerable efficiency loses. The commercially available dewatering pumps are having more than 45 per cent efficiency and have high discharge at low heads, which is considered to be almost double the efficiency of a traditional petty and para. Thus, these types of pumps ensure saving in electricity charges, labour cost for loading, unloading and transporting the pump from the store house to the pumping station etc.The major advantages of the axial flow propeller pumps against petty and para are as follows:

i. As it is a direct coupled pumping units, no life threatening risk to the pump operators, compared to the 'Petti and Para', of which the long flat driving belt are unsafe while working pumping.

ii. The pump shaft does not wear out at all the time, as it does not have direct contact with its relative moving parts. Hence the pump shaft is safe from wear and tear, lasting for long periods.

iii. The sleeves and journal bearings are provided at every supporting areas of the pump shaft wherever relative moving subject to take place. These components are made to inter changeable and easily replaceable on periodical wear and tear.

iv. This model pumps are designed and manufactured by corrosion resistant stain less steels of different grades as per the BIS standard *viz.,* for the fresh

water pumping, SS 304/ SS 306 grades for saline water pumping in Kuttanad and Kole lands. Also ensure less maintenance cost.

v. The properly installed pumping system need not remove from the pumping station for a minimum period of 4-years.

It is estimated that there exists 1000 petty - para pumping units in Thrissur and Ponnani Kole lands and Kuttanad of the State. The total installed capacity of the petty and para pumping units in Thrissur and Ponnani Kole area alone comes around 32.78 MW. It is estimated that a total of 36 million units (MU) of electricity is required to operate these pumps for a period of six months per year. According to the present KSEB subsidized rate (Re. 0.55 per unit) for paddy cultivation, a total amount of Rs. 2 Crore (approx.) is spending per year (of 6 month) by the Govt. of Kerala. If these pumps are replaced with axial flow propeller pumps, it is expected that 70 per cent of cost for electricity can be reduced by way of reducing the electric power consumption from 18 MU to 108 lakh units. Hence it is better to replace the low efficient and high power consumed petty and para pumps with high efficient and low power consumed axial flow pumps (Plate 1.4). The detailed drawings of the vertical axial flow propeller pump and its diffuser are shown in Fig. 1.4.1 and Fig.1.4.2.

The vertical axial flow propeller pump is having its axis in vertical direction in which water enters and ejects along the direction parallel to the axis of rotation. These pumps consist of a prime mover of 50 hp electric motor, thrust bearing, main shaft, stuffing box, impeller, elbow, delivery pipe, bell mouth and a screen. The pressure head is developed by the propelling or lifting action of the impellers as it rotates. The rotation of the impeller is caused by the prime mover in 'on' position. The water enters to the impeller through screen provided beneath the bell mouth which removes the impurities and other debris from entry to suction side of the impeller. The bell mouth is a bell (curvilinear) shaped column assembly which allows water to enter smoothly in to the impeller. The impeller operates at the bottom of the delivery pipe. The impeller has 3-6 blades depending on the designed speed and is keyed at right angles at the bottom

Plate 1.4 Vertical axial flow pump installed at Kole lands of Karalam, Thrissur

Plate 1.4.1 Impeller

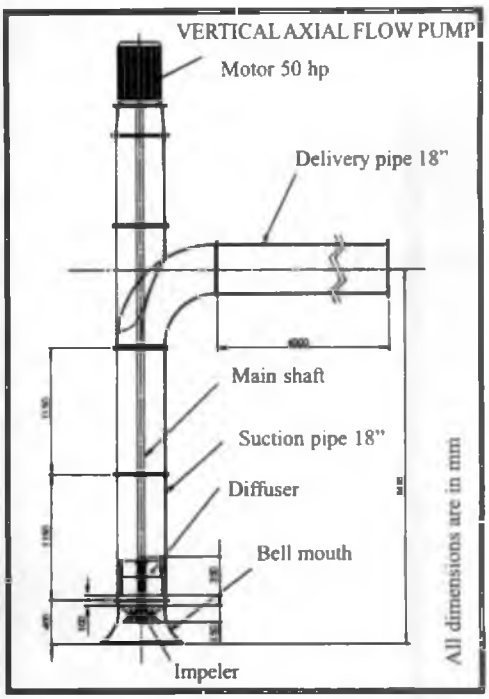

Fig. 1.4.1 Vertical axial flow propeller pump

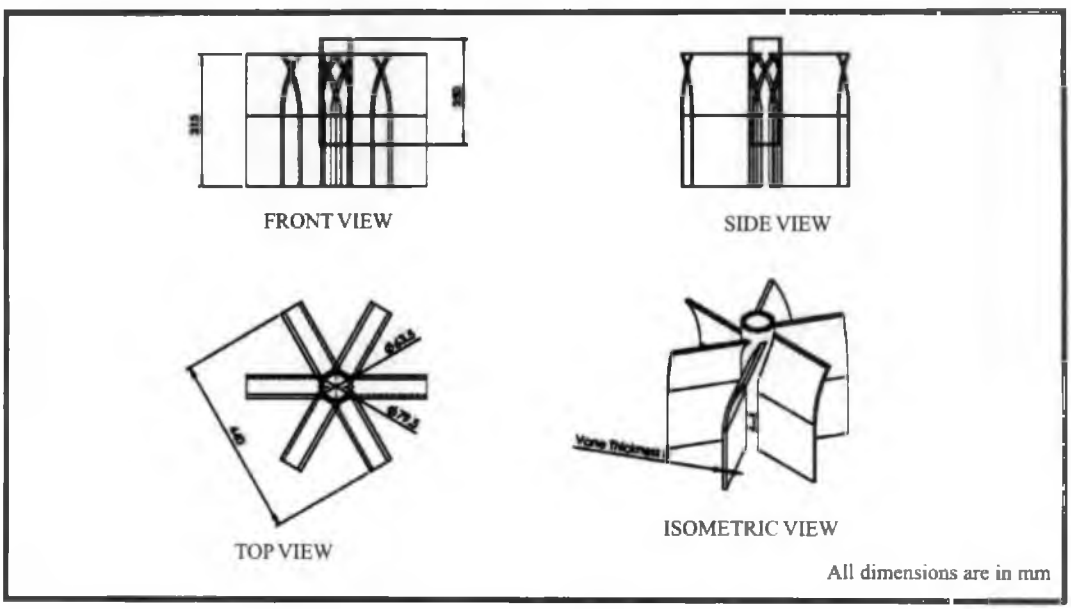

Fig. 1.4.2 Diffuser

of the main shaft. A cone shaped cover is fitted over the locking nut to eliminate eddies and to prevent the entry of sand and grit into the lower pump bearings. This pump ensures high discharge, low head pumping. Such pumps develop pressure head by the propelling action of impeller blades on water. These pumps propel water by the reaction to lift forces produced by rotating its blades. The details of major components of the pump are as follows:

Prime mover: 3- phase induction motor of 50 hp, 6-pole and 960 rpm slip ring induction motor is used as prime mover. An oil immersed slip ring motor starter is used as a starting aid for such motors. An electric panel with fuse, energy and volt meters with proper insulation and earthing is used for the said pump. The fuse protects the motor from excess voltage and the energy meter is used for measuring power consumption while operating the pump.

Thrust bearing: These bearings actually hold and connect the motor with the main shaft assembly. It takes all the undue forces acting radially to the main shaft while in rotation. Also, safe guard the pump and motor units from vibrations and resistive forces. It has an outer diameter of 150mm and inner diameter of 85mm. It is made of stainless steel material.

Main shaft: This shaft holds the impellers at the bottom end and is connected with the motor at the top through thrust bearing. The shaft has a diameter of 63.5mm and length of 4.2m made of stainless steel material. It is also provided with 3 key ways respectively for connecting impeller at the bottom, couplings at the middle and thrust bearing at the top. The main shaft passes through the elbow and delivery pipes, suitably welded with leak proof column assembly over the elbow.

Stuffing box: It is used for preventing leakage of water. It is provided for making the assembly intact and leak proof. It is made of gun metal provided with shaft sleeve with proper gland packing and follower.

Impeller: It is the major part of the pump for lifting water. It is a rotor used to increase the pressure and flow of water. The velocity achieved by the impeller from the motor transfers it into pressure energy during the upward movement of water. Three types of impellers were used for the study. It consists of four vanes (blades) fitted on a hub made of mild steel.

Elbow: It is made of mild steel seamless pipe of diameter of 675 mm connecting the other horizontal and vertical discharge pipes respectively for pumping water to the canal and to receive water from the delivery side of impellers. The elbow is provided with 90 deg. with finished inner curvature for smooth delivery of water through the pipe. A vertical column assembly having main shaft is suitably welded over the elbow to provide leak proof water pumping system.

Delivery pipe: These pipes are fitted just above the impeller and its one end is connected to the outlet of the pump. It is made in three column delivery pipes of dia meters 475 mm each having 1.15 and 0.6 m respectively joined by means of spool pieces.

Bell mouth: It is a bell shaped pipe of 675 mm having a wider diameter at the bottom, so has to have a smooth entry of water to the suction side of the impeller. It is also made of mild steel seamless pipe of 25 cm height. A screen is provided at the beneath of the bell mouth to prevent the entry of impurities into the impeller.

The axial flow propeller pumps as against the traditional petty and para pumping system should be promoted as it accounts for the energy and cost saving technology. A vertical axial flow propeller pump was procured, modified and handed over to Kadumpattupadam Kole Karshaka Sangam, Karalam, Thrissur under this project. The pump was fabricated at M/s. Das Engineering, Karalam, Thrissur on contract basis under this research programme.

Technical specifications:

- Material of construction - Mild steel seamless, stainless steel (304) and gun metal
- Power - 50 hp
- Operating head - 0-3 m
- Discharge – 571.81 lps at a head of 3.13 m
- Pumping efficiency- 56.69 %

5. Pokkali paddy harvester

An indigenous method of cultivating paddy in marshy and swampy inundated fields of coastal and back water regions of Kerala is a unique method of paddy cultivation, popularly known as 'Pokkali paddy cultivation', which got Geographic Indicator (GI) registration by the Govt. of India. The Pokkali field is a unique eco system prevailing in the coastal tract of Kerala with rich bio diversity and amazing capacity to produce organic rice and shrimp alternatively. The lands of Pokkali rice cultivation in marshy and swampy fields with poor drainage systems and are subjected to the tidal action throughout the year. Also, these lands are connected to Arabian sea through backwaters and canals. Due to these naturally adverse conditions prevailing in these lands and the non availability of labourers, the paddy cultivation goes on decreasing every year. Of the various farming operations in Pokkali rice cultivation, the harvesting is done by women labourers by walking on the swampy and marshy inundated paddy fields at waist-deep water, which is labourious, tedious

and cumbersome. Hence, there was a great demand for a suitable harvesting machine, especially for harvesting the paddy, which is under water at the time of harvest due to tidal effects. Though a numbers of paddy combine harvesters are commercially available, none cannot be used in such marshy water logged areas for harvesting paddy. Hence, a power operated floating harvester (Plate 1.5) *viz.*, KAU Pokkali paddy harvester with provisions for harvesting and conveying the ear heads of water submerged paddy stalks by moving on a slushy, marshy and swampy ground was developed and field tested. The machine was fabricated at M/s. Kelachandra Precission Engineers, Kottayam on contract basis under the project.

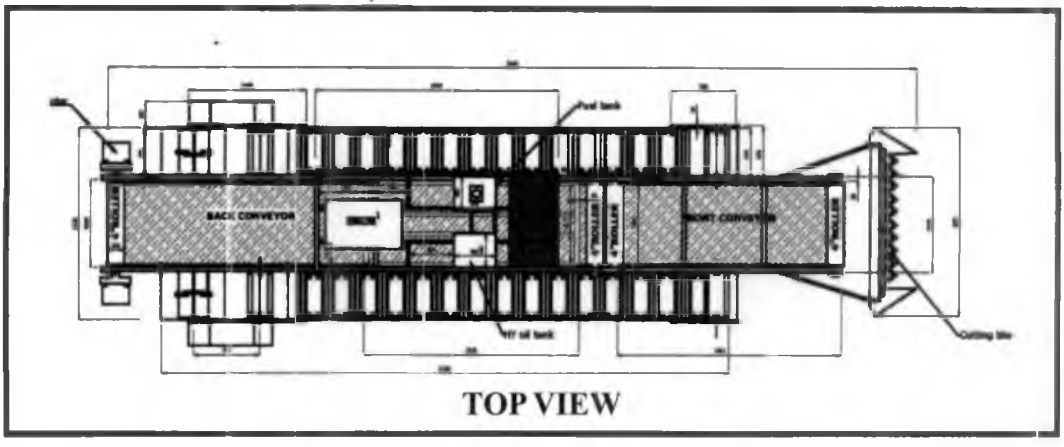

Fig. 1.5 KAU Pokkali paddy harvester

Fig. 1.5 refers to the plan and side view of the KAU Pokkali paddy harvester. It consists of power and control unit, hydraulic system, floating craft with traction device and paddle wheel, cutter bar with reel assembly and belt conveyors. A suitable prime mover is coupled to the hydraulic pump through a shaft. The hydraulic system comprises of a hydraulic pump, motors and control valve with lever. The hydraulic system actuates separate hydraulic motors, which in turn operate all the required moving parts of the harvester. Separate hydraulic motors are provided for cutter bar, front conveyor, back conveyor, right hand floating craft with paddle wheel, left hand floating craft with paddle wheel respectively. The cutter bar is fitted at the front end of the harvester by a swinging type frame. Thus, swinging cutter bar can be moved

Plate. 1.5 KAU pokkali paddy harvester

up or down, and can be operated at any predetermined height of cut. The cutter bar is attached with a reel by means of chain drive. As and when the direction control lever is operated, the hydraulic motors operate the cutter bar and reel simultaneously. The reel gathers the submerged paddy crop and directs it to the cutter bar, where the crop is being cut by properly positioning the swinging front end frame. At the same time, by operating the control lever for the operation of front conveyor, the cut crop from the cutter bar get transferred to the moving front conveyor, from which, it is transferred to the back conveyor and finally to the discharge end of the harvester. Thus the cutter bar, reel, the front and back conveyors are working simultaneously. Its propulsion is accomplished by means of either a paddle wheel or floating crafts fitted with endless tracks, when working in water or muddy soil. A bed former can also be fitted at the bottom of the chassis, so that the harvester can also be used for making seed bed in such swampy or marshy soil. Patent application was filed for this machine.

Chapter II

MACHINERY FOR COCONUT

1. KAU Coconut palm climber

The majority of coconuts are harvested by climbing the palm and cutting the nuts down by hand. This process may seem to be simple but it is quite dangerous. An experienced climber takes about 4-5 minutes just to climb the palm alone (this doesn't include cutting the coconuts and the return trip). Due to its strenuous nature professional coconut climbers are now a few in number and farmers are finding it difficult to harvest the nuts. In response, there is a genuine need to develop a device which is safe and efficient to assist the climbers. At present there are a few models of coconut climbers available in the market. Most of the climber's safety and efficiency aspects are being questioned and needs to be comparatively evaluated and modified. Normally skilled workers climb the palm to harvest the coconuts. Since coconut palms are very tall, any fall from top of the palm can result in severe injury. The climbers employed for climbing coconut palm suffer from musculoskeletal disorders which disable individuals at rates near or above those of traumatic, respiratory and dermatological injuries. The health hazards associated with coconut palm climbing include slip during rainy days, ant and insect bites, bees attack and formation of wart in the palms and legs of the climber. So there is a need of a mechanical assembly

Plate 2.1 KAU Coconut palm climber

which reduces the drudgery and strain in human body, and also it should help the unskilled labour to climb the coconut palms easily and in safe manner.

KAU coconut palm climber (Plate 2.1) is a modified version of the TNAU coconut palm climber. It consists of upper and lower frames fitted with adjustable 'U' frame members. The upper frame is intended for comfort seating of the operator and the lower frame is attached with an actuating mechanism for climbing up and down the palm. Hence the upper frame has to bear an average weight of the worker of about 60-75 kg, without any bending due to cantilever action. Galvanized iron was selected as the material for its fabrication. The lower frame is for placing the legs of the operator and for actuating the upward and downward motion. While climbing, both frames (lower and upper) are moved upward alternatively by means of combined actions of hand and leg (knee and toe action) together. These actions will be just reversed when climbing down. As the lower frame is only for facilitating these supportive actions, aluminium is selected as the material for its fabrication, which in turn helps to reduce the weight of the unit to 9.45 kg. Both the frames are made with square pipe of 20 mm x 2.5 mm cross section. Safety lock pins are provided

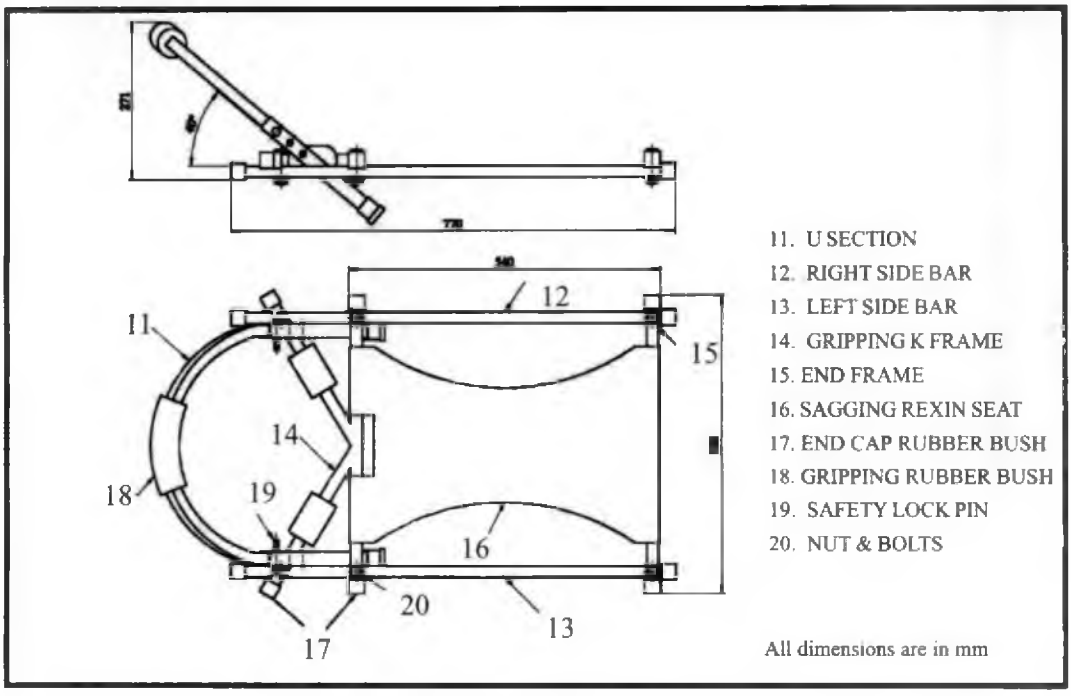

Fig. 2.1 KAU Coconut palm climber

for attaching the 'U' frames with main units which reduced the time for fitting or removing of the climber. Rubber bushes are provided in both frames as gripping material. The lifting of lower frame with toes is a tough task for the users and it induced a lot of strain to the legs. So specially designed footwears are provided on the lower frame. The palm gripping section of the upper frame was made of 'U' shape with an inclination to the horizontal. Hence while climbing; the upper frame will remain parallel to the horizontal thus providing more stability to the climber. 'U' frame is also provided to the lower frame with an inclination to the horizontal for giving more safety to the operator. Sagging type rexin seat is provided on the upper frame which increased the comfort and safety of the operator. The details of the parts and its measurements are given in Fig. 2.1. Its technology was transferred to M/s. Metal Industries, Metind Nagar, Shoranur and M/s. Athena Wire Products, Govt.Press (P.O). Shoranur-2.

Technical specification:

- Consist of upper, lower and adjustable 'U' frames
- Upper frame-made of Galvanized Iron (GI) and lower frame-made of Aluminium
- Safety lock pin, rubber bushes and specially designed foot wears
- Weight of the unit - 9.45kg

2. Power operated continuous coconut husking machine

Coconuts have protective cover of fibre of varying thickness. Coconut husking tools of various types and shapes have been in use for many years; but these are basically manual operated hand tools. The simplest of these is a vertical wedge of about 60cm height and 6 cm wide. The operator pierces down the raw coconut on the sharp edge of the vertical wedge. As the wedge penetrates in to the husk of the coconut to 2 to 3 cm, the operator turns the coconut around the flat vertical wedge, so that the husk opens up at that place; two or three repeatations of this operation opens the husk at the spike end of the coconut and it gets loosened from the inner kernel. The loosened husk can be removed from the kernel on pulling by hand. Other house hold tools like machete or felling knife, craw bar and axe are all used for coconut husking, but this husking operation is a very skilled job requiring high force. It is a risky job for the unskilled people.

A lever operated improved husking tool developed and patented by Kerala Agricultural University (Patent No.192670 dt.25.08.1995) is a simple, user friendly device requiring less force to husk the coconut; this is manually operated and gives less output. Though some power operated machines are reported, the husking mechanism is basically a pair of counter rotating rollers with some finger-like projections and husking is done by passing the raw coconut through these rollers, one by one. It is found that this mechanism fails to accept varying sizes of raw coconuts, damage is high and feeding is intermittent. Accordingly there is a real and continuing need for the development of an improved power operated machine for continuous husking of coconut for large scale coconut farmers. Hence a power operated continuous rotary coconut husking machine was developed and tested.

The power operated coconut husking machine (Plate 2.2) comprising of a rotary member, which is rotatably mounted inside a stationary member, the arrangement

Plate 2.2 Power operated continuous coconut husking machine

being such that the annular space between the two said members is elliptical or oval axially, so that the raw coconut can be fed in to this space through a feeding chute or inlet opening. A plurality of short knife-like projections is provided radially on the outer concave periphery of the inner rotating member and on the inner concave periphery of the outer stationary member. The orthographic views of the machine are shown in Fig. 2.2. As the raw coconut is fed to the said oval space between the said rotating member and stationary member through the inlet opening, the rotary member rotates and the raw coconut is carried along the said annular space to which protrudes a series of short knife-like projections, the husk of this coconut gets beaten due to the relative motion between the rotary and stationary members and due to the penetration of the said knife-like projection. Thus the husk gets loosened and this

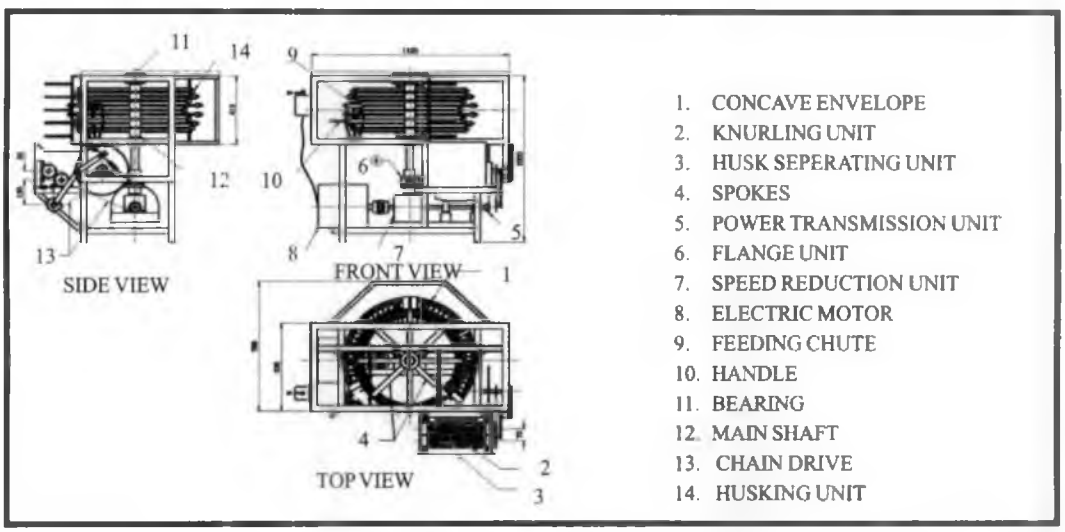

Fig. 2.2 Power operated continuous coconut husking machine

treated raw coconut with loosened husk on it, is then moved out through the outlet on to a pair of counter rotating closely mounted fluted rollers where the loosened husk is pulled down by the said rollers and the husked kernel is passed on to the collecting tray. Patent application was filed for this machine.

Technical specifications:

- Power Source: 3φ induction motor of 5 hp and a 30:1 speed reduction box.
- Capacity of 450-500 nuts/hr
- Less than 2 % of nut breaking.

3. Coconut splitter

The present tools used for coconut splitting are unsafe not user friendly. A simple tool was developed to split the husked coconut into two halves. Two models were developed and tested.

Model I (Plate 2.3) consists of a stand, on which a wedge shaped cutting blade is connected to a handle using a chain. In this model, the wedge blade is loaded by the handle thus cutting the coconut into two when released. It can split six coconuts in one minute. Model-II (Plate 2.4) consists of a handle, a stand and a spring loaded wedge shaped cutting blade. The husked coconut is placed at the bottom platform and spring loaded handle is released. The cutting edge moves downward and hits the husked coconut and splits into two. It can split five coconuts in one minute.

Plate 2.3 Coconut splitter (Model I)

Plate 2.4 Coconut splitter (Model II)

Technical specification:

Model I:

- Made of Mild Steel.
- Nut breaking is 2%.
- Can split six coconuts in one minute.
- Chain loaded wedge shaped cutting blade.

Model II:

- Spring loaded wedge shaped cutting blade.
- Made of Mild Steel.
- Nut breaking is 3%.
- Split five coconuts in one minute.

4. Copra separator

Traditionally copra separation is done by using kitchen knife which is an unsafe and danger. The manually operated copra separator developed was intended for

Plate 2.5 Manually operated copra separator

separating copra from coconut shell without risk. Copra separator (Plate: 2.5) consists of a blade made of 9 cm long and 3 cm wide MS plate welded to a handle which can be rotated about a fulcrum. It is provided with a rotating handle made by wood. The whole unit can be fixed on a table or a slab. The copra is separated by slightly pressing the coconut shell against the blade and rotating the handle. By using this hand tool 12 copras can be separated out from the shells per minute. This is a simple and easy hand tool for small scale farmers and for house hold purposes.

Technical specifications:

- Materials of construction - Mild steel and wood
- Capacity - 12 copras per minute
- Size of blade – 9 x 3 cm

5. Multifunction unit

The unit is simple and can perform five operations such as coconut husking, scraping, copra separating, tender coconut punching and splitting. This unit is specially designed and fabricated as homestead tool. The main parts of these units are shown in Plate 2.6. It is made as a portable kitchen appliance made up of steel plated mild steel round pipes which can be dismantled and assembled easily.

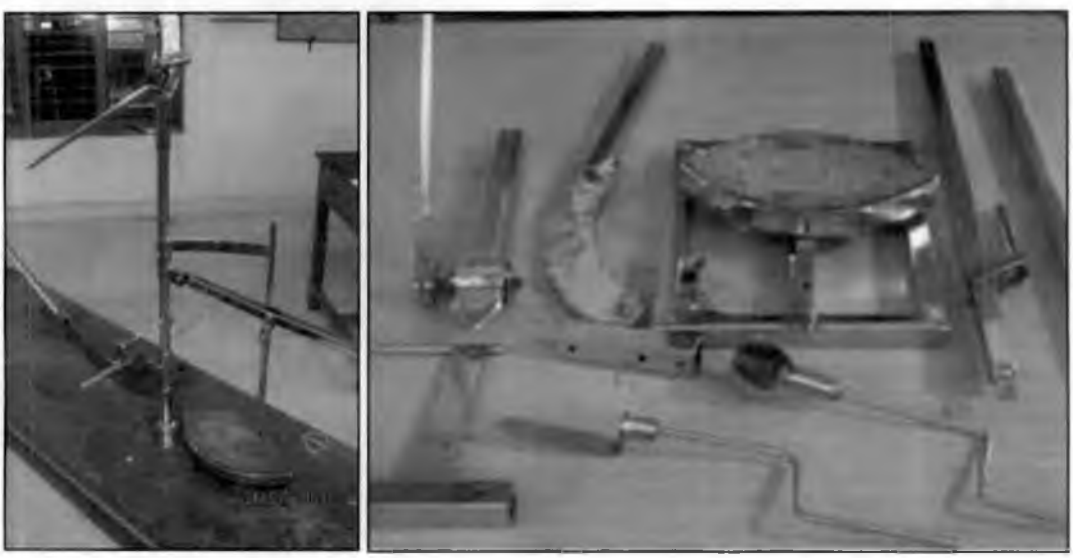

Plate 2.6 Multifunctional unit and its major parts

Chapter III

MACHINERY FOR VEGETABLES AND PEPPER

1. KAU bed former suitable to mini tractors

The conventional practice of seed bed preparation for vegetable cultivation is preparation of ridges after clearing the land surface. The seed bed preparation for cultivating tapioca, coleus and other tuber crops are also in the same method. These are cultivated as a homestead crops in Kerala. Large tractors cannot operate in such small strips of lands in the homestead cultivation. Hence a prototype of the bed former suitable to mini tractors was suitable designed and developed. This is a scale down proto type (Plate.3.1) of the tractor operated Kaipad bed former.

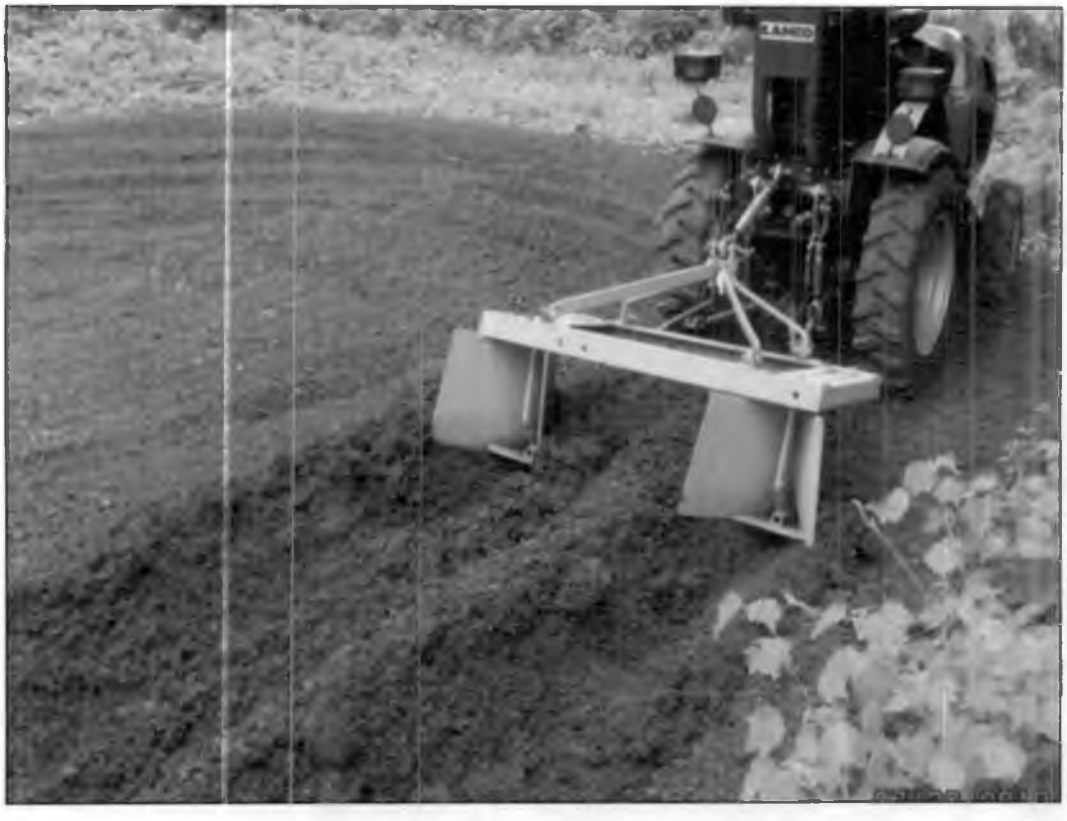

Plate 3.1 Bed former attached with KAMCO mini tractor 18.5 hp (TeraTRAC)

It consists of a curved Tyne and forming boards fitted on the main frame. The entire unit can be connected to the 3-point linkage of the mini tractor. Many trials were conducted in the University farms and the results are satisfactory and acceptable to the farmers. The cost of operation is reduced to fifty per cent compared to the conventional method. It was designed and fabricated specially to suit KAMCO mini tractor (TeraTRAC) of 18.5 hp (Fig 3.1). Its technology was transferred to M/s. Kerala Agro Machinery Corporation (KAMCO), Athani, Kerala.

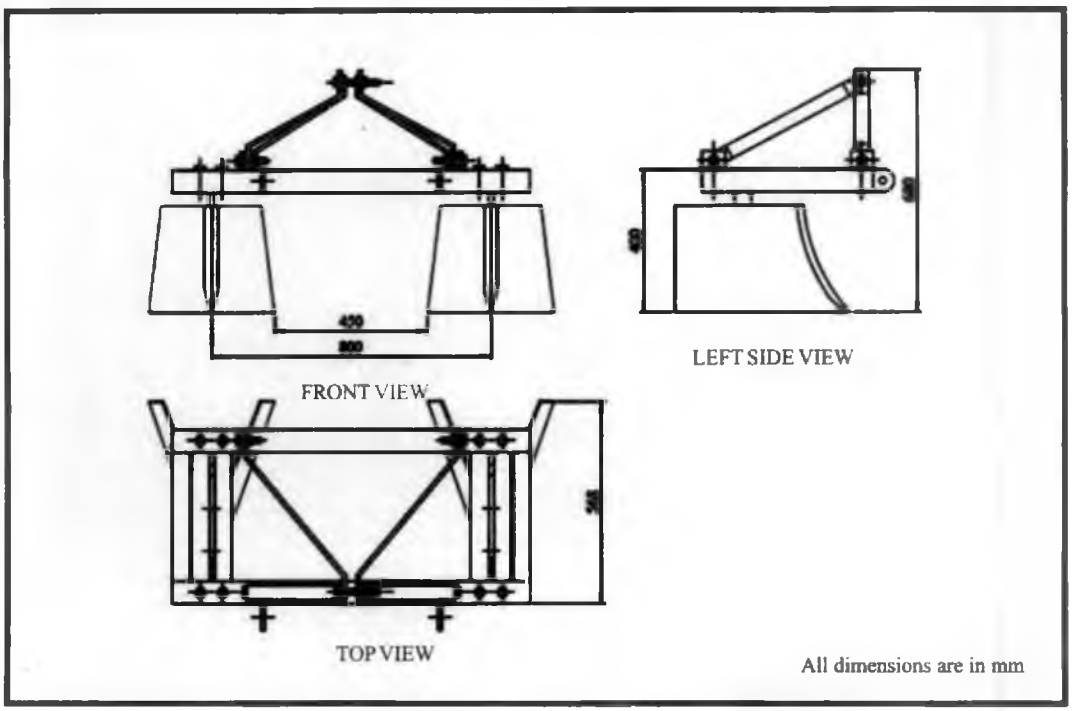

Fig 3.1 KAU bed former suitable to mini tractor

Technical specification:

- Material of construction - Mild steel
- Width of bed - 30-45 cm
- Height of bed - 35-43 cm
- The field capacity of the bed former- 1.5 acres/hour
- Cost of operation is reduced to 50 % compared to the conventional method
- The depth and width of seed beds formed can be varied

2. Coleus harvester as an attachment to a mini tiller

Coleus (*Solenostemon rotundifolius*) commonly known as Chinese potato, is a major tuber crop of our State. It is grown in most of the homestead gardens of Thrissur, Palakkad and Malappuram districts. It grows well in warm humid climate and in drained medium fertile soils. It is raised purely as a rain fed crop in the State from June to December. The first step in coleus cultivation is preparation of nursery, which is usually done during May-June every year. It is planted on raised beds at a spacing of 15 x 15 cm at a depth of 5 to 10 cm. Harvesting is done when haulms dry up, i.e., 4 to 6 months after planting. Using spade and forks, the tubers are taken out from the soil. Manual harvesting of coleus is very tedious and time consuming operation which requires proper handling, devoid of cuts, breakage, bruises and injuries. To overcome these problems and decreasing the cost of harvesting operation, a self propelled coleus harvester was developed modified and field tested under this project. The irregular geometry of tubers, different maturity stages and soil conditions were the major constraints in its modification.

Plate 3.2 Coleus harvester as an attachment to a mini tiller

The coleus harvester was designed and developed as an attachment to a mini tiller (Plate 3.2). It consists of a prime mover, a digger, rotary blade, and driven wheels. The prime mover is a 3.5 hp 2- stroke diesel engine. The use of such a tiller proved to be advantageous for wide variety of reasons like the compactness, small size, easy movement on narrow terrains, and ease of operation for women, smooth mobility and also a 360° turning facility of handle. Its main frame accommodates all the attachments and accessories of the harvester. It holds the digger assembly and bolted to chasis of the mini tiller. The tynes fitted to the digger is the penetrating part of the equipment. It takes most of the soil resistance during operation. The two

sets of diggers with flat and angular tynes were made and tested. The flat tynes were made of MS square 300 mm x 20 mm x 20 mm and angular tynes were made of MS angle 300 mm x 5 mm x 25 mm. The ends of the tynes were provided with a slight bending for better penetration and earthing up of coleus from soil. The tynes were positioned in such a way that it makes an angle of 40° with the vertical. Provisions were made to adjust the penetrating angles for better performance. Rotary slasher is the other major part of the harvester. It is attached to the rear side of the tiller. It is made is such a way that the L-shaped tynes were removed and rubber flaps of 75 x 75 x 0.3 mm were fastened to it. The drive to which is transferred through chain sprocket assembly from the engine. The wheels of tillers are act as vehicle traction elements to generate enough tractive force to overcome soil resistance and to ensure resistive forced motion. On operation, the digger tynes pierced into the soil at a depth of 1-15 cm and at an angle of 40° to digout the coleus lying under the soil. The uprooted coleus coming over the inclined tynes of the digger were then pushed out by means of the rotary splasher rotating just above the digger. The scattered coleus lying in the seedbed collected easily and hence the harvesting becomes easier and faster. A rubber mudguard is provided to protect the operator from scattered stones or debris which may be thrown away as projectile along with coleus. The field capacity of the coleus harvester is 0.057 $ha.hr^{-1}$. Harvesting of coleus by manual method requires 148 man hours per ha. At the present wage rate of Rs. 500 per day, the total cost of operation by manual method is about Rs. 31,250 per ha. By mechanical harvesting the total cost of operation is Rs. 7680 per ha. Hence the savings over conventional method is Rs. 24,470 per ha. The field efficiency of the harvester was calculated as 91%.

3. Coleus peeler

Peeling of coleus is necessary for culinary purposes. Conventionally, peeling is done by beating the sack filled with coleus and then its outer skin is removed by scrubbing. The scrubbing is done by using knives. It causes stain, itching and wounds on fingers and a time consuming process. The power operated coleus peeling machine reduces drudgery involved in the peeling process. This unit can be used as

an attachment to the table top wet grinders or as a separate unit. It consists of stainless steel peeling mesh press fitted to the rotating drum and another stainless and a

Plate 3.3 Coleus peeler (Model-I)

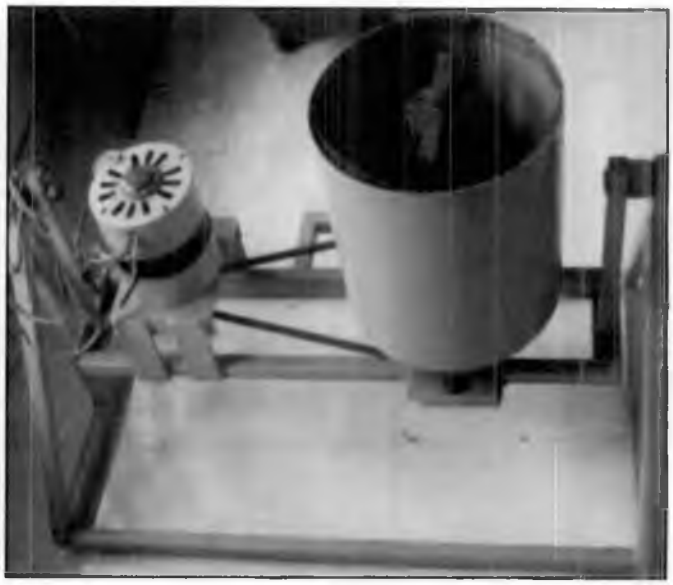

Plate 3.4 Coleus peeler (Model-II)

directing rod. The raw coleus with sufficient quantity of water is fed to the annular space between the stationary and rotating meshes. The outer skin gests scrubbed due to rubbing action of the stationary and rotating wire meshes. The treated coleus can be taken out and washed for using as cleaned vegetable. Thus this peeler is used as an attachment to a table top wet grinder (Model –I) (Plate 3.3) by replacing the grinding stone with stationary cylindrical wire mesh at the centre and directing rod with wire brush arms and by inserting a wire mesh at the inner periphery of the rotating drum of the wet grinder. For commercial purposes, separate electric motor operated units with same parts can be used (Model –II) (Plate 3.4). These machines can be used for removing outer skins of similar hardness, shape and size vegetable seeds. The capacity of the machine is 15 kg/hr. Patent application was filed for this equipment.

4. Thorny bush uprooter

Thorny bush uprooter is a simple hand tool (Plate 3.5) developed for removing thorny plants or bushes vegetable gardens and orchards. It consists of a claw type scoop attached to a long handle of length 1.0 m. V- cuts are provided on both ends

of the scoop to remove thorny plants. It has to be inserted slowly into the root and plucked quickly.

Plate 3.5 Thorny bush uprooter

5. Banana sucker uprooting machine as an attachment to a tractor

Uprooting of banana suckers from the mother plant without damage is very essential for obtaining good quality planting material for banana cultivation. Immediate clearing of land after harvest of banana is yet another problem faced by the banana farmers as minimum time is available to them between harvest and fresh planting of fields. In conventional methods, banana suckers are uprooted by using sharp hatchet and spade, taking care that the planting suckers are not in any way damaged. It is a risky job for the unskilled people. The chances for the damage of the suckers are more in the conventional methods. Accordingly there is a real and continuing need for the development of a banana sucker uprooting machine operated by a suitable power source at banana farms. A power operated banana sucker uprooting machine as an attachment to a tractor was developed and field tested.

The tractor operated banana sucker uprooting machine (Plate 3.6) comprises a double acting hydraulic cylinder, gib crane, tyne and direction control lever. The outer end of the gib crane is fitted with the tyne which penetrates into the soil, uproot and lift the banana suckers from the soil. The other end of the gib crane is pivoted at hitch assembly separately mounted at the rear of the tractor. The up and down motion of the gib crane is achieved by actuating the double acting hydraulic cylinder. One end of the double acting hydraulic cylinder is pivoted at a suitable location in supporting frame and the other end is hinged at a suitable location on the gib crane. The schematic of the banana sucker uprooting machine as an attachment to a tractor is shown in Fig. 3.2. A manually operated direction control lever is provided to operate the banana sucker uprooting machine as and when required. The output pipe from tractor hydraulic system is coupled at and is connected to the direction control lever. Thus for uprooting the banana suckers the tractor with above

Plate 3.6 Banana sucker uprooting machine as an attachment to a tractor

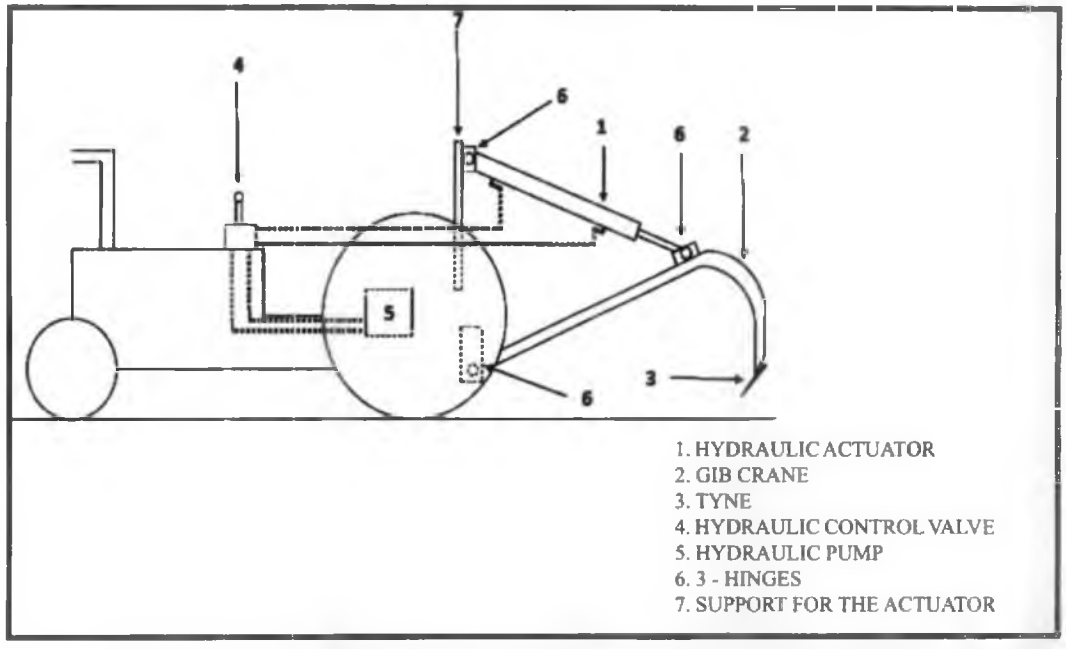

Fig. 3.2 Schematic of Banana sucker uprooting machine as an attachment to a tractor

said attachment has to be bought near to the soil sucker composite, keeping the tractor engine in running position and its gears at neutral position. By changing the hydraulic control levers of the tractor in 'on' position, the direction control lever is slowly moved to a position by which the double acting hydraulic cylinder actuates the gib crane to move downwards. So that, the tyne fitted at the outer end of the gib crane pierces adjacent to the soil sucker composite. When it penetrates up to its maximum root zone depth, the tractor moves slowly forward and at the same time, the gib crane moves up by actuating the double acting hydraulic cylinder through the direction control lever. Thus the banana suckers are get uprooted by means of this tractor attachment. Patent application was filed for this attachments.

6. Tractor operated mulching machine

Mulching is the practice of covering the soil surface in the inter spaces of the crop with different materials with the prime objective of soil and water conservation. Mulches can either be organic such as grass clippings, straw, bark chips, paper and similar materials or inorganic such as stones, brick chips and plastic. The major advantages of mulching include protection of soil from soil erosion, reduction of evaporation and conservation of soil moisture thereby reducing the quantity and frequency of irrigation water, weed control, reduction of soil compaction from the impact of heavy rains, maintenance of even soil temperature etc. The organic mulches improve the condition of the soil and provide ideal environment for earthworms and other beneficial soil organisms. Inorganic mulches, especially plastic or synthetic bring out solarisation effect which controls the soil borne diseases. Maintenance of a warm temperature even during night time enables seeds to germinate quickly and the young plants to establish a strong root growth system rapidly. Manual method of mulching with plastic sheet for large scale cultivation is laborious and costly. Hence a tractor drawn mulching machine was developed and field tested.

The tractor mounted mulching machine (Plate 3.7) consists of a main frame, two half plough bottoms, side rubber wheels, sheet and pressing rollers. The two half plough/bottoms fitted on either side of the main frame scrapes and scoop the soil to form seed of bed of 80 cm width.

The roller provided at the centre press the bed make a compact seed bed. The plastic sheet (30 micron) is kept with the vertical frame of the unit holds tightly between the roller and the compact soil bed. The pair of side rubber wheels provided

Plate 3.7 Tractor operated mulching machine

on either side of rubber wheels stretch the sheet properly during laying of the sheet. Thus, the plastic sheet spread uniformly (mulches) and covers the seed bed.

7. Goat faecal pellet pulverizer

Goat faecal matter is good farm yard manure. The dried goat faecal pellets cannot be used directly as it will not disintegrate with the soil easily. It needs to be pulverized especially for making pot mixture and for easy application as Farm Yard Manure (FYM). Two models (Model I and Model II) were developed and are shown in Plate 3.8 (a) and Fig.3.3 and Plate 3.8 (b). The machine consists of an electric motor as prime mover (0.5 to 3 h.p), hopper and a belt driven pulverizing drum. The drum is stationary with diameter 30 to 60 cm, made of MS sheet. A sieve is provided at the bottom of the drum. The beater (blades) fitted at the bottom of the shaft rotates at a speed of 300 rpm. Due to the impact and shear cutting principles, the dried pellets get crushed inside the drum and ejects through the sieve. The faecal matter will remain inside until it attains a size smaller than the size of holes in the sieve. The unit can also be used for pulverizing other dried faecal pellets, cow dung and other

dried organic matters. The capacity of the machine with a 3 h.p. electric motor is 450 to 500 Kg/hr. Its technology was transferred to M/s. Athena Wire Products, Govt. Press (P.O), Shoranur-2 and now it is commercially availabele as Manure Pulverizer.

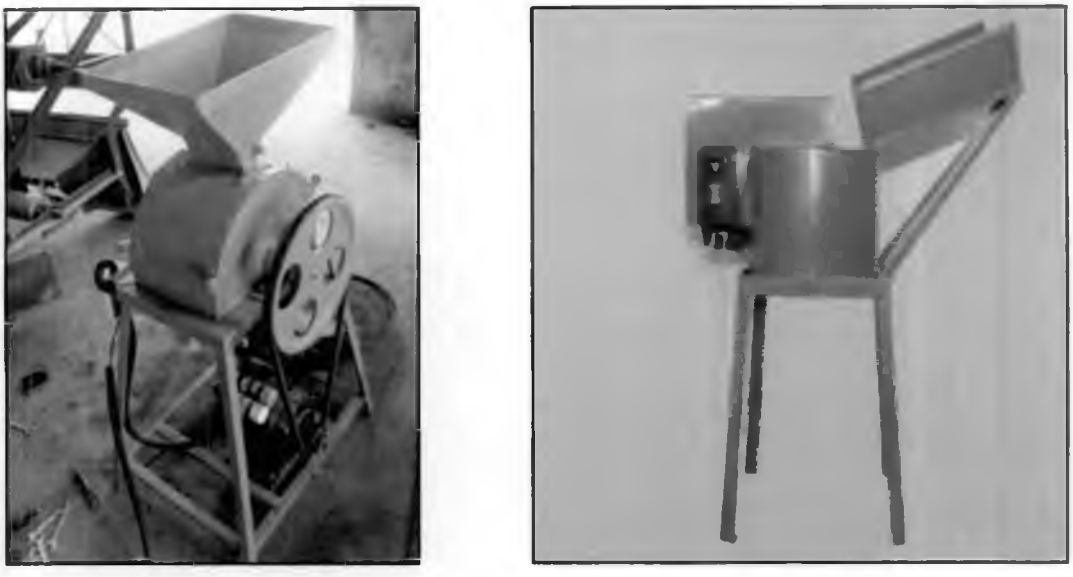

Plate 3.8 Goat faecal pellet pulverizers (a) Model – I and (b) Model –II

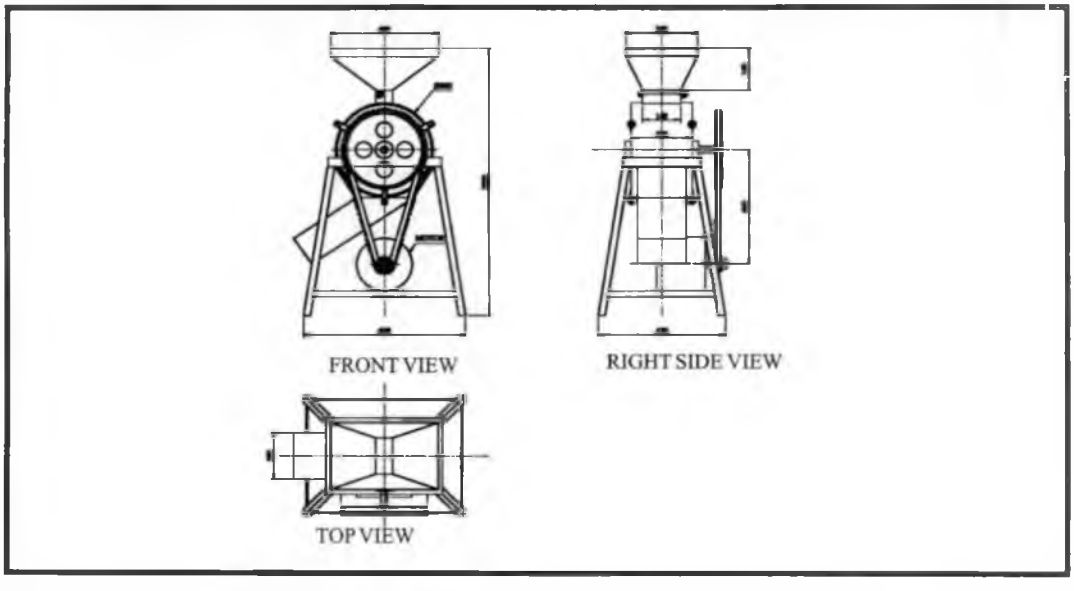

Fig. 3.3 Goat faecal pellet pulverizer (Model-I)

8. Pepper harvester

The basic concept was to develop a battery operated pepper harvester (Plate 3.8) to cut pepper stalks without damage to its wines and berries. It consists of a 12 V battery, a small motor, belt driven pulleys and rotating blades. There are two sets of belts, one set directly connected to the motor and the other connected parallel to the first set and are linked by a set of pulleys. The belts are placed adjacent to each other

Plate 3.8 Pepper harvester

so that the second set of belts rotate by the force of first set. When the motor is started, first set rotates in clock wise direction and second set rotate in opposite direction by the pulling force of the first set. The pulling force developed at the tip of the rotating blade causes to pluck the pepper stalks from the pepper wines, as the blades are fixed at the front pulleys. The cut pepper stalks are conveyed to the collecting bag which is placed at the bottom of the equipment. The movement of pepper stalks through belts cause shredding of berries from stalk. The dropped berries are collected in the collection bag provided at the bottom of the belt. The capacity of the harvester was 780 stalks/hr.