DEVELOPMENT OF PEPPER HARVESTER

By

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PROJECT REPORT

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DECLARATION

We hereby declare that this project entitled "**Development of Pepper Harvester"** is a bonafide record of project work done by us during the course of project and the report has not previously formed the basis for the award to us of any degree, diploma, associateship, fellowships or other similar title of any other university or society.

Aneeshya Kamal.K.S

Place: Tavanur

G.K.Krishnanunni

Date: 10-12-2009

CERTIFICATE

Certified that this project report entitled "**Development of Pepper Harvester"** is a record of project work done by Aneeshya Kamal.K.S and G.K.Krishnanunni under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship and associateship to them.

Place: Tavanur

Date: 10-12-2009

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ANEESHYA KAMAL K.S

G. K.KRISHNANUNNI

Dedicated to our Loving Parents and Almighty

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SYMBOLS AND ABREVIATIONS

cm	- centimeter
%	- percentage
db	- dry basis
dia	- diameter
et al.	- And other people
etc.	- Etcetera
fig.	- figure
FPME	- Farm Power Machinery and Energy
g	- Gram
h	- Hour
ha	- hectare
ha/hr	- hectares per hour
hp	- horse power
i.e.	- That is
KCAET	- Kelappaji College of Agricultural Engineering and Technology
Kg/ha	- kilogram per hectare
l/h	- litres per hour
nos.	- Numbers
rpm	- revolutions per minute
Sl.no.	- serial number
Mt	- Metric tonne
Ma	- Major axis
Mi	- Minor axis
l	- Length
b	- Breadth
t	- Thickness
OD	- outer diameter
ID	- Inner diameter
TN	- Tamil Nadu
A&N	- Andaman and Nicobar Islands

Introduction

CHAPTER I
INTRODUCTION

'Spice' can be defined as the dry parts of a plant, such as roots, leaves and seeds, which impart to food a certain flavour and pungent stimuli. (Kenji & Takemasa, 1998) Spices have a profound influence on the course of human civilization. They permeate our lives from birth to death. In everyday life, spices succor us, cure us, relax us, and excite us. Ancient peoples such as the Egyptian, the Arab and the Roman made extensive uses of spices, not only to add flavour to foods and beverages, but as medicines, disinfectants, incenses, stimulants and even as aphrodisiac agents. No wonder they were sought after in the same manner as gold and precious metals.

Asia is known as the 'Land of Spices' as it is the place of origin, production, consumption and export of most spices. India's share of world trade of spices is forecast to increase. India's share in the world spice market is estimated as 46 per cent by volume and 26 per cent by value (Peter *et al.*, 2006). They are Black pepper (Piper nigrum), Cardamom (*Elettaria cardamomum*), Cinnamomum (*Cinnamomum camphora),* Chili pepper (*Capsicum annuum*), Clove *(Syzygium aromaticum),* Coriander *(Coriandrum sativum),* Cumin *(Cuminum cyminum),* Garlic *(Allium sativum),* Ginger *(Zingiber officinale),* Turmeric *(Curcuma longa),* Vanilla *(Vanilla planifolium),* Nutmeg and Mace *(Myristica fragrans.* India plays a significant role on the pepper market both as supplier and consumer. India produces about 64 varieties of spices and is the world's largest producer and exporter, accounting for about 20 percent of world consumption. (Menon, 1998)

Among the major spices black pepper which was originated in Kerala has been one of the most ancient commodities of the spice trade. From Kerala here it spread to the rest of South and Southeast Asia where it became an important spice plant. It was eagerly sought by Europeans. Pepper was termed as *'King of Spices'* for its importance in uses of human beings. Pepper was an essential seasoning in Indian food and there are numerous references to it in Tamil literature dating between the 1st to 4th centuries AD. During 2005-'06, 16,700t of black pepper products were exported to various countries accounting for 6.0 % of export earnings among spices The

growers and traders are liked to call it as *'Black Gold'* for its high market value. (Sasikumar et al., 2008)

Dried fruits of pepper are usually known as peppercorns. Depending on harvest time and processing, peppercorns can be black, white, green and red (actually, reddish brown). The traditional types are black and white; dried green peppercorns are a more recent innovation, but are now rather common in Western countries.

Generally around 75% of production of pepper is exported. The consumption in producing countries except in India is insignificant. India consumes about 40,000 Mt of pepper (Sadanandan, 2000). World exports of pepper also have shown increasing trend but not in proportion with the increase in production. The supply position has increased considerably whereas the demand remained static or achieved only nominal increase. As such the gap between the supply and demand has widened. As a result, the price has declined steeply in the recent years. Usually when there is an over supply, price will decrease, then the growers loose their interest, which will result in decrease in production. Then short supply position takes place resulting in increase in price and more production.

The harvesting season for pepper is from November – February. Harvesting is usually done manually, by hands. The wage for a harvesting labour is Rs100/10 Kg harvested. But the labour experiences intense pain in his hands and especially in his nails after prolonged working hours. Hence, a project entitled, "Development of Pepper Harvester" was undertaken with the following objectives:

1. Identification and analysis of the present methods for pepper harvesting
2. Development of a Pepper harvester as a re-tool to the pepper farming community.
3. Field evaluation of the models by farmers and incorporation of suitable modifications to eliminate problems encountered during field operations.

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

This chapter deals with a brief review of the crop, its characteristics and the research work carried out by various investigators on development of tools to harvest various crops.

2.0 PEPPER

2.1 Origin

Pepper is a large genus, with over 1000 species, in the family *Piperaceae*, which is a perennial climbing vine or shrub with a smooth woody stem mostly found in hot and moist region of Southern India (Govindarajan, 1977). It is a perennial herbaceous woody climber of 5m or more in height with a bushy columnar appearance. The spikes are borne on the piagiotropic branches opposite to the leaves and are 3 to 15cm long. The fruits or berries are 4 to 7mm in diameter and have a pulpy pericarp and a hard endocarp (Purseglove *et al.*, 1981). Fruits are botanically called drupes but generally called berries. The unripe is green with exocarp turning red when ripe and black on drying.

2.2 Varieties

The varieties under cultivation have been evolved by unconscious selection from natural hybridization and vegetative propagations; thus, they show considerable variation in habitat, size and shape of fruit, and fruiting behavior. More than 75 named-varieties are known to be cultivated in India. They are distinguished by the names of the areas of cultivation. Introductions from one area to another have also taken place, resulting in the same variety being known by different names at different places. The common varieties of pepper grown in India are shown in Table 2.1.

Table 2.1 Important cultivars of black pepper and their features

Cultivar	Fresh mean yield kg/vine	Oleoresin (%)	Piperine (%)	Essential oil (%)	Dry recovery (%)	Features
Aimpirian	4-5	15.0	4.7	2.6	34	Good for higher elevations, good in quality, late maturing
Arakulamunda	2	9.8	4.4	4.7	33	Moderate and regular bearer
Balankotta	1-2	9.3	4.2	5.1	35	Moderate and irregular bearing
Karimunda	2-3	11.0	4.4	4.0	35	High yielder, shade tolerant
Kalluvally	1-2	8.4 -11.8	2.5 -5.4	3.0	35 -38	High dry recovery, drought tolerant
Kottanadan	5	17.8	6.6	2.5	34 -35	High yielding. Drought tolerant
Kuthiravally	3	15.0	6.0	4.5	35	High yield, good quality
Narayakodi	1-2	11.0	5.4	4.0	36	Moderate yield, medium quality
Neelamundi	2	13.9	4.6	3.3	33 -34	Tolerant to *Phytophtora* infection
Vadakkan	3	10.8	4.2	3.2	-	Medium quality and yield

2.3 Harvesting and yield

First harvest of pepper is done during the third year after planting. Pepper starts flowering even one year after planting. After flowering, it takes about 8 to 9 months for maturity. Generally, harvesting is done when one or two berries in a few spikes turn orange or red. Harvesting in Kerala is usually done from November to February. The maturity desired at harvest for production of various end products is given in Table 2.2.

Table 2.2 Maturity of pepper desired at harvest for different end products

End-Product	Maturity at harvest
White pepper	Fully ripe
Black pepper	Fully mature and nearly ripe
Canned pepper	4 – 5 months after fruit set
Dehydrated green pepper	10-15 days before maturity
Oleoresin	15-20 days before maturity
Oil	15-20 days before maturity
Pepper powder	Fully mature with maximum starch

2.4 Constituents of pepper

The major constituents of pepper are starch, fibre and protein but more significant ones are the piperine and the volatile oil, which contribute the pungency and aroma respectively (Sumathikutty *et al.*, 1979). The white pepper has a higher starch content but lower fibre content compared to black pepper. The major constituents of black pepper and white pepper are given in Table 2.3.

Table 2.4 Constituents of white- and black-pepper

Chemical constituents (%)	Black pepper	White pepper
Moisture	13.0	14.0
Volatile oil (v/w)	4.1	3.8
Piperine	2.3	3.2
Nonvolatile ether extract	12.0	8.2
Oleoresin	9.6	7.2
Starch	40.5	48.0
Crude fibre	14.0	4.0
Ash	7.0	2.0
Acid insoluble ash	1.5	0.6

2. 5 HARVESTING EQIPMENTS

2.5.1 COUNTER WEIGHT PALM CLIMBER

Muhammad C.P et al., (1998) conducted a study on counter weight palm climber. The counter weight palm climber concept is the permanent installation of a weight of about 50kg at one end of a pair of pulleys fitted on a cross arm. A set of smoothly slid able steel wire of which is tide at the bottom of the palm. On giving a light upward force, the operator can easily go up to the palm top. After harvesting nuts he can put a bunch of it on the foot pegs and slide down comfortably. The device was fabricated and tested. It took 15 seconds to go up and come down a 4.5 m palm and 5min. for preparation. The permanent weight and accessories cost about Rs.250/-.

Width of conveyor belt : 6 cm

2.5.2 JACK FRUIT HARVEST

Mohammad C.P *et al.*, (1999) conducted a study on jack fruit harvester for easy harvesting of the jack fruits. The manually operated jack fruit harvester is a handy and simple tool which can ensure safe handling of jack fruits.

Plate 2.1 Jack Fruit Harvester

The special feature of the tool is that a person standing on the ground (ie, without climbing up on the tree) can harvest jack fruits and lower safely to the ground. The harvester consists of a long telescopic pole with a hook knife at the top. Besides, a rope- woven basket attached to a metallic frame tied to a long rope is used for holding the detached fruit and lowering it safely to the ground. The said pole is also used to position the basket for containing the fruit within the basket before its detachment. Now the rope is held firmly after positioning the basket so as to contain the fruit. The operation is so simple that a layman can harvest the jack –fruit easily from a height of about 12m. The net weight of the equipment is about 5 to 8 kg and its cost

around Rs 1000 /-. For harvesting fruits at higher level the pipe can be extended and fixed in position with a screw and wing nut. Women can also use the tool safely.

SPECIFICATIONS:-

Year of development	: 1999
Pole (usually three pipes)	
Materials	: Aluminium or Iron
Standard length of pipe	: 400 cm.
Minimum length of pole	: 420 cm
Maximum length of pole	: 1150 cm
Basket	
Diameter	: 40 cm
Height	: 50 cm
Woven net (nylon rope)	: 0.3 cm
Metal weight	: 200 gm
Net weight	: 5 to 8 kg

2.5.3 IMPROVED FRUIT PLUCKER

Muhammad C.P *et al., (2000)* conducted a study on improved fruit plucker.The improved fruit plucker is an improved hook type plucker for plucking fruits like mangoes, sapota etc. The net of common plucker is lengthened and extended downwards like a chute.

Plate 2.2 Improved Fruit Plucker

The lower end of the net is open but kept folded upwards so that the fruits are stored as in a sack. After detachment, the fruits are conveyed downward at a safe velocity, and stored at the bottom of the chute. The advantage is that more quantity can be plucked in a batch since the fruits are stored in the net at the bottom of the pole thereby giving a better balance than the

conventional top loading type. The cost of the equipment is about Rs 1000/- for 12 m long; it weighs about 6 kg.

SPECIFICATIONS

Year of development	: 2000
Length of pipes	: 11.5 m
Weight (11.5 m)	: 6 kg
Chute	: Net cloth, jute sack
Ring and hook	: Mild steel
Clamp	: Mild steel
Set screw	: Mild steel.

OTHER METHODS OF COLLECTING NUTS

2.5.4 POWERED PALM CLIMBER

Muhammad C.P *et al., (2000)* conducted a study on powered palm climber. The power operated direct drive climber has a power pack to give an output speed of 16rpm with two sets of solid rubber drive wheels. Each set of wheels consists of four wheels placed diametrically opposite to the trunk of the palm. The wheels move axially with respect to the trunk. Four tension springs could hold these drive wheels always pressed against the trunk at the required normal force. This arrangement can accommodate the variation in the diameter of the palm trunk. The pedestal attachment to the main frame carried the operator up and down the palm. Initially the machine was powered by a single phase one hp electric motor; and is envisaged for use of a light weight petrol engine. It took one minute to climb up a palm of six meters height and 50 seconds to climb down.

2.5.5 HARVESTING OF OTHER HORTICULTURAL FRUITS

The lowly mango picker or more locally known as sigpao, might be considered as a very simple tool ordinarily used for harvesting mango fruits but it plays an important role in making harvesting easier and in preventing losses that occur during the process. Traditionally, the use of sigpao has long been practiced in fruit-producing provinces, which definitely have

their own designs of sigpao. However, problems in the use of these pickers such as low capacities and ineffective designs which cause losses during harvesting, have been encountered

To address these problems, the Agricultural Engineering Division of the Bureau of Plant Industry (BPI-AED) has developed an improved mango picker designed to ease picking operation and reduce losses. The modified design, which is based on the results of the review and field testing of the performance of the existing sigpaos, was released years back and is now being used in some mango-producing provinces all over the country. The improved mango picker has the following parts: a ring frame with a diameter of 27 centimeters; a comb with four loops used to separate the fruits from the peduncle; a blade which cuts the peduncle of the fruit for faster harvesting; a net which catches the fruits to prevent them from falling directly on the ground; and a handle which is attached to the adjustable pole.

Although harvesting by hand is found effective in order to minimize bruises on the fruits, the use of a harvesting tool is practical and convenient especially for tall mango trees. The blade in the improved sigpao enables the harvester to keep the peduncle intact (cut about 2.5 cm from the fruit), hence minimizes the flow of latex

The improved sigpao can harvest a kaing of mango (which averages from 16 to 22 kilos of fruits, depending on fruit size) in 2.32 minutes - a rate that is better than the traditional sigpaos which have capacity ranges of 3.58-5.38 minutes per kaing of mango, according to BPI-AED. This enables the farmer to save on labor expenses because the improved sigpao guarantees zero damage on the newly harvested fruits, results of field tests show. But of course, a skilled laborer must do the harvesting in order to maximize the performance of the sigpao.

Another feature of improved sigpao is that it is made of lightweight, noncorrosive materials. Its aluminum handle can be adjusted from 3.35 m to 5.5 m long for use in tall mango trees. Weighing only 1.2 kilograms, this tool can be used by anybody who is capable of doing the harvesting operation. Priced at P600 per unit, improved sigpao ensures high return on investment in terms of durability and efficiency. It can also be used for picking santol, star apple, guyabano, guava and other fruits. Maintenance, such as sharpening of blades, should be done regularly to keep it in good shape.

2.5.6 Harvesting Of Fruits and Nuts

A universal hand held tool for harvesting fruit and nuts. Harvesting is accomplished by a plurality of specially shaped spring wire tines. Tines are covered with plastic to minimize fruit and tree damage. Passing through a guide bracket secured to a handle, tines are held by a retainer that slides along the handle. Moving the retainer along the handle adjusts the tine spacing to accommodate different sizes and shapes of fruit. Retainer can be locked in any of a number of selected positions. Extension handles of various or adjustable length can be attached to harvest the crop safely from the ground. Fruit, such as olives that will be used to make olive oil, can be stripped from the branches using a raking motion into a tarp or container on the ground. To harvest for edible fruit without allowing it to fall to the ground a removable container is easily attached under the tines to capture the fruit. The container is made from a pliable material with a resilient aperture to reduce bruising or damage to the fruit. Tine attachment to the retainer has an adjustment feature that allows radial motion of the tines for spacing adjustment but prevents lateral or rotational motion thus maintaining the selected tine spacing during use.

TOOLS FOR HARVESTING CITRUS FRUITS

2.5.6.1 Citrus Clipper

Plate 2.3 Citrus Clipper

Wow, we searched the planet for a decent citrus clipper, and then we came across this one, sourced from a reputable manufacturer of hand tools.

The clipper is used by most citrus farmers in South Africa as well as neighbouring states, for harvesting fruit such as oranges, grapefruit, naartjies and lemons. The citrus clipper has an "anvil" cutting action, meaning it has a sharp blade that cuts against a "blunt" face [as opposed to a "bypass" cut where the 2 blades of the scissor cut past each other]

The clipper's blades are designed and shaped in such a way that they will fit into the calyx of the fruit, cutting the stem off as close to the calyx as possible. The shorter the remaining stem, the less damage to other fruit during the harvesting & packing process. The citrus clipper also has a rounded tip to ensure the skin of the fruit is not inadvertently damaged during harvesting. Leather straps attached to the clipper allow the picker to attach the tool to

his finger, negating the need to put the clipper down, after harvesting each individual fruit. Spares available include springs and nut & bolt sets.

2.5.6.2 Lemon Clipper

We call this a lemon clipper but it has many more applications than just the harvesting of lemons. However, let's start with lemon harvesting. Due to the shape of the lemon fruit, where the calyx is more exposed to the worker [compared to oranges], and this clipper is ideal for this purpose. The blades operate on the bypass system and are extremely sharp. Due to the slight upward curve of the **blades** the skin of the fruit is not damaged during cutting, and the tips are rounded and pointed. Since introducing the scissor to citrus farmers as an alternative to the traditional, heavy lemon clipper the tool has been a huge success. The harvesting of grapefruit has also been made easier with this scissor and we believe that with some training and concerted effort the lemon clipper can also be used for the harvesting of oranges as well.

Plate 2.4 Lemon Clipper

2.5.6.3 Clip N Pick Fruit Picker

The Clip N Pick system is the number one tool used by avocado harvesters and other harvesting companies who need to harvest difficult fruits and nuts such as mangos, persimmons, chestnuts and other types of hard to reach specialty fruit This handy little tool eliminates the pack out destroying "hook sticks". It provides "hand picked quality" on fruit types of mangos, avocados, citrus and other delicate fruits. It is also ideal to use for maturity testing, early spot picking or for those elusive "shiners". Replaceable mesh bags are heavy duty tear, abrasion & mildew resistant. Clip-N-Pick comes in two parts and can be ordered

separately. The first part is the frame which comes with a replaceable bag and replaceable blades. The second part is the 6 foot to 12 foot telescoping pole.

Plate 2.5 Clip and Picker

2.5.6.4Mechanization of Dates Fruit Harvesting

Mohammad et al; (2004) conducted a study on mechanization of dates and found out the following results. The date palm (phoenix dactylifera.L) is native to Iran, Iraq, Saudi Arabia and many oases in the desert areas of northern Africa, Date is an important crop in feeding.

Date fruit harvesting and post harvest handling are tedious and labor-intensive. In a majority of the date growing regional, hand harvesting is the predominant harvesting method. However due to the lack of experienced labor during harvesting season, low output and human hazard motivated a need for mechanically date fruit harvesting. Therefore; mechanization of date fruit harvesting is considered as the most important of date cultural operation, due to need for improved mechanical harvesting methods in one hand , and increasing of income for date growers in other hand. This paper discusses the strategies for improving new method for date palm cultural operation, and factors affecting on it.

2.5.6.5 NUT HARVESTING TOOLS

The Limb Shaker is designed for nut harvesting and fruit thinning. Simply hook a limb and squeeze the trigger. A quick, vibrating motion immediately sends fruit to the ground. As a nut harvester the tool is exceptional in young trees and small acreage where knocking is commonly applied. Thinning stone fruit has never been quicker or easier.

Olistar Evolution is the preferred olive harvesting tool worldwide. Its lightweight design and superb raking performance makes olive harvesting quick and easy, delivering a total harvest regardless of the stage of ripening or the type of cultivar. A uniquely designed rake makes the tool adaptable to different sized branches for ease of movement and penetration into the tree.

Plate 2.6 Limb Shaker

Plate 2.7Olistar Harvesting Tool

2.5.7 Harvesting Bag

With this bag around your waist both hands are free to pick your abundant crops. It is made from poly-canvas and it is very strong (same material ambulance stretchers are made from). It has excellent abrasion resistance and the whole unit is machine washable.

Plate 2.8 Harvesting Bag

Capacity is approx 1/3 bushel = 12 litres. Features an easy-to-adjust quick-release buckle waist belt. The fruit is picked and placed in the bag which is kept open by the unique plastic hoop support. The bag is emptied via a bottom release chute.

2.5.7.1 FRUIT PICKER BAG

Now you can pick your fruit safely, quickly and easily, while standing on the ground. This lightweight metal head slides onto most wooden pole/dowel or rakes (maximum 2cm) with a screw (not supplied) via the tapered hollow tube. Ideal for apples, pears, peaches, plums, persimmons, custard apples, guava, choko, passion fruit & mango but will not fit papaya.

Plate 2.9 Fruit Picker Bag

Works by positioning two picking fingers behind your chosen piece of fruit and with a gentle pull or twist, dislodging the fruit into the soft cotton catching bag.

Materials and Methods

CHAPTERIII

MATERIALS AND METHODS

This chapter mainly deals with various steps undertaken to evolve the proposed tool. In the initial phase of project, concepts and techniques for harvesting the pepper were thought off and their practical feasibility was studied. Some of these concepts were used for developing the harvesters. The different models developed and their working and specifications of the developed tools are described below: -

3.1 Test models

The conceptual development of the tool was done by studying various garden tools available in our farm machinery lab**.** The study was undertaken in the workshop of this College.

3.1.1 Model no: 1

The basic concept was to develop a simple tool which was easy to handle and farmer friendly. The tool caused minimum damage to veins. The raw materials selected for the tool were mild steel plate, Aluminium conveying pipe, stainless steel blade, PVC pipe and other accessories to support harvesting.

3.1.1.1 Cutting unit

For the correct positioning of the blade on the panicle a V- groove was given on the mild steel sheet (2mm) thick. The PVC pipe was cut elliptically with an inclination of 45^0 to horizontal. The mild steel sheet was also cut in an elliptical shape so that it would fit into the cut section of the PVC pipe. Another MS sheet was provided as support to the elliptical plate and both were welded. Two stainless steel blades were attached to the plate in such a way that the clearance between them was equal to mean diameter of panicles. For supporting the stain steel blades on the plate two M.S sheet were provided. The cutting mechanism of the tool was the shearing action by the stainless blades by pulling the pipe vertically downwards. The harvested panicles are collected through the pipe to the ground.

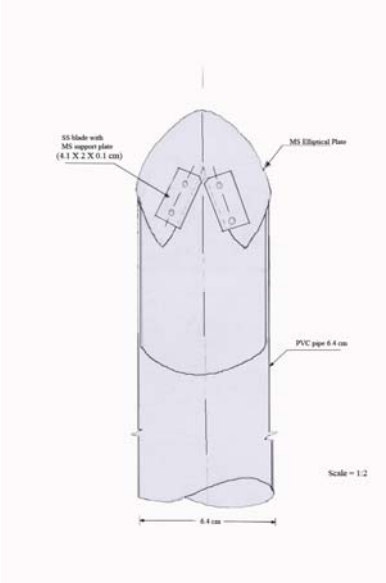


Fig. 3.1 Cutting Unit of Model no: 1

3.1.1.2 **Conveying Mechanism**

The harvested panicles were conveyed through the hollow Al pipe to the ground. The diameter of the pipe was 6.2 cm so that the harvested panicles could be conveyed without any bridging action.

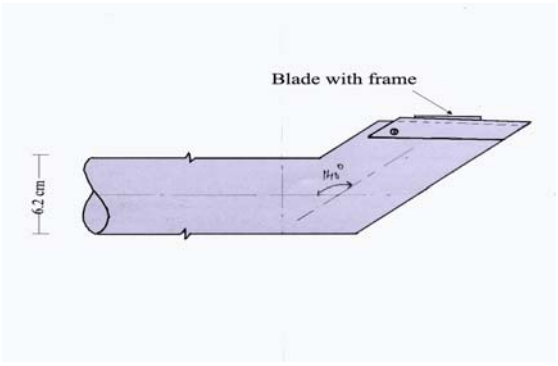


Fig.3.2 Conveying Mechanism of model no: 1

SPECIFICATIONS:-

Table 3.1.1.1 Specifications of Conveying pipe and Cutting blade

Sl No.	Part	Material	Dimensions (cm)		
			l	b	t
1	Part 1	Al	260	6.2	0.1
2	Part 3	SS	4.5	2.0	0.1

MAIN PARTS OF THE TOOL

Part 1 - Conveying pipe

Part 2 - Elliptical mild steel plate

Part 3 - Cutting blade (stainless steel

Table 3.1.1.2 Specifications of Elliptical mild steel plate

Sl No.	Part	Material	Dimensions (cm)		
			Ma	Mi	t
1	Part 2	MS	6.6	5.0	0.2

(Major Axis – Ma; Minor Axis- Mi)

3.1.2 Model no: 2

The tool consists of – a long handle, rope mechanism, a cutting blade, hand lever and a collecting basket.

3.1.2.1 Cutting Unit

For the construction of the blade a mild steel plate, 2 mm thick was selected from which the required dimensions of the blade were cut out. Then the two plates of the blade were properly aligned and the position of the hole was fixed, so that it gives the correct cutting action .The hole was drilled using 4 mm drill bit. The plates were fastened using a nut and bolt. A lock nut was provided to give the tool the required pivoting action. The testing of the blade was made by fixing one of the plates (fixed plate) in a bench vice and inserting panicles of different diameters in between the blades and cutting them.

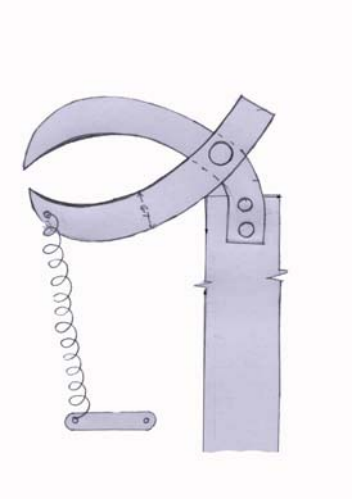


Fig. 3.3 Cutting Unit of Model no: 2

A hollow rectangular Aluminium pipe of suitable length was selected and the tool was mounted on its frame. A 1mm hole was made on the movable plate with a drill bit.

3.1.2.2 Handle lever

A handle brake was provided at the bottom of the pipe in order to regulate the cutting action. Brake wire with an outer was inserted through the hole of the movable plate and through the pipe to the handle so that the operator can use the tool easily.

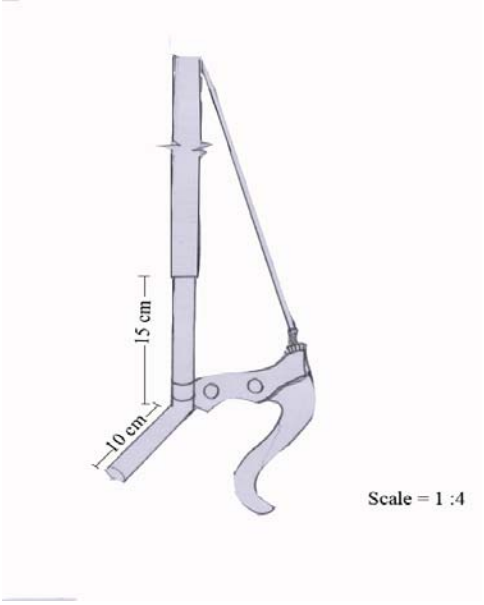


Fig. 3.4 Hand lever of model no: 2

3.1.2.3 Conveying Section

For collecting the panicles a basket was set, just below the blade with a required angle for proper conveyance through it. A 4 mm metal wire was bended in the form of a circular ring of diameter 13.5 cm over which nylon net was stitched to form a basket. When the basket is filled it can be easily disposed to the required destination and again the process can be continued. The main advantage of the proposed tool was that panicles can be harvested and collected simultaneously without causing much loss.

MAIN PARTS OF THE TOOL

Part1- Blade with spring

Part 2- Al square frame

Part 3 – Handle with lever

Part 4- Collecting basket

Fig.3.5 Conveying Section of model no: 2

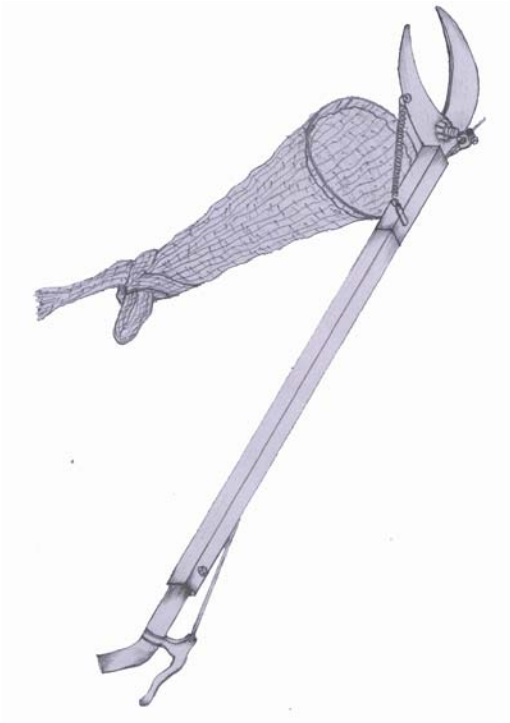


Fig. 3.6 Isometric view of Model no: 2

SPECIFICATIONS

Table 3.1.2 Specifications of the proposed Model no: 2

Sl. No.	Parts	Material	Dimensions(cm)				
			l	b	t	ID	OD
1	Part1	MS	10	1.9	0.2	-	-
2	Part 2	Al	170	2.2	0.15	-	-
3	Part 3						
	1) handle	MS	25	-	-	-	2.0
	2) hand lever	Plastic	17.5	-	-	-	-
4	Part 4	Nylon	-	-	-	-	13.5

3.1.3 Model no: 3

The raw materials used for this model are – bended mild steel plate (2mm thick), carbon steel, mild steel springs, and blade from leaf plate, nylon pulleys, belt rope, mild steel plate clamps, hand lever and other accessories.

3.1.3.1 Cutting unit with spring, rope and pulley arrangement

The tool basically works with a cutting action provided by the guiding plates which is operated by the handle lever, through rope and pulley arrangement.

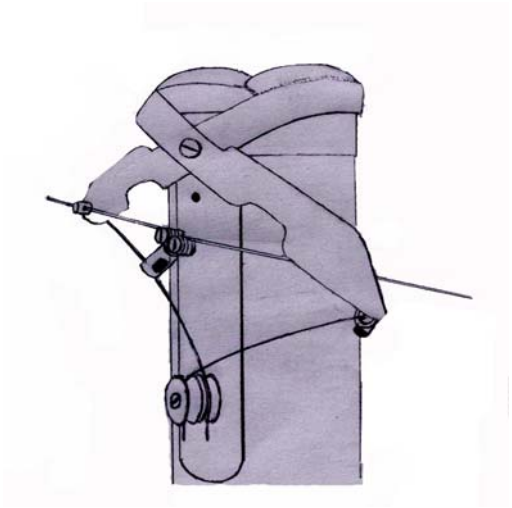


Fig.3.7 Cutting unit with spring, rope & pulley arrangement model no: 3

For proper setting of the blade two mild steel plates were bended in the shape of a half round. From leaf plates two blades of equal length and width were made by bending and grinding with the required inclination for proper cutting. The two blades were placed in such a way that there is no gap between the two blades for the correct shearing of the panicle. These blades were then welded to the mild steel plates. For the proper movement of the blades two springs were attached so that their combined action provides the required force for the movement of the two blades. For utilizing the maximum spring tension, a nylon pulley was provided on a pin i.e., pivotally joined. The wrapping of the rope with the pulley provided the required angle of pull. It also helped for the easy movement of the rope.

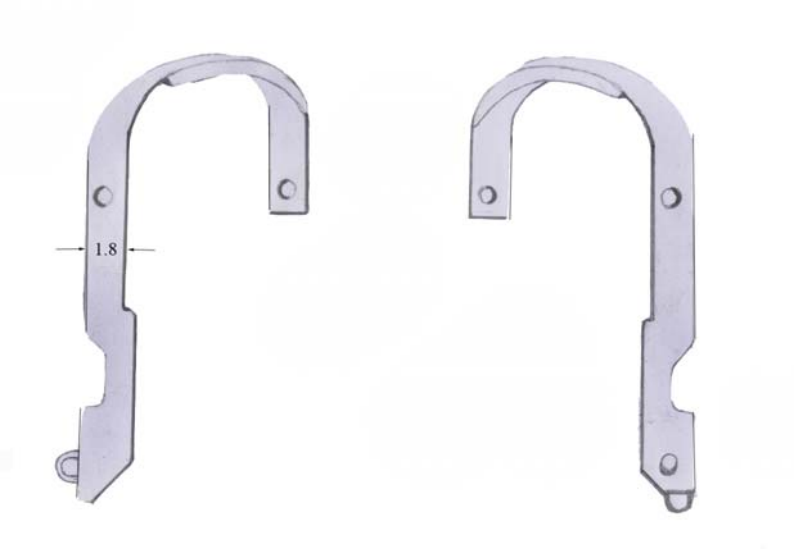
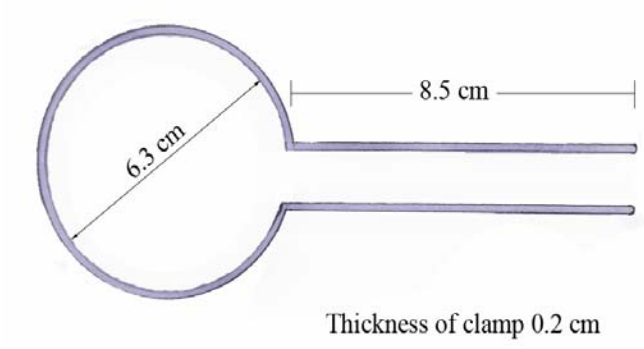


Fig. 3.8 Cutting Blade of Model 2

3.1.3.2Clamp arrangements

We have provided two clamps at the bottom of the pipe, one for guiding the rope to the lever as well as for getting maximum drive and other for attaching the hand lever. Clamp1 was used in order to provide the required tension and to prevent the sagging effect of the rope a nylon pulley was also attached to the clamp. An MS sheet (2mm thick) of length 29.7 cm was bended to the required shape with outer diameter 6.3cm and a spacer was provided in order for the firm fixing of the clamp on the pipe. The positions of the holes for spacer and the pulley were located. A 6 mm hole was drilled on the clamp for inserting the spacer. The wooden spacer was also drilled with the same bit. The pulley was also drilled so that it can freely rotate. Clamp2, it is a lever clamp and is provided for controlling the motion of the hand lever by the user. It also has two holes one for hand lever and other for spacer. A 6mm bit was used for the purpose.



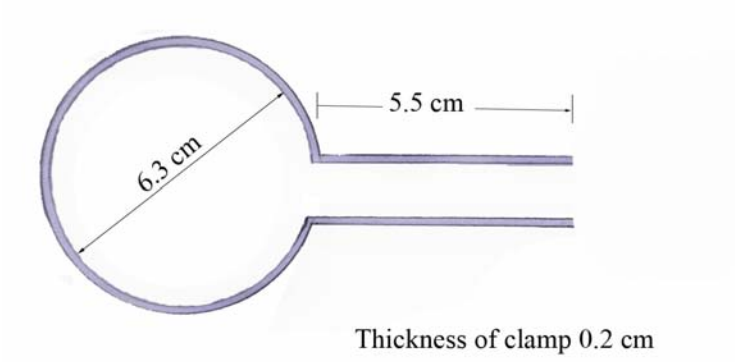


Fig.3.9 Clamp arrangement of Model no: 3

3.1.3.3 Hand lever

The hand lever controls the entire working of the tool. The movement of the lever stretches the spring which moves the blades closer and cuts the panicle held between them. Once the lever is free the spring moves the blades apart to its original position, the lever all attains its original position with the help of a lever spring.

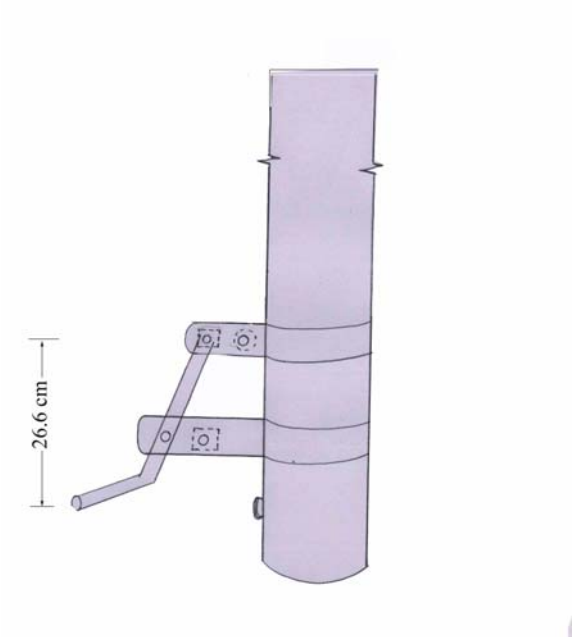


Fig.3.10 Hand lever of Model no: 3

3.1.3.4 Conveying pipe

The panicles which were cut are simultaneously collected also. This function was performed by the circular aluminium pipe with a specified diameter of 6.2cm and it was collected at the lower end of the pipe. For the easy collection of the harvested panicles a collecting bag was hung around the waist of the operator. When the bag is sufficiently loaded, the operator unloads the panicles to the required destinations.

MAIN PARTS OF PROPOSED TOOL

Part 1- Cutting part with spring, rope and pulley arrangement

Part2- Clamp arrangement

Part 3- Hand lever

Part -4 Conveying pipe

SPECIFICATIONS:-

Table 3.1.3 Specifications of Proposed Model no: 3

Sl No.	Part	Material	Dimensions (cm)			
			l	b	t	D
1	Part 1					
	a) guiding plate	MS	17	1.8	0.2	-
	b) cutting blade	Leaf spring	6.2	1.5	0.2	-
	c) pulley	Nylon	-	-	-	2.5
	d) spring	MS	7.5	0.15	0.5	-
	e) wire rope		201.5	-	-	0.2
2	Part 3					
	a) hand lever	MS	26.6	-		1.8
3	Part 4	Al	260	-	0.15	6.4

Table 3.1.3.2 Specifications of the Clamp arrangements for Model no: 3

Sl No	Part	Material	Dimensions(cm)				
	Part 2		l	b	t	d	ofs
1	a) clamp1	MS	29.7	2.5	0.2	6.3	5.5
2	b) clamp2	MS	36.7	2.5	0.2	6.3	8.5

Results and Discussions

CHAPTER IV
RESULTS AND DISCUSSIONS

This chapter highlights the results of the various models developed for harvesting pepper.

4.1 Test Models

The developed models were tested and the results are discussed in terms of easiness in operation, damage to harvested berries, amount of harvesting loss etc. Due to lack of time extensive evaluation of the developed tools were not possible, instead they were tested in the farm and campus itself.

4.1.1 Model no: 1

The model 1 described above was tested for the Panniyur variety located in our campus. The advantage of this tool was that once the panicle was correctly inserted between the plates it could be easily harvested and conveyed simultaneously. One of the main limitations of the tool was that the insertion of the panicle into the cutting portion of the blade was difficult.

4.1.1.1 Cutting unit

The panicles positioned to the blade due to the v- groove provided on the cutting unit which was cut elliptically. The inclination in the pipe enabled the blade to firmly hold to the panicle. The sharp edges of the SS blade provided the necessary shearing action and the clearance between the blades was just enough to insert the panicle in between the blades. The panicles harvested by shearing action were conveyed through the pipe to the ground.

4.1.1.2 Conveying Mechanism

The harvested panicles were conveyed through the hollow Al pipe to the ground. The diameter of the pipe was enough to convey the panicles without any damage and bridging action.

4.1.2 Model no: 2

The Panniyur variety was selected for testing the second model. The panicle could be easily harvested and collected at the same time. The percentage of loss was very less compared to the previous model. It was more user friendly with its simple working and efficient cutting action.

4.1.2.1 Cutting Part

The blade made of mild steel plate, 2 mm thick selected was having the required efficiency. Then the two plates of the blade with proper alignment and correct positioning of holes helped it for correct cutting action. A lock nut provided gave the tool the required pivoting action. A hollow rectangular Aluminium pipe that was selected with the suitable length helped for its proper mounting of the blade. A 1mm hole made on the movable plate with a drill bit helped it for the moving action.

4.1.2.2 Handle lever

A handle brake provided at the bottom of the pipe helped for the regulation of the cutting action. Brake wire with an outer was inserted through the hole of the movable plate and through the pipe to the handle; this helped the operator to work easily with the proposed tool.

4.1.2.3 Conveying Section

The collection of the panicles was done with the help of a basket which was set just below the blade with a required angle for proper conveyance through it. A 4 mm metal wire was bended in the form of a circular ring of diameter 13.5 cm over which nylon net was stitched over it has got the required strength for its collection. When the basket was filled it can be easily disposed to the required destination and again the process was continued.

4.1.3 Model no: 3

This model could overcome limitations associated with the previous ones. The two mild steel plates could move freely over the pin and the tension in the wire rope was enough to guide cutting blades to the panicle. The spring provided along with the cutting unit could move the plates apart once the load was removed. The positioning of the panicle to the blade was difficult.

4.1.3.1 Cutting part with spring, rope and pulley arrangement

The cutting action provided by the guiding plates which is operated by the handle lever, through rope and pulley arrangement worked efficiently with the required efficiency. For proper setting of the blade two mild steel plates were bended in the shape of a half round. From leaf plates two blades of equal length and width were made and this gave the required cutting action. The two blades were placed in such a way that there is no gap between the two blades for the correct shearing of the panicle. These blades were welded to the mild steel plates. For the proper movement of the blades two springs were attached and their combined action provides the required force for the movement of the two blades. For utilizing the maximum spring tension, a nylon pulley was provided on a pin i.e., pivotally joined. The wrapping of the rope with the pulley provided the required angle of pull. It also helped for the easy movement of the rope.

4.1.3.2 Clamp arrangements

The two clamps provided at the bottom of the pipe, one for guiding the rope to the lever as well as for getting maximum drive and other for attaching the hand lever. Clamp1 which was used provided the required tension and to prevent the sagging thick) of length 29.7 cm was bended to the required shape with outer diameter 6.3cm and a spacer which was provided helped for the firm fixing of the clamp1. Clamp2, it acted as a lever clamp and it helped for controlling the motion of the hand lever by the user. It also has two holes one for hand lever and other for spacer.

4.1.3.3 Hand lever

The hand lever controls the entire working of the tool. The movement of the lever stretches the spring which moves the blades closer and cuts the panicle held between them. The entire cutting efficiency of the tool was controlled by the hand lever.

4.1.3.4 Conveying pipe

The panicles which were cut are simultaneously collected also. This function was performed by the circular Aluminium pipe with a specified diameter of 6.2cm and it was collected at the lower end of the pipe. For the easy collection of the harvested panicles a

collecting bag was hung around the waist of the operator. When the bag is sufficiently loaded, the operator unloads the panicles to the required destinations.

Overview of Result

From the field tests, done for each model it was evident that the proposed models were good for the Panniyur variety which was seen in our campus. Out of these models the model no: 2 were suited as the best. Its light weight and easy handling helped for better performance and collection of the panicles with not much loss. The model consists of a simple square frame with cutting part at the top and a corresponding basket for collecting the harvested panicles.

Future line of work

Following modifications on the existing pepper harvesting models are suggested to overcome certain drawbacks experienced during its operation.

Model 1

1. The inclination of blades with the horizontal should be increased to facilitate correct cutting action by the blades.

Model 2

2. The Aluminium frame should be made telescopic so that it can be used to harvest panicles above 4 m.
3. The movement of the blades can be mechanized by using electronic gadgets.

Model 3

4. The thickness and length of the blades should be increased to enhance the cutting action.
5. Suitable mechanism should be to incorporated with the tool to deflect the leafs which cause hindrance to harvest.
6. The operation can be motorized in future.

Model 1

Plate 4.1 Cutting unit of Model no: 1

Model no. 2

Plate 4.2 Cutting unit of Model no: 2

Plate 4.3 Cutting operation of Model no: 2

Plate 4.4 Conveying Section of Model no: 2

Plate 4.5Hand lever of Model no: 2

Plate 4.6 Operation of Model no: 2

Model No 3

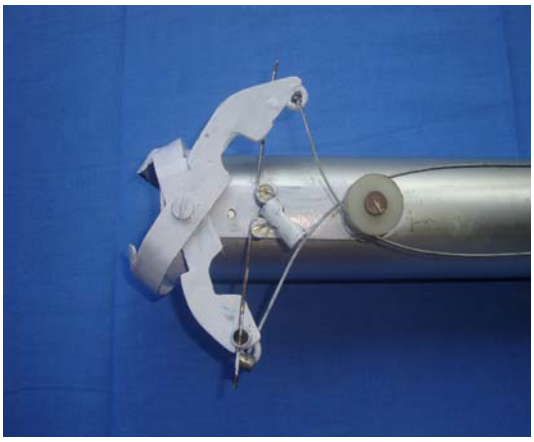


Plate 4.7 Cutting unit of Model no: 3

Plate 4.8 Open position of Model no:3

Plate 4.9 Closed position of Model no: 3

Plate 4.10 Hand lever of Model no: 3

Plate 4.11 Operation of Model no: 3

Summary and Conclusion

CHAPTER V
SUMMARY AND CONCLUSION

'Black pepper' is termed as *'King of Spices'* for its importance in uses to human beings. Pepper is an essential seasoning in Indian food and also abroad which makes it capable of excellent export potential. As each berry has its own value, harvesting should be done with almost care so that the loss of a single berry is inevitable by the farmers. The present harvesting method is manual plucking with bare hands. Prolonged working time causes pain and stress.

By taking into consideration the drudgeries of the farmers a project work entitled "Development of Pepper Harvester" as an achievement to the farmers was undertaken to overcome the problems associated with pepper harvesting. The present method undertaken is through hand plucking at the rate of Rs/-100 per 10 Kg and it usually depends on the thickness of the panicles available on the concerned veins on the plant.

The proposed models basically consisted of a cutting unit, a conveying section and a hand lever. The tools are operated manually which eliminates other expenses to be met by farmers. From the field tests done for each models it was evident that the proposed models were good for the Panniyur variety which was seen in our campus. Out of these models the model no: 2 was found to be suited as the best for the Panniyur variety. Its light weight and easy handling helped for better performance and collection of the panicles with not much loss. The model consists of a simple square frame with cutting part at the top and a corresponding basket for collecting the harvested panicles.

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DEVELOPMENT OF PEPPER HARVESTER

By

ANEESHYA KAMAL.K.S

G.K.KRISHNANUNNI

PROJECT REPORT

Submitted in the partial fulfillment of the requirement for the degree

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In

Agricultural Engineering

Department of Post Harvest Technology & Agricultural Processing

Faculty of Agricultural Engineering and Technology

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR-679573, MALAPPURAM

Kerala Agricultural University

2009

Abstract

ABSTRACT

Kerala is the leading producer of Black Pepper, king of spices in India. The farmers are well aware about the excellent export potentials of pepper, pepper by-products and their value-addition. The harvesting of pepper is of great concern to the farmers. The shortage of harvesting labour and their high wages causes burden to pepper farmers. Under the project entitled “Development of Pepper Harvester”, three models were fabricated. The objectives considered for the development of the tool was incorporated during the fabrication phase. Primary testing of the developed models were conducted under field condition. The tests revealed that Model no. 2 was the most successful and effective for harvesting pepper.