# DEVELOPMENT AND TESTING OF A PINEAPPLE PEELER, CORER CUM SLICER

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## PROJECT REPORT



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# DECLARATION

We here by declare that this project report entitled **"DEVELOPMENT AND TESTING OF A PINEAPPLE PEELER, CORER CUM SLICER"** is a bonafide record of project work done by us during the course of project and that the report has not previously formed the basis for the award of any degree, diploma, associateship, fellowship, or other similar title of any other university or society.

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# CERTIFICATE

Certified that this project report entitled **"DEVELOPMENT AND TESTING OF PINEAPPLE PEELER, CORER CUM SLICER"** is a record of project work done jointly by Bindhu.K.George, Bindu Kochugovindan and Vidhu.K.P under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship, or associateship to them.

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# SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| % | - | Percentage |
| Agri. | - | Agricultural |
| CFTRI | - | Central Food Technological Research Institute |
| cm | - | Centimetre |
| Dept. | - | Department |
| et al | - | And others |
| FIB | - | Farm Information Bureau |
| FPME | - | Farm, Power, Machinery and Energy |
| g | - | Gram |
| ha | - | Hectare |
| Hg | - | Mercury |
| hr | - | Hour |
| I.U. | - | International Unit |
| ISA | - | Indian Standard Angle |
| KCAET | - | Kelappaji College Of Agricultural Engineering and Technology |
| Kg | - | Kilogram |
| M | - | Million |
| mm | - | Millimetre |
| MS | - | Mild steel |
| ° | - | Degree |

| | | |
|---|---|---|
| Ø | - | Diameter |
| ºC | - | Degree Centigrade. |
| ºF | - | Degree Fahrenheit |
| PHT and AP | - | Post Harvest Technology and Agricultural Processing |
| pp | - | Page |
| rpm | - | Rotations Per Minute |
| Rs. | - | Rupees |
| RTS | - | Ready To Serve |
| s | - | Seconds |
| SS | - | Stainless steel |
| t | - | Tonne |

# INTRODUCTION

India is the second largest producer of fruits after Brazil and the second largest producer of vegetables after China. The total estimated annual production is 70 M tonnes of which fruits constitute 25 M tonnes. Due to inadequate facility for processing the produce, nearly 35% of the total production is wasted. The fruits and vegetables are highly perishable in nature because of high moisture content (70-95%), soft texture, unit size etc. A substantial return can be obtained by processing and marketing these products at small-scale level in India. India's share in world trade of processed fruits and vegetables is only about 1% (Post harvest technology of fruits and vegetables, Dr. P.H.Pandey, 1997)

Fruits such as mango, banana, citrus, guava and papaya are cultivated through out the country and others in certain pockets. Yield potential of fruit crops are given in table 1.1 and table 1.2 and fruit production of different states in table 1.3

Pineapple is one of the commercially important fruits of India and it is grown in Assam, Kerala, West-Bengal, Tripura, Meghalaya, Bihar and Karnataka. In Kerala, pineapple occupies an area of 6180 ha (FIB.1997). Vazhakulam area of Ernakulam district is the most potential pineapple-growing tract of Kerala. Two important varieties under cultivation in Kerala are Kew and Mauritius. Of late, Mauritius has gained more importance than Kew, occupying about 60% of total pineapple acreage in the state. The suitable climate, better marketing prospects both as fresh fruit and processed product, better keeping quality and less damage during distant transport have elevated this variety to the status of a commercial variety in Kerala.

**Table.1.1: Yield Potential of Fruit Crops, 1997**

| Fruit | Present yield (t/ha) | Potential (t/ha) |
|---|---|---|
| Mango | 8.11 | 15 |
| Banana | 26.40 | 58 |
| Citrus | 8.06 | 30 |
| Apple | 6.11 | 30 |
| Guava | 10.77 | 20 |
| Pineapple | 14.45 | 85 |
| Sapota | 13.75 | 80 |
| Papaya | 16.94 | 80 |
| Grapes | 19.20 | 25 |
| Ber | 5.00 | 20 |
| Passion fruit | 4.50 | 15 |

(Source: Survey of Indian Agriculture –1997)

**Table 1. 2: Production of Major Fruits 1994**

| Fruit | Production (t) |
|---|---|
| Mango | 9223256 |
| Banana | 10447842 |
| Citrus | 2186852 |
| Apple | 1168252 |
| Guava | 1204310 |
| Pineapple | 858978 |
| Grapes | 652413 |

(Source: Indian food industry, Data bank 13 (6) 1994 Nov-Dec.)

**Table 1.3 Fruit Production in Select States of India**

| States | Production of all Fruits (t) |
|---|---|
| Andhra Pradesh | 4724139 |
| Assam | 1036000 |
| Bihar | 3358983 |
| Gujarat | 1915000 |
| Karnataka | 3438046 |
| Kerala | 1931000 |
| Madhya Pradesh | 1282264 |
| Orissa | 1036000 |
| Tamil Nadu | 2369033 |
| Uttar Pradesh | 3354063 |
| West-Bengal | 1149300 |

(Source: Indian Food Industry-Databank, 13(6) 1994, Nov-Dec.)

Pineapple is commercially exploited in value added forms such as canned pineapple slices, and titbits, canned juice, jam, squash, concentrates and R.T.S beverages. The main by-products of pineapple processing are canned syrup, vinegar, silage, bran, waxes, proteases, bromelin, fibre and cattle feed.

The main processing stages in the pineapple value addition process are peeling, coring and slicing. Traditionally peeling and slicing are done with sharp knives. In the processing industries of Kerala, peeling is done manually, using knives of different shapes, and slicing, mechanically. Hand punches are used to trim the slices and to remove the core. These series of operations are time consuming, labour intensive, and involving drudgery of work and with limited production capacity. Considering the favourable agroclimatic conditions of Kerala for growing fruits and taking into account many other factors, it is now being increasingly realised that fruit processing in general and pineapple processing in particular needs to be encouraged so as to reduce wastage and to balance seasonal production factors apart from adding value to the produce. This will lead to increased skilled labour requirement and thus to better employment generation along the length and breadth of the state. The value added products can also be exported and would fetch better foreign exchange and ultimately contribute meaningfully towards sound economic stability.

The fruit processing industry in India is extremely decentralised, as a large number of processing units are in village and small scale sectors .The available literature and visits conducted to various pineapple processing industries in Kerala revealed that there exist no viable equipments for the peeling, coring and slicing of pineapple. A Ginaca machine, which peels and cores pineapple which was found reported is a complicated automatic system involving a number of sensors etc. and is very costly. This machine is therefore not being adopted for use by the small-scale processors of Kerala.

Considering the above constraints, an attempt was undertaken at K.C.A.E.T, Tavanur to develop a low cost, efficient peeler, corer cum slicer with the following objectives:

1. To develop an efficient manual pineapple peeler, corer cum slicer.
2. To evaluate the performance of the fabricated machine.

# REVIEW OF LITERATURE

## 2.1 Origin and Agronomical Aspects

Pineapple (*Ananas Comosus)* of Bromeliaceae family is one of the choicest fruits of the world owing to its characteristic pleasant flavour, aroma, sweet juice and seedlessness. It is described as *Queen of fruits.*

Pineapple is probably indigenous to Brazil although it had spread to the other parts of tropical America by the time of Columbus, who took it to Europe. It was brought to India by the Portuguese in 1548.

It is a humid tropical plant and grows well both in plains and also at elevations not exceeding 900m. It tolerates neither very high temperature nor frost. It grows in almost any type of soil provided it is free draining. It is tolerant to drought because of special water storage cells. In India pineapple is grown in Assam, Kerala, West Bengal, Tripura, Meghalaya, Bihar and Karnataka.

The rainy season is the best time of planting. The field is prepared by ploughing, harrowing, etc before planting. Pineapple is cultivated on level grounds, flat beds, ridges or in deep trenches. Trenches ensure moisture conservation but is a labour intensive operation. It can be grown as a pure crop on plantation scale or as an intercrop in coconut gardens.

Different planting materials like suckers, slips, crowns and stumps are used. Suckers arising from underground parts of plant are commonly used. These produce fruit in 18 months. Slips arise from the fruiting stem and from the crown on top of the fruit. Plants from slips and suckers propagated from disc cutting take over two years to produce fruit. A planting density of 43,500 plants / ha can be followed keeping a distance of 30cm between plants, 60cm between rows and 90cm between beds. The plantation is allowed to remain on the same site for 4-5 years after which it is renewed. (Pineapple –An Industrial Profile, C.F.T.R.I. 1985)

The multiple fruit matures 5-6 months after flowering. It is formed by an extensive thickening of the axis of the inflorescence called peduncle and by the fusion of the small berry like fruits produced by each flower. The edible portion is formed by rachis, perianth and bracts. The entire fruit has outer spiny and pointed structures, which are the hard and dried stigmas of carpels. (Bilgrami et al, 1985)

## 2.2. Varieties

As many as 80 -90 varieties of pineapple are under cultivation in different part of the world. The most important commercial varieties grown in the world are Kew, Giant Kew, Smooth Cayenne, Hilo, Queen, Singapore, Spanish, RedSpanish, Selonger green, Sarawah and Mauritius. But in India only the exotic verities like Kew, Queen, and Mauritius are cultivated on commercial basis. There are also some indigenous types; the prominent ones are Jaldoop and Lakhat grown in Assam and Simhachalam grown in Vishakapatnam.

The Kew is a late fruiting variety, ripening in August and September. The fruit ripened during October and December are acidic and have no value. The fruits are biggest among all varieties under cultivation weighing about 3kg on an average. The flesh is light yellow, almost fibreless, very juicy and of an agreeable taste with a characteristic flavour. It is cylindrical in shape and slightly tapering at the crown. The eyes of this variety are broad and shallow, making the fruits suitable for easy trimming as required for canning.

The Queen is an early fruiting variety ripening in June – July. The fruits are yellow in colour when fully ripe and have small size, weighing 1.5 to 2 Kg. The prominent and irregular eyes are deep set, a disadvantage for canning. The flesh is sweet, sweetest of all the varieties under cultivation. It has an attractive deep yellow shell colour and is firm, transparent and highly flavoured. So it is in demand for the table. Sugar and acid contents are less than that of Cayenne.

The Mauritius is a mid season variety ripening in July- August. The fruits are medium sized weighing 1.75 to 2.75 Kg on an average. There are two types - yellow and red skinned. The flesh of yellow type is light yellow in colour, fibrous and medium sweet while the flesh of the red type is reddish yellow, fibrous but sweeter than yellow type. Yellow type is oblong, sloping slightly towards the apex and the other one is rounded at the base and sloping abruptly towards the crown.

Kew is the leading commercial variety grown in India. It is valued particularly for it's canning quality. Queen is next to Kew in the matter of production followed by Mauritius both being extensively used for the table.

Pineapple usually flowers from February to April and the fruits are ready from July to September. Off -season flowers produce fruits in September to December.

The fruits are harvested when they just began to yellow, the eyes become full and the bracts wither. The fruits harvested between 115 -130 days after flowering are better suited for canning as they gave maximum yield and minimum *wastage. Sharp knife is used for harvesting the fruit retaining 5-7 cm of* stalk.

The yield depends on plant population per hectare. A plant population of 35,000 - 40,000 / ha, yields about 40-50 tonnes whereas the yield varies normally between 50 – 60 tonnes with a plant population, up to 63,758 plants/ ha. The yield could be increased nearly six times than that obtained from conventional methods without adversely affecting the fruit size and shape.

Grading of pineapple fruits is done on the basis of size, shape, maturity, and freedom from diseases and pest. The fruit may be packaged individually or in-groups by wrapping with paddy straw (Pineapple – an industrial profile, CFTRI, 1985)

## 2.3 Food Value

Pineapple is a good source of vitamin A, B and C, along with calcium phosphorous and iron. The pleasant aroma of the fruit is due to the presence of 11– ethyl hexanoate. Internal ethylene concentrations have been reported in the range of 0.16 to 0.4%. The core contains sodium oxalate, which is the cause of irritation in mouth on consumption. It also contains a considerable amount of longitudinal tissue. Somewhat lower percentage of juice is extracted from cores but it is of very attractive quality. Juice of core is generally lower in sugar and acids. Table –2.1 gives the constituents of pineapple.

**Table: 2.1 Constituents of Pineapple**

| Constituent | Percent |
|---|---|
| Moisture | 85 |
| Sugar | 13 |
| Protein | .0.6 |
| Mineral mater | 0.05 |
| Fibre | 0.3 |
| Calcium | 0.03 |
| Phosphorous | .0.01 |
| Iron | 0.9 |
| Acids | 0.6 |
| Vitamin A (carotene/100 g.) | 60 I. U |
| Riboflavin (mg/100g) | 120 |
| Vitamin C (mg/100g) | 63 |

(Source: Post harvest technology of fruits and vegetables, Dr.Pandey. P.H.)

## 2.4 Products.

Pineapples are used for the production of canned pineapple slices and titbits, canned juice, jam, candy, squash, concentrate and RTS beverages. By-products of pineapple are alcohol, calcium citrate, citric acid, vinegar, pineapple flavour, gum, bromelin, oxalic acid and cattle feed.

Kew variety is preferred for canning purposes. Fully ripe, cylindrical shape pineapple fruits with uniform yellowish read colour are selected, the crown and stem portion removed and washed thoroughly in water. The fruits are sliced and the slices punched, cored and eyes removed to get the pineapple rings of suitable size. The solid and liquid wastes are crown, cull, peels, cores and trimmings.

The styles of canned pineapples shall be in any of the following forms.

a) Slices or rings, segments or wedges and

b) Chunks, cubes or titbits.

The canned pineapple shall be of two grades; grade 1 and grade 2. The contents of the can on opening shall display the following characteristics:

*Grade 1-* The canned pineapple shall possess a good characteristic, practically uniform colour or shall be practically uniform in size, free from defects, intact, possess a tender texture and normal characteristic flavour and secure not less than 85 points.

*Grade 2-* The unit shall possess a good and reasonably uniform colour, be intact, possess a tender texture and normal flavour and shall score not less than 75 points. (Pineapple- an industrial profile, C.F.T.R.I, 1985)

## 2.5 Pineapple Beverage Juice

Six types of derivatives or portions of the fruit are being used. During the processing at various stages these constituents are the core, juice, trimmings, eradicated meat, small fruit, juice drained from crushed pineapple and juice drained from eradicator meat. The constituents are passed through first and second stage press. Then the blending of juices expressed from the solid portion of the fruit and liquid sources is done. It is heated to 60 – 62.5 $^0$C.

Centrifuging is done to remove the excess fibre and other material from hot juice. The juice is canned and then pasteurised or juice passed through flash pasteuriser and then filled. (Pandey. P.H. – 1997)

## 2.6 Pineapple Concentrate

The juice used for concentrate production is exactly same as that for a single strength juice. Then it is concentrated. Pineapple concentrate is made under different proportions like 3 to 1 which has a brix of about 46.5°, 4.5 to 1 with a brix of 61° or 6 to 1 product with a brix of 72°. Concentrates are used as an ingredient in blended fruit drinks and fruit drink products. (Pandey. P.H. – 1997)

## 2.7 By-products

Canning syrup from pineapple waste juice is prepared by mixing equal proportion of can sugar syrup with a juice of small fruits and pomace broken into small pieces. Candy is prepared from fruit core. Peels, core and pomace are mixed with 7to 10% sugar for the production of vinegar.

Bran is prepared from peels and crowns rich in sugar and fibre but with low protein content. Protein is therefore added to it.

Cattle feed is prepared from crowns and skins and silage from crushed skin. The other by-products are waxes obtained from mill juice, bromelin, enzyme from leaves and stem and fibre from leaves. (Pineapple- An Industrial Profile, C.F.T.R.I, 1985)

## 2.8 Methods of Peeling

Peeling is one of the most important preparatory steps in processing of some of the fruits and vegetables meant for canning, freezing and dehydration.

In the beginning of the fruit processing industries, only hand peeling was practised. Several methods, machinery and equipments have been developed since then. The various methods are discussed below.

### 2.8.1 Hand peeling

Hand peeling using stainless steel knives with curved blade and special guard to regulate the depth of peeling can be used universally for any fruit or vegetable. The advantages of this method are minimum investment and water requirement and no enzyme stimulation as in the case of heat and lye peeling methods. The peels can be further utilised and wash water is not contaminated with chemicals. Disadvantages are high labour costs and chance of contamination with micro-organism. Hand peeling has almost been replaced with modern trends of peeling. (Radhakrishnaiah Setty et al, 1993).

In the pineapple processing industries of Kerala, initial peeling is done using knives. The pineapple is then sliced and final peeling done using punches.

### 2.8.2 Peeling by heat

Boiling water or steam loosens the peel of certain fruits and vegetables like tomato, peaches etc and then it can be slipped from fruit by hand or with scrubber. In a steam peeler, the fruits are placed on a moving belt, one layer deep and passed through a steam box equipped with a series of spray heads from which the steam is sprayed directly on the material. Then peel is removed by soft brushes after cooling in cold water. Advantages include easier automation and precise temperature control to minimise peeling losses, absence of chemical contamination of water and reduced pollution problems as compared to chemical peeling. (Radharksihnaiah Setty et al, 1993)

### 2.8.3 Lye peeling

Lye (sodium hydroxide solution) dissolves the fruit and vegetable peels and the rate of dissolution depends on lye concentration, temperature and period of immersion. The surface tissue of most fruits consists of three layers namely epidermis, middle lamella and parenchyma. The middle lamella is composed of pectinous substances that are highly soluble in lye but parenchyma cells are large and more resistant to the lye. Hence epidermis is removed along with middle lamella without affecting parenchyma. Advantages of lye peeling are lower cost, rapid handling, reduced loss of fruit when compared to hand peeling, amenability to large-scale operation and suitability to all shapes, sizes and varieties.

The method involves dipping the fruit into the heated lye for a definite period, followed by thorough washing of the peeled fruit. Residual lye may be neutralised by further dipping in dilute citric acid solution. The disadvantages include high peeling losses, loss of damaged fruits and pollution of large volumes of water. (Radhakrishnaiah Setty et al, 1993)

### 2.8.4 Dry caustic peeling

It constitutes the modification of the lye peeling process developed to overcome some of the serious pollution and waste disposal problems inherent in the ordinary lye peeling process. The process uses infra red energy at a very high temperature to condition the surface of fruit and vegetable treated with strong lye, while the rolling of the conveyer turns the material so as to expose all the material to the infra red energy. This accelerates the chemical peeling activity and process makes use of the lye more completely thereby reducing caustic consumption. The dry soft rubber tipped scrubbers remove about 90% of the loosened peel from the treated material while the remaining peel is removed by brush washers. The advantages include reduced processing cost, lower volume of plant effluent, increased product yield and use of sludge as a cattle feed. (Radahkrishnaiah Setty et al, 1993)

### 2.8.5 Freeze peeling (Cryogenic peeling)

Peaches and tomatoes are frozen quickly in liquid nitrogen, Freon–12 or Liquid air, to a depth slightly below the skin and thawed rapidly in tap water. The flesh is not frozen, so the peel is released easily. Peel losses are reduced to half as compared to conventional processes and pollution problems are avoided to a certain extent. (Radhakrishnaiah Setty et al, 1993)

### 2.8.6 Flame peeling

It utilises high temperature (650-2000 ºF) of spent combustion gases. The material is passed through a flame for very short period for blistering the skin and pulling away from the flesh by high pressure of water. This process is specially applicable to tomato, pepper, onion and garlic. (Radhakrishnaiah Setty et al, 1993)

### 2.8.7 Vacuum peeling

A Bulgarian vacuum method for peeling tomatoes consists of scalding the vegetable at 96ºC and applying vacuum at 600-700 mm Hg for tearing off the peel. It has high peeling efficiency, retention of high fruit quality, low energy requirement as well as costs. (Radhakrishnaiah Setty et al, 1993)

Kyuhong et al (1995) developed a vacuum sucking type persimmon peeler. The main components are the vacuum ejector, vacuum switch, vacuum release valve, peeling knife, air compressor and motor. The prototype is a sequentially controlled machine, which removes stem of the persimmon, fixes it to the machine, peels its skin and discharges it quickly. Peeling performance is 363-398 fruits/hr and 3.9-4.3 times faster than manual peeling.

### 2.8.8 Acid peeling

Peach peel is soluble in hot solution of 0.1% hydrochloricacid, 0.05% oxalic acid, 0.1% citric acid or 0.1% tartaric acid. It disintegrates the peel rather than loosening it. (Radhakrishnaiah Setty et al, 1993)

### 2.8.9 Calcium chloride peeling

Dipping tomatoes in boiling calcium chloride solution loosens the skin for easy removal. Its disadvantage is difficulty in controlling the absorption of calcium by the fruit. (Radhakrishnaiah Setty et al, 1993)

### 2.8.10 Peeling with ammonium salts

Fruits and vegetables, when treated with 0.5-15% aqueous solution of mono, di and tri ammonium orthophosphate at 80-95°C for 3-10 minutes (pH 7.0-9.5) produces astonishing skinning effect without destroying the tissue. The effectiveness can be improved by adding surface-active agents preferably at 0.02-0.2% level. (Radhakrishnaiah Setty et al, 1993)

### 2.8.11 Mechanical peelers

Campbell (1982) described the construction of a peeler for potatoes. It tumbles the potatoes along a rasp like surface on the interior of a rotating, nearly horizontal cylinder.

Mandher and Senthil Kumaran (1995) developed a continuous motorised peeler for raw mangoes. The principle is to rotate the fruit in an enclosed cylinder, against the sharp projections on the inner surface.

Anie et al (1996) developed a mechanical abrasive roller type ginger peeling machine and studied the performance by varying the pre-treatment condition and speed of the roller. The machine consists of an abrasive unit, driving unit, collector unit and frame. Abrasion unit does the work of peeling when ginger rhizomes are pressed manually on to the rotating roller.

Ginaca Machine is used in the processing lines to perform several functions like peeling and coring. Machines of several sizes to accommodate different grades of fruit based on diameter are available. About 90 fruits are peeled per minute by this machine which removes the ends from the fruit, cuts the edible flesh from the peel and the ends and finally removes the core from each fruit. Cut pineapple cylinders are trimmed to remove the last traces of peel and blemishes of various sorts. (Pandey. P. H. 1997).

### 2.8.12 Mechanical slicers.

Nanda (1981) Central Tuber Crop Research Institute, developed a hand operated vertical feed cassava chipping machine which consists of two concentric mild steel drums, the annular space between which is divided into compartments for feeding the tubers. The rotating discs at the bottom of it carries the knife assembly. A pair of bevel gears is provided to operate the machine manually with a crank handle. Later on a pedal operated machine has been developed to increase the output as well as operational convenience.

Telis and Sakhpromenergonaladka (1988) designed a centrifugal beet slicer, which uses a drum within which a central vertical hollow axle rotates a scroll carrying knives and tubes for applying steam for cleaning the knives.

Brockhans et al (1989) developed a bolting device for blade boxes of drum slices. The drum slicer for sugar beet includes an arrangement, which enable the knife box to be inserted or removed easily. The construction is such that the position of the bolting device can be seen while it is being adjusted. This device and the spring, which acts, on it are situated outside the slicing drum. Hence beet particles cannot fall on to them and hinder their movement.

Shcherbakov (1989) developed a knife frame for a centrifugal beet slicer. A rectangular body includes a static part to which a control strip 15 Ø bevel is fixed and a moving part for gap adjustment having a support surface to which ribbed knives are attached in a row and an inclined surface for exit of cosettes. To improve cosette quality, on the support surface is made a longitudinal groove and into it are fixed strips with gap relative to the knife face, which are softer than the knives and act as shock absorbers if foreign materials enter the slicer.

Balasubramanian et al (1993) developed a motorised cassava chipper and tested at Tamil Nadu Agricultural University. The machine consisted of a chipping disc with knives driven by a disc shaft from power source. The tubers can be vertically fed from top and chips are collected at the bottom. The capacity of the chipper is 270 Kg/hr. The chip recovery was assessed at 92% for 1 mm chips at 295 rpm. The cost of chipping was estimated at Rs.18/t.

Kachru et al, (1994) Central Institute of Agricultural Engineering, Bhopal developed a multiple string banana slicer to avoid the drudgery and injury to workers and enhance the capacity and maintain quality gadgets within stainless steel string arrangement. This had a hollow frame of mild steel; 250mm length, 130mm wide and 70mm height. About 126 stainless steel rings (28gauge) 7.5mm in length were tied across the longitudinal side at 5mm above the bottom edge of the frame.

During the experimentation, peeled banana was kept on a 10mm raised platform and the frame with strings moved down manually so as the strings pierced into the fruit pulp to cut the slices. Due to the blunt edge of the string, a force of about 28N was required to pierce a single string into the banana. When so many strings acted over one fruit at a time, the force requirement for strings to pierce into the fruit was very high (about 3.5Kilo Newton) which resulted in compression of fruit form the bottom distortion of pulp. Also due to the pulp, removal of slices after cut was very difficult.

Kachru et at, (1996) developed an electrically operated rotary slicer for raw banana and tested at CIAE, Bhopal. The horizontal type-chipping machine consists of a slicer disc attached with blades of 120° apart. An MS shaft is used to drive the slicing disc. A stainless steel semicircular feeding chute is used for *feeding the peeled banana and chips are directly discharged into the pan by* centrifugal action. It has an efficiency of 90% and produces chips of uniform thickness.

Liju (1997) developed a vertical feed mechanical chipper. The feeding mechanism has a pressing attachment which consists of a mild steel rod with a wooden end plate at disc and which is lifted up. The raw peeled banana is fed through the slots made in the feeding pipes. The pressing mechanism is then released and the rotating disc with blade cuts the banana into round slices of uniform shape and thickness. The stopper attachment on the pressing mechanism prevents the wooden end plates from damaging the plates. Chipping efficiency of the machine is 96% and effective capacity of slicing is 223 kg peeled raw bananas per hour.

# MATERIALS AND METHODS

The fabrication procedure of the pineapple peeler, corer cum slicer and test procedure adopted are described in the present chapter.

## 3.1. General Layout and Details of Machine

The machine consists of the following units:

1. Frame Assembly
2. Centering Mechanism
3. Peeling and coring unit
4. Peeled pineapple outlet
5. Slicing unit
6. Collecting tray

### 3.1.1 Frame assembly

The main frame assembly was fabricated using ISA 35x35x5mm MS section. On to this frame assembly, other subassemblies like vertical main shaft of peeling unit, centering mechanism, stopper mechanism and slicing unit were mounted. **(Fig. 3.1, plate 1)**

### 3.1.2 Centering mechanism

A 20x5 MS flat was made to a circular form of diameter 135mm, which is the maximum size of pineapple, expected. A cam of profile as shown in **fig.3.2** was cut out from a 1mm MS sheet. Four spring-loaded stainless steel rods of 6mm diameter and 95mm length move inwards or outwards of the centre of the

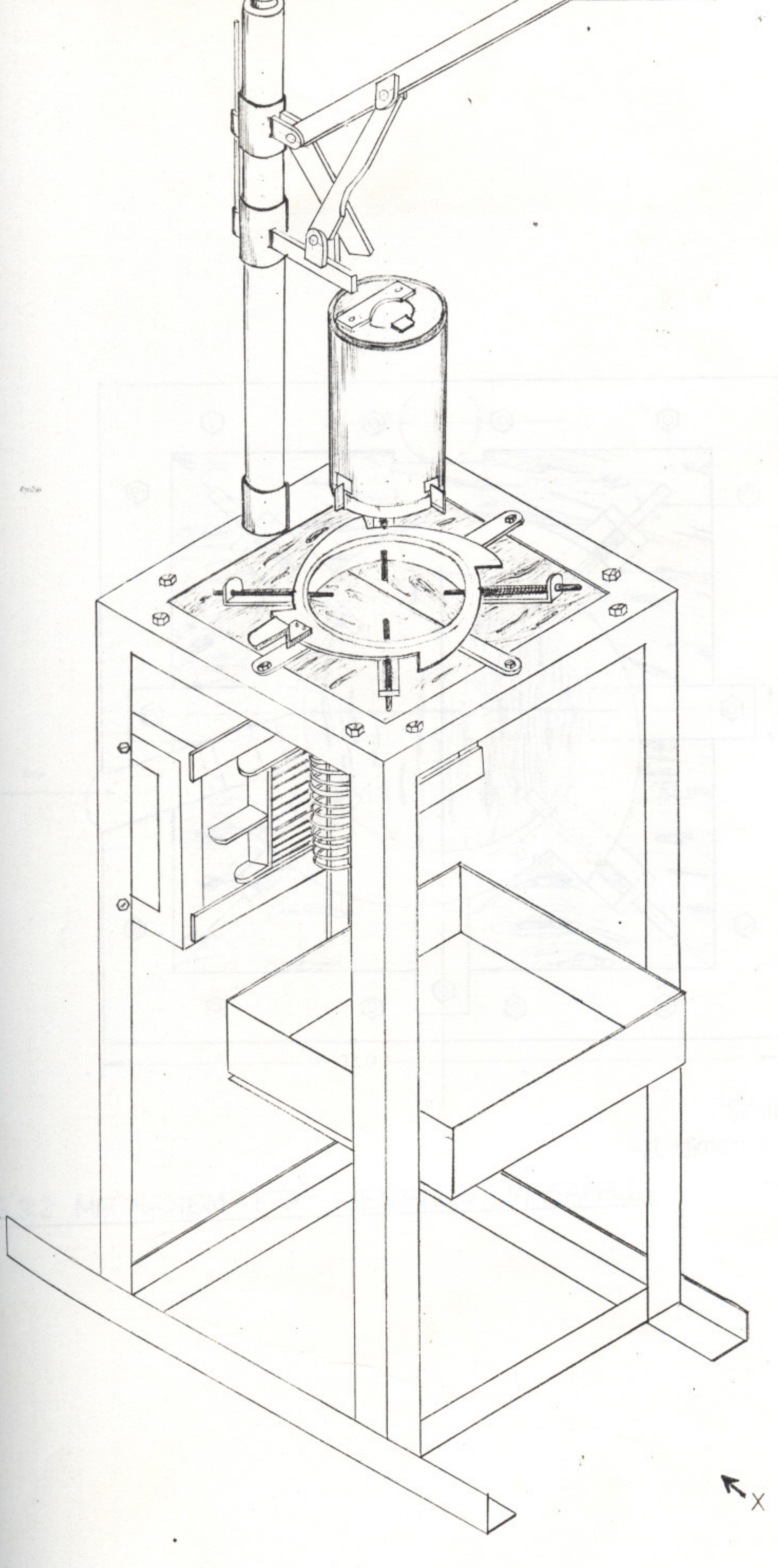
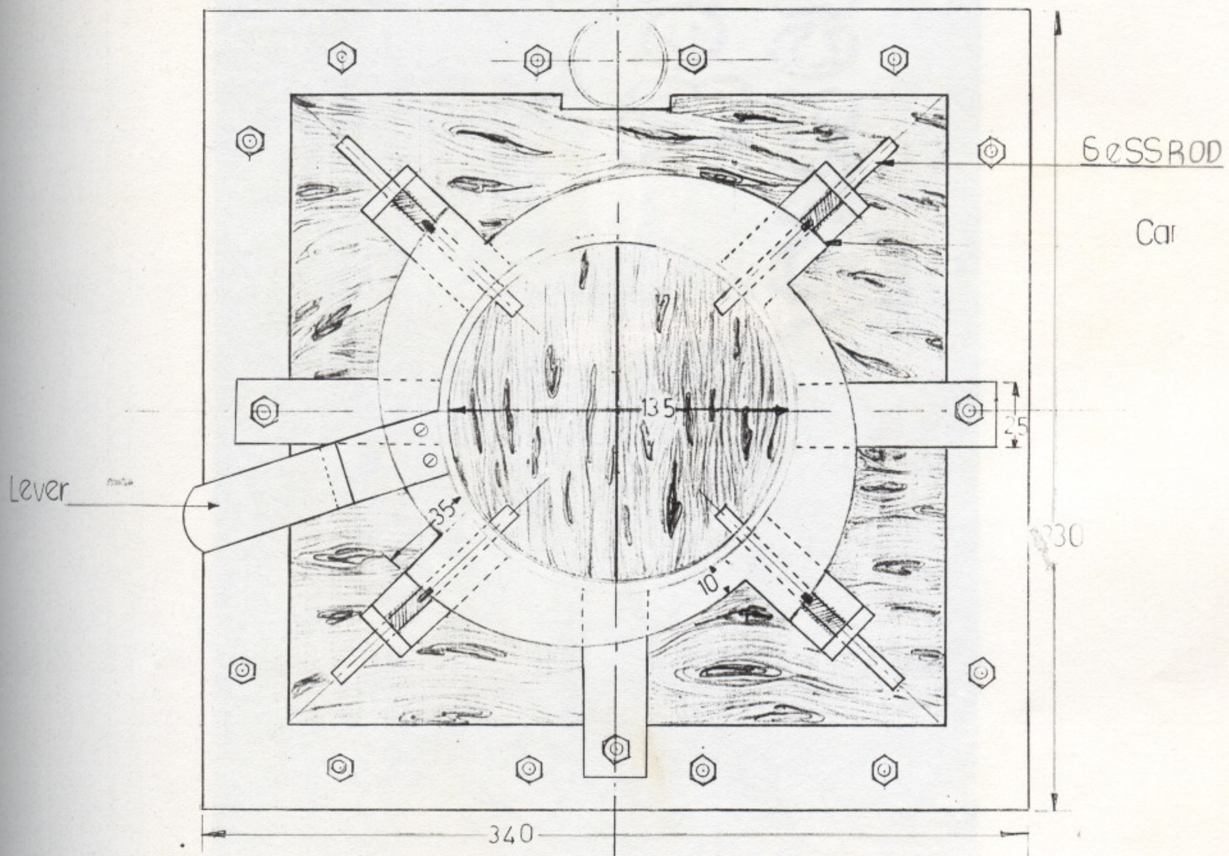



FIG 3:1 ISOMETRIC VIEW OF PINEAPPLE PEELER CORER CUMSLICER




Scale - 1:3
All dimensions in mm

FIG. 3:2 MECHANISM FOR CENTRING PINEAPPLE circular flat through holes drilled, as per the cam profile. A lever was provided to rotate the cam.

### 3.1.3 Peeling and coring unit

The main components of peeling and coring unit are two concentric stainless steel peeling and coring cylinders. For peeling different grades of pineapple, SS cylinders of 72mm, 92mm and 100mm inner diameter, 3mm thick and 160mm length and for coring; SS pipe of 20mm inner diameter, 1mm thick and 165 mm length were used. The grading was based on the average diameter of the pineapple. The size of peeling and coring cylinders were fixed after a preliminary survey of the sizes of the pineapples and their cores. The bottom ends of the peeling and the coring cylinders were machined to give sharp cutting edges. Four sharp cutting blades were riveted at opposite sides of the bottom sharp edge of peeling cylinders with its plane perpendicular to the surface of the cylinder. These blades split the cut cylindrical peel into four, thus aiding its easy removal. The top end of each peeling cylinder is threaded so that it can be attached to a 20mm MS disc of 92m diameter with a central hole of 20mm diameter though which core comes out. This unit was fixed to a movable bush on a vertical shaft.

The vertical shaft is 45mm MS pipe machined smooth for easy upward and downward movement of the peeling and coring unit. A guide made of MS rod of 12mm diameter machined smooth is provided to prevent shaking of the vertical shaft. The peeling and coring unit is moved vertically up and down through proper linkages using operating lever. In order to remove the peeled and cored pineapple from the unit, an MS disc with central hole for the coring cylinder moves inside the peeling unit. This movable disk was welded onto an MS flat outside at the top of the peeling and coring unit through two stainless steel rods of 6mm diameter. For easy removal of the disc two holes of 6.2 mm diameter were drilled on the top disc of the peeling and coring unit. The core comes out through the hole in the disc at the top on successive peeling. The unit is shown in **fig. 3.3**, **plate. 2**

### 3.1.4 Peeled pineapple outlet

This consists of two vaga wooden pieces of dimension 150x70x15mm moving outwards and inwards and is guided through two rails. It is closed by a pulley and rope mechanism and locked in position by gear and key. When closed this forms the platform for pineapples to be cut. After peeling the key is released to open the outlet. The peeled, cored pineapple then gets dropped into the slicing unit.

### 3.1.5 Slicing unit

The slicing unit consists of a holding unit and a blade assembly mounted on a shaft. This is shown in **plate 3.**

#### 3.1.5.1 Holding unit

This unit consists of 12 rings having an inner diameter of 135mm made from SS rods of 6-mm diameter. These rings were welded on to a 300x20x5 MS flat at a spacing of 10mm. This was welded on to the main frame in vertical position and an aluminium flap was provided on to the bottom ring which holds the peeled, cored pineapple that is delivered into the unit **(fig 3.4,plate 4)**

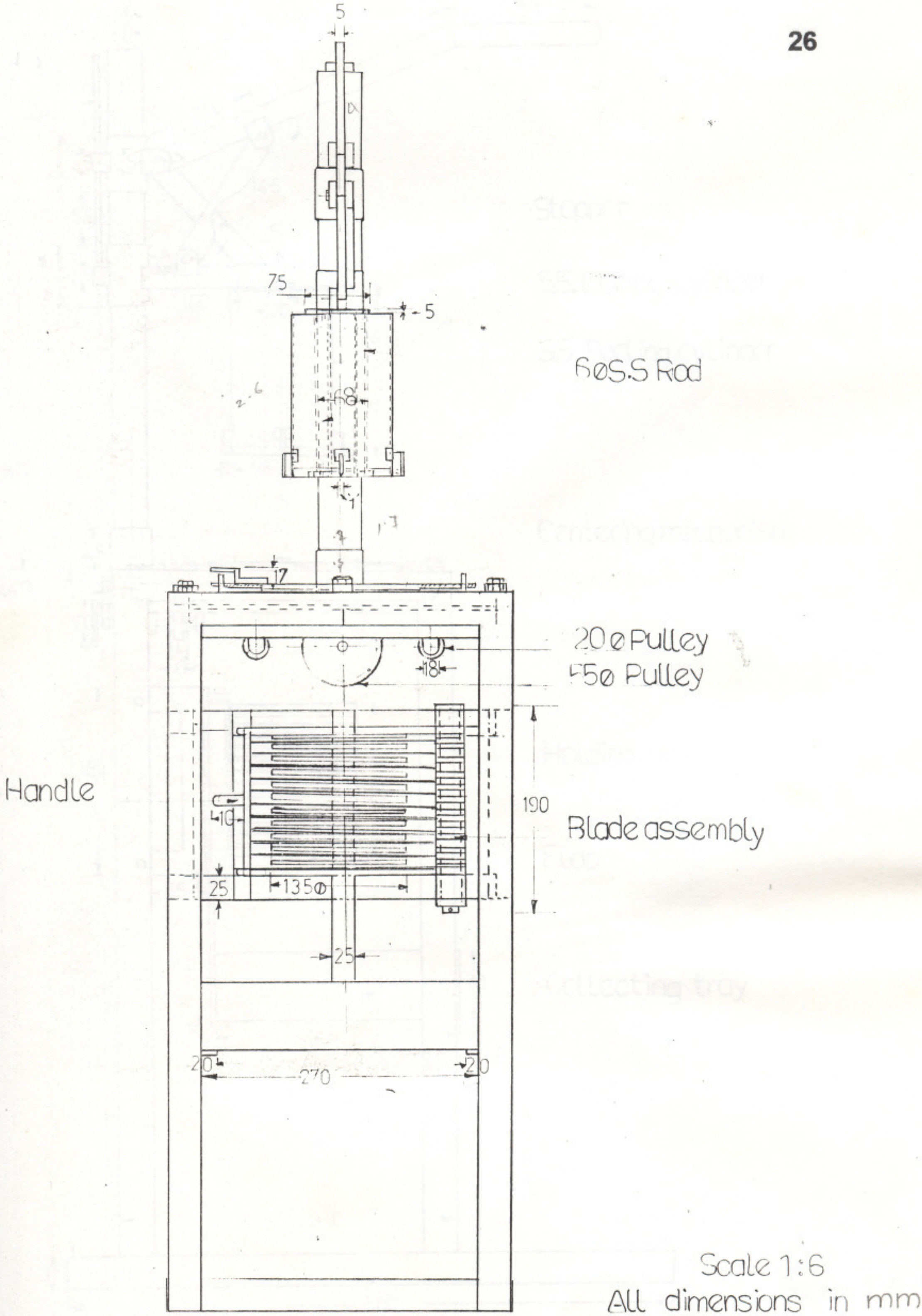



FIG_3.3 FRONT VIEW OF PINEAPPLE PEELER CORER CUM SLICER

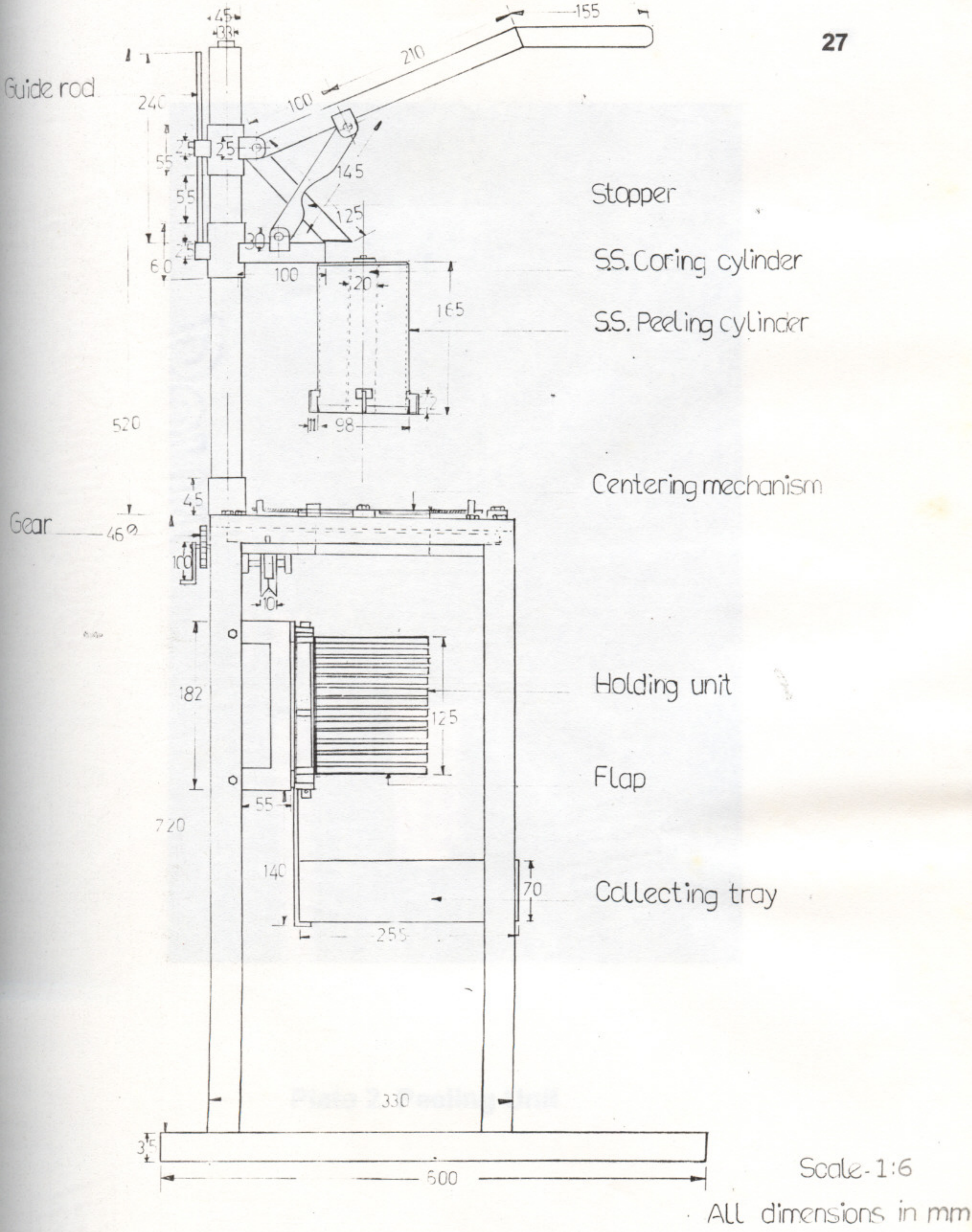



FIG.3.4 SIDE VIEW OF PINEAPPLE PEELER CORER CUM SLICER

#### 3.1.5.2 Blade assembly

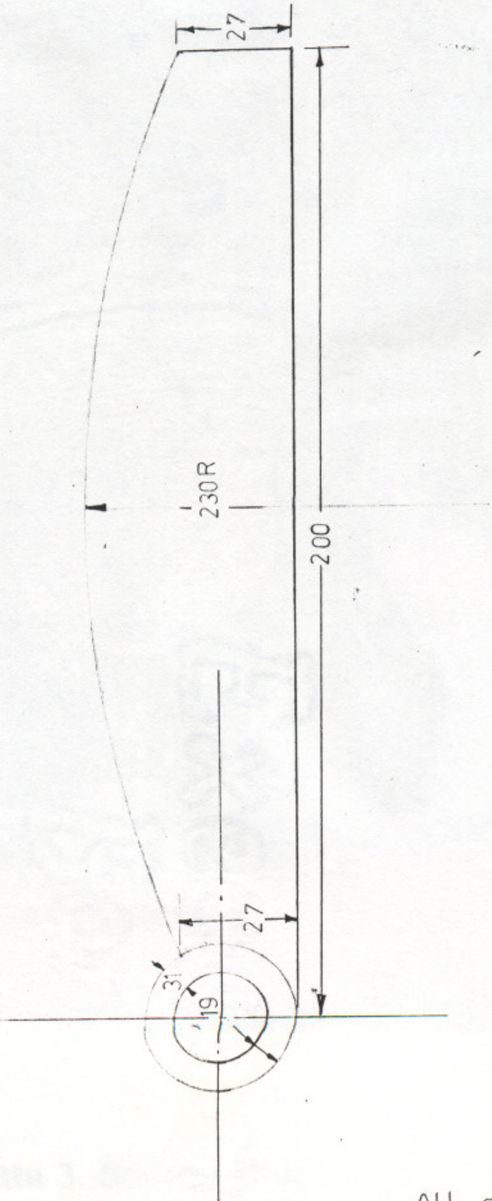
Blades of sharp convex cutting edges having length of 200mm, width of 27mm and radius of curvature of 230mm were cut and machined from high carbon steel **(fig 3.5).** Bushes of 19mm internal diameter were then braced to one end of the blade. These were then mounted onto an MS shaft of 19mm diameter and locked in position using a pin. The unit was then hinged onto the main frame so that it could move in or out through the space between the rings. The spacing between the knives can be increased using 10mm bushes **(plate 5)**

### 3.1.6 Collecting tray

A tray, 265x250x70mm was made from aluminium sheet of 1mm thickness. After the slicing, the flap at the bottom of the slicer is opened to receive the sliced pineapple in the collecting tray.

## 3.2 Performance Evaluation

Matured ripe pineapple bought from the local market was used for conducting the experiment. Approximately 15mm was cut from the bottom and 20mm from the top of the pineapple. It was then cut into two pieces. Each piece was used as a sample for performance evaluation of the machine. Peeling cylinder was chosen according to the size of the sample used. The cut sample was kept on the wooden platform of the peeled pineapple outlet and then centered using centering mechanism. After the centering, the rods of the centering mechanism were brought back to their original position. The pineapple was then peeled and cored by pressing the operating lever thereby the peeling and coring unit pierces through the sample effecting the peeling and coring.




Scale 1:1.5

All dimensions in mm

FIG. 3.5 CUTTING BLADE

Plate 1. Rear View of Pineapple Peeler Corer cum Slicer

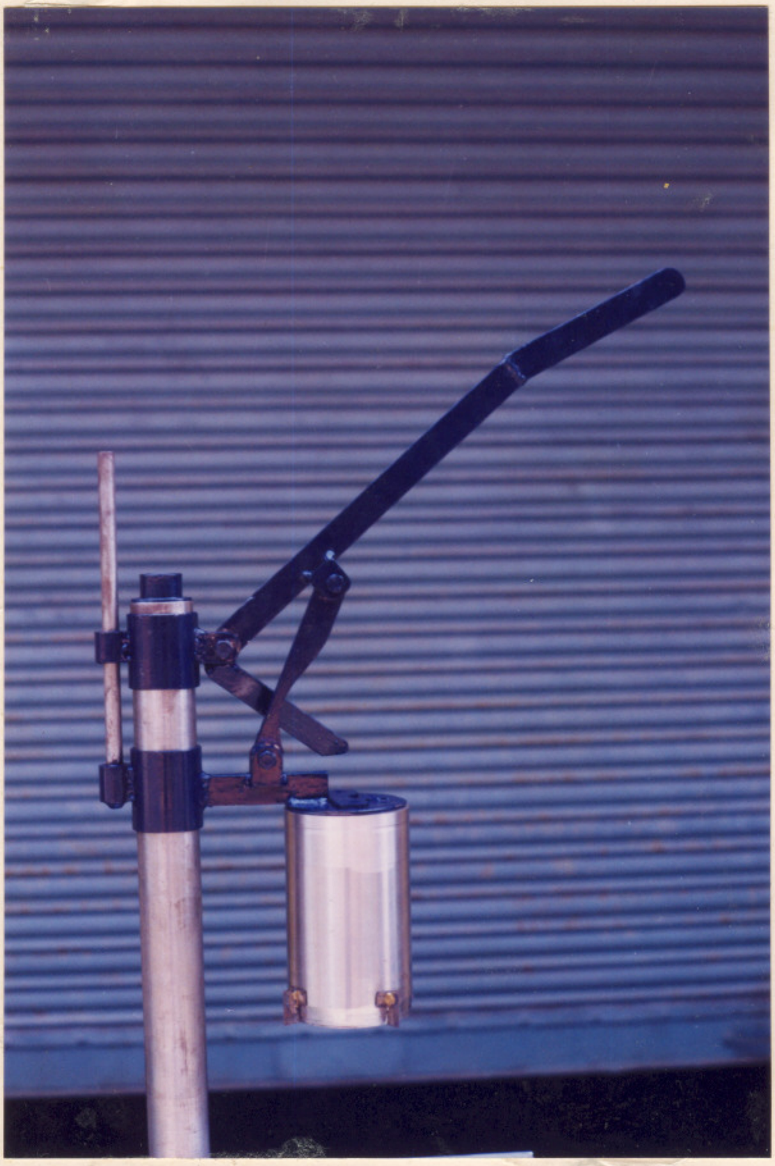


Plate 2. Peeling Unit

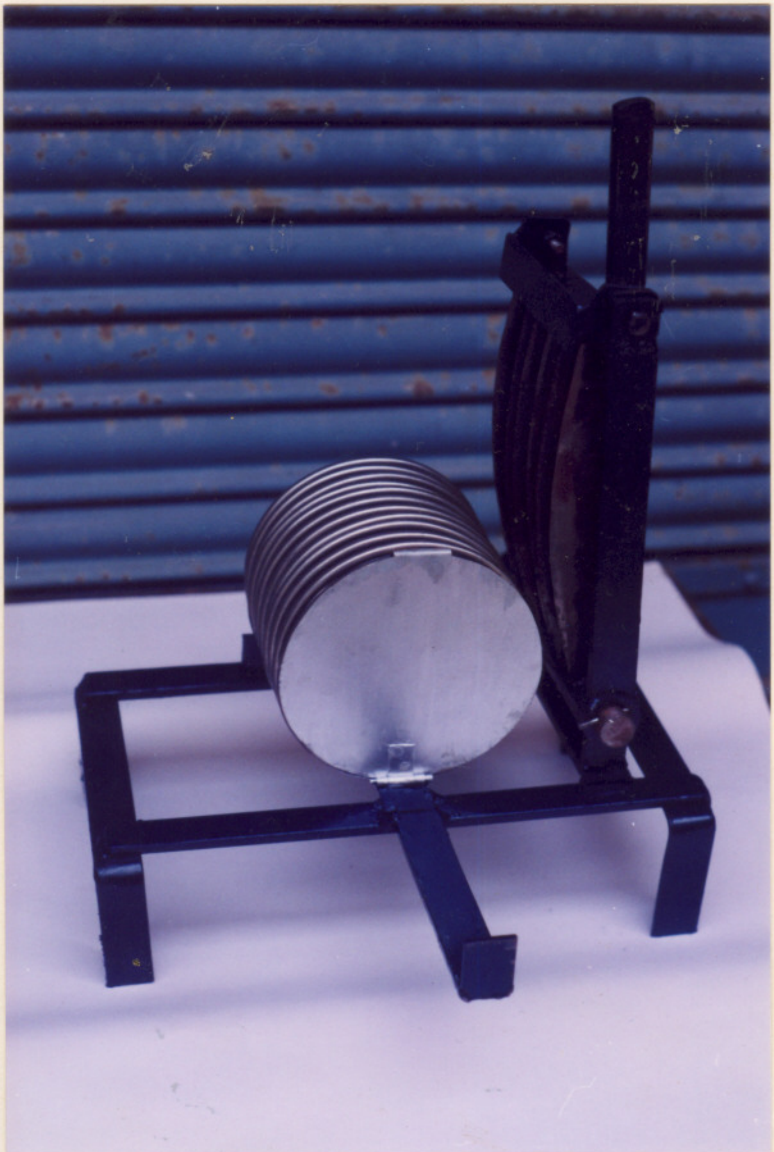


Plate 3. Slicing Unit

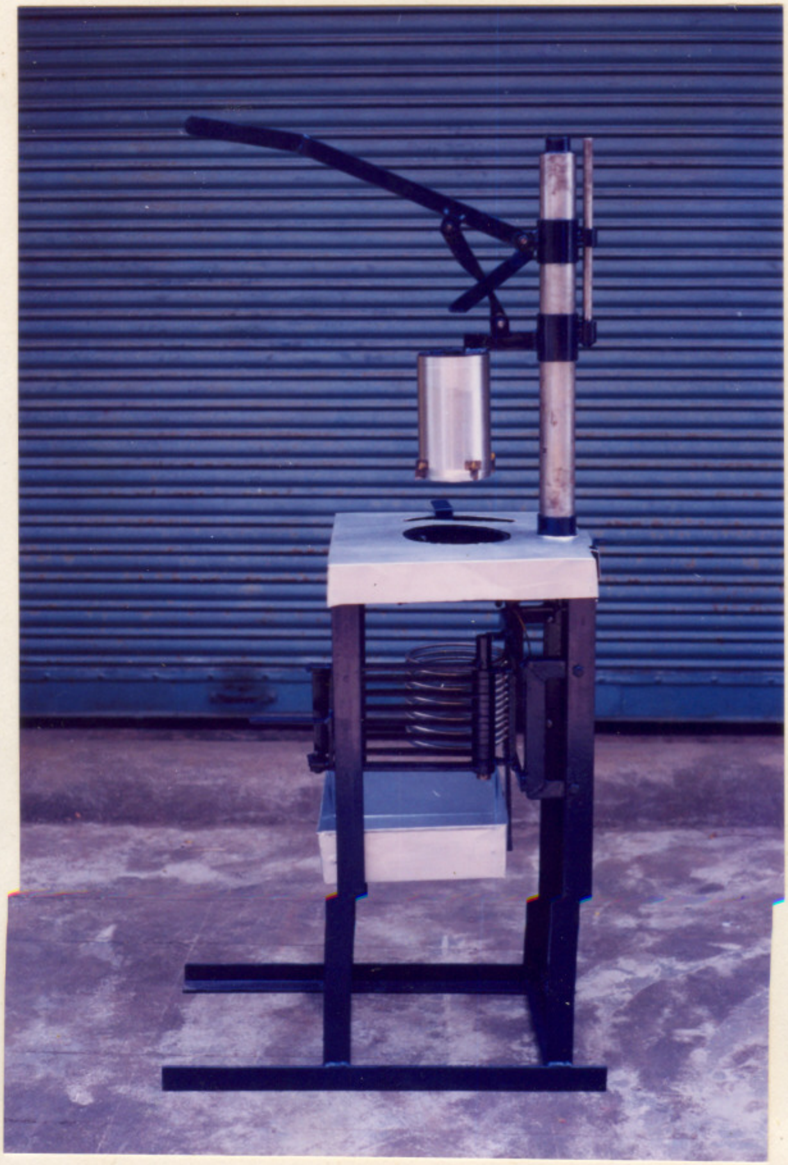


Plate 4. Side View of the Pineapple Peeler, Corer cum Slicer

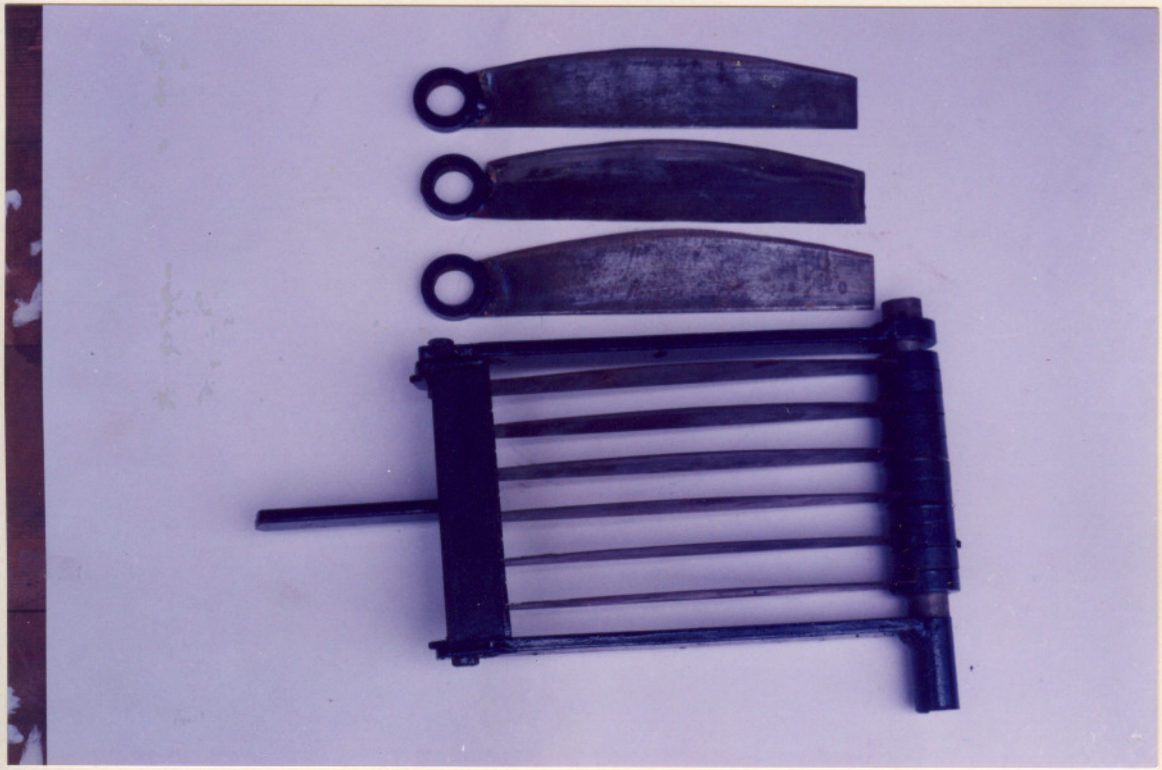


Plate 5. Blade Assembly and Blades

Plate 6. Pineapple Peeler, Corer cum Slicer in Operation

When the operating lever was lifted, the peeled and cored pineapple was pushed out of the cylinder by the disc and rod assembly that moves inside the cylinder. The cut, split peels were then removed from the platform. The spring-loaded wooden platform was moved apart by turning the gear using a key there by unloading the peeled, cored pineapple to the slicing unit. The time required for the operation was noted.

In the slicing unit the pineapple was sliced by pressing the blade assembly on the pineapple through the rings and reversing the unit through the pineapple. The flap at the bottom of the ring was then opened to unload the sliced pineapple to the collecting tray. The time required for the operation was noted and the capacity, peeling efficiency, material loss etc were then calculated. A comparison between manual and mechanical peeling was done.

### 3.2.1 Peeling efficiency.

Each sample of pineapple was subjected to cutting action. After the peeling was completed, the peels remaining on the pineapple were removed manually for each of the samples and their weights were noted. Peeling efficiency was then calculated using the formula:

$$\text{Peeling Efficiency} = \frac{(Y-X)}{Y} \times 100$$

Where, 'Y' is the weight of peel on pineapple (g)

'X' is the weight of peel, remaining on the pineapple which is removed by hand trimming after mechanical peeling (g)

### 3.2.2 Material loss

Material loss for each sample of pineapple was calculated based on the following formula:

$$\text{Material Loss (\%)} = \frac{Z}{(W+Z)} \times 100$$

Where, Z is the weight of the flesh obtained from the peel (g)

W is the total weight of pineapple after mechanical peeling. (g)

For canning purposes, ¾ of the eyes have to be removed.

### 3.2.3 Capacity of the machine

The capacity of the peeler, corer cum slicer which is the number of Kg of sliced pineapple produced by the machine in one hour, was calculated by noting the weight of the peeled, cored and sliced pineapple produced and the time taken for the same. It was then expressed in Kg/ hr.

### 3.2.4 Force requirement

#### 3.2.4.1 Force measurement of peeling unit.

A sample of pineapple was placed in position and weights were hung on the operating lever. The total weight added just to begin the peeling was determined. The effort required at the operating lever to start peeling was then found out from the mechanical advantage, which is calculated from the average length of load arm.

#### 3.2.4.2 Force measurement of the slicing unit

The peeled pineapple was put in the holding unit of the slicer. A spring balance was connected to the lever of the blade assembly. The spring balance was pulled so that the blade began to slice the pineapple. The effort required just to start the slicing action was directly read from the spring balance.

# RESULTS AND DISCUSSIONS

This chapter deals with the results of experiments conducted to evaluate the performance of pineapple peeler, corer cum slicer and its comparative performance with manual method.

## 4.1 Performance Evaluation

The experimental model was evaluated for its overall capacity, peeling efficiency, material loss, force required for peeling and slicing and effective capacity.

### 4.1.1 Overall capacity

The theoretical capacity was found to be 339.2, 520.2 and 728.5 Kg/hr for 72,92 and 100mm diameter-peeling cylinder respectively. A time lag of 15s for peeling to account for centering and opening the peel outlet and 5s for slicing is taken for a skilled worker between successive feedings. So the effective capacity is 41.0, 63.8 and 93.3 Kg/hr for 72, 92 and 100mm diameter-peeling cylinder respectively. Results are shown in the **tables 4.1, 4.2, and 4.3.**

**Overall capacity and effective capacity**

**Table 4.1 For 72mm peeling cylinder**

| Weight of the peeled and sliced pineapple(g) | Time taken for peeling and slicing (s) | Overall capacity (Kg/hr) | Effective capacity (Kg/hr) |
|---|---|---|---|
| 260 | 2.75 | 340.4 | 41.2 |
| 250.7 | 2.7 | 334.3 | 39.8 |
| 265.3 | 2.8 | 341.1 | 41.9 |
| 258.6 | 2.73 | 341.0 | 41.0 |
| | **Average** | **339.2** | **41.0** |

**Table 4.2 For 92mm peeling cylinder**

| Weight of peeled and sliced pineapple (g) | Time taken for peeling and slicing (s) | Overall capacity (Kg/hr) | Actual capacity (Kg/hr) |
|---|---|---|---|
| 341.5 | 2.7 | 455.3 | 54.2 |
| 275.6 | 2.8 | 354.3 | 43.5 |
| 464.7 | 2.8 | 597.5 | 73.3 |
| 534.0 | 2.85 | 674.5 | 84.1 |
| | **Average** | **520.2** | **63.8** |

**Table 4.3 For 100mm peeling cylinder**

| Weight of peeled and sliced pineapple (g) | Time taken for peeling and slicing (s) | Overall capacity (Kg/hr) | Actual capacity (Kg/hr) |
|---|---|---|---|
| 587.4 | 2.9 | 729.2 | 92.3 |
| 560.2 | 3.0 | 672.2 | 87.7 |
| 608.1 | 2.95 | 742.1 | 95.4 |
| 620.6 | 2.9 | 770.4 | 97.6 |
| | **Average** | **728.5** | **93.3** |

It is seen that the capacity of the machine increases with increasing diameter of peeling cylinder which is because the weight of the peeled pineapple varies according to the size but the time for peeling a single piece does not change. The general trend for actual capacity also is same for the same reason.

## 4.2 Peeling Efficiency

Peeling efficiency was calculated using the formula give in 3.2.1

**Peeling efficiency**

**Table 4.4 For 72mm peeling cylinder**

| Wt of peel (g) | Wt. of peel removed after mechanical peeling (g) | Peeling efficiency (%) |
|---|---|---|
| 100.2 | 1.0 | 99.1 |
| 72.3 | 0.7 | 99.0 |
| 80.4 | 0.8 | 99.0 |
| 97.6 | 1.9 | 98.01 |
| | **Average** | **98.8** |

**Table 4.5 For 92mm peeling cylinder**

| Wt of peel (g) | Wt. of peel removed after mechanical peeling (g) | Peeling efficiency (%) |
|---|---|---|
| 141.6 | 1.4 | 99 |
| 57.6 | 0.8 | 98.6 |
| 206.1 | 2.1 | 98.9 |
| 161.6 | 0 | 100 |
| | **Average** | **99.1** |

Table 4.6 **For 100mm peeling cylinder**

| Wt of peel (g) | Wt. of peel removed after mechanical peeling (g) | Peeling efficiency (%) |
|---|---|---|
| 250.3 | 0 | 100 |
| 235.7 | 1.7 | 99.3 |
| 243.5 | 2.7 | 98.9 |
| 253.8 | 1.3 | 99.5 |
| | **Average** | **99.4** |

It is observed that peeling efficiency increases slightly with increase in diameter of peeling cylinder. This may be due to the increased area of contact and therefore increased support from the pineapple, which enables the circular sharp portion to easily cut through the fleshy portion.

## 4.3 Material loss

Tables 4.7, 4.8, and 4.9 give the material loss for the 72mm 92.mm and 100mm peeling cylinders respectively.

**Material Loss.**

**Table 4.7. For 72mm peeling cylinder**

| Weight of peeled pineapple (g) | Weight of flesh obtained from peel (g) | Material loss (%) |
|---|---|---|
| 260 | 5.0 | 1.9 |
| 250.7 | 6.0 | 2.3 |
| 265.3 | 4.0 | 1.5 |
| 258.6 | 4.6 | 1.7 |
| | **Average** | **1.85** |

**Table 4.8 For 92mm peeling cylinders**

| Weight of peeled pineapple (g) | Weight of flesh obtained from peel (g) | Material loss (%) |
|---|---|---|
| 341.5 | 6.6 | 1.9 |
| 464.7 | 9.6 | 2.0 |
| 254.0 | 4.9 | 1.9 |
| 410.3 | 5.9 | 1.4 |
| | **Average** | **1.8** |

Table 4.9 For 100mm peeling cylinders

| Weight of peeled pineapple (g) | Weight of flesh obtained from peel (g) | Material loss (%) |
|---|---|---|
| 587.4 | 10.6 | 1.8 |
| 560.2 | 11.8 | 2.1 |
| 608.1 | 10.8 | 1.7 |
| 620.6 | 11.2 | 1.8 |
| | **Average** | **1.85** |

The material loss is found to be more or less same for cylinders of different diameters.

## 4.4 Force required for peeling

Length of effort arm = 475mm

Length of load arm = 100mm

Mechanical advantage = 4.75

**Table 4.10. Force required for peeling**

| Diameter of peeling cylinder (mm) | Effort (Kg) | Force (Kg) |
|---|---|---|
| 72.00 | 19.00 | 90.25 |
| 92.00 | 21.00 | 99.75 |
| 100.00 | 25.00 | 118.75 |

The force required for slicing increases with increase in diameter of the slicing cylinder. This is mainly due to the increased area of contact and increased frictional resistance offered by the peeled surface of the pineapple. The cutting resistance and frictional resistance offered by the pineapple as the peeling cylinder moves through the pineapple increases as the diameter of the peeling cylinder increases.

**Table 4.11 Force required for slicing**

| SL. No | Force (Kg) | |
|---|---|---|
| | For 10mm slices | For 20mm slices |
| 1. | 6.5 | 5.0 |
| 2. | 7.5 | 6.0 |
| 3. | 7.0 | 5.5 |
| | **Average = 7.0** | **Average = 5.4** |

The force required for slicing 10mm slices is found to be more than for slicing 20mm pieces. This is again due to the increased cutting resistance and frictional resistance requirement.

## 4.5 Comparison Between Manual And Mechanical Peeling

The results are shown in table 4.12

**Table 4. 12 Comparison between manual and mechanical peeling**

| Total time required for peeling one sample of 600 g. (s) | | Total time required for slicing the peeled pineapple in to 20mm thick pieces (s) | |
|---|---|---|---|
| Manual | Mechanical using 92mm peeling cylinder | Manual | Mechanical |
| 160 | 16.5 | 15 | 6.3 |
| 180 | 16.4 | 16 | 6.2 |
| 150 | 16.6 | 15 | 6.4 |
| 175 | 16.6 | 14 | 6.3 |
| **Average = 166.25** | **16.53** | **15** | **6.3** |

Peeling using the fabricated machine is found to be 10 times more effective than manual peeling and slicing is about 6.5 times more effective than manual slicing. Besides, even and uniform slices of 10 mm and 20-mm thickness can be obtained by the fabricated machine.

# SUMMARY AND CONCLUSIONS

India is the second largest producer of fruits and vegetables. Due to inadequate facilities for processing the produce, nearly 35% of the total production is wasted. A substantial return can be obtained by processing and marketing these products on a small scale in India. Pineapple is one of the commercially important fruits of India which is exploited in value added forms such as canned pineapple slices, titbits, juice, jam, squash etc .The main processing stages in value addition are peeling, coring and slicing .In the processing industries of Kerala, peeling is done using sharp knives and slicing is done mechanically. Hand punches are used to trim the slices and to remove the core .The series of operations are labour intensive, time consuming and involves drudgery of work.

The newly developed pineapple peeler, corer cum slicer has two concentric stainless steel cylinders, which, on lowering, peels and cores the pineapple. In the slicing unit, blades move in between the rings of the holding unit and slices it. Peeling cylinders of three diameters can be used interchangeably to suit the size of the pineapple. The thickness of slices can be increased by increasing the spacing between knives using bushes. The machine can also be used to peel other vegetables and fruits of similar types.

The actual capacity of the machine is found to be around 100 Kg/hr for a100 mm diameter peeling cylinder, which is much higher than the existing conventional method. The peeling efficiency is about 99%. The material loss is only about 2%.

Modification of the machine can further improve the performance. Some suggestions that may help future research work are listed below:

1. The centering mechanism could be made conical so that the pineapple is centered automatically when placed.
2. The linkage of the peeling unit could be modified to reduce the effort required for peeling.
3. Core cylinders of different diameters could be fabricated to remove the core completely.
4. Pointed knives of greater width could be used for better cutting.
5. Operating lever of the slicing unit could be modified according to ergonomic considerations.

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# APPENDIX – I

## CALCULATION OF OPERATING COST

**Initial cost (C)**

| | | |
|---|---|---|
| Fabrication cost of peeler, corer cum slicer machine including cost of material | = | Rs.3, 000.00 |
| Average life of machine | = | 10 years |
| Working hours per year | = | 1200 |
| Salvage value | = | 10% of initial cost |
| | = | Rs. 300.00 |

**A) Fixed cost**

| | | |
|---|---|---|
| 1. Depreciation | = | C-L/ LxH |
| | = | 3000-300/10x1200 |
| | = | Rs.0.23/ hr. |
| 2. Interest on investment @ 15% | = | (C+S) x 15/2xHx100 |
| | = | $\frac{(3000+300)}{2 \times 1200 \times 100} \times 15$ |
| | = | Rs.0.21/ hr. |
| Total fixed cost | = | Rs.0.44/hr |

**B) Variable cost**

1. Labour wages

Wages of a labour = Rs.120/day of 8 hr.

= Rs.15/hr.

2. Repair and Maintenance cost

@ 105 of initial cost p.a. = 3000x10x1200/100

= Rs.0.25/hr.

Total variable cost = Rs.15.25/hr.

Total operating cost = Rs.0.44/hr + Rs. 15.25/hr

= Rs.15.69/hr.

# APPENDIX II

## Specifications of the Machine

Weight of the machine = 32 Kg

Dimensions = 600 x 277 x 1240 mm

**Specifications of the peeling cylinder**

| Inner diameter (mm) | Thickness (mm) | Length (mm) | Cutting angle | |
|---|---|---|---|---|
| | | | INNER | OUTER |
| 72 | 3 | 162 | 10º | 12º |
| 92 | 3 | 162 | 10º | 12º |
| 100 | 3 | 162 | 10º | 12º |

# DEVELOPMENT AND TESTING OF A PINEAPPLE PEELER, CORER CUM SLICER


By

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## ABSTRACT OF THE PROJECT REPORT

Submitted in partial fulfilment of the requirement for the degree

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Faculty of Agricultural Engineering and Technology

Kerala Agricultural University

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# ABSTRACT

Pineapple is one of the commercially important fruits of India .The main processing stages in value addition of pineapple are peeling, coring, and slicing. An experimental model of pineapple peeler, corer cum slicer was developed to make the processing of pineapples easy and less time consuming. The peeling and coring unit consists of two concentric stainless steel cylinders, which on lowering, peels and cores the pineapple. In the slicing unit, the blades move in between the rings of the holding unit and slices it. The machine can be used to peel pineapples of any size using peeling cylinders of varying diameters with minimum material loss (about 2%). The peeling efficiency of the machine is 99%. *The capacity is about 41, 63.8; 93.3 Kg of peeled pineapple per hour for* 72, 92, and 100-mm peeling cylinders respectively. The thickness of cut slices can be varied by using bushes between knives.