R.P.F. III

# FINAL REPORT

1. Institute Code No : Tech.I(670)

2. I.C.A.R. Code No: PI-89/12-ICI-N10/9538

3. Name and Address of Research Institute/Centre:
Central Plantation Crops Research Institute, Kasaragod - 671124, Kerala.

4. Project Title : Design and development of small scale palm oil extraction unit.

5. Name and Designation of Project Leader : SJD Bosco, Scientist (Senior Scale)]

6. Name(s) and Designation of Project Associates including Project Leader and work to be done:

| Sl. No: | Name and Designation | Time spent | Work done |
|---|---|---|---|
| 1. | SJD Bosco, Scientist, Senior Scale (ASPE) | 25 | Design, fabrication/purchase and testing of all units required for the mill |
| 2. | K. Madhavan, Scientist, Selection Grade (E&I) | 16 | Calculation of the power requirement for various units and assessing in the design and development |
| 3. | Sunil Gulati, Scientist (FM&P) | 3 | Assisting in the design and development |
| 4. | Sebastian George.A Sr.Technician | 8 | Assisting in the design and development |
| 5. | T.V.Singh Scientist (FM&P) | 3 | Helping for installation of all units at Palode in the absence of Project leader |

7. Location of Research Project with complete address (Division/Section/Sub-Centre)
Physiology, Bio-chemistry and Post-Harvest Technology Division
CPCRI, Kasaragod - 671 124, Kerala State.

8. Date of start : February 1989

9. Date of termination : March 1997

10. (a) Objectives ( Not more than 150 words )
To develop a small scale palm oil extraction unit to cater to the need of oil palm plantation upto 30 ha.

10. (b) Practical Utility including background information ( Not more than 150 words):

India has been importing palm oil for past several years. Oil palm, the richest yielder of vegetable oil yields 4.1 to 4.6 T/ha/year. It is proposed to cultivate this crop by small and medium land holders under irrigated condition. This means that the extension of cultivation of oil palm to small and medium farmers. At present only few palm oil extraction units are available which are able to cover more than 50 ha plantation. Not like other crops, oil palm has to be harvested and processed in right time to obtain good quality oil. If the plantations are scattered, the Fresh Fruit Bunches(FFB), from which oil will be extracted, has to be transported to the oil mill. Thus, transport cost of FFB will become one of the factors in determining the cost of oil production. Added to this, there may be a possibility in increasing the Free Fatty Acid (FFA) content in the oil. High FFA not only makes the oil inedible, but also make's rate of rancidity faster, fixes the colour and increases refining loss. Therefore, the palm oil extraction unit should be located amidst plantation. Moreover the plantations with a low yield and yield obtained during lean season of a year from the larger area are a disincentive for large scale processing mills. On the other hand, it is difficult to collect the fruits from small holders to larger processing mill without affecting the quality of the produce. Thus, processing of oil palm is an integral part of oil palm plantation developments. It was, therefore, decided to develop a small scale unit for extracting palm oil which would be catered to the need of oil palm plantation of 10 ha to 30 ha.

11. Technical Programme:

**1989-90**

1. Collection of information and literature about the major units of oil palm processing /oil mill.
2. Design and fabrication/collection of major units for the designed capacity of the plant.
3. Design of the Low cost furnace in which oil palm waste can be used as fuel.

**1990-91**

1. Design and development of sterilizer, stripper and digester and determination of the capacity of the hydraulic press required.
2. Installation and testing of the fabricated units.

**1991-92**

1. Fabrication and testing of digester
2. Procurement and testing of hydraulic press
3. Fabrication and testing of stripper
4. Design and fabrication of clarifier and storage tank
5. Installation at Palode
6. Analysis of oil extracted

**1992-93**

1. Fabrication of clarifier
2. Fabrication of other accessories required for the mill
3. Installation and testing at Palode
4. Analysis of oil extracted

1993-94
1. Testing of the clarifier
2. Installation and testing at Palode
3. Quality analysis of extracted oil

1994-95
1. Installation and testing at Palode
2. Quality analysis of extracted oil

1995-96
1. Dismantling and shifting equipments to Palode
2. Erection of all equipment at Palode
3. Testing for efficency

1996-97
1. Testing for trial run
2. Testing for efficiency

12. Final Report:

DESCRIPTION OF THE PROCESS:

Palm oil is derived from the mesocarp of the fruit. Processing of oil palm fruits demands adoption of techniques different from other oil seed crops. The oil is held in the cells of the fibrous mesocarp. It may be extracted from the fruit by loosening the fibrous mesocarp and by breaking the cells. A flow diagram of the extraction process which shows the steps involved in the oil extraction process is given in Fig-1.

**Steam Generation:**

A non-IBR mini boiler using mill and plantation wastes as fuel was used for steam generation. It has a capacity to generate 130 kg steam / hr with a maximum pressure rating of 8 $kg/cm^2$. The fuel feeding is done manually. The water feeding is done by using a single phase electric multistage pump. For better thermal efficiency, arrangement has been made for natural draft of flue gas and smoke.

**Sterilizer:**

The purposes of the sterilization of FFB are (i) to inactivate the enzyme lipase which otherwise increase the FFA content of the oil by hydrolisis and oxidation , (ii) loosening of fruit from bunches which is firmly fixed and (iii) to soften cell wall and coagulate proteins which will facilitate oil extraction in the subsequent stages. A horizontal type sterilizer with a capacity of 200 kg FFB was designed and developed. It consists of cylinderial miled steel container housed horizandally with one side closed and other side with lid which can be closed air-tight.. For easy loading and unloading of the FFB, a movable perforated cage is provided which can be moved to and fro on the rail. The sterilizer is provided with steam inlet and outlet, pressure gauge, condensed water outlet, etc. Sterilization is carried out at steam pressure of 2.3 to 2.6 $kg/cm^2$ for the period of 45-60 minutes. Total sterilization time including loading and unloading ranges form 60 to 80 minutes.

**Stripper:**

The loosen fruits of sterilized bunches are stripped off with the aid of a mechanical bunch stripper. It is a rotary drum made of mild steel angle iron and flats rotating at the rate of 20 - 25 rpm. The angle irons are placed with equal inter spacing so that the nstripped fruits will fall throygh this gap. Baffles are provided in the inner surface of the drum which will help in carring the bunches and drop on the central shaft. Due to this impact force, the fruits will be detached from the bunches. It will take about 5 minutes to strip the fruit of 200 kg of sterilized bunches.

**Digester:**

Purpose of digestion is to convert the losse fruit into pulp/mash wherein the cell walls will be broken to facilitate the release of oil with the help of thermal and mechanical energy. During this process, nearly 50% of the oil will be released in the form of oil-water emulsion. The losse fruits obtained from the stripper are fed manually to the digester. The digester is a veritcal cylindrical vessel provided with beater arm rotating at slow speed of 25 - 30 rpm. Live steam and hot water are injected into the vessel to maintain a temperature of the mash around 90 - 95° C. It can digest about 50 kg of fruit in 5 minutes.

**Hydraulic press:**

The digested mash consisting of oil, water, seeds and fibre. the oil from this mash can be extracted either by hydraulic press or screw press. The capacity of the hydralic press and perforated press cage were designed. Hydralic press of 30 Tonnes capacity is used. The hot mash is charged into the press cage and subjected to pressing at the rate of 75kg/cm$^2$. The pressing is done while the mash temperature is around 80 -90° C. The hot oil-water mixture with suspended solids is expelled leaving the solid press cake in the cage. The perforated cage can hold about 25 kg mash and each pressing cycle is of about 5 minutes duration. Both digester and press are integrated with a platform to facilitate the handling of mash.

**Clarification:**

The oil-water mixture is filtered to remove the fibrous debris and is collected in the clarifier. Clarification is carried out by overflow technique. Clarifier is a vertical cylinderical vessel of 230 liter capacity with steam coil. The oil water mixture is diluted with hot water and heated to 90 to 95 C with the help of steam coil. the oil being lighter, rises to the top and is decanted continously into a collecting tank. The watery sludge at the bottem is discharged as waste.

**Performance of the unit:**

The process flow diagram of this unit which was prepared based on the resuslt obtained is given in the Figure. 1. The extraction efficiency and oil recovery of the unit is given in the Table. 1.

List of equipment with approximate cost:

| Sl. No. | Units | Cost (Rs) |
|---|---|---|
| 1 | Boiler | 75,000 |
| 2 | Sterilizer | 75,000 |
| 3 | Stripper | 60,000 |
| 4 | Digester | 30,000 |
| 5 | Hydraulic press | 75,000 |
| 6 | Clarifier-3 Nos. | 30,000 |
| 7 | Centrifuge | 30,000 |
| 8 | Storage tank | 20,000 |
| 9 | Building | 2,00,000 |
| 10 | Miscellaneous | 5,000 |
| | **Total** | **6,00,000** |

Benefit-Cost Ratio:

Following assumptions are made to calculate the Benefit-Cost Ratio:

1. Cost of the unit :Rs 6,00,000.00
2. Life of the machines :10 years
3. Solvage value :10%
4. Wages for labourer :Rs 75/day
6. Number of labourer required :3
7. Number of working days/year :300 days
8. Quantity of FFB to be processed/day - 200 kg/batch -20batches/day :4000 kg/day
9. Quantity of oil to be obtained 19 % of FFB :
9. Cost of electricity :Rs 1/unit

**Fixed cost**

1. Annual depreciation @ 10 % :Rs 60,000.00
2. Annual interest @ 15 % :Rs 90,000.00
3. Annual maintenance @ 10 % of depreciation :Rs 6,000.00

Total Fixed cost/year :Rs 1,56,000.00

Variable cost

| | |
|---|---|
| 1. Labour cost | : Rs 225.00 |
| 2. Cost of electricity for 10 units | : Rs 10.00 |
| Total Variable cost | : Rs 235.00 |

Total cost /day

| | |
|---|---|
| 1. Fixed cost/day | : Rs 520.00 |
| 2. Variable cost /day | : Rs 235.00 |
| Total cost /day | : Rs 755.00 |

**Therefore,**

**(i). Cost of processing of one kg of FFB : Re 0.18**

**(ii). Cost of extraction of one kg of crude palm oil : Re 0.95**

13. Approximate expenditure incurred in the Project: (Give reasons for variation, if any , from original estimated cost)

14. Publications and material (one copy each to be supplied with this proforma)

a) Research papers (under preparation)

b) Popular articles(under preparation)

c) Reports(under preparation)

d) Seminars and workshops (Relevant to the Project) in which the Scientists have participated:

Nil

e) Material developed (such as new varieties of crops or breeds of farm animals, implements, products etc.):

Equipment for extracting palm oil such as sterilizer, stripper, digester and clarifier were developed

15. Details (Nos. etc.) of Field/Laboratory Note books and final material and their location:

Laboratory Note book : 1

Equipmentdeveloped were installed at CPCRI (RS), Palode.

16. Comments / suggestions of Project Leader regarding possible future line of work that may be taken up arising of this project:

1. By developing screw press of smaller capacity, the extraction efficiency can be increased.
2. For extractimg the oil from the kernel of the nut, nut separator, nut cracker and kernel separator can be developed

17. Signatures with name of Project Leader and Associates:

a. SJD Bosco, Scientist, Project Leader Senior Scale (ASPE) — S. John Bosco
b. K. Madhavan, Project Associates Scientist (Selection Grade) — Madhavank
c. Sunil Gulati, Project Associates Scientist (FM&P) — went on transfer —
d. Sebastian George.A , Project Associates Sr.Technician — Sebastian A George
e. T.V.Singh, Project Associates Scientist (FM&P) — T. V. Singh

18. Signature (with comments, if any) of Head of Division/Section/Station:

V Rajagopal

19. Signature (with comments, if any) of Director:

Dr Nanjundan

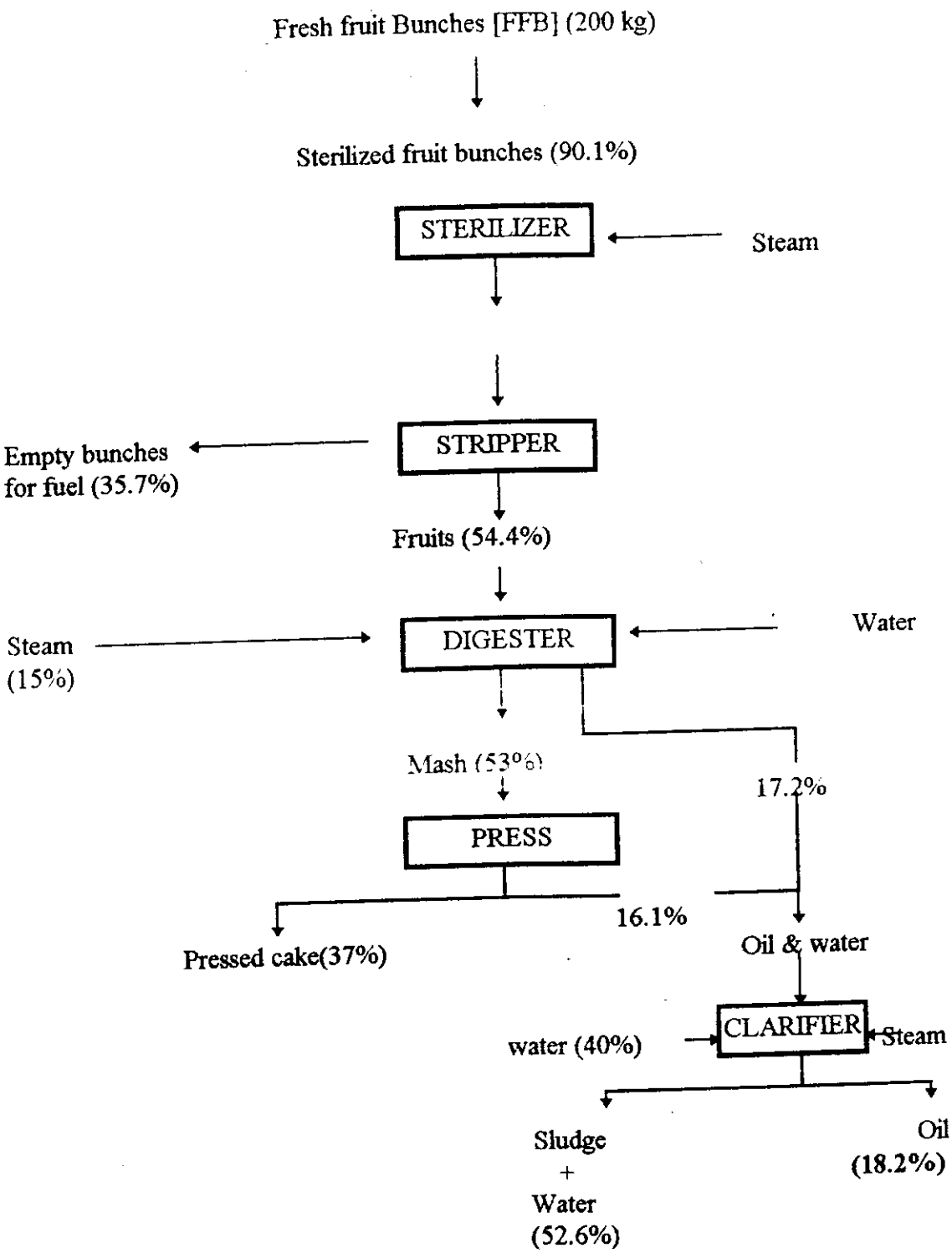


**FIG- 1. PROCESS FLOW DIAGRAM**

**Table. 1 Extraction efficiency and oil recovery of the unit**

| FFB (kg) | Quty. (kg) | | | Sludge | | | Fibre | | | Raw palm oil | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | on conde | on FFB | Quty. (kg) | % oil | | Quty. (kg) | % oil | | Quty. (kg) | % oil | |
| | | | | | on sludge | on FFB | | on conde | on FFB | | on FFB | Oil recovery |
| 230 | 43.0 | 2.3 | 0.43 | 156.4 | 2.9 | 2.0 | 15.3 | 24.1 | 1.6 | 42.3 | 18.4 | 82.0 |
| 210 | 40.0 | 1.9 | 0.37 | 142.8 | 1.9 | 1.3 | 13.9 | 22.7 | 1.5 | 37.8 | 18.0 | 85.0 |
| 196 | 39.2 | 1.2 | 0.49 | 133.3 | 2.8 | 1.9 | 13.0 | 31.7 | 2.1 | 35.1 | 17,9 | 79.9 |
| 240 | 45.0 | 2.8 | 0.52 | 163.2 | 1.9 | 1.3 | 15.9 | 19.6 | 1.3 | 43.7 | 18.2 | 85.4 |
| 228 | 43.0 | 2.1 | 0.40 | 155.0 | 2.5 | 1.7 | 15.1 | 25.7 | 1.7 | 42.2 | 18.5 | 83.0 |
| **Total** | | **2.06** | **0.44** | | **2.4** | **1.64** | | **24.76** | **1.64** | | **18.2** | **83.06** |