CHAPTER VII

BY-PRODUCTS OF RICE MILLING

7.1 Introduction

As per as rice is concerned, nothing is wasted during its processing. The paddy plant gives paddy as well as straw. Straw is a very popular cattle-feed in rural India and used as a roofing material for kutcha houses in rural West Bengal. Similarly, even during its processing, paddy continues to give many by-products that are as useful as the finished product itself. The amount and elaborateness of these products depends upon the processing technology used. With improvements in rice milling techniques, more by-products have now become available.

In this chapter we have discussed the various by-products of rice mills such as rice bran, husk, ash and broken rice or khud. We have put special emphasis on rice bran oil as it requires the most capital intensive processes and has a great market potential, but adds characteristics of formality and brings an organized nature to the industry. We have noted this fact in the last chapter that in this processing industry, technological level and size of operation are closely related to social characteristics of labour. If dhenkies lie in one end of the spectrum of rice milling processes, then rice bran solvent extraction plants are at the opposite end.

7.2 Types of By-Products

The main by-products of the rice milling industry are husk, ash and bran. The proper utilization of these by-products through modernization of the industry has enormous significance to the local, regional and national economy. The economic importance of husk and ash has been found to be rather limited, probably only to the local economy, but bran has significantly played an important role in increasing profitability of the mills and in solving the edible oil crisis in India. This has been made possible relatively recently, especially since the introduction of sheller-cum-separator-cum-polisher system in 1971, replacing the traditional huller system. On an average, one quintal of clean paddy yields 70-72 kilograms (about 71 per cent) rice, 5 kilograms (five per cent) of bran, 20-22 kilograms (about 21 per cent) of husk and three kilograms (three percent) of ash in modern rice milling techniques. At
present, these by-products are used in various ways. The following flow chart gives a clearer picture.

**Figure 7.1: Paddy By-Product System**

![Flow chart of Paddy By-Product System](image)


### 7.3 Rice-Bran

The most useful by-products of rice milling industry is undoubtedly the rice bran which has an immense importance to the rice mills as it is used for producing fat-free edible oil and also as a raw material of solvent plant. Rice bran oil has a very good market value, which can go a long way in increasing substantially the profitability of the rice mills.

#### 7.3.1 Rice Bran Oil

Rice bran is the brown layer between the rice and the outer husk of the paddy. As rice bran is enriched with oil, protein, vitamins and minerals, it is undoubtedly the most useful by-product of rice milling industry. Due to the presence of these constituents, rice bran is considered as good source of oil (rice bran contains 15 to 25 per cent of oil). This oil can be
Rice bran is economically obtained only by solvent extraction process. Rice bran is also an important source of animal feed and a wide number of industrially important articles. The number of products obtained from rice bran is given in Table 7.1.

Table 7.1: Rice Bran and its Various Uses

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Crude rice bran oil.</td>
<td>Edible oil after processing</td>
</tr>
<tr>
<td>II. Wax</td>
<td>Food additives, drugs, cosmetics</td>
</tr>
<tr>
<td>III. Fatty acid</td>
<td>Soap, paint etc.</td>
</tr>
<tr>
<td>IV. Phytic acid</td>
<td>Food additives</td>
</tr>
<tr>
<td>V. Protein</td>
<td>Animal feed and food application</td>
</tr>
</tbody>
</table>

Source: Sah, 1985

Rice bran is used as a raw material for the solvent plant industry. Its oil is also used as a raw material for candies and confectionery, dairy-based items, vanaspati, chemical industries, and for making chewing gums (Sah, 1985). As rice bran oil is fat free, its use as edible oil is also now widely advocated on medical grounds for protection against heart diseases and malnutrition.

About 22–28 per cent rice bran is obtained from parboiled rice and 14–16 per cent from the raw rice. For quite some time, the Government of India has been concerned with the production of edible rice bran oil in the country to reduce the large imports of edible oils. In India, the total annual (1986-87) production of rice bran was about 26 lakh tons, but only 16 per cent of it went for edible oil production. Typically, rice bran contains 15 – 20 per cent oil. If all the available rice bran could be utilized for oil extraction, roughly 6 lakh tons per year of rice bran oil could be added to the edible oil supply.

The deficit of edible oil in West Bengal is around 0.45 million metric tons. Money spent on annual purchase of edible oils amounts to Rs 13,500 million at Rs 33,000 per metric tons (GOWB, 2000). Higher production of rice bran oil can bring down the total requirement of such purchases. A large portion of this production (about 50 per cent) is contributed by Burdwan district.
At present there are about 24 rice bran oil extraction units in the state with a processing capacity of 3.8 lakh metric tons rice bran oil per annum. The present annual production is around 20,000 metric tons but the state has the capacity to produce around 2,00,000 metric tons annually as currently only 10 per cent of the paddy grown is milled in modern rice mills (GOWB, 2000).

The Government of India has provided massive incentives for making edible quality rice bran oil and for turning it into vanaspati, which is a nutritious cooking medium.

The quality of rice bran in respect of oil content and refinedness varies from place to place. This is due to the nature of the milling applied. India has *three* rice processing systems: traditional huller rice mill, sheller rice mill and modern rice mill. Normally, bran yielded by huller mills has the lowest oil content (Table 7.2) as it contains an appreciable quality of husk and broken rice mixed in it. The quality of bran that comes out of sheller mills is far better in this respect. Thus, a substantial quantity of bran goes waste in the huller process. To reduce this wastage, the huller system was replaced by sheller-cum-polisher-cum separator system by the Government of India’s Amending Act of 29 of 1968.

<table>
<thead>
<tr>
<th>Method of milling</th>
<th>Bran obtained from</th>
<th>Oil content (in per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huller</td>
<td>Raw paddy</td>
<td>4 – 6</td>
</tr>
<tr>
<td></td>
<td>Parboiled paddy</td>
<td>4 – 6</td>
</tr>
<tr>
<td>Sheller</td>
<td>Raw paddy</td>
<td>12 – 15</td>
</tr>
<tr>
<td></td>
<td>Parboiled paddy</td>
<td>15 – 20</td>
</tr>
<tr>
<td>Modern</td>
<td>Raw paddy</td>
<td>15 – 20</td>
</tr>
<tr>
<td></td>
<td>Parboiled paddy</td>
<td>25 – 30</td>
</tr>
</tbody>
</table>

Source: *Utilization of By-products from Rice Milling Industry*, National Productivity Council, New Delhi, April 1981.

De-fatted or de-oiled bran is another product obtained after the extraction of oil from rice bran. This is used as animal feed.

The rice millers of Burdwan city sell their bran to the local wholesalers. The cost of the bran rose from Rs 220 to 260 in 1986-87 to Rs 500 to 650 in 1998-99 per quintal indicating a
doubling in the rate in only 12 years. This happened due to an increased demand as more mills have now begun to use modern processing. Rice bran oil extraction plants of Burdwan are Dutta Solvent (closed at present), D.P. Agro Mills Pvt. Ltd., Supreme Oil Industries Ltd. in Alamganj, Bansal Oil Industries Ltd. on Katwa Road, Sethia in Bam Battala and Memari Mill in Memari (Figure 7.2). Of the total rice bran oil production of West Bengal, the contribution of Burdwan city and its surroundings is significant. Among the 4 most promising grain processing units in the state, 2 are solvent plant and situated at Burdwan city proper that is, D.P. Agro Mills Pvt. Ltd. and Supreme Oil Industries Ltd (GOWB, 2000).

7.3.1.1. Characteristics of Rice Bran Oil
Rice bran oil is reported to be one of the best edible oils containing 80 per cent polyunsaturated fatty acids. The low content of linolenic acid and high content of tocopherols in rice bran oil make it more advantageous than other oils. Apart from being antioxidant, tocopherol (Vitamin E), which is present to the extent of 2 to 3 per cent, is regarded as a nutrient for the brain and a precious vitamin that helps to maintain the proper balance in the nervous system. In Japan, rice bran oil is popularly called heart oil as it keeps the blood cholesterol level relatively low due to presence of linolenic acid, and also due to its tocopherols and oryzanois. The ratio of monounsaturated fats (MUFA) and polyunsaturated fats (PUFA) in rice bran oil is almost near the value recommended for controlling arthritis problem.

Oryzanol, which is uniquely found in rice bran oil, is well known for its scientifically proven beneficial impact on raising good cholesterol (HDL) while reducing the bad cholesterol (LDL) particularly the triglycerides (VLDL). It is also known to have anti-itching, anti-dandruff and anti-ageing properties (Report of D.P. Agro, 2001). Oryzanol is reported as having a marvelous effect in accelerating human growth, making the blood circulation smoother and stimulating the secretion of hormones. As oryzanol has marked therapeutic values, it is helpful for the treatment of vegetative stigmata and autonomic asynergia in the nervous system. It also has anti-arteriosclerotic activity and is useful for hair preparation, skin ointments, health foods and revitalizing tonics (Jain, 1998).

Rice bran oil has significant amount of tocotrienols, which apart from decreasing serum cholesterol, decreasing hepatic cholesterol biosynthesis, having hypocholesterolemic effect and being powerful anti-oxidant, are also known to have anti-thrombotic and anti-carcinogenic properties (Report of D. P. Agro, 2001).
LOCATION OF RICE BRAN OIL (SOLVENT) PLANT
BURDWAN CITY AND ADJOINING AREAS


Figure 7.2
Rice bran oil has high content of squalene, which is considered good for skin nutrition and for maintaining integration and tone of the skin. It is well known for its anti-wrinkle properties.

Rice bran oil has 3 classes of anti-oxidants (oryzanol, tocopherols and tocotrienols) instead of the common one class (tocopherols) found in other edible oils. As such it has a remarkable oxidative stability and a longer shelf life. This oil has high oxidative stability, which was found to be equivalent to or better than soyabean canola, corn, cottonseed and safflower oils in a model system.

Foods fried in rice bran oil have better flavour and odour stability at increased storage temperatures (Julian, et al., 1998). Foods deep-fried in refined rice bran oil absorb less oil compared to other oils. This oil can cook 15 per cent more food compared to other oils. Blends of rice bran oil with soyabean oil tended to decrease the deterioration of soyabean oil (Satyanarayanan, 1999). Moreover, the products deep-fried in refined rice bran oil retain their taste and blandness for long period without any deterioration.

High content of natural antioxidants present in the rice bran oil help in controlling production of free radicals which can cause injury to the inner lining of blood channels and initiate coronary diseases, certain cancers, cataracts, rheumatoid arthritis, Parkinson's disease and contribute to the ageing process (Report of D. P. Agro Pvt. Ltd, 2001).

The National Institution of Nutrition (NIN) proved that among various edible oils rice bran is the only oil, which is antimutagen (anti-carcinogen). Rice bran oil is devoid of any mutagenic activity when heated to high temperatures.

By several experiments NIN has been concluded, among the consumed edible oil of India, the rice bran oil is best for resisting cholesterol, which is clear from the table below:
Another characteristic feature of rice bran oil is the presence of one to 5 per cent wax on an average. The wax has to be removed while refining.

### 7.3.1.2. Factors of Location of Solvent Plants

For examining the location of solvent plants, we had to include the local rice mills too as they are the main suppliers to D.P. Agro Mills of Burdwan. As the rice mills supply the oil plants with bran, which is the raw material, they exist in a near-symbiotic relationship. Bran oil plants are very much tied to the source of raw material locationally; like cane sugar loses sucrose with time, bran increases free fatty acid with the passage of time. Hence the oil plant must be situated very close to rice mills. An analysis of opinions expressed by rice millers makes clear the factors influencing the concentration of solvent plants in Burdwan city and its surroundings. These factors are:

- Burdwan district (especially the villages surrounding the Burdwan city) ranks first in paddy production in West Bengal.
- The number of sheller-based and modern rice mills has been increasing in the surrounding areas of Burdwan and within the city; the older machinery mills are replaced by modern sheller-cum-polisher-cum separator system, which produces more and better quality bran.
- No license is needed for setting up of rice mills. This encourages the concentration of rice mills in this area and as a consequence there is constant supply of rice bran for continuing the solvent plant’s operations.
- These solvent plants are situated on and very close to the main transport routes like the G.T. Road, Burdwan-Katwa Road, and G.T. Road by-pass, providing easy accessibility.
• Moreover, rice bran is a bulky material leading to increased transport charges if the oil plants are located away from the mills.
• Labour is available at cheap rates locally or from other parts of the district. Many of these workers are skilled in agro-processing techniques due to the existing mills.

7.3.1.3. Methods for Extraction of Rice Bran Oil

There are methods for extracting oil from rice bran: (a) hydraulic pressing; (b) X-M milling; and (c) solvent extraction. Among the three methods solvent extraction is very popular at the solvent plants of Burdwan region. It is the most viable method for obtaining oil from rice bran as well as other oil-bearing materials. The process has many distinct advantages:

• The recovery of oil is very high;
• It can profitably extract oil otherwise going as waste in oilcakes;
• No damage is done to the proteins in this process;
• Keeping property of the de-oiled meal is increased, due to less amount of residual oil content; and
• De-oiled meal is more or less in powder form and, therefore, ready for immediate use.

Keeping in view these advantages, oil from rice bran is mainly extracted through the solvent extraction process.

*Types of Solvent Extractors*

In India, a few of the plants are extracting rice bran oil with the help of batch extractors and the rest are using continuous extractors. Our surveyed solvent plant, D.P. Agro Mills Private Limited, Burdwan uses continuous extractors.

*Continuous Extractors*

The continuous solvent extraction process can broadly be divided into two types: (a) immersion type extractors, and (b) percolation type extractors. In Burdwan region, the percolation type extractors are used in the solvent plant.

In a continuous extraction system, rice bran passes through the following phases to form crude rice bran oil.
Purification
It is the first step for solvent extraction. Rice bran obtained from rice mills contains broken rice, husk, stones, sand, and other undesirable materials. It is necessary to clean this bran before oil is extracted. Bran is generally passed over a vibratory screen for separation of these unwanted materials.

Steam Cooking and Drying
The cleaned rice bran is then cooked and conditioned. Cooking and conditioning is important for any oil-bearing material as it breaks down the cell walls holding the oil. It coagulates the protein, converts part of the starch to dextrine, and generally helps in the subsequent process of granulation or pelletization for extraction. The aim here is two fold; on the one hand, the cell should be broken down and, on the other, it is necessary to provide binding material for subsequent pelletization of the bran.

Pelletization
During this process of pelletization, the cooked bran passes through the specially designed tapered holes of rotating die plates and bran emerges as compact pellets. The pellets emerging from the pelletizing machine are generally hot and contain high moisture. It is, therefore, necessary to flash cool the pellet, preferably in a horizontal perforated pellet cooler. This reduces the moisture content and simultaneously hardens the pellets.

Counter Flow Continuous Extraction
The cooled and partially hardened pellets, still at a temperature of about 70°C are transported to the solvent extraction plant. For this transportation, a conveyor, which keeps the pellets intact and reduces the breakage, is used. The extractor is the heart of the entire process. In the extractor the solvent hexane trickles over the bed of rice bran pellets and percolates through the bed. The resultant liquid is a mixture of oil and hexane, which is known as miscella (crude oil plus hexane).

Washing with Fresh Solvent
During continuous extraction and counter flow, miscella washing with fresh solvent is continued.
Miscella Separation, Water Control in De-Oiled Bran and Storage

In this step de-oiled bran and miscella are separated. De-oiled bran then goes for solvent recovery. Excess moisture in de-oiled bran has been controlled by regulatory system. Then, dry de-oiled bran is stored.

Weighing and Packing

Finally, weighing and packing of de-oiled bran is completed.

Filtration of Miscella and Distillation

After separation of miscella from de-oiled bran, sometimes miscella goes for filtration separately. In the plant surveyed by us, filtration is done through a perforated mat along with distillation. Distillation is a process by which the crude oil and the hexane in vapour form are separated. This is done by simple vaporization of hexane.

The condensed solvent and water mixture are passed through solvent water separators, which work, on the principle of hydrostatic balancing of columns of the two liquids. This is possible as hexane and water do not mix.

A flow chart of a solvent extraction process is shown in Figure 7.3.
Figure 7.3: Flow Chart of a Continuous Extraction System for Rice Bran

Rice Bran

- Purification
- Steam Cooking and Drying
- Pelletization
- Counter flow Continuous Extraction
- Washing with Fresh Solvent
- Miscella Separation
- Storage of Solvent

- Storage
- Washing and Packing
- Water Control in De-oiled Bran
- Solvent Recovery from De-oiled Bran

- Fresh Solvent

- Distillation
  - Oil
  - Oil Feet
  - Filtration
  - Crude Oil
  - Liquefaction

- Steeling

- Hexane

- De-oiled Bran
- Miscella
The entire electrical system in the solvent extraction plants must be of flame proof category (Rao, 1982). Normally, the whole process is generally controlled by a central control panel, which is housed in a specially enclosed and air pressurized room. Fresh air is continuously circulated through this room. This prevents ingress of solvent vapours by accident, which may cause explosions. There are indicating lamps, alarm lamps, external flame-proof push-buttons and transparent double glass window for observation to ensure safety. This too is most uncommon in informal manufacturing units.

7.3.1.4. Refining of Crude Rice Bran Oil

Oil fresh out of the seeds is mostly nutritious and healthy. The seeds rich in Essential Fatty Acids (EFAs) contain many valuable side components. By and large, they contain all the essential vitamins and minerals needed for their own assimilation. Many of these components are rich in antioxidants. As unprotected EFAs go rancid quickly, the last thing the oil manufacturers want is to have us purchase their oil in the grocery store, just to find that it has gone rancid. To prevent this, they remove and alter them. By the time the oils we eat have been through the refinement process, a radical change has taken place. These processes are called degumming, neutralization, bleaching, winterization and deodorizing (Figure 7.4).
Figure 7.4: Flow Chart of the Alkali Refining Process for Crude Rice Bran Oil

- **Crude Rice Bran Oil**
  - Degumming
    - Gums
  - Centrifugation
  - Neutralization W/NaOH
    - Centrifugation
      - Neutralized Oil
        - 1st Water Washing
        - 2nd Water Washing (Warm)
        - 3rd Water Washing (Hot)
          - Supercentrifugation (Separation of Washing Water)
- **Alkali (Soap Foots)**
- **Vacuum Bleaching**
  - Press Filtration
    - Bleached Oil
  - Deodorization
  - Cooling
  - Winterization
    - Filtration (Bag Fillers)
    - Press Filtration
      - High-Grade Edible Oil
7.3.1.5. Rice Bran Oil in Burdwan

We have noted that there are 6 rice bran solvent plants around Burdwan (3 in running condition in our study region). Of these 6, one is now closed due to some labour problems. We have studied one of the biggest of the 5 plants, that is, D. P. Agro Mills located within the city in Alamganj area.

The following are our findings and observations:

- On an average 100 tons rice bran has been processed per day at our surveyed solvent plant, D.P. Agro Mills on the basis of 300 working days. The number of working days depends upon the supply and price of rice bran and also the demand of rice bran oil.
- The price of rice bran varies from Rs 5,000 to Rs 6,300 per ton. Oil recovery is estimated to be 20 per cent from the bran.
- Average loss of hexane (chemical exist in rice bran oil) is about 5 litres per ton of rice bran processed. On an average the cost of hexane is Rs 16 per litre approximately.
- Consumption of power is about 55 Kwh (approximately) per ton of rice bran processed. Approximately the bill for electricity consumption per month varies between Rs 1.5 and Rs 3 lakh. Such higher expenditure for power consumption helping to place this industry towards formality.
- The selling price of the different products is assumed as under:
  (i) Rice bran oil (edible grade) varies from Rs 32 to Rs 37 (MRP Rs 44 per litre) per litre.
  (ii) Oilcakes from de-oiled bran (DOB) vary from Rs 1,800 to Rs 3,100 per ton.
  (iii) Acid oil varies from Rs 14,000 to Rs 17,000 per ton.
- The minimum time taken for processing of rice bran into crude oil is four hours and for refining crude oil into edible form, the time requirement is 48 hours.
- There is no peak season for rice bran oil production. The amount of production on an average is same throughout the year.
- For establishing solvent plant in West Bengal the following licenses must be granted:
  (a) Explosive license – granted by central government as the solvent (hexane) used for processing of rice bran is highly inflammable.
  (b) Fire license – granted by state government.
  (c) Trade license – issued by Burdwan municipality or appropriate authority.
(d) S.E.O (Solvent Extracted Oil) license – needed for raw/crude oil processing plus crude oil refining. The authority granting this license is Directorate of Vanaspati and Vegetable Oil (New Delhi).

(e) Pollution control license – issued by Pollution Control Board (State government), Durgapur.

Due to the need of taking so many licenses mentioned above, the establishment of a solvent plant is not quite easy like setting up a rice mill. A rice mill requires only two licenses - trade license issued by Burdwan Municipality or appropriate authority and pollution control license issued by Pollution Control Board (state government). Therefore, a solvent plant can be defined as an informal unit only with a lot of caution. The characteristics that add attributes of informality to this top-end activity of rice milling are related to its labour and employment. We will discuss them in more detail later in this section.

Realizing the problems related to licensing and to encourage more solvent plants, the Government of India has de-licensed the solvent plants. This is one of the measures that have followed economic reforms in the country. The grant of food license has also been withdrawn. Sale tax is also exempted in order to encourage the producer/owner of the solvent plant to increase production that is involvement of more manpower. In addition, the government has taken up several measures to encourage the growth of solvent plants. These include provision of depreciation on a straight-line method at ten per cent per year for plants and machinery and on civil works at five per cent per annum.

Other characteristics of a solvent plant includes:

- The workers in most cases have had previous work experience in other solvent plants. A fresher or an inexperienced worker is not usually appointed in a solvent plant. This means that entry in this sector is comparatively more difficult than entry in rice mills.
- Rice bran oil plant workers have a separate trade union. This unionization has ensured increased job protection of workers.
- An important feature in the solvent plant is that the worker’s families are not allowed to reside in the plant’s quarters. Only the workers are allowed to stay here.
7.3.1.6. Marketing

Before the purchase of rice bran, its percentage of oil content is tested in the laboratory. The important bran testing laboratories of West Bengal are General Inspection and Survey Company Limited (GISCOL) Calcutta, and Industrial Research Bureau (IRB) Howrah. Our surveyed plant D.P. Agro Mills Private Limited has its own bran-testing laboratory. The main criteria for buying rice bran are its oil sand silica and free fatty acid (FFA) contents (oil content should be more, FFA should be lowest possible). After testing the standard of bran for minimum requirements (that is, 20 per cent oil content in Burdwan District), it is purchased. The solvent plants of Burdwan city and its surroundings almost always purchase rice bran locally. Even D.P. Agro Mills also purchase the maximum amount of rice bran locally. Most of the bran is purchased directly from the mills; a very small amount may be purchased through brokers.

After production, edible quality refined rice bran oil goes in tankers to the pouch packing section. This section is at the Dutta Solvent (now closed) Alamganj, which is the first mill (established in 1962) in the family of the D.P. Agro. The rice bran oil of this plant has been packed by Sarju Exports in Dutta solvent, indicating its early root in the oldest plant. D.P. Agro Mills marketed their product in the brand name of ‘Health’ initially in Calcutta from where the brand’s popularity spread all over the state.

To reach Health to the consumers from the marketing centre, it passes through four types of businessmen. This entire structure resembles a pyramidal system (Figure 7.5), just like the feudal-colonial structures that existed in agriculture of Burdwan at one time. At the top of the hierarchy, there are super-stockists. There are seven such super-stockists in West Bengal. From the top to the base of the pyramid, the number of businessmen keeps increasing and value addition also takes place in each step. Quite justifiably it may be said that this industry creates employment for several thousand people.
During oil extraction, several other by-products are produced again. The by-products produced during oil refining are de-oiled bran, acid oil and wax. The acid oil is transported by tanker to the soap factories of Burdwan city; these are Joyguru Soap Factory (Saraitikar), Joy Hind Soap Factory (Nabab Hat), Bharat Soap and Barddhaman soap (Pir Baharam). Clearly we see another chain of manufacturing is being created by the oil plants. The price of acid oil varies from Rs 14 – Rs 17 per kilogram. The de-oiled bran is used for making of fodder, like Kopila gokhaddo, Susam, which has a large market locally. This same material is also used as food for poultry birds and for fishes (in pisciculture). The price of de-oiled bran varies between Rs 1,800 – Rs 3,100 per ton. But the price of fodder varies between Rs 5,000 – Rs 5,300 per ton (as it is mixed with other material beside de-oiled bran). Thus we see that rice milling has created extensive industrial linkages in the region and has caused an industrial wave of various sorts. Interestingly, this entire operation including its linkages is in the informal sector having an unorganized nature. No webpage of the Government of India can give data about these linkages and tell exactly how much capital is working in all these activities. Excepting the trade unions, there have been no serious efforts on the part of the government to carefully look into this intricate industrial linkages. However, though this industrial processes are in the hands of private individuals, and there is not much real control of the government over them, policies made at the centre in Delhi do affect them and determine their course of growth or non-growth. We shall discuss the current trends
occuring in rice mills in the last chapter, but before that we must outline the labour characteristics of oil mills.

7.3.1.7. The Profile of Solvent Plant Workers

In our surveyed solvent plant there were 180 workers, among which 25 workers were engaged in white collar jobs (2 computer operators, and the rest 23 includes chemist, manager accountant, clerk and cashier) and 152 workers were engaged in direct oil processing. There were only 3 women workers employed mainly for washing the filter cloth and for packing. This job discrimination against women workers also indicates their lower status than male workers in this sort of factories. Among 152 workers there are 10 daily and 60 contract labourers. These thike or job-based temporary workers are employed in jobs such as loading, unloading, and husk carrying.

Income

The daily workers get Rs 75 per day, a rate that is considerably higher than the wage given by rice mills. In case of daily workers, there is no pay on days when jobs are not available. The contract labourers get the wage at different rates determined by mutual contract between the sardar and solvent plant owner.

The payments of all the contract labour are paid to the sardar who have brought them to the solvent plant. Sardar himself earns an additional 20 per cent on the total payment of all contract labourers. Different rates for different types of work and pattern of sardar’s payment are very much similar to rice mills.

The salary of the monthly paid staff varies between Rs 2,300 and 4,000, again indicating a higher scale than the rice mills. The office staffs get between Rs 3,000 and 6,000 monthly (with free food and lodging in case of those with 12 hours duty). All the workers get 8.33 per cent bonus (during Durga Puja), not exceeding Rs 3,500, depending on their monthly payment.

Leave

The monthly staff enjoys 88 days leave annually (including Sundays). The rules of enjoyment of leave are such that if they work on any holiday, they would obtain 1 1/2 times more wage than any working day, but if they failed to attend on a holiday, their wage would
be deducted 1 ½ times than any working day. This negative wage rule in most cases compels workers to serve 26 working days in the plant. The working hours of the blue-collar worker is eight hours including lunch. The working hours of the office staff is from 8 am to 8 pm. They have a break of two-three hours for afternoon snacks and lunch. If the blue-collar workers work more than eight hours they would get overtime for extra hours. In this plant, oil production and processing take place all day long in three shifts (6 am – 2 pm, 2 pm – 10 pm, 10 pm – 6 am), reflecting a high demand for oil. The workers work on rotation in the three shifts.

**Literacy**

Educational qualifications of the 25 office staff range from postgraduate, to graduate, to just literate. Among 152 blue-collar workers, the qualification of 89 per cent is Madhyamik and only 11 per cent workers are less than Madhyamik, showing much higher literacy levels than rice mill workers. The qualification of female workers is less than Madhyamik.

The owners of the solvent plant have introduced *Janata* policy for each worker. The yearly premium is Rs 30 for each worker and paid by the company/plant. In accidental deaths, the assured capital is Rs 1 lakh, which indicates their jobs are partially protected.

**Earning Members**

The number of earning member per family is an important indicator of the economic condition of the worker. The single income family is not predominant among the solvent plant workers with about 36 per cent of them in this category. About 45 per cent are in the category of double income family besides about 18 in the category of families with three or more earning members (Table 7.4).
Table 7.4: Number of Earning Members per Family

<table>
<thead>
<tr>
<th>Number of earning member per family</th>
<th>Number of solvent plant workers</th>
<th>Percentage share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65</td>
<td>36.11</td>
</tr>
<tr>
<td>2</td>
<td>82</td>
<td>44.99</td>
</tr>
<tr>
<td>3 – 4</td>
<td>25</td>
<td>13.88</td>
</tr>
<tr>
<td>Above 4</td>
<td>08</td>
<td>4.44</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>180</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

From the above figures it is quite clear that the economic condition of the solvent plant workers is not so miserable like most other informal sector workers in the third world. Double income families are common, because majority of the worker's age group is between 20-30 years and their father is also actively earning. In some cases these workers have joined this plant as a second job. Another cause of double income families is most of the rural origin workers living in joint families. In such cases, the earning member may be even five where there are other three or four brothers.

**Housing**

The nature of housing is also an important socio-economic indicator. Among the total workers, about 43 per cent (contract labourer and office staff) live in plant's quarters. About 54 per cent live in own houses and the rest about 3 per cent live in rented houses (Table 7.5). The quality of housing is not so poor as that of rice mill workers.

Table 7.5: Housing of Solvent Plant Workers

<table>
<thead>
<tr>
<th>Housing</th>
<th>Number of workers</th>
<th>Percentage share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own</td>
<td>97</td>
<td>53.88</td>
</tr>
<tr>
<td>Plant’s Quarters</td>
<td>78</td>
<td>43.33</td>
</tr>
<tr>
<td>Rented</td>
<td>5</td>
<td>2.77</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>180</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Average Length of Stay*

Except the contract labourers, majority of workers' average length of stay in this plant is 2 years for better environment and amenities than the previous solvent plants. Among the 180 workers, about 3 per cent have worked in this plant from its inception; about 11 per cent are
serving for 5 years, and workers serving for more than 2 years but less than 5 years are about 14 per cent. About 30 per cent workers have worked here for 2 years. The contract labourers (about 33 per cent) stay here for a year as per the rule of contract. The percentage of new comers is 8. Sometimes the contract labourers may renew their contract.

Original Home

The largest segment of workers (44 per cent) employed in this plant are from the surrounding villages of Burdwan city. There are workers (about 22 per cent) also from the city proper. Migrant workers (about 33 per cent of the total workers) usually come from Purulia (about 33 per cent), Bankura (about 3 per cent), and Birbhum (10 per cent). Workers also come here from other states like Bihar (50 per cent), Orissa (about 2 per cent) and Kerala (about 2 per cent).

From the above description, it is clear that the workers from other districts mainly come from agriculturally backward districts like Purulia, Bankura and states like Bihar where it is difficult to get jobs. A fraction of the workers before joining this plant used to work in rice mill. Though the rice mills and solvent plants are both included in the informal sector, the latter is more sophisticated than the former due to its adoption of up to date technologies, comparatively more literate workforce than rice mills, more intricate marketing system and advertisement by festoons or by local media.

Job Specialization

The important designations within a solvent plant are: fireman for firing the boiler (1 fireman per shift), helper to help the fireman (2 helpers for 1 fireman per shift), incharge, who takes care of overall operation (1 incharge per shift), mechanic – specialist in repairing machines (1 mechanic per shift), godown keeper – who takes the charge of the godown, chairman and managing director- responsible for the overall profitability of the company and liaison with government and other institutions like banks, financial institutions, and so on. He will also be concerned with planning and budget approvals.

7.4 Rice-Husk

Rice-husk is another by-product of great significance. Husk consists of outer shell covering the rice kernel and constitutes 16 to 25 per cent by weight of paddy processed. Rice husk
contains moisture, ash (most of which is silica), ligneous, cellulose, a little protein and very small amount of vitamins.

The commercial utilization of paddy husk resulting from milling has a major impact on the economics of paddy processing.

- Rice husks are efficient fuels for drying purposes of all types. The modern rice processing industry requires heat energy for mechanical drying of raw or parboiled paddy and for generating steam, which can be used for parboiling process. According to the comparative studies of boilers utilizing different fuels, husk-fired boilers are the cheapest. This low cost enables rice millers to avoid the use of expensive diesel or furnace oil. At the same time, dependence on electricity, the supply of which has become uncertain in the present situation of power shortage, is generally reduced. To illustrate the status of rice husk in today’s economy, we can say that three kilograms of rice husk equals to one kilogram of fuel oil. The utility of rice husk does not end here.

- When husk is used as fuel in the rice mill, large quantities of grey ash is produced. When husk is converted into grey ash, the silica content of the resultant product goes up considerably. This content then becomes about 90 to 95 per cent. This silica is in an extractable form and is a cheap raw material for the manufacture of sodium silicate. Rice-husk provides a cheap source of high purity silicon for solar cells and electronics industry. Cheap silicon is produced by a metallurgical process in which silica and carbon are heated together. Rice husk which contains 15 per cent silica can provide pure silicon (as reported in Science Today, Vol. 16, No. 8, p. 12). Cement from paddy husk has been recently recommended by the Central Building Research Institute, Roorkee, India. The rising cost of building materials has made it imperative to take immediate measures for the development of new cement materials, that are economically more viable than existing materials. It is worthwhile that rice husk ash is being used to some extent as a partial replacement for portland cement. Ash provides a cheap source of silicon-di-oxide that allows for reaction with lime or portland cement hydration products to form binding materials.

- Furfural is a chemical produced from rice-husk. This is used as a catalytic agent in petrochemical industries as well as for many chemical products. In India furfural plants are under integrated projects. For the manufacturing of furfural, no raw material cost is
needed as husk is available freely from rice mill, which is part of the integrated project (as reported in The Economic Times, 30th September, 1983).

- Rice husk is used for making various kinds of boards.
- Finally, husk, mixed with the powder of wood has been used for making ceiling boards.

With improvements in technology and especially as natural mineral resource bases are depleted, there may occur many more uses of rice husk from mills.

7.5 Ash
The burned husk produces two types of ash – black ash (which is of poorer quality) and white ash (which is of better quality). Ash from rice mills is now renowned as a construction material. For example, white ash mixed with lime is used for construction of heat resistant bricks for boiler plants. Black ash is used for side filling packing in the cold storages. In some places, bricks are formed for building homes. Black ash is frequently used for filling of low lands.

Black ash is also used in agriculture. It is mixed with the soil especially in the cultivation fields of potato and onion in order to improve the aeration and increase fertility of the soil as well as for increasing the size of the potato and onion.

In addition, there are various industrial uses of this ash. For example, ash is used during the manufacturing of steel retaining heat. The Tata Steel Corporation uses ash from the mills for this purpose. Ash is also used in ice factories. In iron casting workshops, black ash is used as an alternative of sand.

7.6 Broken-rice
Another by-product of rice milling process is broken rice. In traditional milling processes more broken rice is produced than in modern mills. In this respect, this particular by-product is quite the opposite to rice bran oil. Broken rice is usually known as khud, food for the poorest of the people. Commonly in Burdwan region, broken rice is used as a fodder. Nowadays, khud is used for making rice powder. Rice powder or chalguri has many traditional uses such as making pithe (a kind of sweet cake in sugar syrup) that is eaten during the festival at the time of harvest. Many Bengalee sweet makers use chalguri to mix
with cottage cheese for making the sweetmeat. In South Indian dishes like idli and dosa, chalguri is a basic ingredient. Chalguri is also used for the preparation of papad, which has spawned an indigenous industry with wide participation of women workers.

7.7 Summary
In this chapter we have discussed the various by-products of the milling processes of paddy - starting from rice bran, which has the greatest commercial value, we have outlined the other by-products and their uses. These include husk, ash and broken rice, each having its specific use and market niches. For example, ash has both industrial and agricultural uses, besides its use as a construction raw material. Husk is used not only as a fodder but also as an important fuel for running the boilers in mills. At the same time, it has found use in board making. Thus, we have seen that rice milling is not the end in itself and the uses of its by-products have a very long downstream chain effect on the economy and labour participation in Burdwan region. A greater economic utilization of these by-products, therefore, will further enrich rice milling industry and improve economic condition of the region.

The labour characteristics related to these by-products are also widely diverse. On the one hand are the innumerable dhenkis dotting the rural homes and operated by women, on the other hand are the huge mechanized solvent plants operated often by a few workers. In the middle are rice mills of various sorts, some chatal-based and dependent on the sun, some mixed, and some having dryer. At each technological level, nature and quality of by-products vary immensely. Many modern rice mills hardly produce any broken rice at all. Like rice mill workers, solvent plant workers are an integral part of informal manufacturing sector that encompasses a large segment of the Indian economy - from its largest metropolis where recent rural migrants squat on the pavements or find temporary jobs in various services, to the smallest town and even in rural areas.

This chapter reveals that solvent plant workers do not anymore lie at the lowermost stratum among the labourers of the urban economy of Burdwan and its surrounding region. They still have their rural roots intact, but changing technologies and improvements in rural economy have much altered that situation. Consequently, social and family structures too have changed and a new industrial labour class is being created in the mills of Burdwan. As evident from our study, the workers of such plants live a reality that straddles both 'rural' and 'urban' and creates a new form of synthesis unthought of before.
We may now ask the question: what relationship does the informal nature of rice milling have with the better economic utilization of the by-products? The informal nature of the industry has prevented the inflow of large-scale capital and adoption of new technology for improving production efficiency in Burdwan region. Many rice mill owners still continue to use the old technique or combine them with new techniques. There are several reasons behind the reluctance to adopt new technology by mill owners – the most important of them is the labour intensiveness and trade unionization of the labour force. As long as the techniques are kept labour-intensive, low wage levels can ensure better production and more profits. However, the mill owners in most cases would not openly agree to this, and complain about trade union activities interfering with production. We intend to come back to this aspect later on in our chapter on problems of the industry.