FEATURES OF THE RICE INDUSTRY IN THE SOUTHERN SECTOR OF GHANA-POST HARVEST HANDLING PRACTICES AFFECTING QUALITY

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SUMMARY

This study was carried out in the major rice growing areas of southern Ghana.

The first part of the work was a survey during which rice farmers, middlewomen and rice mill operators were interviewed in all aspects of their respective vocations.

Most of the rice grown in the south of the country was irrigated and the farmers worked on plots allocated to them by the Irrigation Development Authority.

Those engaged in the marketing of the crop were mainly women who often times financed the operations of the farmers and got paid in kind.

Most of the mills (84.2%) covered in the survey were small mills of capacity not exceeding 500 kg. paddy $(h)^{-1}$. The operators of these mills were invariably untrained and all their skills were acquired on the job.

Physical and chemical quality analysis were conducted on samples of locally produced rice and compared with imported rice.

While the chemical compositions of local rice were within acceptable ranges, the physical quality was very low. This was attributable mainly to poor post harvest handling on the part of farmers and middlewomen as well as the mill operators' lack of the appropriate skills in rice milling.

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1. INTRODUCTION

Rice is listed as one of the four main cereals grown in Ghana, the others being maize, sorghum and millet (Statiscal Service, Accra, 1987). The national annual production is between 46,000 and 56,000 tonnes of milled rice while consumption ranges from 80,000 to 100,000 tonnes per year (WARDA, 1986). The above statistic indicates clearly that imported rice is an important part of the rice consumed in this country.

The crop is one which can be grown in several parts of the country profitably provided farming methods and post harvest handling processes are improved (Nelson, 1988). However, inefficient farming and post harvest handling techniques have led to very low quality and ironically high production costs for locally produced rice. With the large area of Ghana suited for rice production, the country could be self-sufficient in rice production if the small farmers who have a higher cost-efficiency are encouraged to increase their yields per unit area. (Asuming-Brempong, 1989)

A survery of the market in Accra indicated at the end of 1988, although farmer's production costs were rising steadily, market price for locally produced rice was significantly less (Ø6,000 - Ø7,000 per 50 kg.) compered to imported rice (8,000 - Ø9,000 per 50 kg.). A number of reasons could be attributed to this situation. Notable among these are:

i Locally produced rice is usually not graded and it has a high percentage of brokens

ii There is a high level of contamination with extraneous materials such as unhusked paddy, husk, stones, red rice, pieces of metals, dicoloured grains etc. in the rice.

iii The rice is sent from the mill straight to the market and it in therefore unseasoned. This is believed to affect the cooking quality of the product.

Local post-harvest processes like threshing, drying and milling seem largely responsible for this state of affairs. (Oteng, 1989)

There is therefore the urgent need to document precisely the different methods employed in the above-listed post-handling processes in the country. A knowledge of this would enable one to pin-point exact problems and to suggest practical ways of overcoming them. This paper attempts to do this for the southern rice growing sector of the country.

The demand for rice is so high that even very poor quality rice somehow manages to get sold. This state of affairs provides no incentive for producers to season the milled rice before putting it on the market.

Proximate and other chemical analysis were carried out on locally produced rice to ascertain whether our not-so-good production methods has had any effect on these properties.

Physical quality analysis was also performed on some local rice samples and compared to foriegn grading requirements to find out where the local industry stands as against the interational market.

It is hoped that this work would be extended to cover the whole country. The results obtained thereafter would provide adequate background information for the national rice industry. It would be of great help in the quest to improve the quality of locally produced rice.

2 LITERATURE REVIEW

Rice, Oryza sativa is an annual swamp plant and it is the staple food for approximately half of the human race (FAO, 1966). Rice is generally grown by peasant subsistence farmers in many parts of Asia, Latin America and Africa whilst its production in Australia and the United States is highly mechanised. 100 million hectares are planted with rice annually. 90% in South-East Asia whilst the whole of Africa produced about 10 million tonnes, China the leading producer of the crop produced over 155 million tonnes of the total world production of 411 million tonnes in 1982 (FAO Production Year book 1982).

O sativa is believed to have been domesticated over 4,000 years ago in India and since then many cultivars with diverse physiology and morphology have been selected by man to suit local tastes and enviro-ments. They have been grouped according to the characteristics of their seeds and according to the conditions under which they are grown (Cobley and Steele, 1976). Although it is difficult to satisfactorily classify so many cultivars, 3 subspecies under O sativa can be recognised namely:

- O s subsp indica: Long grains and grown in the hot climatic conditions of Asia and Africa.
- O s subsp japonica: High yield with short and round grains adapted to the cool temperatures of Japan Korea and North China.
- O s subsp javanica: With characteristics intermediate between indica and japonica.

Depending on the systems of cultivation, 3 classes are indentified:
- Swamp rice, accounting for most of the world's output.
- Floating rice, grown in flood waters.
- Upland rice which is usually rain-fed.

Rice became a Ghanaian staple food rather recently although the crop has been cultivated in the country for several centuries. The most significant attempts at increasing its production were made during the last world war (1939 - 45), in the early sixties and in the early seventies (Asafo, 1985).

Cultivation of rice in Ghana is spread throughout the country. The crop is grown in the savannah areas in the North and the swamps in the South.

The most suitable soils for rice cultivation are heavy alluvial soils which are either flooded and waterlorged occassionally or subjected to artificial irrigation.

Rice is cultivated under four main ecologies in Ghana namely:

i) Rainfed upland
ii) Rainfed lowland
iii) Inland swamp
iv) Irrigated.

The irrigated ecosyster covers 5% of the total rice growing area of Ghana, rainfed upland ranging between 10% and 15% with the rainfed lowland accounting for a maximum of 65% (Oteng, 1987).

Although rice is grown in all the administrative regions of the country, the North has in recent years been identified as the major rice growing area. In 1975, the region accounted for more then 61% of the total land area under rice cultivation (Thakur, 1981).

A wide range of local and high yielding varieties are grown in the country including.

a) Local cultivars such as Mendi, Bazulogo and Gona.
b) High Yielding Varieties amongst which are DS 3, CG 20, GRUG 6, GRUG 7, ITA 22 ITA 306, IR 5, IR 8 and IR 442.

2.1 HARVESTING

Harvesting is a critical operation in rice production and timeliness of the harvest is essential for maximum output. Delayed harvesting results in a high percentage of brokens and wastage in the milled product from sun-cracked grains. In long grain paddy for example, a loss of 2% in head rice is suffered for everyday harvest of ripe grain is postponed (FAO, 1966).

Lodging at harvesting which considerably reduces yield is a major problem on rice fields. Grist, (1975) states that, lodging may be the direct result of environmental conditions or may be specific to variety. Environmental factors concerned include high winds, spacing, temperature and disease. Also tall varieties with weak stems are especially susceptible to lodging.

Rice is usually harvested at a moisture content of 20 - 25%. When this falls to between 15 and 20%, the kernels shatter from the head very easily (Stout, 1966).

Freshly harvested rice spoils rapidly because of high tempereture high moistures contents, high rates of respiration, high microbiological action and the presence of foreign material. As a result, after harvesting, the rice is usually bound into sheaves and dried for a while to slightly reduce the moisture content before threshing. This field curing is mostly done by peasant farmers to enhance head rice yield. It must be done slowly and uniformly till the moisture content is about 15 - 17% before threshing. (Shankara and Bhattacharya, 1986,b)

2.2 THRESHING, WINNOWING AND DRYING

Threshing is the separation of the grain from the panicles but not removing the husk. This is usually done at a grain moisture content of 15 - 17%. Most peasants thresh manually by beating the cut plants on logs and frames, human threading on the panicles or by driving animals over the plants. These methods are labour consuming hence there is a progressive shift towards mechanical threshing. (Wasserman and Calderwood, 1972).

Manually, winnowing may be done by tossing the paddy into the air and allowing the wind to carry off the chaff. Mechanical threshers are often equipped with fans and other devices for winnowing, a number of which have been described by Grist (1975).

After threshing, the grains are usually dried further to supplement the preliminary field curing. This when properly done makes for paddy with good keeping quality and maximum head rice yield at milling. The chemical and organoleptic properties of the rice is not expected to change as a result of this drying (FAO, 1966) Commonly, drying is done in the sun on drying floor. There is however, a gradual shift to artificial drying in a number of places.

2.3. MILLING

There is a range of mill sizes and the degree of sophistication of milling and the preparation of the final product is a function of the market requirements. (Flynn and Clarke, 1980).

Chung, (1986) stratified the various milling systems into four categories.

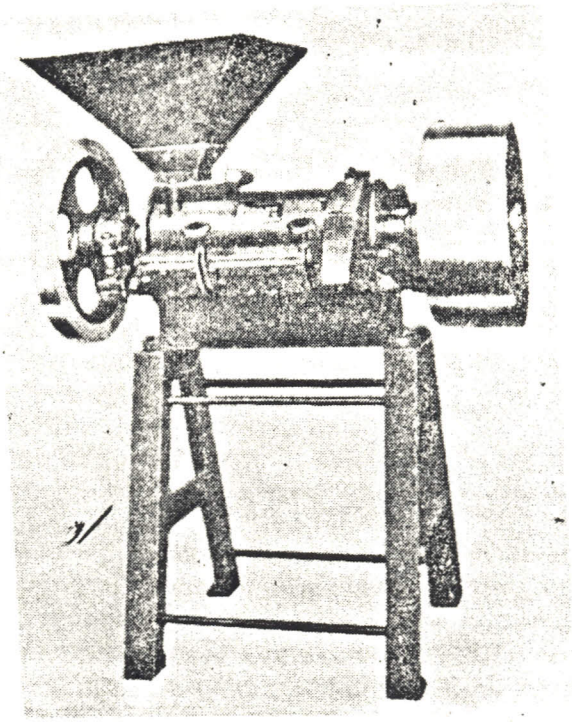
i) The Engelberg milling system, characterised by single pass hulling and whitening (Fig. 1a, b.)

ii) The European milling system using the disc type stone huller and vertical cone-type whitening machine (Fig. 2)

iii) The Japanese milling system (which uses rubber roll huller and horizontal friction and/or abrasive type whitening machine, (Fig. 3) and

iv) The chemical milling system which employs a Chemical solvent extraction and removal process.

FIG. 1a: HULLER



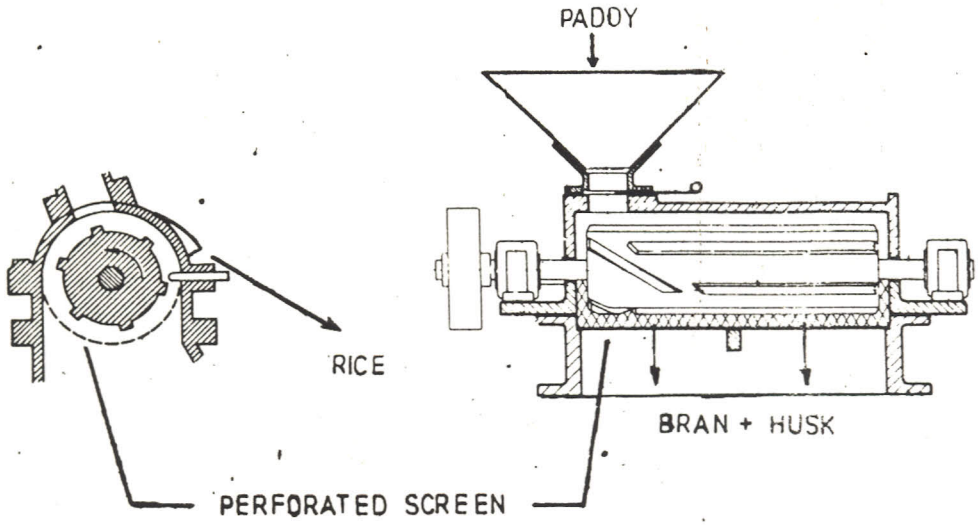


FIG. 1b: CROSS SECTION OF HULLER

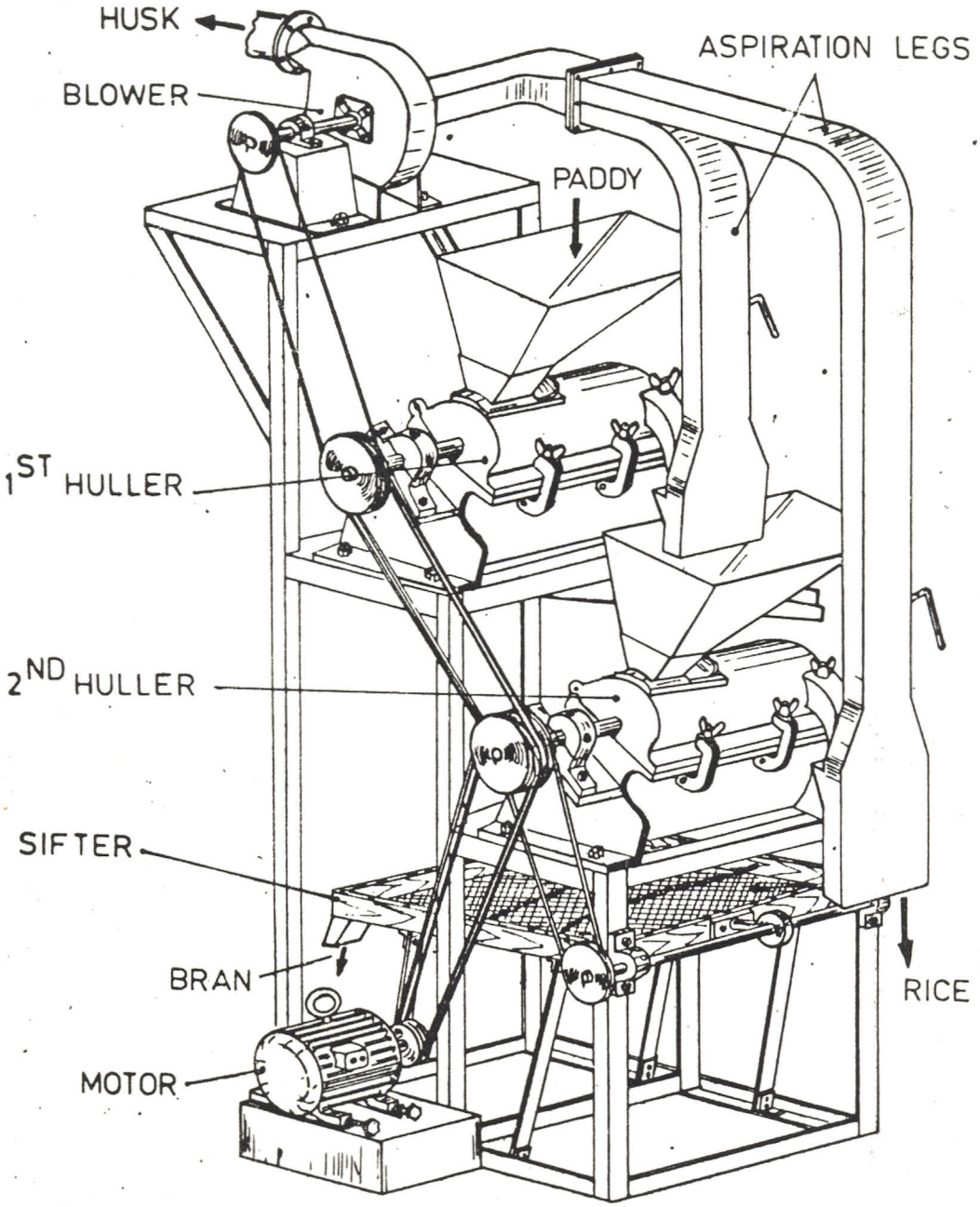


FIG. 2 : DOUBLE HULLER MILL

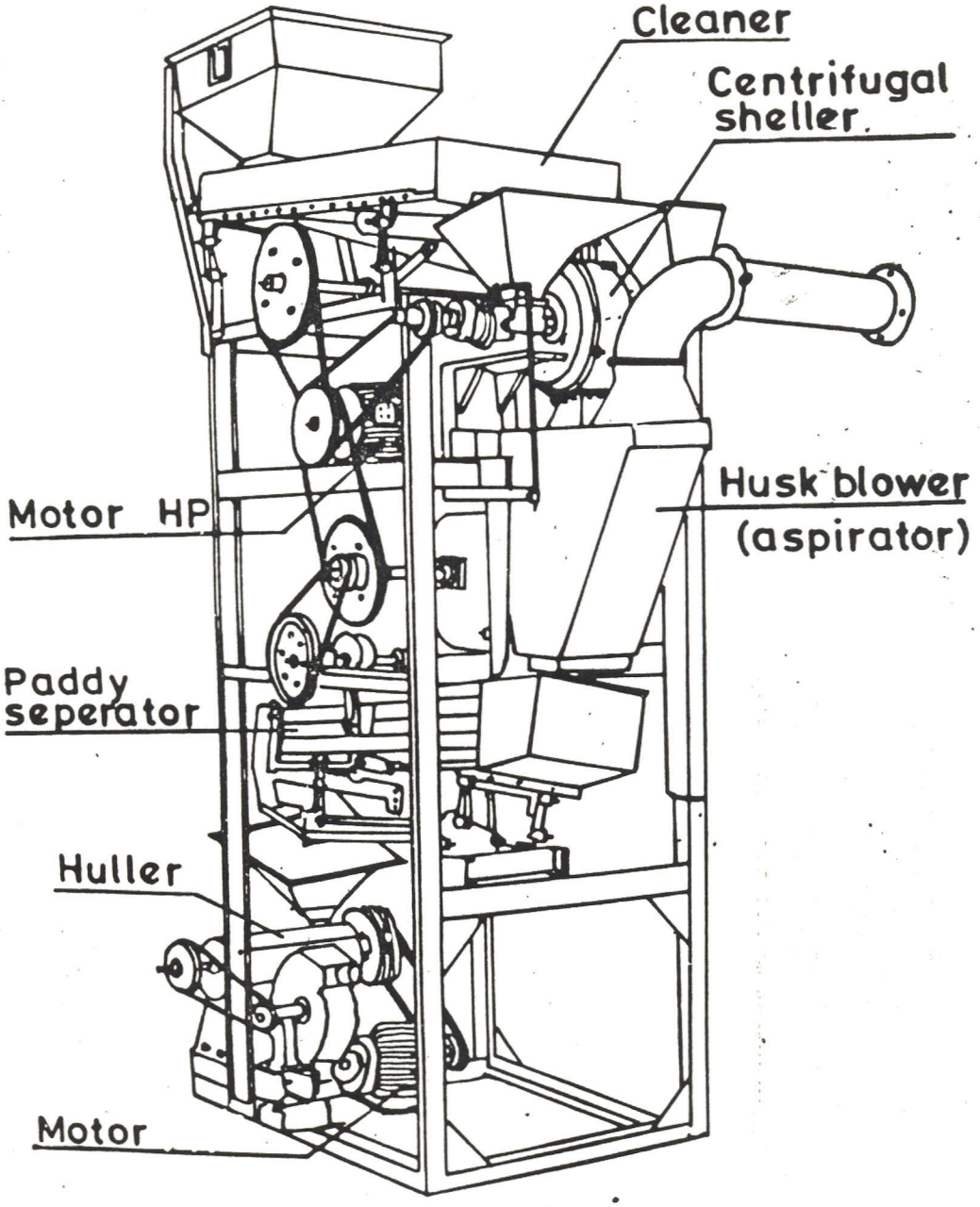
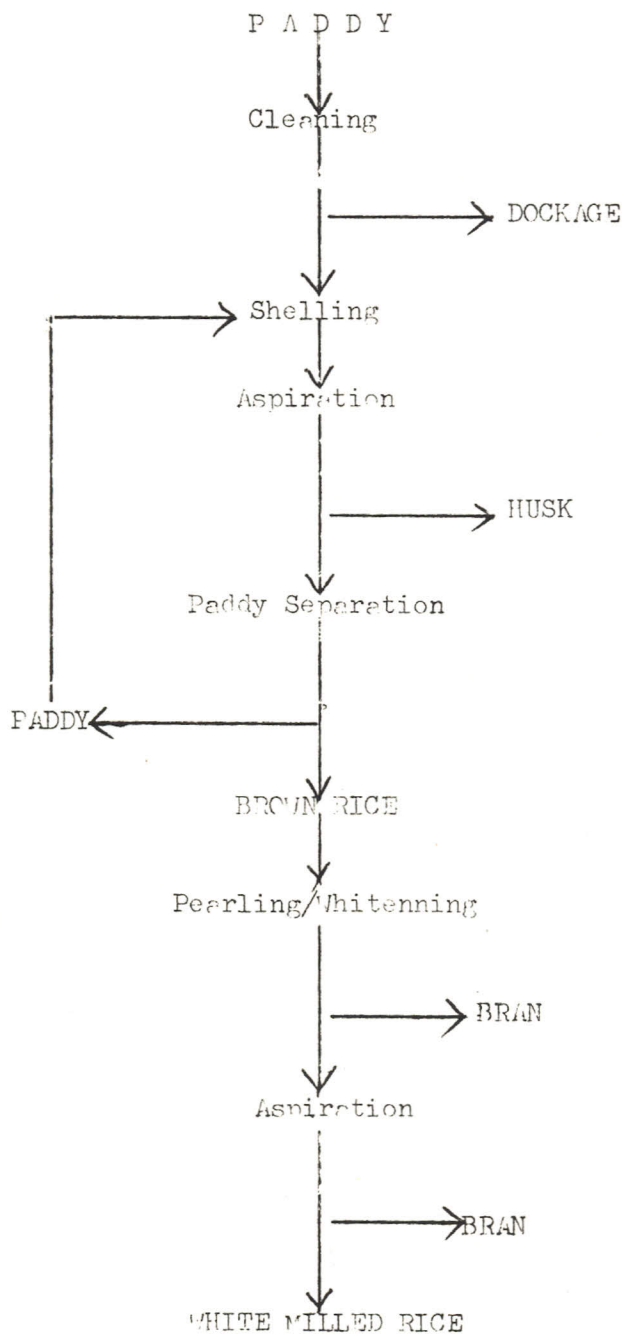


FIG. 3: MINI RICE MILL

Rice milling involves cleaning, dehusking, paddy separation and bran removal which is also called whitening or pearling. Polishing and parboiling may be done to suit market demands.

Below is a flow diagram of a mini rice mill operation showing the various intermediate and by-products of the different operations.

FLOW DIAGRAM OF MINI RICE MILL OPERATION



2.3.1 CLEANING

Before milling, the paddy is usually soreened for foriegn matter such as dust, nieces of stalk, foreign seeds, soil and pieces of metal among others. In the cleaning exercise, foreign materials lighter than the paddy are removed by aspiration. A Magnet is employed to remove metallic (iron) impurities, whilst particles which are either larger or smaller in size but heavier than the paddy are removed by sieves. Specific gravity separators known as destoners are used to remove impurities, (usually stones) the same size as the paddy but heavier. Shankara and Bhattacharya (1986, b) note that paddy intake is often subjected to a preliminary cleaning called scalping before storage and prior to the main cleaning in the mill.

2.3.2 DEHUSKING

While mechanized dehusking or shelling and milling are becoming more usual, traditional hand pounding remains important in many Asian countries and less than 10% of rice produced in Africa is mechanically dehusked (Grist, 1975). In most rice mills, dehusking or shelling is done by shellers which may either be disc shellers - usually consisting of an upper stationary and a lower rotating disc - or two rubber rollers rotating in opposite directions at different speeds. The objective of these is to remove the husk from the paddy with a minimum ofdamage to the bran layer and if possible without breaking the brown rice grain. However, the structure of the grain makes it necessary to apply friction to the grain surface during this process and as a result, a certain percentage of brokens cannot be avoided. Araullo et al (1976) stress that uniformity of the grain is essential for optimum head rice yield as the shelter could be adjusted according to the variety to be processed. The negative effects of dehusking of mixed varieties can be avoided by grading the paddy prior to processing. The percentage of paddy actually dehusked (sheller efficiency) varies between 80 - 95% and depends on:-

(1) The uniformity of the paddy.
(2) The variety of rice
(3) The condition of the paddy
(4) The type of sheller
(5) The condition of sheller
(6) The operator of the machine.

2.3.3. PADDY SEPARATION:

Usually what comes out of a sheller is a mixture of husks, dehusked rice, unshelled paddy and some broken rice. The husks, is removed by aspiration of dehusked rice and paddy which is passed through special paddy separators to remove the paddy which is returned to the sheller. This paddy refered to as "return paddy" is usually either shorter or thinner than the normal paddy. Shankara and Bhattacharya(1986, b) advice the "return paddy" should be collected and de husked separately to increase duhusking capacity.

The objective of paddy separation is to obtain brown rice free of paddy from the mixture of brown rice and paddy. The paddy separators makes use of the differences in characteristics of paddy and brown rice such as specific weight, buoyancy, dimensions and surface texture (Chung, 1986). Furthermore Chung (1986) lists 3 types of paddy separators

i) Tray type separator using differences in specific gravity and dimensions

ii) Compartment type separator using differences in specific gravity and surface texture.

iii) Screen type separator using differences in dimensions.

2.3.4. BRAN REMOVAL

A number of terms including whitenning and pearling are used to refer to this. The various definitions of these terms may at times be confusing.

Some amount of bran removal is essential for easy cooking and storage. Excessive removal however reduces the nutritive value of rice. In the processing of milling to white polished rice, 76.3% of thiamine, 56.6% of riboflavin and 63% of niacin are removed and lost for humen consumption. (Kik and Williams, 1945).

Two types of bran removers may be identified, one of emery and the other of metal. Those of emery (called whiterners). Remove the bran by abrasion with emery while those metal (called pearlers) remove bran by friction between the rice grains. In more sophisticated operations, bran removal is done in a stepwise manner in several polishers to reduce breakage to a minimum.

Bran produced from this operation is separated from the whole grains, broken grains and rice germs by aspiration. In rice being produced for a competitive market, whole grains are separated from brokens through various processes of grading. Glazing, which is coating the grains with small amounts of oil, talc, glucose etc. in revolving drums is often times done before the rice is put on the market.

2.3.5. POLISHING

This term is often used wrongly to refer to pearling or whitening. This is actually the removal of the bran particles still sticking to the surface of the rice after pearling. The surface is slightly brushed or polished to give it a shinier appearance. This process may be accomplished by a rice polisher machine consisting of revolving rollers or drums encased in a fine wire mesh with an inner covering of sheepskin.

2.3.6 PARBOILING

According to Grist (1975), parboiling probably originated in India some 2000 years ago and is now practised in many countries, and simply defined parboling as a process of steeping paddy in cold water and then into hot water or in steam at low pressure. About 60% of the nearly 70 million tonnes of paddy produced in India annually is parboiled (Shankara and Bhattacharya, 1986, a)

Araullo et al (1976) list the objectives of parboiling as

i) to increase the total and head rice yield of paddy.
ii) to prevent loss of nutrients during milling.
iii) to salvage wet or damaged paddy.
iv) to prepare the rice according to the requirements. of consumers in certain parts of the world.

Parboiled rice usually has a brownish colour the extent of which depends on the soaking and steaming conditions as well as on often undesirable smell due to action of becteria while the paddy is soaking in cold water.

Several methods of parboiling have been developed in a bid to eliminate smell and attain a not-too-brownish a colour. In the (Central Food Technological Research Institute; Mysore, India), Hot soaking process for example, paddy is soaked in hot water (65 - 70°C) for 3 - 4 hours to avoid the development of smell. The extent of colour depends on the soaking and steaming conditions, for example, the greater the heat treatment during soaking and steaming, the higher the colour. Also, after steaming, the paddy sould be immediately spread out to cool quickly.

Shankara and Bhattachany (1986a) estimate that paddy after parboiling contain between 30 - 40% moisture which must quickly be dried to about 14% moisture for safe storage or for milling.

The method of drying parboiled rice is very crucial for milling outturn. It is generally recommended that drying should be in two stages rather than one continuous drying process which could result in as high as 50% brokens in the milled product. In the first stage, paddy should be dried to about 16 - 20% moisture content and rested for at least 3 - 4 hours. This tempering process allows the moisture content in the centre of the grain to diffuse to the suface and the moisture to get equalised throughout the grain eliminating the moisture gradient - the principal cause of breakage in the grain - resulting rom the first stage of drying.

After drying, it is desirable to rest paddy again for several hours before milling for best results.

Paddy varieties preferred for parboiling are the brittle ones and the long and slender due to the fragility and their poor ability to withstand the ordinary milling process (Garibaldi, 1972). Also those varieties which cook soft when not parboiled, cook less hard after parboiling and as such are prefered.

The advantages of parboiling have been summarised in an FAO (1949) report as follows.

"Parboiling makes it possible to produce, from a given amount of paddy more rice, with less breakage in milling to use a lower grade of paddy; to obtain rice with superior keeping qualities and to retain more of the nutrient of the grain during milling, washing and cooking. As a consequence, the adoption of parbliling would result in a large saving of rice and, even more important, of valuable vitamins and minerals". Also, bran from parboiled rice contains more oil than raw rice and is of a a superior quality because it has a lower concentration of free fatty acids.

However, it is worth noting that parboiled rice takes a longer time to cook, has a flavour which may not be desirable to many people, is difficult to polish because it is harder and develops more rancidity in storage as natural antioxidants are destroyed by heat. Also the parboiling equipment and the time spent during the process definately add extra costs to the total processing costs.

2.4 MARKETING

Marketing is a set of human activities directed at facilitating and consumating exchanges (Huang, 1986). The marketing functions are buying, selling, storing, grading, packaging, financing, risk-taking and market information. Asafo (1985) indentified two main forms of rice marketing systems in the country namely traditional marketing and that by large mill operators often refered to as the Recognised Mills.

The traditional market which has gained a lot of ground from the Recognised Mills is operated mainly by women. This system has been quite efficient as the women go to the farmers to buy paddy at the farm gate and pay a competitive price for it.

The pricing policy of the government protects the producer with a minimum guaranteed price which the state owned agencies eg. the Recognised Mills and the Food Distribution Coporation will offer the farmer in the absence of higher prices.

3 SURVEY DESIGN

The survey carried out under this work was aimed at covering the major rice growing and processing areas in the south of the country. The major towns in and around which these activites were significant included Tema, Ashaiman, Dawhenya, Asutsuare, Kpong, Akuse, Afife and Afienya. These areas were generally acknowledged to be suitable for the production of the crop. As a result, the Irrigation Development Authority as well as other institutions have stations in most of these areas for the production of rice. The rice industry is a major source of employment for the people living in the areas mentioned above. People in these areas engaged in various aspects of the rice industry were interviewed for the purpose of this study.

A questionnaire was prepared covering the various aspects of the rice industry and tested in the Ashaiman and Dawhenya areas. The questionnaire was redesigned and separated into three (3) parts (ie. Farming, Milling and Marketing) to facilitate a much more extensive survey. The revised questionnaire was employed in the remaining areas mentioned above.

The relevant information was collected by visits to farms and mill houses and sample of farmers, mill operators and middlewomen interviewed. As much as possible the interviews were conducted in a language in which the respondent was fluent. The help of local interpretors was sought where necessary. The questionnaires were filled with the responses of the respondents

A total of 68 (sixty eight) respondents (30 farmers, 20 mill operators and 18 middlewomen) were interviewed during the survey (Table 1)

Copies of the questionnaries used have been attached to this report (Appendices 1, 2 and 3)

Table 1: Sample Size of Respondents

OCCUPATION	NUMBER	PERCENTAGE
Farmer	30	44.1
Middlewomen	18	26.5
Mill Operator	20	29.4
TOTAL	68	100.0

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4. SURVEY FINDINGS

4.1 FARMING

Of the farmers interviewed, 8 were from Asutsuare, 7 from Ashaiman, 6 from Dawhenya, 4 from Afife, 3 from Kpong and one each from Akuse and Afienya (Table 2). Table 2 also shows the age distribution of farmers which varied considerably. Although the general age range of the farmers interviewed was from19 to 55, most of the farmers (56.7%) were aged between 35 and 45 years.

TABLE 2: AGE DISTRIBUTION OF FARMERS

AREA/TOWN	AGE CLASSES (YEARS)					TOTAL	RERCENTAGE
	19-34	35-39	40-44	45-49	50-55		
Asutsuare		3	3	1	1	8	26.7
Ashaiman	1	1	2	2	1	7	23.4
Dawhenya		2	1	1	2	6	20.0
Afife		1	1	1	1	4	13.3
Kpong	1		2			3	10.0
Akuse			1			1	33.3
Afienya				1		1	33.3
TOTAL	2	7	10	6	5	30	100.0
PERCENTAGE	6.6	23.4	33.3	20.0	16.7	100.0	

Table 3 shows that 16.7% of the farmers had no formal education and 20.0% of them had had post-seconday eduction. The percentage of farmers with primary education was 36.6% while 26.7 had obtained Secondary education

The rice farming experience of the farmers varied widely. Whilst 10% of them had over 15 years experience, 33.3% had 1 - 5 years experience (Table 4). The bulk of the farmers (56.7%) had cultivated rice for between 6 to 15 years.

TABLE 3: EDUCATIONAL BACKGROUND OF RICE FARMERS

AREA/TOWN	TYPE OF EDUCATION				TOTAL
	NO FORMAL EDUCATION	PRIMARY	SECONDARY	POST-SEC	
Asutsuare	1	3	2	2	8
Ashaiman	2	1	3	1	7
Dawhenya	1	3	2		6
Afife	1	1	1	1	4
Kpong		2		1	3
Akuse				1	1
Afienya		1			1
TOTAL	5	11	8	6	30
PERCENTAGE	11.7	36.6	26.7	20.0	100.0

Although the farmers were mostly local townsmen, a number of absentee-farmers existed at Asutsuare and the Irrigation authorities were in the process of getting rid of them and reallocating their plots.

Most of the rice grown in the southern sector of the country was irrigated. The Irrigation Development Authority (IDA) of the Ministry of Agriculture had stations at Ashaiman, Dawhenya, Asutsuare and Afife. In a number places around the above-listed stations, independant farmers cultivated upland rice. These farmers usually took advantage of small ponds and streams and either pumped or diverted water from them unto their farms.

The IDA mode of operation as well as areas under irrigation varied considerably from place to place. The approximate area under irrigation were 120ha (300ac) at Ashaiman, 200ha (500ac) at Dawhenya, 400ha (1000ac) at Asutsuare and 880ha (2200ac) at Afife.

Whilst local rivers had been demmed at Ashaiman, Dawhenya and Afife, at Asutsuare, IDA pumped water directly from the Volta River unto the fields. Considerable differences also existed in the imputs supplied and the nature of services provided by IDA to the farmers. At Afife where most services were provided, the IDA prepared the farmers' plots and sowed it with seeds developed from the IDA seed-farm for a fee.

TABLE 4: RICE FARMING EXPERIENCE OF FARMERS

AREA/TOWN	NUMBER OF YEARS				TOTAL
	1 - 5	6 - 10	11-15	OVER 15	
Austsuare	2	1	4	1	8
Ashaiman	3	2	2		7
Dawhenya		3	2	1	6
Afife	2	2			4
Kpong	2			1	3
Akuse		1			1
Afienya	1				1
TOTAL	10	9	8	3	30
PERCENTAGE	33.3	30.0	26.7	10.0	100.0

In collaboration with a consortium of banks, the IDA supplied the farmers with fertilizers, herbicides, insecticides, fungicides and any other chemicals that were needed in the course of production. The main differences between operations at Afife and Asutsuare were that farmers selected their own seeds from the harvest and did the sowing themselves at Asutsuare. Also whilst payment for the inputs and services were in kind at Afife, cash was collected at Asutsuare. IDA neither provided mechanisation services nor did the sowing for the farmers at Ashaiman and Dawhenya. Other chemical inputs were supplied only when available Farmers therefore had to often times buy these inputs with cash from the open market. The farmers' individual holdings were small ranging from 1.0-3.75ac (0.4 - 1.5ha). For most of the serious farmers, rice farming had become a full time job. Due to the heavy demands of the various tasks particularly scaring of birds, farmers or their relatives had to be on their farms every single day of the period that there was a crop on the field.

Most farmers worked with their families althouth during major operations like tilling, harvesting and threshing, labour was either hired or the farmers organised themselves into groups and helped each other.

The number of croppings done in a year depended on the availability of water in their canals. Most farmers usually sowed 2 (two) crops in a year.

4.1.1 CULTIVARS

As IDA did the sowing for the farmers at Afife, a single cultivar was usually sown for all the farmers. The current cultivar on the fields at the time of this survey, was ITA 234.

In all other areas, a number of cultivars were grown by the different farmers and DS 3 was by far the most common cultivar grown in the Ashaiman - Afienya - Dawhenya area. Under good conditions farmers harvested (2.0 - 2.5 t)ac^{-1} or (5.0 - 6.0t)ha^{-1} of DS 3. The commonest cultivar in the Asutsuare area was IR 3273 which was a shorter grain but higher yielding cultivar than DS 3.

Other cultivars grown to a lesser extent in the Southern sector included DS 2, CICA 4, CG - 20, ITA 222, GRUG 6, GRUG 7 and Thailand.

Most farmers obtained their seeds from other farmers who received their stock from the Asians who were formerly in charge of the stations. The University of Ghana Agricultural Research Station at Kpong, the Ghana - Korea Saemeul farms at Asutsuare and the Kpong Farms of the Volta River Authority also tested and distributed seeds to farmers.

Many of the farmers grew other crops apart from rice with others being solely rice farmers. These auxillary crops were mainly vegetables maize and cassava. The crops were not grown on the irrigated plots but often on upland rain-fed areas. The sizes of these farms were variable. Whilst the better organised and relatively richer farmers managed to assemble inputs and labour to produce large quantitites of the above mentioned crops for the market, others just grew enough for home-use.

4.1.2. SEED SELECTION:

Except at Afife where the IDA seeded the farmers' plots for them all other farmers had to select seeds for planting the next season from the harvest. Often times, the seed-paddy was further dried to a lower moisture level than paddy for milling and this was believed to facilitate germination.

4.1.3 HARVESTING

Although some of the farmers used the theoritical number of days to maturity as a guide, most of them decided harvesting time by visual assessment. Harvesting was done when about 90% or more of the field was brown. Due to the fact they did not have any reliable means of determining moisture content at harvesting the farmers just took some grains and bit through to ascertain degree of dryness prior to harvesting.

Generally, farmers on irrigated plots drained the land for up to about 10 - 14 days before harvesting. Harvesting was manual and it was done just as the soil was firm enough for people to walk on easily and not for the movement of heavy equipment. A few farmers however maintained that a dry field attracted rodents and with them, dangerous reptiles, which destroyed the crop and threathened humans. These farmers prefered to be safe and hence moved slowly through muddy fields to harvest their crop.

As stated above, harvesting was entirely manual. Although the cutlass was said to be the faster implement, some farmers were not accustomed to its use and therefore prefered to use the sickle in harvesting. At Asheiman, Dawhenya and Afife, the sickle was the main harvesting equipment while 58.8% of the farmers interviewed used the sickle for harvesting, 8.8% had access to and employed mechanical means in harvesting (Table 5).

TABLE 5: HARVESTING EQUIPMENT USED BY FARMERS

AREA/TOWN	TYPE OF EQUIPMENT			TOTAL
	SICKLE	CULTLASS	MECHANICAL	
Asutsuare	1	8	1	10
Asheiman	7			7
Dawhenya	6			6
Afife	4			4
Kpong	1	2	1	4
Akuse			1	1
Afienya	1	1		2
TOTAL	20	11	3	34
PERCENTAGE	58.8	32.4	8.8	100.0

Most farmers recognised the critical nature of harvesting and threshing and as a result, usually employed labour to harvest their ripe fields. Some farmers had however organised themselves into small groups to help each other with these operations. Family members also lent helping hands here.

The area of crop harvested in a day was about an acre (0.4 ha) on the average. Most farmers conceeded that the time spent on harvesting was a bit longer than expected and they cited labour and financial reasons for this.

Lodging of plants as well as shattering were quite a common sight. Although shattering was not a characteristic of the common cultivars grown, this usually occured as a result of over-ripe fields and hurried harvesting on the part of hired labour.

A number of reasons were attributed to the incidence of lodging at maturity. Notable amongst them were:

(i) Plant height at maturity: Whilst most cultivars were reasonably short, a cultivar like IR 442 was tall and prone to lodging;

(ii) Occassional outbursts of strong winds

(iii) Too much water on the field at maturity

(iv) Over-application of nitrogen fertilizers.

4.1.4 THRESHING:

Field-curing which is conditioning of the paddy before threshing by drying for about a day on the field was rarely done. The paddy was threshed almost immediately after harvesting.

Just as harvesting, threshing of paddy was entirely manual. Manual threshing however had a number of drawbacks. Apart from the cost of labour and the longer time spent on the operation, some paddy was lost through scattering unto the field. Also the extent of contamination with straw, stones and mud was quite high.

In the Tema-Ashaiman area, threshing was mainly done by spreading a tarpaulin on the ground and beating the panicles aginst stones and blocks laid on the tarpaulin (Table 6)

However, in almost all other areas in the south of the country, this was not the practice. Threshing was mainly be beating the panicles aginst the edges of wooden trapezoid boxes (referred to as "bambam" in some areas). The biggest problem encountered in this form of threshing was loss due to scattering of the paddy and incomplete recovery of the paddy as the process was entirely manual.

TABLE 6: THRESHING METHOD USED BY FARMERS

AREA/TOWN	METHOD USED			TOTAL
	BEATING AGAINST STONES/BLOCKS	THRESHING BOXES	MECHANICAL	
Asutsuare		7	1	8
Ashaiman	7			7
Dawhenya		6		6
Afife		4		4
Kpong	1	2		3
Akuse			1	1
Afienya		1		1
TOTAL	8	20	2	30
PERCENTAGE	26.7	66.6	6.7	100.0

Drying after threshing was one operation which was religiously adhered to by the local farmers. The paddy was sundried on concrete floors for 2 - 3 days depending on the intensity of the sun and the moisture content at harvesting. All the farmers recognised the importance of this operation as it conditioned the paddy for storage and eventual milling.

4.2 FINANCE

Financing farming operations was one of the major problems of the rice farmer. At Asutsuare and Afife where inputs and service were provided on credit to the farmers by a consortium of banks through the IDA, their financial burdens were considerably reduced. The farmers areas in these/however complained of high interest rates and service - charges on the loans advance them. Money was however needed to hire labour for operations such as scaring of birds, harvesting, winnowing and drying. Other sources of finance therefore had to be sought.

In the other farming areas, as assistance from the financial houses was virtually non-existent, a few of the farmers relied on personal resources. Most of them had to fall on financiers who also acted as middlewomen. These women advance the farmers money to finance their farming operations and they often times got paid back in paddy after the harvest.

4.3. FARMERS' ASSOCIATIONS

In some of the major rice growing areas, Rice farmers' Associations existed nominally. These associations were far from well organised and many farmers hardly derived any benefits from them. At Asutsuare, Ashaiman and Dawhenya, 18 farmers representing 60% of all farmers interviewed belonged to Farmers' Associations (Table 7). However no such associations existed around Afife, Kpong, Akuse and Afienya.

TABLE 7: MEMBERSHIP OF FARMERS' ASSOCIATION

AREA/TOWN	WHETHER A MEMBER?		TOTAL
	YES	NO	
Asutsuare	7	1	8
Ashaiman	6	1	7
Dawhenya	5	1	6
Afife		4	4
Kpong		3	3
Akuse		1	1
Afienya		1	1
TOTAL	18	12	30
PERCENTAGE	60.0	40.0	100.0

4.4 MACHINERY AND EQUIPMENT

The vast majority of the farmers did not have any machinery or equipment of their own. In the Afife and Asutsuare areas where the IDA provided land preparation services, the farmers had little incentive to own these equipment. In other areas however, the high cost of these equipment prevented farmers from owning them. The handful of farmers who owned such equipment provided land preparation services to their colleagues.

These equipment broke down frequently and repair and maintenance costs were very high.

4.5 MARKETING

At Afife the farmers were complelled to sell at least 50% of their harvest to government agencies (The Ghana Food Distibution in this case) to offset the inputs and services provided them.

The rest of the harvest was sold off as they wished. At Asutsuare however the farmers sold all their produce on the open market and paid what they owed to the IDA and the banks in cash. At Afife, most of the farmers milled the paddy before selling the rice to the middlewomen to increase their profit margin.

In all other areas (except Afife area) in the south of the country, the middlewomen took control of the paddy when it was on the drying floors. Some of these women travelled to the outlying areas to purchase paddy to be milled and sold. The majority of the middlewomen kept their paddy in the mill houses after it had been dried to the required moisture level despite occassional losses. Most of the farmers and middlewomen endeavoured to keep and mill different cultivars separately as a mixture of cultivars resulted in a high percentage of brokens during milling.

Table 8 illustrates the age distribution of the middlewomen and it shows that 50% of those interviewed were aged between 24 and 34 years. No women aged over 50 years was found in this business.

TABLE 8: AGE DISTRIBUTION OF MIDDLEWOMEN

AREA/TOWN	AGE CLASSES (YEARS)					TOTAL	PERCENTAGE
	25-29	30-34	35-39	40-44	45-50		
Dawhenya			2	1	1	4	22.2
Ashaiman	3		1			4	22.2
Asutsuare	2	1	2		1	6	33.4
Afife	1	2		1		4	22.2
TOTAL	6	3	5	2	2	18	100.0
PERCENTAGE	33.3	16.7	27.8	11.1	11.1	100.0	

Of the 18 middlewomen interviewed, 50.0% had had no formal education (Table 9). Only 2 representing 11.1 % possessed secondary education whilst 38.9% of the middlewomen had primary education.

TABLE 9: EDUCATIONAL BACKGROUND OF MIDDLEWOMEN

AREA/TOWN	TYPE OF EDUCATION				TOTAL
	NO FORMAL EDUCATION	PRIMARY.	SECONDARY	POST-SEC.	
Dawhenya	3		1		4
Ashaiman	1	2	1		4
Asutsuare	2	4			6
Afife	3	1			4
TOTAL	9	7	2	0	18
PERCENTAGE	50.0	38.9	11.1	0.0	100.0

4.6 INSTITUTIONAL FARMS

The University of Ghana had an Agricultural Research Station (ARS) at Kpong where rice was cultivated. Although the rice was irrigated, only 2 main crops were cultivated between March and April and in September. Also Cowpea, Soybean and maize were grown on experimental basis at the station.

The two man cultivars of rice grown at the station were GRUG 6 which was meduim grain and GRUG 7, a long grain cultivar. Although practices like weeding, spraying, fertilizer application and so on were strictly adhered to on the experimental plots, others like visual assessment of matured fields, draining of irrigated areas prior to harvesting and the use of the sickle as a harvesting tool were not different from the practices of the farmers on the IDA plots. The station had an old combine harvester which frequently broke down and harvesting was often manual.

Field curing of the paddy before threshing was sometimes done. When the combine was in use, it also did the threshing, but otherwise, the practice was carried out by beating bundles of paddy against asbestos tubes on tapaulin, just as the small farmers did. Drying after threshing was also by the sun on cement floors.

There were silos at the station where paddy that was to be milled was stored prior to milling seed-rice produced for future use and for distribution to the farmers in the surrounding areas were stored in bags in a seed store. Paddy in storage, either for seed or milling was properly treated against infestation.

The station was however plagued with the problems of lack of money to buy expensive inputs, lack of a proper tilling equipment and the frequent breakdown of existing machines.

Kpong Farms was a subsidiary of the Volta River Authority (VRA) and situated near Akuse. Kpong Farms was clearly the best organised and most purposeful rice establishment in the south of the country. It had been in operation since 1982 and had a staff strength of 50 including senior Management and junior supervisory staff. The outfit had a workshop, irrigation, field work, processing and marketing divisions.

Two main cultivars, ITA 222 and ITA 306 were grown on this farm and cultivation was all year round. Irrigation water was obtained from the Volta Lake. Small quantities of Cowpeas, Soybeans and maize were grown alongside the rice for the use of the workers on the farm.

In addition to the usual practice of using colour to determine maturity of the field, grains were sampled from the field and their moisture content determined prior to harvesting. Harvesting was entirely mechanical by means of combine harvesters which were equipped with crawler tracks and rarely got stuck in loose soil. The capacity of the combines was however low and each could harvest 2 - 3 hectares of paddy per 8 h. day.

There was no need for field curing on this farm as the paddy was dried to a uniform moisture content of 12 - 14% in mechanical driers before milling. Although there were occassional incidences of lodging due mainly to heavy rainstorms, the main problem on the farm was the attack of birds on the crop.

Threshing was also by the combines and the dried paddy was put into 800kg bags and either stored for up to 3 months depending on market demand or sent straight to the mill house for milling. When paddy was stored, it was fumigated against damage regularly. Paddy to be sown as seed in subsequent croppings was carefully selected, and dressed.

The Ghana-Korea Saemaul Farm was situated at Asutsuare and was a subsidiary of AFKO Fisheries (Gh) Ltd at Tema. The company had leased 230 ha(575ac) of land from the Ghana Sugar Estates Ltd (GHASEL) which had virtually closed down.

Out of this area, 32 Ha (80ac) was under irrigation. The company trained young school leavers free-of-charge on scientific methods of rice production. The course was ran 3-4 times a year for 30 participants at a time.

The farm was established in 1986 and among the cultivars grown were IR 3273, ITA 22, ITA 306 and Thailand. Two main crops were cultivated in a year, March to July and September to January. During the major season (March - July), maize was grown alongside the rice.

Harvesting of matured fields was sometimes mechanical by means of a combine harvester and at other times manual, employing the sickle. The establishement also had a mechanical drier and sundrying of paddy was not done there.

Land lease payrents were made to GHASEL which together with IDA also charged the f rms water bills.

4.7 MILLING

The rice mills in the southern sector of the country could be roughly classified into 3 categories (Table 10)

(i) Small size mills with capacity of up to ½t (500kg) paddy per hour

(ii) Medium size mills with capacity of ½t - 1t (500 - 1000kg) paddy per hour

(iii) Large mills with over It (1000kg) paddy per hour capacity.

4.7.1 SMALL MILLS

Most of the small mills were privately owned and operated by men between the ages of 18 and 50 years (Table 11) Most of the mill operators (44%) were aged between 35 and 44 years.

Often times, there was 1 supervisor and 2 or 3 assistants per mill. These mill-house workers almost invariably had had formal training in rice mill operation. All the experience they possessed had been aquired on-the-job. This state of affairs had been partly responsible for the poor quality of locally milled rice on the market. Of the 16 small mill operators interviewed, 56.2% of them had had primary education and 43.8% possessed secondary education (Table 12)

TABLE 10: RELATIVE CAPACITIES OF MILLS

AREA/TOWN	SIZE OF MILLS			TOTAL	PERCENTAGE
	SMALL	MEDIUM	LARGE		
Asutsuare	8	1		9	23.8
Worawova			1	1	2.6
Tema		1		1	2.6
Ashaiman	7			7	18.5
Afife	10			10	26.3
Dawhenya	2			2	5.3
Akuse		1		1	2.6
Kpong	3	1		4	10.5
Afienya	1			1	2.6
Michel Camp	1			1	2.6
Accra			1	1	2.6
TOTAL	32	4	2	38	100.0
PERCENTAGE	84.2	10.5	5.3	100.0	

TABLE 11: AGE DISTIBUTION OF SMALL MILL OPERATORS

AREA/TOWN	AGE CLASSES							TOTAL
	15-19	20-27	25-29	30-34	35-39	40-44	45-50	
Asutsuare			2		1		1	4
Asheiman		1			1			2
Afife					3	1		4
Dawhenya			1					1
Kpong	1		1		1			3
Afienya							1	1
Michel Camp	2							1
TOTAL	2	1	4	0	6	1	2	16
PERCENTAGE	12.5	6.3	25.0	0,0	37.4	6.3	12.5	100.0

TABLE 12: EDUCATIONAL BACKGROUND OF SMALL MILL OPERATORS

AREA/TOWN	TYPE OF EDUCATION				TOTAL
	NO FORMAL EDUCATION	PRIMARY	SECONDARY	POST-SEC	
Asutsuare		2	2		4
Ashaiman		1	1		2
Afife		1	3		4
Dawhenya			1		1
Kpong		3			3
Afienya		1			1
Michel Camp		1			1
TOTAL	0.0	9	7	0.0	16
PERCENTAGE	0.0	56.2	43.8	0.0	100.0

Almost all the mill had been operating well below capacity. This was attributed to the irregular supply of paddy which was closely tied to the farming seasons.

Also the high cost of spare parts and their scarcity especially rubber rollers and polishing sieves was another important factor. Those who brought paddy to be milled were either farmers or middlemen who bought from the farmers. They had to clean and winnow the paddy before milling because almost all the mills were not equipped with pre-cleaners. Partially milled rice did not fetch a good market price hence all the customers preferred white-milled rice.

It was found out that most of the small mills (57.2%) were fairly new and had been installed between 1986 and 1988. The oldest mill encountered was at Ashaiman and had been installed in 1974 (Table 13).

No parboiling was done in the south of the country by the small mill operators.

The fee for milling did not vary significantly from place to place, although in certain areas, particularly round Afife, customers had to pay mill operators in kind (with milled rice). Table (14) shows the sources of power utilised by the small mills.

TABLE 13: YEAR OF INSTALLATION OF SMALL MILLS

AREA/TOWN	BEFORE 1975	1975-80	1981-85	1986-88	TOTAL
Asutsuare		1		3	4
Ashaiman	1			2	3
Afife		1	3	3	7
Dawhenya			1	1	2
Kpong		1		2	3
Afienya			1		1
Michel Camp				1	1
TOTAL	1	3	5	12	21
PERCENTAGE	4.8	14.2	23.8	57.2	100.0

TABLE 14: SOURCES OF POWER OF SMALL RICE MILLS

AREA/TOWN	SOURCE OF POWER		TOTAL
	DEISEL	ELECTRICITY	
Asutsuare	2	2	4
Ashaiman	1	2	3
Afife	7		7
Dawhenya	2		2
Kpong	3		3
Afienya	1		1
Michel Camp	1		1
TOTAL	17	4	21
PERCENTAGE	18%	19.0%	100.0

While 81% employed deisel, 19% of the small mill used elecctricity. The deisel engines, though suited for the rural farming areas, were subject to periodic breakdowns which halted milling operations. Very often, external assistance was sought from local mechanics in the event of equipment breakdowns.

This was so because, most of the mill operators knew very little of equipment repair and maintenance.

No functional Mill Operators' Association existed in any of the main rice producing areas in the south of the country.

The disposal of by-products presented a problem for most of the mill houses. In areas with significant poultry and livestock industries, the bran was sold to the animal farmers. In other areas, and at times when the demand for bran was low, the bran had to be burnt off together with the husk.

Almost all the small mills (95%) were of Asian origin with 66.8% coming from Mainland China and Japan (Table 15). While the small mills from India and the U.K. were Engelberg Hullers,. Those from China, Japan and Taiwan were mini Rice Mills using rubber rollers.

TABLE 15: COUNTRY OF ORIGIN OF SMALLMILLS

AREA/TOWN	C O U N T R I E S					TOTAL
	CHINA	JAPAN	INDIA	TAIWAN	U.K.	
Asutsuare	1	1		2		4
Ashaiman	1	1		1		3
Afife	3	4				7
Dawhenya		2				2
Kpong		1	1		1	3
Afienya			1			1
Michel Cap			1			1
TOTAL	5	9	3	3	1	21
PERCENTAGE	23.9	42.9	14.2	14.2	4.8	100.0

4.7.2 MEDIUM SIZE MILLS

In the southern sector of the country, 4 mills which could be described as medium sized for the purpose of comparison with the smaller ones were indentified (Table 10). 3 of these mills which were exactly of the same make and size were located in the Kpong-Asutsuare area. These were owned by Kpong Farms - a subsidiary of the Volta River Authority (VRA), the University of Ghana Agricultural Research Station at Kpong and the Ghana-Korea Saemaul farms at Asutsuare. The mills, installed in 1987 and of Japanese origin, had a capacity of 1 ton paddy $(h)^{-1}$ each.

These, just like all the smaller mills were operating far below capacity. Paddy for milling by the mills was partly produced by the owner establishments and also from individual farmers or middlewomen from far and near, who have their paddy milled for a fee. It was the insufficient amount of paddy produced by the owners and the irregularity of the clients that mainly accounted for the under-utilization of the mills.

The Grains Warehousing Co. Ltd. - a subsidiary of the Bank of Ghana installed a 1 ton of paddy $(h)^{-1}$ capacity at Tema in 1985. This mill was of United Kingdom origin and was also operating far below capacity. The company had no farms of its own and therefore had to buy all its paddy from farmers in areas, far and near to the mill. It was the absolute dependance on other farmers, inadequate funds for purchases at the peak, seasons coupled with poor storage conditions (paddy was kept in the open and covered with tapaulin that accounted for the below capacity production.

Due to the relative newness of these mills, the acquisition of spare parts had not become a problem. Parts supplied by the manufacturer together with the equipment were not yet exhausted.

Staffing and organisation at the mills were markedly different as the mill operator and attendants worked under the supervision of senior management personel. A fairly good attempt was also made at record keeping at these mills. However, apart from the Kpong farms of VRA which gave its mill operating staff some technical training, operating staff at all the other larger mills had also acquired experience on-the-job. While the Ghana-Korea Saemaul Farms Mills used deisel, electricity was the source of power for the other mills

These mills were fitted with cleaners and an appreciable degree of cleaning of the paddy to remove dust, metal pieces, stones and other foriegn matter was done prior to milling. Kpong Farms, and the Ghana-Korea Saemaul Farm had installed mechanical driers to reduce the moisture content of the paddy to the required 12-14% for efficient milling out-turn. Except the Grains Warehousing Co. mill, paddy separators were fitted on the other mills to increase the whole-grain yield and to improve the quality of the bran. Although grading sieves accompained these mills it was only at Kpong Farms that grading was done and 2 grades of rice apart from grits, were put on the market for sale.

The mills under discussion had no parboiling facilities and only white rice was produced. However, some already parboiled rice was sometimes sent from the Northern Regions to Kpong Farmers to mill on request.

Of the by products of the milling process, the husk was usually burnt off. The bran was kept by the mill houses and sold as a feedstuff.

The milled grain recovery of the mills varied widely and were not different from that obtained by the smaller mills although whole grain percentages were often higher. Milled grain recovery ranged from 60% - 72%.

4.7.3 LARGE MILLS

The Crown Rice Co. Ltd mill was by far the most elaborate rice mill in the southern sector of the country. It was situated in Accra. The goverment of Ghana owned 20% shares in it and 80% shares controlled by A. Irani and M. Ashkar. It was installed in 1977 and was of West German origin. Crown Rice Mill had extensive parboiling facilities - the only one of its kind in the south of the country. It had an installed capacity of 2 tons paddy $(h)^{-1}$.

Due to the inadequate supply of paddy, the mill had not operated above 10% capacity since installation and at the time of visiting the mill in June 1988, it had not been in operation for 15 months. The econoric future of this mill was therefore very much in doubt. The mill used to mill paddy supplied by Kpong Farms, of VRA but with acquisition of a good mill by Kpong Farms, that supply was cut. As one would expect, the mill was also equipped with elaborate cleaning and paddy separator accessories.

Althouth electricity was the main source of power for the mill, the husk obtained after milling was used as fuel in the boiler house to generate steam for parboiling. The bran was sold to livestock farmers just as other mills did.

The efficiency of the parboiling done here was in doubt as the milled rice yield was only 58% as against 64 -65% for white rice. Also parboilied rice sold cheaper than white rice because of consumer preferences and low quality of paddy parboiled.

The Agricultural Development Bank and the National Investment Bank owned the Oti Rice (Co. Ltd.) Mill installed at Worawora in in the Volta Region in 1975. It also had a capacity of 2 tons paddy $(h)^{-1}$ but due to a variety of problems had not been operational for quite a while.

5. RICE QUALITY DETERMINATION

5.1 PHYSICAL QUALITY ANALYSIS:

The quality of rice is closely related to the cleanliness and quality of its milled whole kernels (Webb and Stermer, 1972). Some standards for rice quality are observed in all countries although in some, the requirement are simply that the grain should be clean and dry. In a few countries such as the USA and Italy, legislative measures have been taken to prescribe well defined grades (U.S. Dept. Agr., 1972).

In Ghana, virtually no grading of locally produced rice is done apart from the Kpong Farms of the V.R.A. which puts 2 grades of rice on the market.

The levels of brokens as well as other undesirable materials such as brown rice, red rice, unshelled paddy and husk among others are very high compared with International standards. As a result, it is not the highest quality of rice that is imported into the country. Table (16) shows a comparison of locally milled rice from various sources and some types of imported rice commonly available on the Ghanaian market.

Another major difference between imported and locally produced rice is colour. The local rice is usually unseasoned, that is, the period between harvesting and consumption is very short giving it a pleasantly white colour. As imported has been well seasoned due to the long storage period, the colour is sometimes off-white with some amount of discoloured grains (Table 16)

Despite its off-colour and flavour, the cooking quality of imported rice is prefered to local rice. According to Bhattacharya (1987), "new rice" swells poorly during cooking and gives out a thick and sticky gruel. The grains do not elongate much and they also generally split open. The cooked rice is very sticky and lumpy. These undesirable properties gradually change during storage of rice for a few months. "Old rice" swells nicely during cooking and grains elongate well and remain whole without splitting and the cooked rice is fluffy and non-sticky-qualities preferred by the Ghanaian consumer according to Oteng (1989).

TABLE 16: COMPARISON OF THE PHYSICAL QUALITY OF SOME LOCALLY PRODUCED AND IMPORTED RICE SAMPLES

RICE SAMPLE	WHOLE GRAIN(%)	BROKENS(%)	BROWN RICE(%)	RED RICE(%)	DISCOLOURED GRAINS(%)	PADDY(%)	HUSK(%)	EXTRANEOUS MATERIAL(%)
Local I	79.2	20.2	0.2	-	-	0.2	-	-
Local II	78.9	19.8	0.2	-	-	0.2	-	-
Local III	71.4	26.7	0.5	0.2	-	0.4	0.5	-
Local IV	60.9	38.2	0.6	0.2	-	0.1	-	-
Local V	59.6	39.3	0.6	0.3	-	-	-	-
Local VI	55.2	42.7	0.9	-	-	0.7	0.3	-
Local VII	52.6	46.1	0.8	0.4	-	-	-	-
Local VIII	32.4	66.9	0.5	0.1	-	-	-	-
Local IX	25.6	71.8	0.6	-	-	1.1	0.4	0.4
Chinese Rice	67.2	32.4	-	-	0.3	-	-	-
U.S. No.5	73.4	24.3	-	0.2	1.7	-	-	0.2
Thailand Grade B	92.7	5.7	-	-	1.4	-	-	-

Samples of locally milled rice were collected from O.B. Mini Rice Mill (Ashaiman), Kpong Farms (Grades A & B), Mini Rice Mills at the Asutsuare IDA station, University of Ghana ARS Mill (Kpong), Ghana-Korea Seamaul farm Mill (Asutsuare) Dunyo farms Rice Mill (Afife) Grains Warehousing Mill (Tema) and the Ghana food Distribution Corp. Mill (Afife).

5.2 PROXIMATE ANALYSIS

Using the Official Methods of Analysis of the Association of Official Analytical chemists (AOAC), 12th Edition (1975), proximate and other analysis were carried out on 5 samples of locally produced rice and their milling fractions (Table 17)

The composition and properties of rice and its fractions are subject to varietal and environmental variability. Comparing the results in Table (17) to those of previous workers some of which are listed below, one could conclude that the nutritional qualities of local and foriegn produced rice do not differ appreciably.

The concentration of protein, fat, ash as well as the minerals analysed for (calcium, iron and phosphorus) was very high in the rice bran. This decreased progressively as one moved from the bran to the brown rice then to the binlids and white rice. This confirmed the general assertion that the bulk of the above nutrients are to be found in the aleurone layer and the germ which come out in the bran after milling.

Citing the commpositional data compiled by Kik and Williams (1945). Mc Call et al (1951), the Nutritional properties of rice by Houston and Kohler (1970) and his own summary of physidchemical data of rice of (1966), Juliano (1972) attributed the wide ranges in values reported largely to the inherent variability of rice and to the differences in analytical techniques used by different investigators. Another reason for the wide variation in the composition reported for each milling fraction is the difficulty of milling equally rice samples that differ in grain hardness, size and shape and number of cell layers of the aleurone.

TABLE 17: PROXIMATE ANALYSIS OF SOME SAMPLES OF LOCALLY PRODUCED RICE AND MILLING FRACTIONS (ON DRY BASIS)

FRACTION	% DRY MATTER	% PROTEIN	% FAT	% ASH	MINERALS (Mg/100G)		
					Ca	Fe	P
Paddy	87.8 - 88.4	7.6 - 8.9	1.3 - 1.7	5.0 - 6.2	61.5-144.5	4.3-20.2	376.0-529.0
White Rice	86.6 - 87.8	7.5 - 10.0	0.6 - 0.9	0.3 - 0.7	41.2-69.5	1.8-7.2	156.8-291.7
Binlids	86.8 - 87.8	7.7 - 10.2	0.8 - 1.0	0.4 - 0.8	44.2-121.8	3.1-6.9	220.0-314.7
Brown Rice	87.0 - 87.9	8.2 - 10.7	2.1 - 2.5	0.9 - 1.3	50.5-126.1	6.6-18.5	457.7-908.3
Rice Bran	88.6 - 89.3	12.0 - 12.5	16.3 - 18.2	6.5 - 8.4	364.4-516.1	8.9-30.2	862.0-942.0
Husk	90.6 - 93.3	1.9 - 2.1	0.1 - 0.3	16.5 - 19.0	56.4-84.2	29.0-33.1	149.3-153.4

6. CONCLUSIONS AND RECOMMENDATIONS

It has been established by Asuming-Brempong (1989), that Ghana can only achieve a comparative advantage in rice production when a greter emphasis is placed on the small farmer who has a lower cost/ output ratio.

From this report, it is evident that the post-harvest handling practices of the small farmers leaves much to be desired and it is a major contributing factor to the poor physical quality of locally produced rice. There is an urgent need for a governmental rice policy in this country. If this policy should focus on the small farmer) as it is suggested should be, then firstly, the farmers ought to be encouraged to form strong and viable co-operative associations. Inputs and technical services could be channelled through these groupings.

The critical nature and the ultimate effect on quality of such operations as harvesting, threshing and drying ought to be brought home to the farmers through the extension services which needs strengthening and the IDA authorities where applicable. Mechanisation of harvesting would pose serious problems as individual holdings were small and in many places, varieties sown and cultivation periods were not properly synchronised. However, interested agencies like the Food Distribution Coporation, Irrigation Development Authority among others and individuals could provide Mechanical threshing, winnowing and drying services to the farmers for a fee. This would definately go a very long way towards the improvement of the quality of our rice.

In the past work by breeders of the crop has focused on the development of high yielding, disease, shattering and lodging resistance. Due to the poor post-harvest handling and the type of treatment the paddy receives in the mills, there is the need to focus breeding work on the development of crack-resistant strains. It is worth noting that such work has already begun in some rice producing Third World countries with some success.

From section 4.7, it could be noted almost all the mill operators in the areas covered by this survey had had not no training in the art of milling rice. This state of affairs could very well be the case in whole country. The consequence of having unskilled mill operators is a lot of "trail and error" in the milling process leading to the production of poor quality rice.

There is also the urgent need to encourage mill operators to form groupings through which some technical skills could be transfered to them. This could begin in the major rice producing area and eventually cover the whole country.

Standards should be set for marketable paddy and milled rice and grading should be encouraged in all mills with grading machinery. Accompanying this should be price differentials for different grades of milled rice. This calls for independent Rice Marketing Companies which would offer competitive prices to producers and make the internal rice market more efficient. Existing rice marketing groups like the Grains Warehousing Co. Ltd. and the Food Distribution Coporation should be given greater autonomy to determine prices at which they buy from producers. These companies should also be encouraged to season their milled rice through specified periods of storage before marketing.

There is also the need to monitor closely the local rice industry as against the volume of imported rice. As the quantity and quality of the local rice gradually improves, measured restrictions should be put on amounts imported as an incentive to the local industry.

It is expected that as greater attention is paid to the post-harvest handling processes and marketing draw-backs, rice with high broken percentages and low quality would find it difficult to sell on the market. Research should therefore be carried into effective ways of utilizing this sub-grade rice. Recipes for adults as well as children need to be developed in this regard.

Rice brockens could also play an important role in the development of weaning foods programmes of the Food Research Institute and the nation as a whole.

Finally it should be pointed out that plans are at foot in extending this work to cover the entire country. It is hoped that the results thereafter obtained would provide adequate background information the national rice industry to enhance planning for the future.

7. ACKNOWLEDGEMENTS

The authors wish to express their thanks to the staff of Chemical laboratory of the Analysis Division of the Institute for the tests carried out on some paddy and milling fractions samples. Special mention is also made of Mr. S.A. Tagoe who assisted during the collection of field data and his colleagues of the Processing Division of Institute who helped in the determination of the physical quality of some rice samples.

We also acknowldge the help and co-operation accorded us by the officials of the Irrigation Development Authority at their various stations, Mr. Lakis Papastavrou and staff of the Kpong Farms of V.R.A. at Akuse, Dr. J. Oteng and staff of the University of Ghana Agricultural Research Station at Kpong, the Ghana-Korea Saemaul Farms at Asutsuare as well as all the respondents interviewed during the course of this work.

Finally we would like to extend our thanks to Mrs. Beullah Delle Adadevo-Sallah who typed this script.

8. GLOSSARY OF TERMS

- Abrasive polisher (Whitener): A machine used to remove bran from brown rice, using abrasive action between the kernal and the emery stone.

- Aspiration: A process of cleaning by moving a large volume of air through a thin layer of grain, to separate particles lighter in weight than the grain.

- Aspirator: A machine used in aspiration.

- Binlids: See Brewer.

- Bran; The outer covering of rice kernel after the husk is removed.

- Bran Stablisation: Heat or other treatment given to rice bran to stop deterioration of its oil.

- Brewer(Binlids): Milled rice who sizes range from ¼ to ½ of a full grain.

- Brokens: Pieces of the rice kernel that are less than 3/4 the size of a full grain.

- Brown Rice: Rice grain obtained after removal of the husk from the paddy. Also called unpolished rice or dehusked rice.

- Carborundum: An artificial abrasive, whose hardness is about 2 - 3 times that of emery. Chemically, it is silicon carbide.

- Chalky grain: Grain which has some portion as opaque or milky white in appearance.

- Degree of Polishing/Milling: It is an indication of the amount of bran removed in the milling process.

- Dehusking /Shelling: The process of removing husk from paddy during milling

- Destoner: A machine that separates stones from grain. Usually used to separate stones of the same size as the grain.

- Discoloured Grains: Rice grains which have changed to yellowish or brownish or black colour during storage.

- Drying: The process of reducing the moisture content in the grain.

- Emery: Naturally available abrasive material used in some rice mills.

- Engelberg Huller: See Huller.

- Extraneous/Foreign Matter: Materials such as stones sand, chaff, straw or other seeds mixed with the paddy or rice.

- Friction Polisher/ Pearler: Equipment used to polish brown rice using friction between the rice grains.

- Grading: The separation of broken rice grains from unbroken rice and separation of brokens of different sizes.

- Head Rice (Whole grain): Kernels of milled rice which are 3/4 the size of full grains or longer.

- Head yield: The amount of head rice obtained when paddy is milled It is the total rice minus the brokens.

- Hull (Husk): Outer covering of the paddy grain.

- Huller: Engelberg huller - Widely used as a small capacity rice mill. Removes both husk and bran from paddy in one operation.

- Husk; See Hull.

- Immature Grains: Paddy grains which are not fully developed: usually green and thinner and lighter compared to a fully matured grain.

- Kernel: Edible portion of paddy grain.

- Milled Rice: Rice obtained from paddy after the husk and bran have been removed.

- Milling Recovery/Yield: Weight of milled or commercial rice recovered from from the original paddy. Usually expressed in percent

- Moisture Content: Amount of water in the grain. Expressed as a percent based on wet or dry matter.

- Paddy: Unhusked rice.

- Paddy Separator: Machine used to separate the mixture of paddy and brown rice obtained after shelling.

- Parboiled Rice: Rice obtained from paddy that has been soaked, steamed and then dried.

- Pearler: See Friction polisher.

- Pearling: The process of removal of bran from brown rice. A number of terms like scouring and whitening are used to refer to it.

- Polishing: The removal of the bran particles still sticking on the surface of the rice after pearling. Very often confused with and wrongly equated to pearling or whitening.

- Raw Rice: Rice milled from paddy which has not been parboiled.

- Red Rice: Rice with any degree of redness.

- Scalping: Rough cleaning of paddy. Removal of most foreign matter prior to drying and storage.

- Scouring: See pearling.

- Sheller: Machine used to remove husk from paddy.

- Shelling: See dehusking.

- Sifter; Machine used for sieving impurities smaller or larger than paddy grain.

- Tempering: Temporarily holding the paddy between drying periods. It allows the moisture content in the centre of the grain to diffuse to the surface and the moisture to get equalised throughout.

- White Belly: White portions in the milled rice kernel. See Chalky grain.

- Whitener: See Abrasive polisher

- Whitening: See pearling.

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FOOD RESEARCH INSTITUTE

(C.S.I.R.)

PROCESSING DIVISION

QUESTIONNAIRE OF RICE INDUSTRY

(FARMING)

JANUARY, 1989

PERSONAL DATA (PERSON IN CHARGE)

Name:.....

Age:.....

Sex:.....

Marital Status:.....

Educational Background:.....

.....

.....

.....

Any Special Skills or Professional Qualification:.....

.....

.....

.....

PERSONNEL

No. of Employees: .....

Structure of Staffing:.....

.....

.....

.....

.....

.....

(Indicat any special training for staff)

PRE-PROCESSING

FARMING - How long have you been a rice farmer? .....

- What varieties of rice do you grow? .....

.....

.....

.....

- What are the differences between the varieties? .....

.....

.....

.....

- Where do you get your seeds from?

.....

.....

.....

- At what time (s) do you plant?

.....

.....

- What other crops do you grow?

.....

.....

.....

.....

- for each crop:- is it for cash income only, mixed cash income and home use or for home use only?

CROP	CASH	CASH/HOME USE (%)	HOME USE
i).....			
ii).....			
iii).....			
iv).....			

Others:

HARVESTING

- How do you know the crop is ripe for harvesting?

.....

.....

- What is the optimum (best) harvesting time? No. of days after sowing; weather conditions; soil conditions etc.)

.....

.....

.....

- What equipment do you use in harvesting?

.....

.....

- Do harvesting equipment sometimes get stuck in the soil?

Yes/No

- How many days is usually spent in harvesting a ripe field (indicate size of field. . .....

- Are the number of days spent in harvesting longer than expected?

Yes/No

- Any reasons for this?

.....

.....

.....

- Do you sometimes have to add paddy which is drier with another for milling? Yes/No.

- Why?

.....

.....

.....

- Are there incidences of shattering (opening of the husks for the seeds to drop out) at harvesting? Yes/No

- What do you think causes this?

.....

.....

- Any incidences of lodging (plants falling on their sides) at harvesting? Yes/No

Others

.....

.....

.....

.....

FIELD CURING (This is the drying of the rice before threshing)

- Do you do this? Yes/No
- If so, Why do you do it?

.....

.....

.....

- How do you do it?

.....

.....

- Is part or all of the harvest sold directly to creditors or middlemen Yes/No

PART/A LL

- Is part of harvest given to the landlord? Yes/No

Others

.....

.....

.....

THRESHING

Threshing involves separating the grain from panicles but not removing the husk.

- What are the methods used.

.....

.....

.....

- What problems do you face during threshing?

....

.....

.....

.....

- Threshing (kg/hr)

....

Others

....

DRYING AFTER THRESHING

- Is this done? Yes/No

- Why?

.....

.....

.....

- What methods are used?

....

.....

.....

.....

Others

.....

.....

.....

- Do you save some of the seeds for the next planting season? Yes/No

- Are these (seeds) set apart in different storage areas or containers? Yes/No

- Are any special treatments given to the seed grains? Yes/No

- If yes, what is the treatment?

.....

.....

.....

Others

.....

.....

.....

- COOPERATIVE SOCIETIES/ASSOCIATIONS

- Are you a member of any association or society for rice growers/millers? Yes/No

- Name of such a group/s if yes .....

.....

- How long (yrs.) have you been a member .....

W hat benefits do you get for being a member of the group/s?

.....

.....

.....

Any other information

.....

.....

.....

FINANCIAL SUPPORT

What are your sources for financing your operations?

.....

.....

.....

How is the support provided? Credit facilities etc.

.....

.....

.....

TECHNICAL SUPPORT (Maintenance, repairs, operations etc.)

- Do you have any problems of technical nature? .....

.....

.....

- Are you able to handle these yourself? Yes/No

- If not, what local or external agencies provide technical assistance to your establishment?

.....

.....

- Name the agency and indicate the type of assistance.

.....

.....

.....

- Is the assistance on regular basis or it is requested for as and when it is needed?

.....

.....

- How often is such assistance provided?

.....

Others:

.....

.....

.....

.....

FOOD RESEARCH INSTITUTE

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PROCESSING DIVISION

QUESTIONNAIRE ON RICE INDUSTRY

(MILLING)

JANUARY, 1989.

PERSONAL DATA (PERSON IN CHARGE)

Name:.....

Age:.....

Sex:.....

Marital Status:.....

Educational Background:.....

.....

.....

.....

Any Special Skills or Professional Qualification:.....

.....

.....

.....

PERSONNEL

No. of Employees: .....

Structure of Staffing:.....

.....

.....

.....

.....

.....

(Indicate any special training for staff)

MILLS AND MILLING

- Location of the Mill

  .....

- Name of Mill: .....

- Shareholders/owners(s) of mill

  .....

  .....

  .....

- Year of installation (Age) of Mill .....

- Source (country of origin) of equipment: .....

  .....

- How easily do you obtain spare parts?

  .....

  .....

- Have you done any major equipment replacement since installation?

  .....

  .....

  .....

  .....

- What is the installed capacity of the mill? .....

- At what capacity is the mill operating?.....

- Why is the mill not operating at 100% capacity? (if not)

  .....

  .....

- Source(s) of paddy?

  .....

  .....

- How reliable are the sources?

  *Very reliable/fairly reliable/not reliable

- Where is the paddy grown

  *Same area as mill/elsewhere

- What clients use milled product for?

  * Sale/consumption

- How do clients get paaddy? *They are farmers/They buy from other sources.

- How much do you charge per unit weight of paddy?.....

- Does milling go on all year round?..... Yes/No

- If not, when does milling take place?

  .....

  .....

- Is this a rice eating area or the market is outside?

  .....

  .....

  Others

  .....

  .....

  .....

PROCESS OF MILLING

- Removal of foreign matter

- Do you clean the paddy before milling? Yes/No

- What type of foreign matter is removed?

  .....

  .....

- How do you do the cleaning? .....

  .....

- What equipment are used for this cleaning operation?

  .....

  .....

  .....

  .....

- Other Milling Steps

- Unit processes:- pieces of equipment and machinery and what each one does.

- What happens to the rice husk?

  * kept by miller/taken away by customers

- What do you/customers use the husk for:

  .....

  .....

  .....

- What are the sources of power for your mill?

  .....

  .....

  .....

--How much rice have you milled each year in the past years?

  .....

  .....

  .....

What is the persentage (%) yield of milled of milled rice? ie how milled rice do you get from 10kg of paady?

  .....

  .....

- Is any form of grading of milled rice done? Yes/No
- Do all customers want white rice or some want it not-sowhite?

.....

.....

- What are the problems you usually encounter?

.....

.....

.....

.....

- Others:

.....

.....

.....

PARBOILING

- Do you have any equipment for parboiling? Yes/No
- If not, do you have any plans of purchasing one? Yes/No
- Do you produce parboiled rice Yes/No
- Who does the parboiling? Customers/Miller
- What procedure do you adopt in parboiling?

- How do you dry after parboiling?

.....

.....

.....

.....

- What is the milling yield of parboiled rice? ie. How many kgs. of parboiled rice do you get from 10kg of paddy?

.....

.....

- How acceptable is parboiled rice on the market.

* very acceptable/fairly acceptable/not acceptable

- What is the market price of parboiled rice (compared to raw rice)

.....

....

.....

- How well does parboiled rice keep (compared to raw rice)

.....

.....

111
222.....

- Are there any problems associated with parboiling in particular?

.....

.....

.....

.....

COOPERATIVE SOCIATIES/ASSOCIATIONS

- Are you a member of any association or socity for rice growers/ millers? Yes/No

- Name of such a group/s if yes

.....

.....

- How long (yrs.) have you been a member .....

What benefits do you get for being a member of the group/s?

.....

.....

Any other information

.....

.....

.....

FINANCIAL SUPPORT

What are your sources for financing your operations?

.....

.....

.....

How is the support provided? Credit facilities etc.

.....

.....

.....

TECHNICAL SUPPORT (Maintenance, repairs, operations etc.)

- Do you have any problems of technical nature? .....

.....

.....

- Are you able to handle these yourself? Yes/No

- If not, what local or external agencies provide technical assistance to your establishment?

.....

.....

- Name the agency and indicate the type of assistance.

.....

.....

.....

- Is the assistance on regular basis or it is requested for as and when it is needed?

.....

.....

- How often is such assistance provided?

.....

Others

.....

.....

.....

.....

FOOD RESEARCH INSTITUTE

(C.S.I.R.)

PROCESSING DIVISION

QUESTIONNAIRE ON RICE INDUSTRY

(MARKETING)

JANUARY, 1989

PERSONAL DATA (PERSON IN CHARGE)

Name: .....

Age: .....

Sex: .....

Marital Status: .....

Educational Background: .....

½.....

.....

.....

Occupations engaged in/special skills or Professional Qualification:

.....

.....

.....

PERSONNEL

No. Of Employees: .....

Structure of Staffing:.....

.....

.....

.....

.....

.....

(Indicate any special training for staff)

- From where is the paddy obtained?

.....

.....

- Quantity f of paddy per trip.

- Frequency of trips.

- Do you sell the paddy to others? Yes/No

- If yes, who are they and how reliable are they?

.....

.....

.....

.....

- What treatment is given to the paddy before storage?

.....

.....

S STORAGE

- Where is the paddy stored before milling?

.....

.....

- Are the different varieties stored separately? Yes/No

- How long is this storage period (maximum and minimum times)

.....

.....

- What treatment is given to the paddy in storage?

....

.....

Price of paddy: 1987 -

1988 -

1989 -

- How and to whom is the milled rice sold?

.....

.....

.....

.....

- How long is the milled rice kept before sale (maximum and minimum times)

.....

.....

Price of milled rice: 1987 -

1988 -

1989 -

Cost of milling paddy. 1988 -

1988 -

1989,-

COOPERATIVE SOCIETIES/ASSOCIATIONS

- Are you a member of any association or society for rice growers/millers? Yes/No

- Name of such a group/s if yes

.....

....

- How long (yrs.) have you been a member .....

- What benefits do you get for being a member of the group/s?

.....

.....

.....

Any other information

.....

.....

.....

FINANCIAL SUPPORT

- What are you sources for financing your operations?

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.....

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.....

- How is the support provided? Credit facilities etc.

.....

.....

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Others:

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