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IMPROVING THE COMPETITIVENESS AND MARKETABILITY OF LOCALLY-PRODUCED RICE IN GHANA

DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID)

CROP POST HARVEST PROGRAMME

PROJECT R6688

3. An Assessment of Rice Post-Harvest Systems

3.1 – Post Harvest Practices

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EXECUTIVE SUMMARY

This study confirmed that rice post harvest operations are broadly similar across the three rice production systems in Ghana although there are minor regional differences. In the irrigated schemes in the south, farmers harvest by hand and thresh the paddy in the field. After drying, the crop is bagged for storage, or, more commonly for immediate sale either to small-scale traders or to larger traders, either direct, or through a farmers' association. The majority of small-medium mills are of the Engelberg huller type and of variable quality, but there are sophisticated machinery, including de-stoners prior to milling and a whitener after milling, produce a better quality rice than the small local mills.

Both men and women participate in the post-harvest handling of rice. Generally, men are responsible for harvesting, threshing and storage and women are responsible for cleaning (winnowing) and parboiling. In Upper West region women play a more important role in harvesting, although men alone are responsible for threshing. In Northern and Upper East regions and in at least one irrigated scheme in the south (Asutsuare in Greater Accra region), threshing is mainly carried out by women.

Threshing of paddy is usually carried out manually by teams of family, communal or hired casual labour. Various threshing machines have been field tested in different parts of Ghana over the years but to date none has been widely adopted. In the inland valley systems, paddy is usually threshed by beating panicles with sticks on bare earth floors, thus contamination with soil particles and stones is common. This can lead to damage to milling machinery and to presence of stones in milled rice. Concrete threshing floors are often provided in the irrigated rice schemes and so contamination with soil and stones should be less of a problem in paddy from these areas.

Generally, drying poses no particular problem for farmers in the Northern region of Ghana. Paddy is usually very dry at harvest. The main season rice and non-irrigated rice, harvested in December when the humidity is very low, may be too dry, with moisture contents of 12% or below. In Upper East and Upper West regions the majority of farmers sun-dry their paddy, wither on the flat roofs of their houses or on beaten earth floors in the compounds, but again, drying is not a particular problem.

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1 INTRODUCTION

1.1 Background

Rice is becoming an increasingly important staple in Ghana due to urbanisation, increasing incomes and a growing preference for convenience foods. In 1996 the per capita annual consumption was estimated at 19-20 kg. Although rice is one of the four main cereals grown in Ghana, with an estimated total area under rice cultivation as 100,000 ha (Ministry of Agriculture 1995), it only accounts for 8% of the total cultivated area. Estimates of total annual production vary considerably, ranging from 80,000 to 200,000 tonnes (FAO).

In a recent study of Marketing of Rice in Ghana, Day (1997) observed that farm-gate prices were consistent within any one area and that there was little incentive for farmers to improve their practices as there was no price differential for better quality local rice. Farmers did not experience any difficulty in selling all of their paddy although in the markets local rice is often considered to be of inferior quality.

In the 1980s imported rice accounted for about one-third of total consumption. Half of this was in the form of food aid (Timmins 1991). However, with the advent of the structural adjustment programme and the complete liberalisation of the market, rice imports have increased steadily. In 1996 imports were estimated at about 170,000 tonnes. Currently more than 50% of the rice consumed is imported. Imported rice is perceived to be of a higher quality and consequently commands a higher market price.

For the local rice industry to be able to survive, it has been suggested that it must be able to compete with imported rice on the liberalised Ghanaian market. Quality issues are therefore of fundamental importance to the future of the Ghanaian rice industry. Since the quality of any processed product is limited by the quality of the raw materials, it is important to look at the entire production chain to see where quality is being compromised.

1.2 Study objectives

This study on the post production practices affecting quality is part of the second phase of a DFID - funded project to investigate the factors responsible for the poor marketability of locally produced rice in Ghana compared with imported rice.

The study examined the rice post production systems in northern Ghana with the aim of:

- identifying the practices which contribute to eventual low quality of the product.
- assessing the quality of samples at various stages of the post production chain.
- identifying appropriate interventions needed for improvement of the system and enhancing the quality of the product.

1.3 Study area

The study was carried out in the three leading rice growing regions of Ghana, Upper West, Upper East and Northern Region. In 1995 the area under rice production in these three regions was reported to be 58,800 ha, 59% of the total production area.

Upper West

In the Upper West Region, rice cultivation is almost entirely rainfed, crops are, therefore, completely dependent on prevailing weather conditions and it is only possible to produce one crop of rice a year. The Ministry of Food and Agriculture (MOFA) has a Farmers' Support Programme (The Low Risk Rice Project) in the region through which the farmers are provided with land preparation services, seeds and in certain cases, fertiliser. The cost of these inputs are recovered from the farmers after the harvest. Technical Officers on these projects provide technical advice to the farmers. The main survey areas in this region were around the towns of Wa, Jirapa and Loggu.

Upper East

The main areas surveyed in the Upper East Region were around Navrongo and Tono. In Navrongo, rainfed cultivation of rice is carried out in some surrounding valleys along the same lines as the MOFA support programme in the Upper West region described above.

Tono is the Head Office of the Irrigation Company of the Upper Regions (ICOUR). ICOUR was established to promote the production of food crops by small scale farmers within organised and managed irrigation schemes. The company is funded by the Ghana Government and is currently operating projects at Tono and Vea. About six thousand families living on the periphery of the project are organised into committees of 10 to 15 farmers each. The executives of these committees form the link between the farmers and the company.

Over 2,400 ha. (6,000 acres) of irrigated land is available for cultivation at Tono. Originally 927 ha. of the total area was allocated to rice cultivation while 1,500 ha was under other crops, such as vegetables. Due to the dwindling amount of water in the dam the area actually cultivated has decreased over the years. In the wet season of 1997, 400 ha was put under rice and during the dry season of the same year, this was reduced to 300 ha.

ICOUR has large grain storage capacity consisting of an 8 unit silo with a batch capacity of 200t per unit. At the time of the survey all silos were empty apart from a few bags of milled rice. The company also has a Satake rice mill with a capacity of 1t/hr bought with a Japanese grant. In addition to the paddy levied from farmers the company may purchase additional paddy from the farmers at the beginning of the season. However the mill is currently under utilised due to lack of capital to purchase paddy (Manful et al.1998).

Northern region

In the Northern Region farmers from Naha, Gaa and Bontanga were interviewed. The Naha (Tamale District) farmers were small farmers who cultivated rice in surrounding

lowland valleys which flood during the rainy season.

The Gaa (Gushiegu-Karaga District) provides the best opportunity for large scale rice farming in the region. The large flood plains of streams are utilised for rice cultivation during the rainy season. As the farms are larger, tractors and combine harvesters are utilised in this area.

Bontanga (Tolon-Kumbungu District) is the site of an irrigated rice project of the Ghana Irrigation Development Authority (GIDA) of MOFA. At Bontanga, the Bontase river has been dammed to irrigate an area of 480 ha (1200 ac). About half of this area, 240 ha (600 ac) is usually cropped with rice with the rest used for the production of vegetables and other cereal crops.

Rice farming at Bontanga is at its peak during the dry season (February to June). Between 450 and 600 farmers from 32 surrounding villages benefit from the project. During the wet season (June to November), most local farmers prefer to cultivate their traditional farms. During this time, GIDA reallocates plots on a temporary basis to anyone wishing to farm there. This practice, though inevitable, is thought to have hampered the development of the estate.

2 RESEARCH METHODOLOGY

Information was gathered by means of a formal questionnaire, pre-tested in the survey areas and modified accordingly. Information about social factors and preharvest and agronomic practices was collected in order to gain an insight into the scale and level of sophistication of the farming process (see survey data at Appendix 1).

Rice samples were taken in the field at the following points in the production chain:

- Paddy taken directly from the panicles at harvest,
- Paddy sampled during the threshing process,
- Paddy which had been winnowed and, in some cases dried, and ready for sale or processing.

Samples were also taken during processing operations as follows:

- Paddy after parboiling
- Milled rice direct from the mill
- Milled rice prior to marketing

The moisture content of each sample was taken using a Kett Moisture Meter. This instrument measures moisture content in the range of 11.0 - 30.0%. Any field sample with a moisture content higher than 14% was carefully shade dried to prevent deterioration.

All paddy samples were visually examined for contamination with stones and weed seeds and then dehusked by a double pass through a Satake (THU 34A) laboratory Rubber Roll Dehusker. The brown rice was then examined for the presence of immature (green), chalky, mouldy and red grains. The brown rice samples were test milled using a Satake (BS08A) laboratory single pass friction mill. The degree of whiteness was set to between 'low' and 'medium' on the equipment. The yield of both brown and milled rice as well as the percentage broken grain was also determined. In the case of milled rice samples, quality attributes including levels of brokens, foreign matter, red rice and damaged grain were measured.

The milling and parboiling sectors of the rice processing chain in these regions were examined under a separate technoeconomic survey (Manful et al., op.cit). Where appropriate, additional data obtained from that survey has been utilised in this report.

3. RESULTS

3.1 Social factors

The majority of farmers in all regions were married men, over 30 years old, only two women (widows) farmed in their own right. In the Upper West and Northern regions few farmers had any formal education. In the Upper East most had received a formal education.(Table 1)

Table 2. Average Number of Full Time Employees Per Farm

	Upper West	Upper East	Northern
Average	5.1	2.9	5.1
Range	(1-12)	(1-10)	(1-18)

Planting times, as expected, varied slightly from region to region but were consistent within regions. In areas where cultivation was rainfed, the planting time depended on the state of flooding of the inland valleys where rice was cultivated. Most planting in the Northern Region was carried out between mid June and early July while in the Upper East Region, planting started in mid July through mid August. In the Upper West Region, planting was done between June and July in most places. At the irrigation estates of Tono and Bontanga some farmers produced two crops a year, planting in August/September and again in January/February.

Most farmers were aware that they should be using more fertiliser, herbicide etc but could not afford the increased costs involved. On the Tono irrigation scheme the average yield of rice was between 3.2 and 3.5 t/ha in 1996. This represents a progressive decline from yields of 4.2 to 5.1 t/ha in 1990/91. The main reason given for this situation was a marked reduction in the use of herbicides and fertiliser due to high costs. The recommended fertiliser application rates per hectare were 7 x 50 kg bags of compound fertiliser costing ¢280,000 and 4 x 50 kg bags of ammonia fertiliser costing ¢108,000.

Similarly at Bontanga the application of fertiliser used to be a requirement of the project management, however its use has now virtually ceased, due to high costs, with a resultant decline in yields.

3.2.1 Acreages

The number of acres cultivated by a farmer varied widely. The average holdings on the irrigated projects at Tono and Bontanga were small (1.0 and 2.5 acres respectively). On the open fields however the number of acres cultivated was much

higher ranging from 5 acres to as much as 300 acres for large scale fully mechanised commercial seed growers.

3.2.2 Varieties

A wide range of varieties, both traditional and introduced, were cultivated in the three regions (Table 3). The major varieties grown in the Northern Region included GR 18 (Afife), GR 19, GR UG 7 and an unspecified TOX line which are all improved varieties, bred in Ghana. In the Upper East Region IR 18, Abidjan, GR 18 (Afife), GR 19, IR 442, TOX and an unspecified Thai variety were predominant. IR 8 and IR 5 were also grown by some farmers in the region. A few exotic varieties were being tried by the agronomists at ICOUR for possible introduction to farmers in the near future. In the Upper West Region, fewer varieties were grown and farmers were often unaware of the variety, simply identifying it as "local" or "improved".

While the improved varieties were early maturing, higher yielding and in most cases shorter, the indigenous ones matured over longer periods and were considered to be more drought and disease resistant and also competed better with weeds, though they were reported to be more prone to lodging.

Table 3. Varieties of Rice Grown

Northern	Upper West	Upper East
Afife	Local	Afife
Farro 15	Improved	IR 8
GR 19	IR 16	Abidjan
Mandee	Mandee	Manbrano
Bontanga	Indian	TOX 3108
Adny		Thailand
TOX 18447		TOX 442
Indonesia		GR 18
Dekuku		GR 19
GRUG 18		IR 442
GRUG 7		IR 5
Local		IR 8
Ugaga		BW
Kukpla		

As shown in Table 4, farmers obtained their seeds from a number of sources. On the irrigation estates a majority of the farmers obtained their seeds from either the IDA or ICOUR. The Ministry of Food and Agriculture (MOFA) supplied seed, mainly GR 18 grown by selected seed growers, to farmers on their Low Risk Rice Projects. In all regions fellow farmers and local markets were reported to be an important source of seed.

Table 4. Farmers' Source of Seeds

Northern	Upper West	Upper East
Other farmers	MOFA	GIDA
GIDA	Local market	Other farmers
Ghana Seed Company	Other farmers	ICOUR
MOFA		Local market
Local market		MOFA

3.2.3 Other Crops

All the rice farmers surveyed cultivated other crops (Table 5). In all three regions rice is considered to be a cash crop with 81%, 64% and 61% of the harvested rice being sold in the Northern, Upper East and Upper West regions respectively. Other cash crops included soybeans, cotton, groundnuts and vegetables. Maize, yam, sorghum, millet and cowpeas were the major staples grown, though farmers also sold a proportion of these crops.

Table 5. Other Crops Grown by Rice Farmers in order of Prominence

Northern	Upper West	Upper East
Maize	Maize	Maize
Yam	Sorghum	Groundnuts
Sorghum	Yam	Soybean
Cowpea	Groundnuts	Millet
Groundnuts	Millet	Tomatoes
Cassava	Cowpea	Cowpea

Millet	Bambara beans	Sorghum
Soybean	Cassava	Okro
Onions	Okro	Pepper
Pepper	Pepper	
Tomatoes	Other legumes	
Cotton		
Okro		

3.3 Harvesting

Most farmers interviewed indicated that they considered a rice field mature when panicles were brownish and drooping. The farmers also stated that once a field was mature, arrangements were immediately made for harvesting, though labour was not always available when required. However, it was observed that whilst this may be true for the farmers on the Tono Irrigation Project, in most other areas the fields over dried before harvesting.

At the Bontanga irrigation sites it was possible in most cases for the fields to be drained of water to facilitate harvesting. In cases where the fields were not properly levelled prior to seeding , effective draining was impossible and farmers therefore had to walk through muddy and swampy fields to do the harvesting. At the Tono site the majority of the fields observed were not drained effectively, the stems of the plants were still submerged in water during harvesting . In this region, the recorded moisture contents at harvest ranged between 19 and 25.3% (Table 6).

On rainfed sites, the fields were left to dry naturally before harvesting was done. In extreme cases where water collected in parts of a field for an unusually long time, harvesting was carried out in swampy conditions. On the large out-field farms, soil condition was said to be the main determining factor of time for harvesting. This was because combines were used in harvesting and the soil must to be firm enough to prevent the equipment from getting stuck in the field. However, the real time of harvesting was determined by the availability of combines to a particular farmer.

There is an acute shortage of combines (which are, in most cases, rented) in the area and by the time most farms were harvested, they were over-dried, with all samples recording moisture contents below 14%

Table 6. Moisture content at harvest (%m/m)

Northern	Upper West	Upper East
12.27%	11.73%	22.18
(11.1-13.7)	(10.0 -15.7)	(19-25.3)

Means and (ranges)

Most of the small scale farmers harvested their rice manually, this task was usually carried out by women and children. The knife and the sickle were the main tools used. While the sickle was the exclusive harvesting tool on small farms in the Northern Region, the knife was preferred in the Upper West. In this region the rice was often harvested panicle by panicle as opposed to the cutting of an entire field as observed in the other regions. In the Upper East Region, both knife and sickle were being used side by side. A mechanical harvester of Japanese origin (Kubota) had been introduced on the irrigated field of the Northern Region and was reported to be gaining in popularity, though availability was a problem. On the large scale open fields in the Northern Region, the use of combine harvesters was predominant (Table 7).

Table 7. Tools Used in Harvesting

Region	Combine Harvester	Sickle	Knife	Kubota Harvester
Upper West	-	14.3%	85.7%	-
Upper East	4.6%	59.0%	36.4%	-
Northern	22.2%	70.0%	-	7.8%

The time taken to harvest a unit area of paddy depended on the type of equipment used. With the combines, between 6 and 10 acres could be harvested in a day depending on the age and condition of the equipment. The mechanical harvester (Kubota), can harvest between 1 and 2 acres per day. The number of days spent in

harvesting an acre manually varied considerably. Labour was provided mainly by family members and casuals were engaged as a supplement when required. Depending on the number of hands available, the time taken to harvest one acre was reported to be from 1 to 7 days.

As a result of the length of time spent in harvesting and the delayed harvesting times, shattering and lodging were reported on most of the paddy fields. On the irrigated fields and some other areas where harvesting had to be done in muddy conditions, the farmers reported that leeches in the mud were a problem as they had no protective footwear.

After harvesting, the women carried the paddy from the fields to the threshing site. The headloads are extremely heavy, particularly when the paddy is wet and the women may have to carry the load for up to 1km (see photographs at Appendix 2)

3.4 Threshing

Field curing was not carried out. In a few instances it was observed that the harvested rice stalks were piled up in heaps prior to threshing. However this practice was due to unavailability of labour or machinery rather than as an ageing/maturation process. Threshing was carried out manually on all of the small farms. A mechanical thresher had been introduced onto the irrigation site at Tono but was not popular due to cost, erratic availability and reported slowness in operation.

On the irrigated estates of Tono and Bontanga, concrete threshing floors were available. However, the number of such floors was very few and only in close proximity to a very limited number of fields. The majority of farmers did not use them, preferring to thresh at a site close to the crop to save time and effort. A few farmers at Bontanga used tarpaulins but these were not popular due to the high purchase cost

Manual threshing was mainly carried out by women, often helped by children. The women reported that the task was very arduous and often caused arm and back pain.

In the Northern and Upper East regions the rice stalks were spread on clay floors, usually on the track near the fields and beaten with sticks until the paddy was separated from the straw. These threshing floors were not specially prepared other than being swept to remove loose dust and stones. In the Northern region threshing areas were sometimes a shallow dug-out area to try to prevent scattering. In the Upper West the crop was harvested by panicle. These were often transported to a firm threshing floor, either a concrete base or a flat outcrop of natural rock.(see photographs at Appendix 2).

After threshing, the paddy was winnowed by throwing the grains against the wind. In some cases the winnowed paddy was sun dried before bagging. However it was more usual for it to be bagged and transported to the farmer's home either by head load, bicycle or farm vehicles, where available. The paddy was then stored or further dried depending on the moisture content, which was judged by experience. Some farmers reported that they had concrete floors at home for subsequent drying but the majority again used clay floors.

Table 8. Threshing Methods Used by Farmers

Method	Northern	Upper East	Upper West
Combine	23.1%	4.5%	-
Sticks on clay floor	46.2%	81.9%	35.7%
Sticks on tarpaulin	3.8%	-	-
Tractor on clay floor	11.5%	-	-
Sticks on concrete floor	15.4%	13.6%	21.4%
Sticks on rocky floor	-	-	42.9%

The main problems considered to be associated with threshing were the contamination with stones and physical losses due to scattering on impact. This was confirmed by a complimentary study on Post Production Losses (Olosu and Boxall, 1998). In the Northern region paddy breakage due to the mechanical action of combine harvesters was considered to be a serious quality problem

3.5 Paddy quality

3.5.1 Contamination with stones and weed seeds

As expected, paddy taken straight from the panicles was not contaminated with either stones or weed seeds. Analysis of paddy sampled after threshing and before parboiling or milling, showed that these were introduced during this first process. In the Upper East and Upper West the number of stones in samples taken from paddy ready for processing had increased from the levels found immediately after threshing. This indicates that further contamination with stones may be occurring when the paddy is dried at the farmers' homes (Table 9). Overall levels of stone contamination appeared to be lower in the Upper East, probably due to the care taken to use a stone or cement threshing site. The level of stone contamination was shown to reduce in the samples taken after parboiling, indicating that these are being removed either during the washing or drying processes. Nevertheless most samples still contained some stones at this stage which could potentially damage mills and affect consumer acceptance of the milled rice.

As would be expected, the level of weed seeds was fairly constant in both samples 2 and 3. There seemed to be little overall variation between regions, the exceptionally high figure of 14.45% weed seeds found in one sample in the Northern region was from paddy which had been combine harvested. If this sample is excluded then the mean percentage of weed seeds found in Sample 2 was 0.15% (range 0-0.78) showing that contamination in all three areas is of a similar level, at less than 0.6%. As may be expected, the quantity of weed seeds fell in Sample 4 as some were removed during the paddy washing processes.

3.5.2 Varietal admixture

Contamination with red rice was variable. Almost all samples contained some red rice, in some cases the levels were very low but other samples contained up to 25% red grains, indicating that there is considerable mixing of varieties.

Immature grains were found in almost all samples, at levels up to 13.7%. There did

not appear to be any regional variation. The parboiled samples showed a marked reduction in the amount of immature grain present, these grains were obviously being removed effectively by the parboiling processes. Very little chalky grain was found in the samples.

3.5.3 Mould damaged grain

Almost all samples contained mouldy grain. In some cases up to 6.8% of the grains were mouldy, again there did not appear to be any regional variation. The quantity of mouldy grain found in all three samples was fairly consistent indicating that mould growth had occurred in the field. However it should be noted that all samples were taken within a few weeks of harvest, any subsequent deterioration due to storage was not, therefore, detected.

Table 9 Quality of paddy

	% stones	% weed seeds	% red rice	% immature grains	% chalky grain	% mouldy grain
Sample 1 (from panicles)						
Upper West	0	0	2.74 (0.23-5.62)	1.87 (0-6.48)	0.12 (0-0.35)	2.64 (0.71-5.01)
Upper East	0	0	0.47 (0-1.88)	0	0.44 (0-0.74)	1.32 (0.54-2.7)
Northern region	0	0	1.95 (0-8.22)	0.71 (0-2.85)	0.25 (0-0.92)	3.32 (2.21-6.88)
Sample 2 (after threshing)						
Upper West	0.06 (0-0.29)	0.08 (0-0.58)	4.00 (1.1-12.9)	4.16 (0-10.54)	0	2.39 (0.36-5.64)
Upper East	0.09 (0-0.36)	0.01 (0-0.06)	3.14 (0.77-11.2)	5.45 (3.6-7.51)	0.01 (0-0.01)	3.67 (2.1-5.57)
Northern region	0.68 (0-2.47)	1.01 (0-14.15)	2.84 (0.14-6.34)	2.82 (0.09-6.35)	0.02 (0-0.2)	2.48 (0.91-4.67)
Sample 3 (before milling or parboiling)						
Upper West	0.24 (0.02-0.66)	0.04 (0-0.19)	3.17 (0.69-9.18)	3.76 (0.16-13.7)	0	1.28 (0.86-2.3)
Upper East	0.44 (0-1.81)	0.01 (0-0.08)	9.2 (0.96-21.7)	4.29 (0.13-7.5)	0	2.12 (0.87-5.27)
Northern region	0.35 (0-0.64)	0.1 (0-0.54)	10.27 (0.26-25.6)	2.28 (0-7.12)	0	1.41 (0-5.53)
Sample 4 (after parboiling)						
Upper West	0.08 (0-0.41)	0	1.86 (0-10.93)	0.35 (0-0.67)0	0	1.2 (0.1-2.15)
Upper East	0.11 (0-0.45)	0.01 (0-0.07)	3.39 (2.65-5.0)	0.59 (0-1.84)	0	2.19 (0.83-4.71)
Northern region	0.26 (0.17-0.28)	0.07 (0.01-0.17)	9.37 (0.94-17.5)	0.49 (0.07-0.67)	0	2.22 (0.51-4.14)

Mean and (range)

3.6 Parboiling

Parboiling is routinely carried out in the three northern regions. There are slight variations in the parboiling methods from each area, these are reported in the Techno Economic study (Manful et al., op. cit.). Parboiled rice from the Upper East and Upper West is of very good quality, being of a good colour and containing relatively few brokens.

Readings taken with a Minolta Chromameter (Table 10) showed that rice from the Upper West and Upper East had higher L* values, indicating whiteness. They also had higher b* reading (yellow/blue axis) which may be indicative of better milling. Corresponding milling data is not available for these samples so correlations can not be made. The increased a* value (redness) of rice from the Upper West is indicative of the proportion of red grains found in the samples.

Table 10 Average chromameter readings of parboiled rice.

Region	L*	a*	b*
Upper East	47.11	9.27	17.79
Upper West	42.37	10.22	15.07
Northern	30.88	9.83	11.24

3.7 Milling

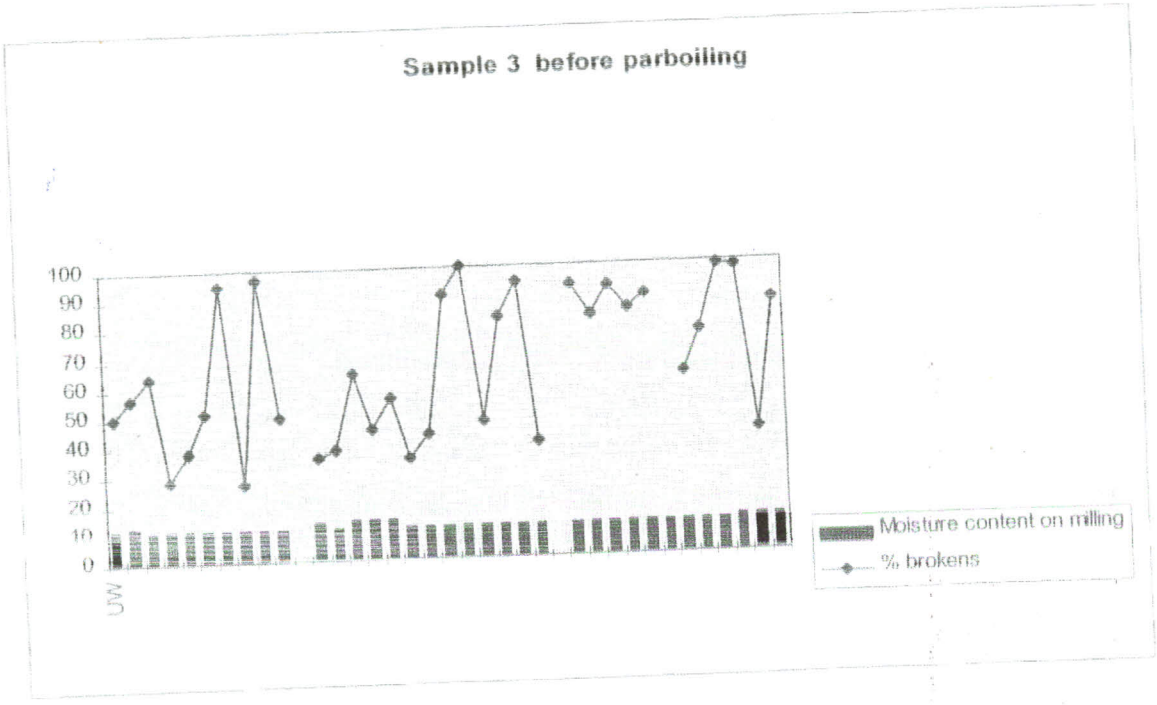
Most rice produced in these areas is milled in small-scale steel hullers, which, in general, are very poorly maintained. Millers cite stones in the grain as a major problem as they cause damage to the mills.

As with parboiling, regional variations in milling techniques exist (Manful et al., op.cit.) which affect the quality of the milled rice. . However since milling is carried out on a custom basis there is little incentive for millers to improve the quality of their outturn.

Due to the high temperatures and low humidity at harvest time paddy in all regions tends to be overdried, the moisture content of paddy before parboiling was found to be <11% in almost all cases. When these samples were test milled in the laboratory the

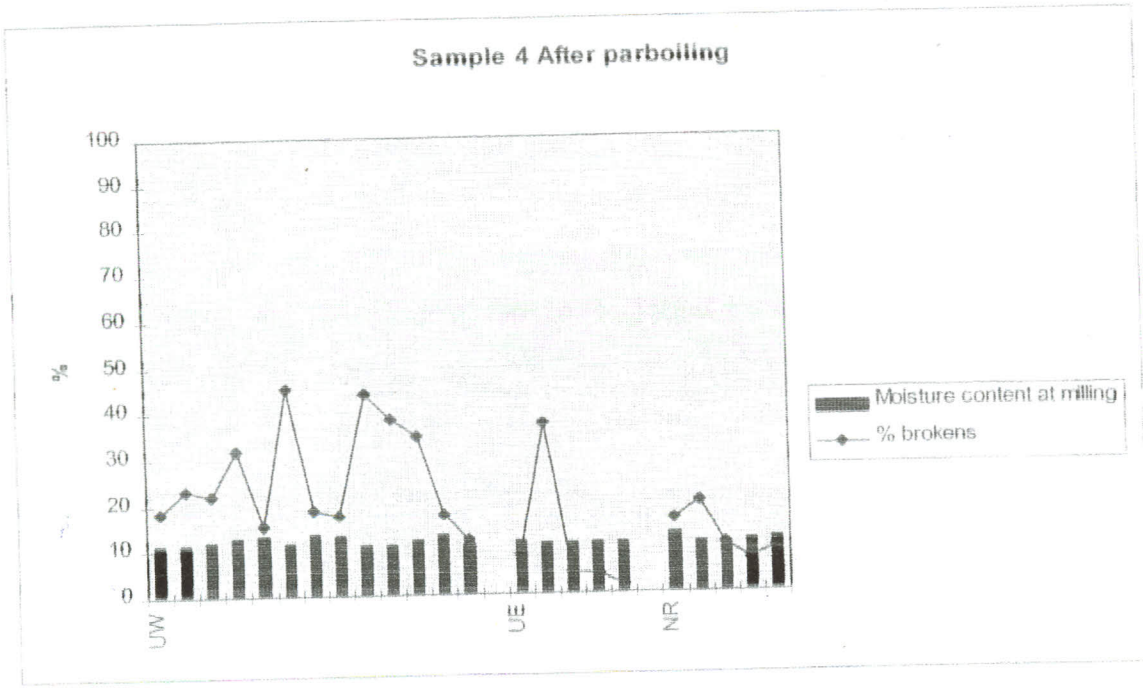
amount of broken grain produced was very high with almost all samples yielding more than 50% broken grain with many samples containing in excess of 80% brokens. Samples with a slightly increased moisture content tended to produce less brokens on milling. (Figure 1).

Figure 1. Moisture content and % brokens from paddy before parboiling.



Paddy which had been parboiled and dried (sample 4) yielded significantly less broken grain. Most samples contained less than 20% brokens (Figure 2). Samples from the Upper West had a higher average brokens content (25.9%) than the other two regions. The majority of samples of parboiled paddy from the Upper East produced fewer broken grains, however insufficient samples were collected to undertake statistical analysis.

Figure 2 Moisture content and % brokens from paddy after parboiling



3.8 Storage and Marketing

In a few isolated cases such as Gaa in the Northern Region and Loggu in the Upper West Region, the farmers had a community depot where the paddy could be stored until needed for sale. At Loggu, an 'Inventory-Credit Scheme' was operated by the farmers in conjunction with Technoserve. Under this scheme, the farmers kept their paddy in a warehouse after harvest and received an agreed percentage of the market price of the paddy at harvest time. At the peak time, the paddy was sold, the advance to the farmers as well as storage and service charges were deducted, and the balance paid to the farmers.

Most farmers stored their paddy at home, either in traditional cribs, in bags or simply heaped on floors in the farmers rooms. Although the storage conditions were far from ideal, no infestation problems were reported.

The stored paddy was sold in batches as and when the farmers needed money. The

storage periods varied according to farmers' needs. Most farmers tried to keep their paddy for between 4 to 6 months to coincide with the next planting season when prices were high but usually had to sell a large proportion soon after harvest to meet their debts. Paddy prices just like any other agricultural product, fluctuated during the year. Prices were reported to be lowest just after the harvest in December and January and highest in August and September, just before the next harvest.

The paddy was usually sold in the market of the nearest town to the farmer in the Upper East and West Regions. In the Northern Region traders, mainly women went to the farmers' houses to buy the paddy which was transported to the markets for sale.

3.9 Farmers' Associations

Farmers' Associations have existed previously in all the three northern regions surveyed. However, in some areas, the groups have collapsed due to their inability to fulfil farmers' needs. At the Tono and Bontanga irrigation projects, the groups were the main link between the farmers and the ICOUR and GIDA authorities who distributed land allocations and preparation services through the associations. In some cases extension training was also organised through the groups. In other areas groups were organised to provide communal labour for critical operations such as land preparation, planting, weed control, harvesting and threshing. The associations also served as a means of exchange and supply of planting material.

4. DISCUSSION

A number of constraints are evident in the rice production system in Ghana. Farmers are faced with many problems from land preparation through to marketing

Land for rice cultivation is generally prepared by tractor-drawn machinery. Very few farmers in the north of the country have tractors of their own and as a result have to rely on others for land preparation services. The fact that the farmers do not directly control these machines often results in untimely planting and subsequent loss of yield and quality. In many cases, the land is just ploughed and not harrowed to ensure a

good plant stand.

The soils in northern Ghana are reported to be low in fertility and for optimum returns from rice cultivation, some fertiliser application is necessary, particularly for the introduced varieties. However, due to the high cost, very few farmers apply the correct rate of fertiliser (if any) resulting in depressed yields. For the same reason, other chemicals for weed and disease control are not applied.

It is evident that a wide range of varieties is grown in northern Ghana. A significant amount of the rice grown is of indigenous varieties which compete better with weeds, but are low yielding, tall, prone to lodging and sometimes shattering. These varieties do not respond to fertiliser application. Some of the indigenous varieties have also become endemic in the soils resulting in high levels of varietal admixture.

Harvesting and threshing are critical operations. The commonest method of rice harvesting in northern Ghana is manual, with either the sickle or cutlass. This method is laborious, slow and often results in the paddy being over-dried in the field before harvest. The combine harvester is used on most of the large scale rice farms due to their extensive nature. However, costs are often high and the machines are not always available on time for the farmers to hire. Mechanised harvesting leads to a high proportion of broken paddy and weed seeds.

Although slow and laborious, manual harvesting appears to have little adverse effect on paddy quality. The main problem likely to result is the loss in quality due to over-drying in the field and consequent cracks in the grain.

Threshing is a critical operation in the processing chain. Although the physical action of beating the panicles with sticks may be expected to damage the grains this was not found to be the case. Broken paddy grains were only found in the combine harvested samples. For this reason parboilers will only used combine harvested grain as a last resort (Manful 1998, op.cit.).

The quality of paddy has a direct implication on subsequent processing operations. Stones, immature grains, damaged grains, varietal admixtures and weed seeds all have an adverse effect on processing yields and consumer acceptance of the product. For this reason many countries set basic quality standards for paddy. For example the Philippine standard for paddy rice stipulates the following maximum tolerance levels at both ends of the grade spectrum:

	Weed seeds	immature kernels	damaged kernels	red rice
Grade 1	None	None	2%	Trace
Grade 5	0.5%	10%	8%	4%

When compared to the quality of paddy recorded during this survey (Table 9) it is apparent that much of the paddy produced in northern Ghana would not comply with even the minimum quality standard required by major rice trading countries.

This study looked at rice harvesting and processing in the three northern regions, the final product was, therefore, parboiled rice. It is evident that differences exist between the parboiling and milling technologies used in each region and that these have an effect on the quality of the milled rice. These differences have been examined more closely in the techno-economic survey. The hot, dry conditions at harvest time mean that paddy is subjected to high temperatures during all drying stages and the paddy tends to be naturally dried to below 11% moisture. This is known to cause internal cracking in the grain and leads to high breakage on milling. Parboiling hardens the grain and repairs the internal cracks, milling breakage is therefore reduced.

5. CONCLUSIONS AND RECOMMENDATIONS

- Seed distribution

  The majority of the seed used by farmers is obtained through informal systems, often being purchased from a local market or neighbouring farmer. Varietal admixtures are high. In this survey almost every sample was found to contain red rice; the presence of immature grains may also be an indicator of varietal

admixture. Major rice producing countries recognise the importance of growing pure varieties to ensure optimum processing quality and eventual consumer acceptance. The introduction of an efficient seed production and distribution system would ensure that farmers had access to good quality seed, the first critical point in any agricultural system.

- Availability of inputs

  Many farmers reported that they no longer use the correct amount of inputs (fertiliser, weedkiller, fungicides etc) due to high costs which can not be met by their meagre profits. Yields on the irrigation schemes are reported to be falling and this survey has highlighted the presence of mouldy grain and weed seeds in the paddy produced. If farmers are unable to use the correct inputs, yields will continue to fall and quality is likely to be compromised. This will further reduce profits and therefore make the purchase of agrochemicals even more difficult. The introduction of a favourable credit scheme might encourage farmers to use the correct chemicals to obtain a good yield and healthy crops.

- Threshing practices

  The presence of stones in paddy causes damage to mills and if the stones are not removed from milled rice consumer acceptance and price are likely to be affected. Simple interventions in threshing practices could reduce the quantity of stones introduced into the paddy. These could include the provision of tarpaulins, the use of threshing boxes, construction of suitably sited concrete aprons or better preparation of clay threshing floors.

- Quality standards

  At present Ghana does not have any quality standards for either paddy or milled rice. There is therefore no incentive for the farmers or the millers to raise the quality of their product. The introduction of suitable standards is likely to raise quality awareness throughout the production chain, from farmer to market.

- Storage conditions / quality deterioration

This survey was carried out within a few weeks of harvest. Any implications which climate or storage may have on quality have not therefore been examined. It is recommended that a quality study should be carried out over a period of a normal storage season to examine the effect of storage on paddy quality.

- Parboiling and milling

  Due to the high temperatures experienced in the Northern regions of Ghana, the traditional parboiling technologies reduce the amount of broken grain in the milled rice. Paddy produced in these regions would be unsuitable for direct milling without prior parboiling.

  Women in the Upper East produced parboiled rice of a better colour and with less breakage than in the other two regions. Their technologies could be transferred to the other regions to raise the quality of the locally parboiled rice. Since all parboiling is carried out on a very small scale there may be opportunities to introduce more sophisticated technologies to raise the level of production to a commercial scale.

- Farmers' groups

  At present farmer's groups exist in some areas, and in places where groups do not exist, farmers should be encouraged to form them. These groups could then be utilised as a vehicle to inform and train the farmers about agronomic practices and the requirements of processors. Technical teams from internal institutions such as, the Food Research Institute and SARI could act as facilitators in thetransfer of relevant improved technologies and monitor the adoption and effect of their dissemination.

It is therefore recommended that funding be sought to address the constraints identified above. Sources of funding could be those donor agencies which have in the past supported the cereal sector of the Ghanaian economy. Within the framework of possible donor support, a GEDPRO (Ghana Enterprise Development Project) involvement could be developed. The proposed project should be development

oriented with the aim of improving the farming and post production practices which affect the quality of rice in northern Ghana.

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Threshing

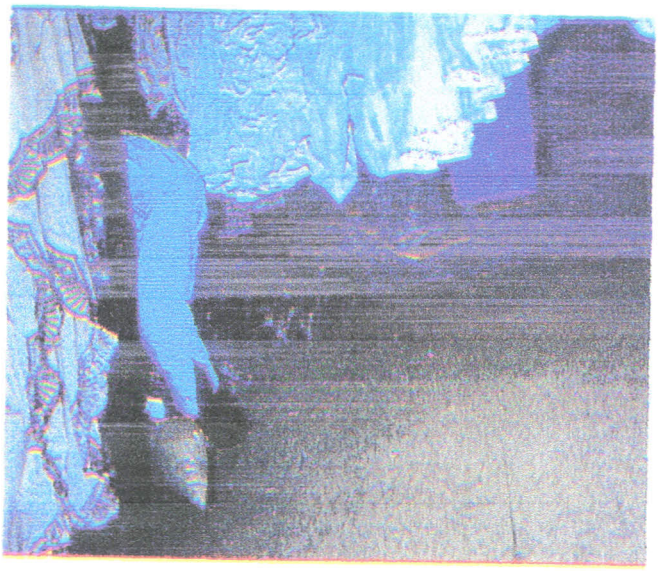
On a concrete apron (UW)

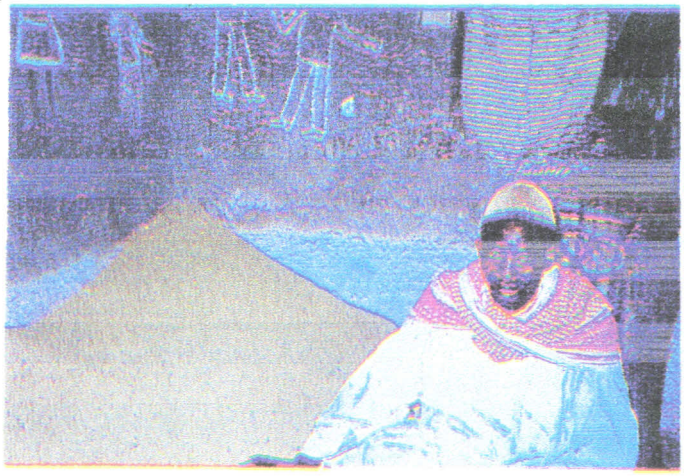
On a road (UW)

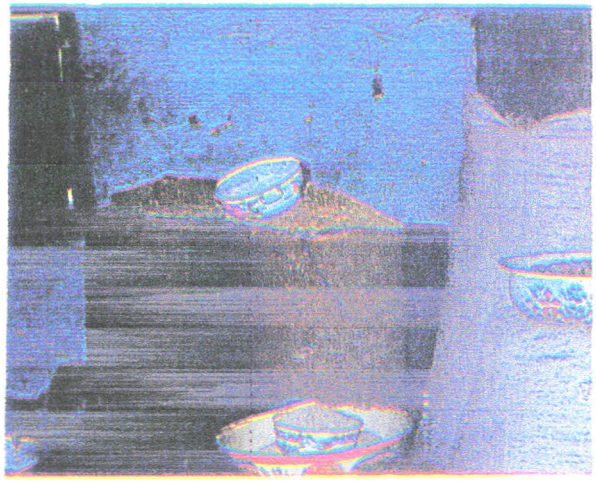
On natural rock surfaces (UE)

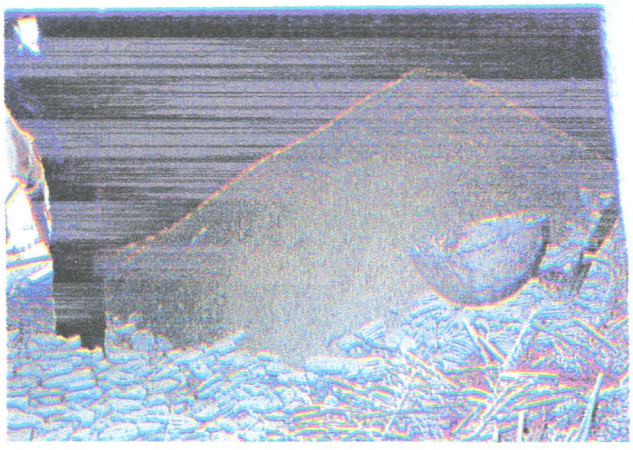
Winnowing (UW)

Storage







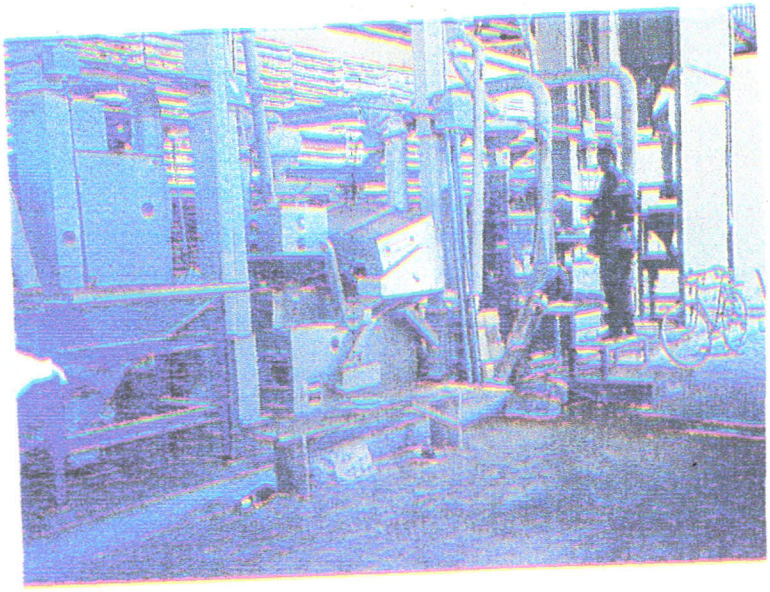


Milling systems

Hand pounding

Steel huller mill (approx. 250 kg per hour)

Single pass rubber roll mill (500kg per hour)

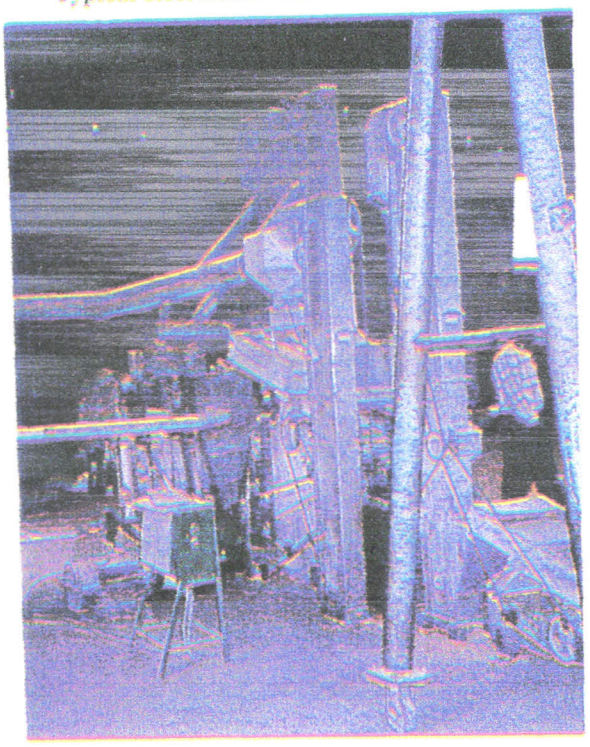


Large scale mill (1tonne per hour)

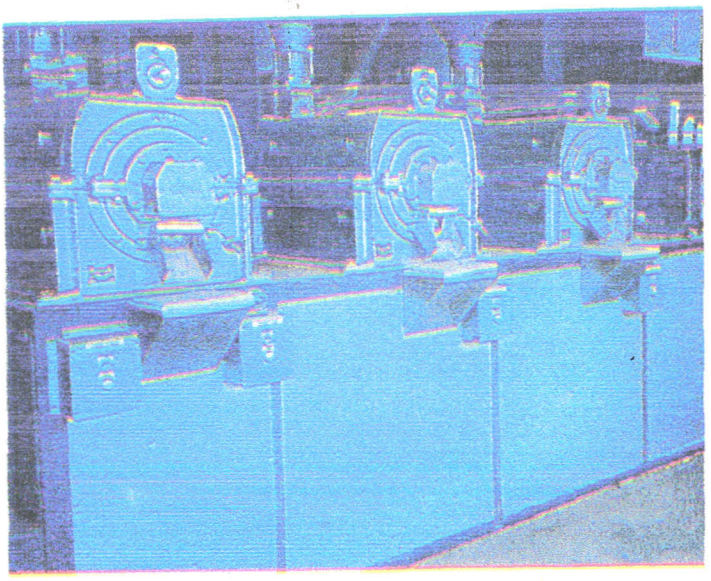
Scale of operations

Typical steel huller mill

Rubber roll mill



1 tonne per hour (Kpong farms)

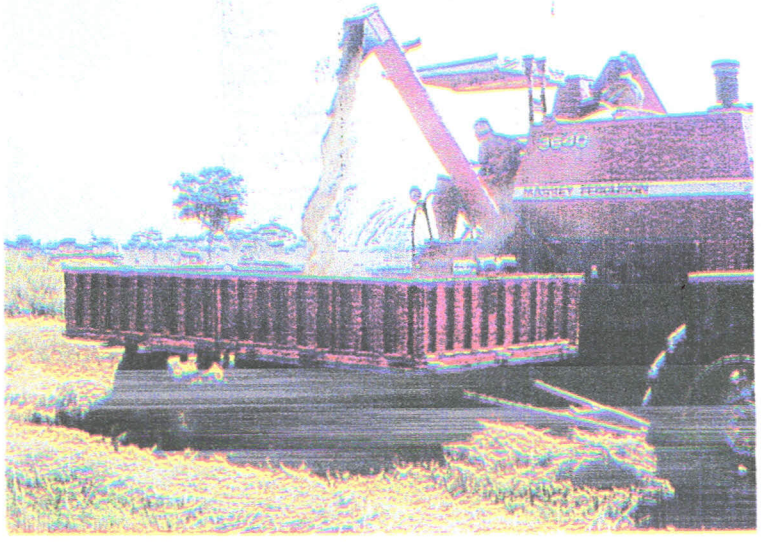


4 tonnes per hour (Nasia, Tamale)

Harvesting

Harvesting by hand

Mechanical harvesting



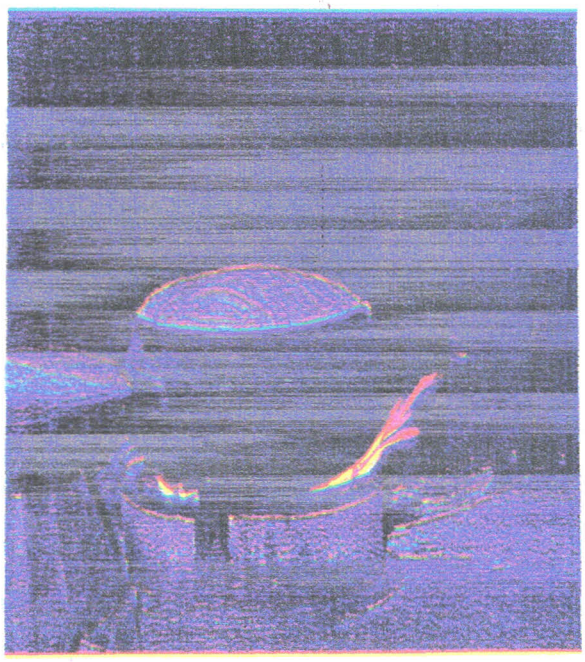
Combine harvesting

Parboiling

Washing paddy prior to soaking (UW)

Removing immature grains

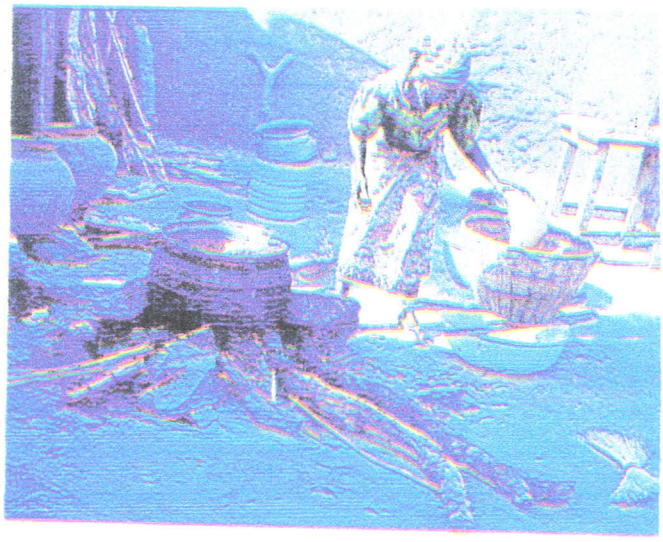
Soaking paddy



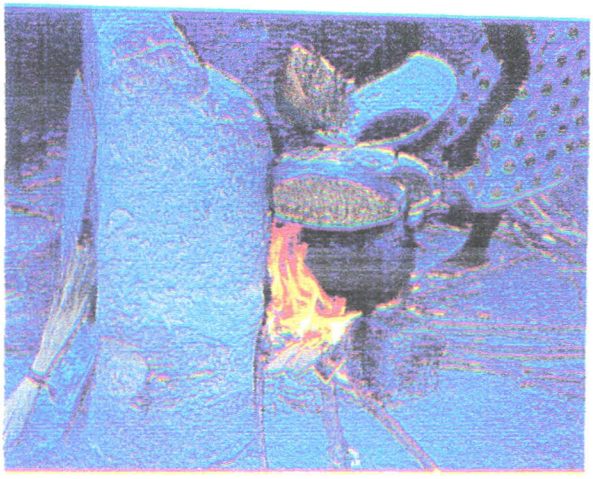
Steaming

Parboiling

Washing



Boiling



Steaming

Drying

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