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

DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID)

CROP POST HARVEST PROGRAMME

PROJECT R6688

3.1 - Post Harvest Practices - John T Manful, Lynda Hammond
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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 1 Age, marital status and educational status of farmers

	Upper West (23)	Upper East (14)	Northern (26)
Age of farmers			
<20	-	-	4.0%
20-29	-	30.4%	20.0%
30-39	50%	21.7%	24.0%
40-49	21.4%	26.1%	28.0%
>50	28.6%	21.8%	24.0%
% married	85.7	87.0	100
Education			
Non formal	57.1%	22.7%	50.0%
Islamic	14.3%	4.6%	15.4%
Primary	14.3%	31.8%	19.2%
Secondary	14.3%	22.7%	15.4%
Tertiary	-	18.2%	

number surveyed is given in parentheses

3.2 Agronomic practices

Almost all the rice farmers interviewed relied on family members to carry out farming activities throughout the year, calling on teams of casual labour at peak activity periods such as weed control and harvesting times. On the irrigation schemes land preparation and irrigation services are available and typical service charges are given below. Many farmers, however, complained that there were often delays in the provision of land preparation, due to the non-availability of equipment, resulting in delayed planting.

ICOUR charges for 1997:[1]

Irrigation levy (for rice) - ¢100,000*/ ha.

Land preparation (Ploughing) - ¢120,000*/ ha.

(Harrowing) - ¢60,000*/ ha.

(Rotavating) - ¢180,000*/ ha.

[1] (* 1US$ = ¢2100)

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% (11.1-13.7)	11.73% (10.0 -15.7)	22.18 (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 (Ofosu 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 (0.91-5.01)
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)	5.42 (3.6-7.51)	<0.01 (0-0.01)	3.67 (2.1-5.57)
Northern region	0.68 (0-2.47)	1.01 (0-14.45)	2.84 (0.14-6.34)	2.82 (0.09-6.35)	0.02 (0-0.29)	2.48 (0.91-4.67)
Sample 3 (before milling or parboiling))						
Upper West	0.24 (0.03-0.66)	0.04 (0-0.19)	3.17 (0.69-9.19)	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 (0-13.75)	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 (0-7.18)	0	1.41 (0-3.53)
Sample 4 (after parboiling)						
Upper West	0.08 (0-0.41)	0	1.86 (0-10.94)	0.25 (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 (0.54-4.14)

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

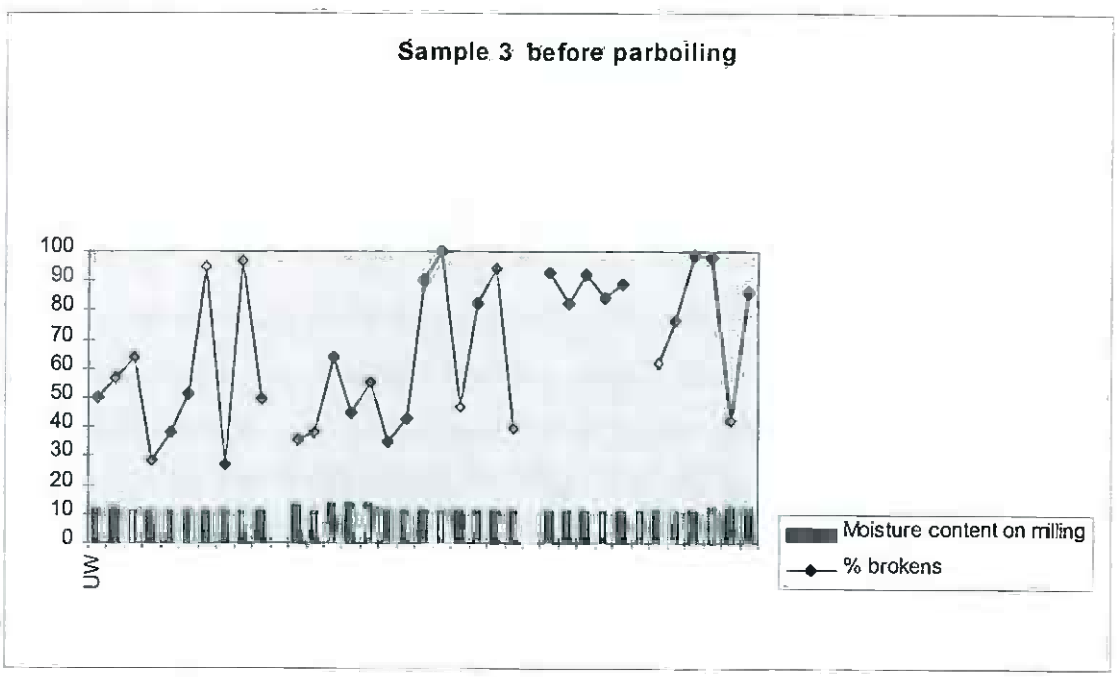
Most rice produced in these areas is milled in small-scale steel hullers, which, in general, are very poorly maintained. Millers cite stones in the grain as a major problem as they cause damage to the mills.

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

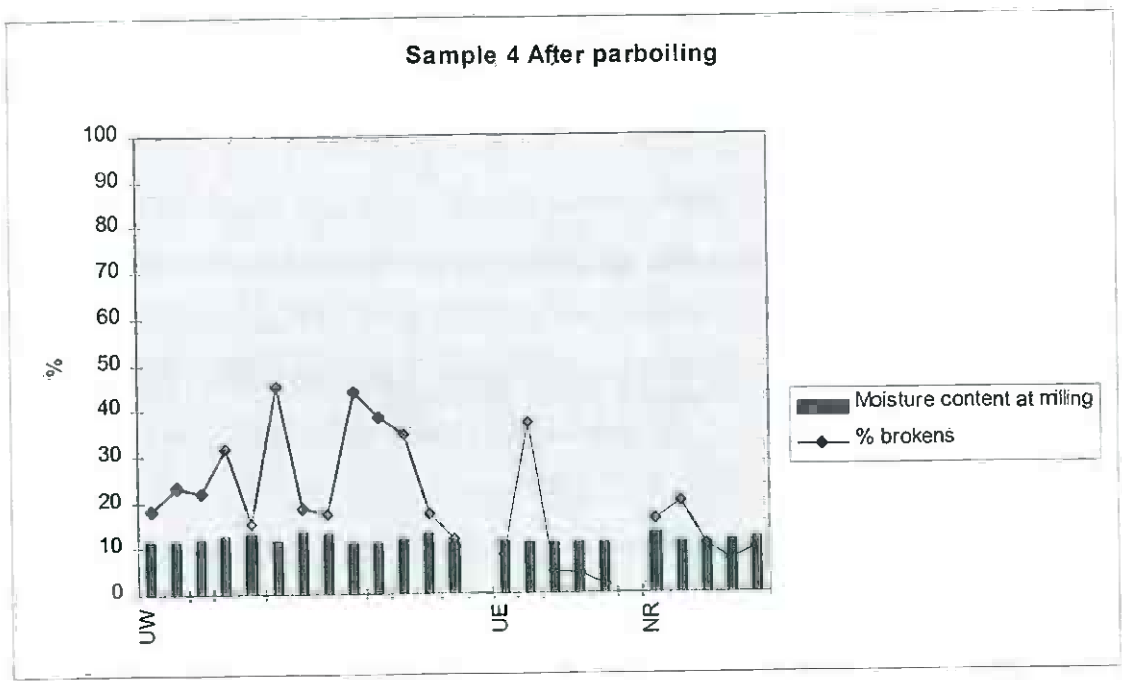
amount of broken grain produced was very high with almost all samples yielding more than 50% broken grain with many samples containing in excess of 80% brokens. Samples with a slightly increased moisture content tended to produce less brokens on milling. (Figure 1).

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 technoeconomic 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 the transfer 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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APPENDIX 1

FARMER SURVEY DATA

FARMERS SURVEY

Northern region: Gusheigu-Karaga District, Tolon- Kumbungu District,

Farmer ref.	Age	Married/ single	Education	Other skills	Full time employees	Time in rice farming	Varieties grown	Reason for choice	Source	Planting time
GAA/001	58	m	Islamic	Tailor Driver	3	36	Afife Farro 15	Y+ Mat E	Adam Kaleem	mid June
GAA/002	43	m	O level		2	18	GR 19 Mandee	Y+ Tall/weeds	Other farmers	mid June
GAA/003	61	m	Islamic	Driver	4	26	Farro 15 Afife	Y+ drought res short	Other farmers	Late June
GAA/004	27	m	nil		1	4	Afife Mandee	Y+ Tall/weeds	Other farmers	Early July
	Age	Married/ single	Education	Other skills	Full time employees	Time in rice farming	Varieties grown	Reason for choice	Source	Planting time
BO/101	67	m	Adult lit Bible school	Pastor	1	12	GR 19 Afife	tall yield	IDA	mid June
BO/102	70+	m			5	10	Afife Bontanga	yield/short early mat.	IDA	July
BO/103	45	m	3 years			5	Afife Mandee	yield/early weeds		mid June
BO/104	30	m			10	10	ADNY Afife	tall/early yield	IDA	June and January
BO/105	40+	m	Islamic 7 years	miller	6	25	Mandee Afife	weeds yield but susceptible to weeds	IDA	June
BO/106	50+	m	Islamic 18 years		8	18	Mandee Afife	weeds yield	Adam Kaleem	June
BO/001	30	m	6th form	Agric tech officer Cert in agric		3	Tox 18447 Afife	yield/early	IDA	late July
BO/002	37	m	non formal		1	17	Tox Afife GR19	early yield but late	IDA	August
BO/003	19	m	JSS 9yrs		4	3	GR19 Afife	early yield	other farmers	mid July
BO/004	58	m	non formal 2 years		3	14	Afife Indonesia	early	IDA	July
BO/005	42	m	post primary teacher training		4	12	Afife Dekuku Indonesia	yield/late tasty/early	other farmers	late July

AK/001/2	27	m	o level	farm manager for A Kaleem irrigation project	18 including manager machinery operator and farm hands	3	GR18 GRUG7	yield (2.5 t/ac)	Ghana seed company	late June
NYA/F01	40+	m		weaver, basket making		20+	Mandee Faro 15	Good for water logged soil, good yield & taste High starch, likes wet but not waterlogged soil	Saves own seed	Watches to see when SARI plant their plots
Nasia Rice Co Ltd.					7	25	GR18 GR19	yields more, heavier early, slender	MOFA	June
TML F10	40+	m			3	20	Afife (GR18) Local	higher yielding	IDA Market	July
TML F11	20+	m	10 primary	facilitator NFE	2	7	Afife Local	high yield	market	late June
TML F 12	30+	m			10 (family) no casuals	20+	Local Afife	earlier higher yield	market	late June
TML F13	30+	m			4	10	GR18 Local	higher yield earlier	market	early june
TML F01	40+	m	up to primary 2			15	Afife (tall type)	nice taste, no lodging, less shattering	Golinga Irrigation keeps own	follows SARI
TML F02	27	m	middle school	fisherman		6	Ugaga Afife	very tall, fairly good yield, weed resistant high yield, susceptible to weeds	Golinga irrigation keeps own	May
TML F 03	30	m				15	Mandee Afife	fairly good yield, nice taste good yield	keeps own	follows SARI
TML F04	20+	m				5	Afife Kpukpla	good for waterlogged sites, late early	keeps own	June

	Crops grown	% sold	Indicator for harvest time	Best conditions for harvest	Tools used	Problems	Acreage	Time/acre	Shattering	Reason
GAA/001	Maize Yam Sorghum Rice	0 0 0 97	Panicle colour	Firm soil	Combine	Can get stuck	40	10 acres/day	Y	Too dry
GAA/002	Yam Soya bean Maize Rice	60 100 80 100	Panicle colour Dry stalks	Maturity and soil condition	Combine	Combines old and slow	60	6 acres/day	Y	Too dry
GAA/003	Maize Rice	0 80	panicle colour	Soil conditions	Combine	Breakdowns	25	8-9 acres/day	Y	Too dry
GAA/004	Maize Rice	57 88	Panicle browns and droops	Soil conditions	Sickle		3	1 week/acre (harvesting alone)	Y	Too dry because soil was muddy at optimum time
BO/101	Tomatoes Cow pea Rice	90 60 60	browning of panicles	soil condition	sickle		1	1day	y	over drying
BO/102	Maize Sorg & mil Soya bean Rice	0 0 100 90	browning of panicles	maturity	sickle		10	1 day	y	lack of water over bearing
BO/103	Cow pea cotton Groundnut Maize Sorghum Rice	80 100 80 0 0 83	browning of panicles	maturity	sickle		4	1day	n	
BO/104	Sorghum Yam Maize Rice	0 0 0 80	drooping of panicles	maturity	sickle		7	1 day	y	over drying.
BO/105	Maize ground nut sorghum cow pea cotton Rice	50 100 50 50 100 83	drying of panicles	maturity	sickle		10	1.4 days	y	over drying because of lack of labour
BO/106	Maize ground nut sorghum cow pea rice	66 100 50 80 90	browning and drying of panicles	maturity	sickle		20	1.5 days	y	over drying
BO/001	Okro Onion Maize Rice	95 97 75 90	drying of panicles	soil condition	mechanical harvester /sickle		1.5	.7 day	n	

BO/002	Maize Vegetables Rice	100 100 100	browning of panicles	soil condition	sickle Kubota		1.5	1 day	n	
BO/003	Cowpea Groundnut Maize Rice	80 90 0 70	Drying and yellowing of leaves	Maturity	sickle Kubota	equipment gets stuck in soil	2	0.5 day	n	
BO/004	Groundnut Vegetables Maize Sorg&mil Rice	100 90 0 100 100	Browning and drooping of panicles	Maturity	sickle		3	1.5 days	n	
BO/005	Maize Soyabean Rice	0 66 90	90% yellowing of panicles	Maturity and soil conditions	Kubota sickle		1.2	1 day	n	
AK/001/2	Maize Rice	100 100	Browning of panicles	Firm soil conditions	Combine harvester Kubota	Machinery gets stuck	300	22 acres per day (3 combines)	y	if too dry
NYA/F01	Yam maize millet sorghum cassava rice	40 0 0 0 0 60	Browning of leaves	Nov/Dec	sickle			3 days (5 people)	y	overdrying
Nasia	rice	100		firm soil conditions	combines	Machinery gets stuck		100 acres 1week	y	late harvesting
TML 10	maize yam cassava rice	0 50 10 90	yellowing of leaves and panicles	maturity	sickle			2 acres 4 days	y	over drying
TML 11	maize cotton rice	10 90 80	browning of panicles drying of stems	maturity	sickle			1 acre 2-6days	y	over drying, harvesting on hot afternoons
TML12	groundnuts rice	100 60	browning of panicles	maturity	sickle			2acres 5 days	y	overdrying
TML 13	maize yam pepper rice	0 80 50 80	browning of panicles	maturity	sickle			2 acres 5 days	y	late harvesting
TML F01	Yam maize sorghum millet cassava Rice	50 0 0 50 0 40	browning of field	November	sickle			4 days per acre 4people	n	

TML F02	Maize groundnuts cowpea cassava rice	0 80 90 0 70	browning of leaves bending down of panicles	November	sickle			2 acres 1 week 5 people	y	too much drying, late harvesting
TML F03	Yam maize sorghum cassava millet rice	50 0 0 0 0 60	bending of panicles, drying of leaves	December	sickle		slow to reduce shattering	10 people/ 3 acres/ 10 days	y	delay in harvest, overdrying
TML F04	maize yam sorghum cowpea cassava millet rice	0 50 0 0 20 0 60 (20 for seed)	browning of field, bending of panicles	Nov	sickle		slow to reduce shattering	4 people 3 days 1 acre	y	overdrying locusts

	Lodging	Field curing	Crop given to creditors or landlord	Where stored	Storage time	How threshed	Threshing problems	Dried after threshing	Where sold	Maximum price
GAA/001	N	N	C Ll bag/acre	IFAD depot	4	Combine		N	Nasia / Yamale market	September
GAA/002	N	N	L	Home	6	Combine		N	Customers come to house	June
GAA/003	N	N	C L 1bag/5acre	Home / market stalls	6	Combine		N	Customers come to house	Mar-June
GAA/004	Y	Y In heaps on farm until harvest complete		Home	6	Tractor	Not efficient	N	Customers come to house	May-June
BO/101	y	n	c	Home	6	sticks on clay floor	spillage pilfering	on floor at home	customers come to house or farm	June July
BO/102	y	n		IDA farm house	4	sticks on clay floor	spillage pilfering	cement floor at project site	customers come to house	
BO/103	y over bearing	n		In cribs at home	6	sticks on tarpaulin	scattering	cement at home	customers come to house	June
BO/104	y	n		Behind house in cribs	1	sticks on clay floor	spillage		customers come to house	June
BO/105	y	n		poured into cribs fumigated	6	sticks on clay floor	cost of labour		customers come to house	June
BO/106	y heavy panicles	y threshers not ready	L	In cribs or in room on floor	6	tractor on clay floor			customers come to house Tamale market	June
BO/001	n	n		sacks in house	6	sticks on clay floor	improper threshing scattering		customers come to house	April May
BO/002	n	done only when labour/ machinery unavailable for threshing. Panicles piled in heaps		bags in house	4	combine if available sticks on clay floor	combine sometimes breaks paddy		customers come to house	May onwards
BO/003	y	n		bags in house	3	sticks on clay floor	scattering pilfering		customers come to house	April
BO/004	y water logging	y In heaps on farm to further dry panicles		sacks in house	5	sticks on clay floor	spillage pilfering	sun dried on concrete floor. Done to ensure germination	customers come to house	

BO/005	y if over dried	n		bags in house	7	sticks on clay floor	stones losses through improper threshing spillage	n	customers come to house	Aug/Sept
AK/001/2	y too much nitrogen	n		bags in Ghana seed company warehouse	7	combine		y if not dry enough. Sun dried on tarpaulins	At seed company	June
NYA/F01	y	n	l	bags in room	5	sticks on clay floor	lack of dry floors for threshing lack of tarpaulin loss of paddy	n	customers come to house	May June
Nasia	y	n	local chief	silos paddy is cleaned and treated with chemicals	3	combine	grain breakage	n	used in mill	n/a
TML 10	y wind	n	l	sacks at home	5-6	sticks on clay floor	tedious scattering	n	Tamale and Nyankpala markets and traders come to home sell by bowl	planting time
TML11	y	n		stores in barn	6-7	sticks on clay floor, prepares a pit (shallow excavation)	tedious itching occasional losses	n	Tamale and Nyankpala markets sells in bags and bowls	May June
TML12	y	n	l	in barn at home	6-7	beating on floor with sticks, shallow excavation	tedious itching losses through scattering	y may have picked up moisture from soil - sundried in compound	Tamale	August- sept
TML 13	y	n	l C(sometimes)	in barn at home	3 months	shallow pit beat with sticks	tedious itching scattering	n	Nyankpala and Tamale markets	planting time
TML01	n	n		in cribs	4 months	beaten with sticks		n	customers come to house	Nov (harvest)
TML 02	y Ugaga	n		poured into cribs	3-4 months	beaten with sticks on prepared floors		n	from house and Tamale market	May June
TML 03	y	n	l	poured into cribs	up to 6	beating with sticks		n	customers come to house	may june
TML04	y	n	c	in cribs	4 months	beaten with sticks		n	Tamale	May June

	Time in an association (years)	Benefits	Major problems
GAA/001	6	Land preparation Inputs	Low market price High Input cost Labour costs Bush fires
GAA/002			Water control Input costs Labour costs Birds Availability of combines Bush fires
GAA/003	6	Inputs	Input costs Labour costs Birds
GAA/004			Input costs Birds Weeds
BO/101	12	Inputs Land preparation	Financial Inputs Labour Birds Land preparation
BO/102			Lack of rain Lack of technical know-how Labour costs Input costs
BO/103			Inputs Birds (Only has bike to transport)
BO/104			Land preparation Inputs Birds (Only bike for transport)
BO/105	15	land aquisition and preparation	Input costs Land preparation machinery
BO/106			Land preparation Input costs Labour costs
BO/001	4	financial assistance in emergency	Fertilizer cost Weed control Labour cost/availability
BO/002			Input cost Rodents Birds Labour cost/availability
B0/003			Input costs Labour cost Birds in dry season Rodents
BO/004			Lack of machinery Labour costs Birds Rodents
BO/005	8	extension training Input supply	Cost of inputs
AK/001/2	yes - no details	Input supply	Lack of finance, input supplies
NYA/F 01			birds, cash flow
Nasia			Land preparation, machinery difficult to obtain, fertilizer and weedkiller- expensiv
TML10			Delay in obtaining tractor services for land prep, weeds (weedkiller expensive), bu
TML 11			weed control, planting tedious, land preparation difficult, birds, bush fires
TML12			seeding a problem - land uneven after ploughing, weed control, fertilizer costs, bir
TML 13			Inputs, lack of finance, birds
TML. 01			weeds, finance, locusts
TML 02			finance, lack of improved seeds, birds, lack of inputs.
TML. 03			lack of finance, inputs, land preparation,weeds
TML. 04			

FARMERS SURVEY

Upper Eastern region

	Age	Married/ single	Education	Other skills	Full time employees	Time in rice farming	Varieties grown	Reason for choice	Source	Planting time
	50	m	Islamic school		3	21	Tox Afife	tall/early yield	IDA other farmers	Mid July
	30	s			1	3	Tox IR8	tolerant disease prone	other farmers	August
	53	m			3	9	Abidjan 442	tolerant/yield prone to disease	other farmers	August
	20	m (female)	SS graduate		2	4	Abidjan	early	ICOUR	late July
	25	m (female)			2	7	Manbranco	yield	ICOUR	August
	24	m	SSS		4	4	Tox 3108		other farmers	August and February
	30	(female)			3	12	Abidjan Tox	yield/ no shattering	ICOUR	Early August
	30	m (female)	6years primary		2	12	Tox		other farmers	July
	25	s	5 years primary		2	5	Tox Thai (previous years)	yield	Navrongo market	Early August and December
	28	m (female)	8 years primary		2	6	Abidjan IR8 New varieties	Highest yielding	ICOUR	August
	27	m			4	7	Tox 442	yield/late	ICOUR	late June
Nav/F01	42	m	OND Agric.	District development officer	1	8	GR18 Afife Abidjan	Higher yield Longer grain and matures earlier	Other farmers	early Feb and early July
Nav/F02	39	m (female)	o level	former receptionist	1	11	GR 18 GR19	higher yield taller longer grain higher market demand	MOFA	late July
Nav/F03	46	m	o level			20+	GR18 Thailand	Higher market demand Yields are comparable	MOFA Other farmers	Early July
Nav/F04	51	m	10 years primary Secondary cert in agric	Tractor operator	3	24	GR18 IR442	Taller high yielding No longer grows 442	MOFA	Late July

Nav/F05	50	m	o level	Former storekeeper at Navasco meat marketing board	1	10	Gr18 Thaialnd	taller	MOFA Other farmers	July
Nav/F11	33	m	general cert Agric	Agroforestry specialisation certificate	3 (+3)	19	Early mat Thai IR8 IR5 Abijan	Early does not lodge Both high yield, late,lodge High yield and market demand low shattering difficult to thresh	MOFA	June and Feb
Nav/F12	40	m	Dip Agric	Carpentry, building, welding, mechanical repairs	5	4	GR18 IR8 BW Tox Abijan	All three early, taste good esp Abi BW expands well	ICOUR other farmers GR18 MOFA	June July Feb Mar
Nav/F13	41	m	middle school		2	16	442 IR8 Abijan 90days	High yield good taste poor yield early	Keep own	June December
Nav/F14	46	m	elementary school Technical Agric Instruction (mechanisation)	technical operator (combine/tractor)	2	26	IR8 442 90 days IR5	high yield good taste high starch, good taste, high yield,early high yield	keep some MOFA	June
Nav/F15	28	s	polytechnic		10	4	Abijan 90 days GR18	early, good taste early late taste not so good	ICOUR other farmers keep some	June July
Nav/F16	40	m	middle school Navrogo farm Inst		2	6	IR8 Abijan 90 days	Late, fairly good Tastes good late much starch early	Keeps own ICOUR	May June Feb Mar

Nav/F17	57	m	Middle school	Storage handling (ICOUR)		20	442 thailand abijan 90 days IR8	not much fert, long grain low starch, ggod taste early, low starch, taste short grain good yield low starch	Keeps own ICOUR	May June Jan Feb

	Crops grown	% sold	Indicator for harvest time	Best conditions for harvest	Tools used	Problems	Acreage	Time/acre	Shattering	Reason
	Maize Okro Rice	0 100 90	Days to maturity	maturity	sickle		2.7	1.5 days	n	
	Maize Millet Cowpea Tomato Okro Rice	20 20 20 20 20 60	Browning of panicle	maturity	knives		1	4 days	n	
	Millet Groundnut Maize Rice	0 0 0 60	Browning of panicles	maturity	knives		1.5	0.5 days	y	over ripening
	Soyabean Tomatoes Rice	100 90 80	Browning of panicles	maturity	knives		0.5	2-4 days	y	over drying
	Tomatoes Soyabean Rice	80 80 65	browning and drooping of panicles	maturity	knives		1	4 days	n	
	Groundnut Maize Rice	60 0 71	leaves and grains become yellow	maturity	knives (sickles too expensive)	seven people harvesting.	0.5	2 days	n	
	Tomato Soyabean Rice	100 100 80	browning of panicles	maturity	knives or sickles		1	2 days	y	Genetic trait
	Maize Millet Sorghum Soya Groundnut Rice	0 0 0 100 0 50	browning of panicles	maturity	knives or sickles		1	1 day	n	harvesting done on time
	Tomato Rice	100 50	yellowing of panicles	maturity ie no of days after sowing regardless of state of ground	sickle		0.5	8 days	n	
	Soyabean Tomato Rice	100 90 25	brown,dry	maturity	knives		2	1 day	n	
	Millet Maize Groundnut Rice	0 0 0 20	browning	maturity and dry soil conditions	sickle (men) Knives (women)		1.5	2 days	n	442 shatters

Nav/F01	Groundnuts Rice	0 90	browning of leaves and panicles	Maturity	sickle/knife		2	1 - 1.5	n	
Nav/F02	Soyabean Maize Rice	100 70 66	browing of panicles	Maturity despite muddy soil conditions	sickle and knife		5	2	n	
Nav/F03	Soyabean Maize rice	100 0 90	yellowing of leaves	Days after sowing Soil condition	sickle and knife		5	1.2	n	
Nav/F04	Millet groundnut maize rice	0 40 50 80	browning of panicles	maturity	sickle		5	1	n	
Nav/F05	Millet Maize Groundnut Rice	0 0 0 40	yellowing of panicles	maturity despite soil conditions	sickle /knives		5	1.4	n	
Nav/F11	Groundnuts soyabean maize millet sorghum tomatoes pepper rice	0 90 0 0 0 80 80 70	colour change green-brown	dryness of field no of days	sickle /knives		1	1 (four people)	y	too dry varietal
Nav/F12	Soyabean groundnuts maize rice	80 80 80 70	browning and hard grains	sept/oct dependant on variety may	sickle, knives combine		5	2 (two women)	n	
Nav/F13	Soyabean Tomatoes Maize Rice	100 0 70 70	colour change green-brown	october-nov apr-may 90 or 120days	sickle knife			2.5 (ten people)	y	too dry
Nav/F14	Maize groundnuts millet rice	40 40 0 40	colour change regardless of soil conditons	Nov 90 days	sickel knife (combine if acreage is high and funds available)			3 (5people)	y	too dry
Nav/F15	maize cowpea rice	80 100 70	colour change	Nov/Dec	knife/sickle			6 (4 people) incldes threshing and winnowing	n	
Nav/F16	maize millet groundnut soyabean rice	50 0 50 ? 50	browning/yello wing	3 months sept/oct august	sickle			2-3 (10 women) includes threshing and winnowing	y	insuffient water too dry

Nav/F17	soyahcan maize groundnut millet rice	100 0 80 0 50	browning/yello wing lodging	sept may	sickle knife			2 (10-15 women) includes threshing and winnowing	y	too dry

	Lodging	Field curing	Crop given to creditors or landlord	Where stored	Storage time	How threshed	Threshing problems	Dried after threshing	Where sold	Maximum price
	y strong winds	yes if lack of labour to thresh but facilitates threshing and winnowing		IDA shed or isn sacks in house	4-6	sticks on concrete floor Combine when available	pilfering losses through improper threshing more debris if combine is used	n	from home/ Kumbungu market	June/july
	n because of close spacing	n	c	sacks in house	4	sticks on clay floor	laborious stones losses	y sun dried on cement floors at home	Navrongo market	April
	y too much fertilizer	n		sacks in house	4-5	sticks on clay floor	stones losses	y sun dried on cement floor at home	Navrongo market	August-September
	y tall variety	n	c	sacks in house	4-5 may be treated with chemicals	sticks on clay floor	losses stones winnowing difficult if no wind	y sun dried on cement floor at home	Navrongo market	March onwards
	n	n		sacks in house	10	sticks on clay floor	losses stones	y sundried on cement floor at home	Navrongo market	June
	y	n		sacks in house	2	sticks on concrete or laterite floor	stones scattering	y sun dried at hme for one day	Navrongo market	July- september
	y tall variety	n	c L	sacks in house	6	sticks on clay floor	laborious losses mud and stones	sundried on clay floors	Navrongo market	April
	n	n	c	n/a	0	sticks on clay floor	sand,clay, stones and losses	sundried on clay floors for up to 2 days	Navrongo market	
	y	n		sacks in house	4-6	sticks on clay floor	losses stones and mud	sundrying on mud floor	Navrongo market	May-June
	n	n		sacks in house	up to 12	sticks on concrete floor	losses	sundrying on tarpaulin	Navrongo	May
	n	n	c	sacks in house	5	sticks on clay floor	stones/mud losses	sundried on cement floor at home	Navrongo	April
Nav/F01	y (wind)	n	l	poly sacks in house	3-4	sticks on clay floor	tedious because of high moisture content Spillage Contamination	sundried on tarpaulin at home (cost c2000/day)	Navrongo or customers come to house	March

Nav/F02	y over drying	n	c l (low risk project)	bags in house	5-6	sticks on clay floor	scattering losses lazy workers don't thresh well	no dry enough	Navrongo market bags and bowls	April
Nav/F03	y too much N	y heaped on farm until harvest is complete	c l (MOFA proj)	bags in house	5	sticks on clay floor	scattering contamination with stones and dust	no	Navrongo market	April/May
Nav/F04	y wind/rain	n	c l	bags in store room at home Sometimes sends paddy to seed insection unit for cleaning	5	sticks on clay floor	spillage contaminationw ith stones and dust	no	Navrongo market	April May
Nav/F05	y excess N	n	c l	bags at home	6	sticks on clay floor	losses stones lazy threshers	no	Navrongo market bags and bowls	March onwards
Nav/F11	y	n	c (owns land)	jute sacks in store room treats Acthlic dust	4 dry 3 wet	sticks on clay	scattering losses stones paddy breakage poor separation frompanicles	y to prevent mould growth reduces weight for transportation spreads on floor	Navrongo	3-4 months after harvest applies to both seasons
Nav/F12	y variety	n	c	jute sacks in store room	4	sticks on clay	Introduction of stones	n	Navrongo market	Feb Mar
Nav/F13	y	n	m	store room treats with Apron +	3-4	sticks on clay	Introduction of stones Breaking of paddy	y some grains may not be dry enough	Navongo market	Jan-Mar
Nav/F14	y	n	c l and chief	jute sacks in house sent to seed company for treatment	4-5	sticks on clay		n	Navrongo market	Mar Apr
Nav/F15	y	n	c	jute sacks in store room	4	sticks on clay	Introduce stones	n	Navrongo	Apr may
Nav/F16	y	n	c l (as a gesture)	jute sacks in store room sometimes treated with chemicals supplied by MOFA	4-5	sticks on clay	Introduces stones laborious	y necessary to dry next season's seed v well. Also for storage. Sundried on floor	Navrongo market ICOUR	Mar Apr

Nav/F17	y	n	c	jute or poly sacks in house	3-4	sticks on clay	introduces stones	y improves storage wet rice low market value	Navrongo market	May June

	Time in an association (years)	Benefits	Major problems
	10	Consultations with IDA Input procurement	Machinery for land preparation costs Input costs Marketing difficulties Birds in d obtained from Kumbungu Rural Bank)
			High water charges Lack of implements for land preparation High cost of land pre cost of labour Birds (obtained land direct from ICOUR) (uses bike for transport)
			Rice diseases Inputs Leeches Rodents Threshing floor Birds
	4	Access to land Land preparation services	Compelled to sell paddy at low price Birds Leeches High labour costs Threshing inappropriate
			Birds Use of basins to cart paddy Inputs Threshing floor Leeches
	4	Supply of Inputs	Input costs Birds
	12	Land preparation services Input distribution	Land preparation Input costs Threshing floors Rodents Birds (has to transport by cart)
	12	As at now -nil. Used to get inputs	Land preparation Water distribution Leeches Diseases Input availability Birds R losses (has to transport by head)
			Distance from home Cost of Inputs Birds Rodents Water distribution
			Input costs
	6	Input supply Land preparation	Input costs Late land preparation by ICOUR Leeches Threshing conditions (has t head)
Nav/F01			Land preparation, weed contro and fertilizers expensive, birds. Selects panicles to
Nav/F02	4 Langali women's group	Mutual assistance for major operations	weed control, over flooding of valleys so head carries fertilizer to broadcast. Labo
Nav/F03	4 Provident farmers group	Land preparation, fertiliser and seed on credit	Late land preparation, plots should be reallocated yearly
Nav/F04	4 Awini farmers group	Inputs obtained through group	Untimely land preparation by MOFA Untimely supply of inputs
Nav/F05	10 Asana farmers group	Mutual assistance. Assistance from MOFA	Labour and transport costs
Nav/F11	19 Bonia village comm (Tono)	Inputs and land preparation on hire purchase	Leeches in water, mice/rodents, diseases, lodging
Nav/F12			Delays in land prep, drought,disease, inputs hard to get
Nav/F13			No finance, inputs,disease,pests rodents
Nav/F14			Finance, land preparation, laborious harvesting,rodents,wilt,drought
Nav/F15			Lack of financial support, drought, inputs, late land prparation
Nav/F16			Lack of finance, inputs, land preparation, disease, rodents birds
Nav/F17			Lack of finance, land preparation,low market value after harvest when you need to season, disease,mice/rodents.

FARMERS SURVEY

Upper West-Wa district, Loggu, Jirapa district

	Age	Married/ single	Education	Other skills	Full time employees	Time in rice farming	Varieties grown	Reason for choice	Source	Planting time
WA/001	70+	m		metal worker	7 (family)	since youth	local improved	later/taller yield	MOFA	June
WA/002	70+	m			9 (family)	3			from market	Uncertain
WA/003	40+	m			10 children 2 wives	15	not known		father	Broadcast in April-May
WA/004	30+	m			2	7	long duration rice	late/tall/yield	Market	Ploughing/broad casting April/May
WA/005	70+	m			7 family	12			other farmers	April May
JRP/001	35	m	O level		2	7	IR64 Late variety	early/yield Taller	MOFA	June
JRP/002	38	widow		Shea processor	1	3	local IR64	taller yields better	other farmers MOFA	May July
JRP/003	35	m	3 years primary		6	9	early late	taller/better yield if adequate rainfall	other farmers	May June July
JRP/004	50	widow			2	12	IR64 long duration	taller	MOFA other farmers	uncertain
JRP/005	42	m	10 years primary		5	12	IR64 late variety	shorter/yield	MOFA other farmers	June
Loggu/F01	43	m	O level	Tally clerk storekeeper	7	11	Mandee Lowland Indian	early but shatters Taller and yields more	Mandee and lowland from market. Indian bought in India	May-June
Loggu/F02	30+	m	Islamic	Butcher	3	15	Local late	Tall late maturing	market	June
Loggu/F03	37	m	Islamic		4	6	Local late	Tall late maturing	market	late may
Loggu/F04	30+	m (female)	NF		4	6	Local variety		market	June

	Crops grown	% sold	Indicator for harvest time	Best conditions for harvest	Tools used	Problems	Acreage	Time/acre	Shattering	Reason
WA/001	sorghum millet maize yam rice	10 0 0 0 100	browning of panicles	maturity	knife		1	2 weeks only family labour	n	
WA/002	cowpea maize sorghum millet yam rice	50 0 0 0 0 100	colour changes - browning of panicles	maturity	sickle knife		2	3 days	n	
WA/003	yam maize millet bambara rice	0 0 0 0 50-70	browning of panicles	maturity	knife		2	1 week (sometimes children fall sick)	n	
WA/004	maize yam sorghum rice	0 0 0 90	browning and drooping of panicles	towards Christmas	knife		2	1 week	n	
WA/005	Yam Sorghum Cowpea Groundnut Rice	0 0 0 100 50	browning of panicles	5 month after planting	knife		2	1 week	n	
Loggu/F01	Maize Yam cowpea millet cassava rice	86 33 86 50 50 88	browning of panicles	At maturity	knife/sickle		7	1.7 days	y Mandee	over drying / varietal characteristics
Loggu/F02	Maize groundnuts rice	30 100 70	drooping and browning of panicles	At maturity	knife		2	5 days (labour availability)	y	over drying
Loggu/F03	Maize cowpea millet/sorghum rice	50 75 20 90	browning of panicles	At maturity	knife		1	3 days		harvests early to prevent this
Loggu/F04	Okro Pepper Rice	95 95 80	browning of panicles	At maturity	knife		1	2 weeks (little labour - harvests by panicles)	n	

JRP/001	Groundnut Maize Beans Rice	75 0 0 50	browning of panicles	At maturity	knife		0.75	1 day	n	
JRP/002	Groundnut Bambara Rice	0 0 0	browning of panicles	At maturity	knife		0.5	4 days	n	
JRP/003	Groundnut Bambara cowpeas sorghum Rice	80 66 66 0 66	browning of panicles	At maturity	knife		1.25	4 weeks	n	
JRP/004	Groundnut Bambara Rice	60 0 0	browning of panicles	At maturity-harvested by panicles because of differential ripening	knife		0.25	20 days not enough people to harvest	y	too dry - shatter on harvesting
JRP/005	Maize Sorghum Beans Rice	25 75 10 25	browning of panicles	At maturity	knife		1	10 days	n	

	Lodging	Field curing	Crop given to creditors or landlord	Where stored	Storage time	How threshed	Threshing problems	Dried after threshing	Where sold	Maximum price
WA/001	y	y to complete harvesting, heaped on a field outside farm		in sacks in house	6	sticks on rocky floor		n	Techiman	May June
WA/002	y delayed harvesting	n		in sacks in house	6	sticks on rocky floor		n	customers come to house	May June
WA/003	y strong winds	n	c	sacks in house	3	sticks on rocky floor	losses through scattering	n	customers come to house	April May
WA/004	n	n	c	sacks in house	4	sticks on rocky floor		n	customers come to house	April May
WA/005	y at times	n		sacks in house	6	sticks on rocky floor		n	Wa market Bags or bowls	April May
Loggu/F01	y	n	owns land	warehouse in town Technoserve inventory credit scheme	6-7	sticks on clay floor	losses through scattering and improper threshing	n	women come to warehouse	May -July
Loggu/F02	y	n		bags at home	6	sticks on clay floor	contamination with stones and mud spillages	n	customers come to house bags and bowls	June
Loggu/F03	y	n		bags at home (groundnuts with Technoserve ICS)	6	sticks on clay floor	expensive labour scattering	n	customers come to house sells in bowls	June - July
Loggu/F04	y	n		In bags at home	6	sticks on clay floor	tedious	n	customers come to house	June
JRP/001	n	y if preoccupied with other duties then panicles are carried home and stored		in house in bags or on panicles	5	sticks on cement floor at home		n	Jirapa market	June to September
JRP/002	y tall varieties	y if preoccupied with other duties. Panicles carried home and stored		on room floor or on panicles	7	sticks on cement floor		y facilitates milling	n/a	

JRP/003	y tall varieties	y to find time to harvest other crops Stored on panicles at home		In room on panicles	10	sticks on clay floor	contamination with stones	y facilitates milling	Jirapa market bags or bowls	May
JRP/004	n	y preoccupied with other duties		In room on panicles Then in barn	7	sticks on rocky floor		n	n/a	
JRP/005	y tall varieties	y stored on panicles		In room on panicles	8	sticks on cement floor		n	Gbare market in bowls	May-June

	Time in an association (years)	Benefits	Major problems
WA/001	10	Communal labour and assistance	weed control Labour costs birds (transport by head)
WA/002	3	Communal labour (MOFA offer land preparation, seeds and fertilizer)	late land preparation weed control Labour cost Birds (transport by head)
WA/003	3	Communal labour	Timely land preparation services No credit facilities (transport by head)
WA/004	3	Communal labour	Late ploughing by MOFA. Weed control costs Birds (transport by head or bike)
WA/005	3	Communal labour	Weed control Birds (transport by head or bike)
JRP/001	2	Land preparation services Input supplies	Late land preparation Weed control (transport by head)
JRP/002	2	Land preparation services Seed supply	Weed control Labour costs Difficulty in land preparation (transport by head)
JRP/003	2	Land preparation services	Weed control Land preparation (transport by head)
JRP/004	2	Land preparation services Seed supply	Weed control Timely land preparation (transport by head)
JRP/005	2	Land preparation services Seed supply	Weed control Soil fertility High input costs
Loggu/F01			Cash from ADB@36%. Poor rainfall. Low prices. Weed control. Labour intensiv
Loggu/F02			Weed control (spear grass) Birds at sowing
Loggu/F03			weed control. Land preparation services
Loggu/F04			Land preparation services Weed control Input costs

APPENDIX 2

PHOTOGRAPHIC RECORD OF POST HARVEST PRACTICES

Harvesting

Harvesting by hand

Mechanical harvesting

Combine harvesting

Threshing

On a concrete apron (UW)

On a road (UW)

On natural rock surfaces (UE)

Winnowing (UW)

Milling systems

Hand pounding

Steel huller mill (approx. 250 kg per hour)

Single pass rubber roll mill (500kg per hour)

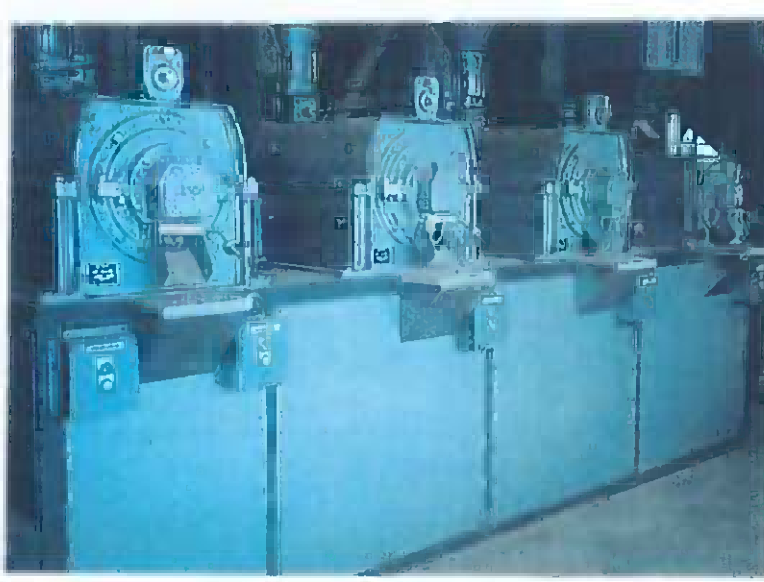
Large scale mill (1tonne per hour)

Scale of operations

Typical steel huller mill

Rubber roll mill

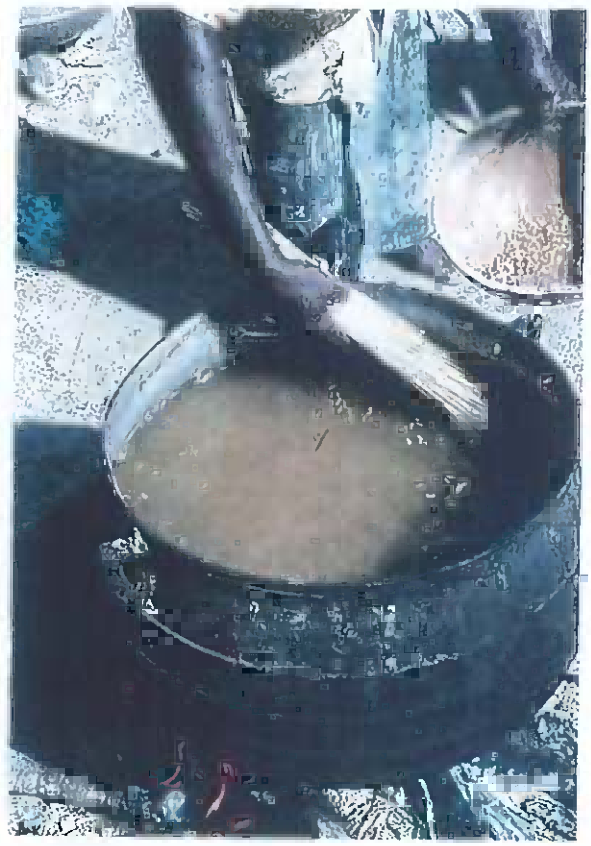
1 tonne per hour (Kpong farms)



4 tonnes per hour (Nasia, Tamale)

Parboiling

Washing paddy prior to soaking (UW)



Removing immature grains

Soaking paddy

Steaming

Parboiling

Washing

Boiling

Steaming

Drying

Storage