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QUALITY PERCEPTIONS OF PARBOILED RICE MARKETED IN SRI LANKA

NATURAL RESOURCES INSTITUTE
The University of Greenwich

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QUALITY PERCEPTIONS OF PARBOILED RICE MARKETED IN SRI LANKA

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The University of Greenwich

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Summaries

SUMMARY

A study was made of the parboiled rice market in Sri Lanka. Rice was obtained from commercial processors, objectively assessed for quality, then evaluated by wholesale traders. Statistical analysis showed that the objective measurement of colour was significant in pricing, together with foreign matter, moisture content and damaged grain. The study will provide information for processors wishing to raise the quality of their products.

RESUME

Une étude du marché du riz à demi cuit au Sri Lanka a été effectuée. Le riz provenait de spécialistes du traitement dans le secteur commercial, sa qualité était estimée de façon objective, puis évaluée par des grossistes. Une analyse statistique indique que la mesure objective de la couleur, ainsi que les corps étrangers, la teneur en humidité et les grains endommagés, étaient pertinents pour la détermination du prix. L'étude fournira une information aux spécialistes du traitement souhaitant améliorer la qualité de leurs produits.

RESUMEN

Se llevó a cabo un estudio del mercado del arroz parcialmente hervido en Sri Lanka. Tras haber obtenido arroz de compañías elaboradoras, se procedió a su evaluación objetiva para establecer su calidad y, a continuación, se presentó al escrutinio de comerciantes al por mayor. El análisis estadístico subsiguiente puso en evidencia que la medición objetiva del color constituía un elemento significativo en relación con la fijación del precio, junto a factores tales como la presencia de materias foráneas, contenido de humedad y granos dañados. Este estudio proporcionará información de utilidad para aquellas compañías elaboradoras que deseen mejorar la calidad de sus productos.

Quality perceptions of parboiled rice marketed in Sri Lanka

INTRODUCTION

With the increases in paddy production seen in the 1980s, there has been a growing awareness of, and increased demand for rice of better market quality among consumers in Sri Lanka. The demand has been further increased by the abolition of the subsidized ration system, and competitive prices on the open market.

Development work in post-harvest rice technology aims to enable the processor to meet the quality requirements of the recently-liberated market. However, these requirements must firstly be determined and quantified.

The subject of quality in rice was considered some time ago. Palipane (1984), broadly reviewed post-harvest practices and technologies, and reported that the primary market, some 70% of the total, was for parboiled rice. However a recent survey conducted in Sri Lanka has revealed that a major portion of the rice which is sold in the open market is of poor quality, containing high levels of sand, stones, and discoloured grains, especially in the lower priced grades (ARTI 1993).

The Sri Lanka Standards Institution(SLSI), has developed standards for paddy and milled rice which are based on grain size and colour of pericarp, and recognize both raw and parboiled grain (SLS 633: 1984, see Appendix 1). The Paddy Marketing Board also has acceptance standards for paddy. However, the extent to which standards are applied in practice has been questioned (Palipane, 1995).

To improve the market quality of rice, three main factors must be considered.

- The quality of paddy for milling must be improved.
- Rice milling techniques must be improved.
- A rice grading system should operate in the country which would not only standardize and rationalize a pricing system, but above all encourage the producer and processor to produce a superior quality rice.

Thus, in an effective rice quality improvement programme, an integrated approach should be adopted where all these factors are taken into consideration and given equal importance. However, the extent to which these improvements can be introduced will be dependent upon the willingness of the consumer to pay for such quality upgrading.

The study of quality/value relationships in Indonesian rice has previously been reported by Conway *et al.* (1992), based on raw rice in store over a one-year period. This report presents the quality perceptions and attributes of parboiled rice marketed in Sri Lanka. The study was undertaken as part of a technology enhancement programme funded by the Overseas Development Administration (ODA) and carried out by NRI and the Rice Production Research and Development Centre of the Paddy Marketing Board, Sri Lanka (RPRDC).

MATERIALS AND METHODS

Study methodology

The methodology adapted for the study closely followed that of Conway *et al.* (1992); and Clarke (1994). The methodology was designed to:

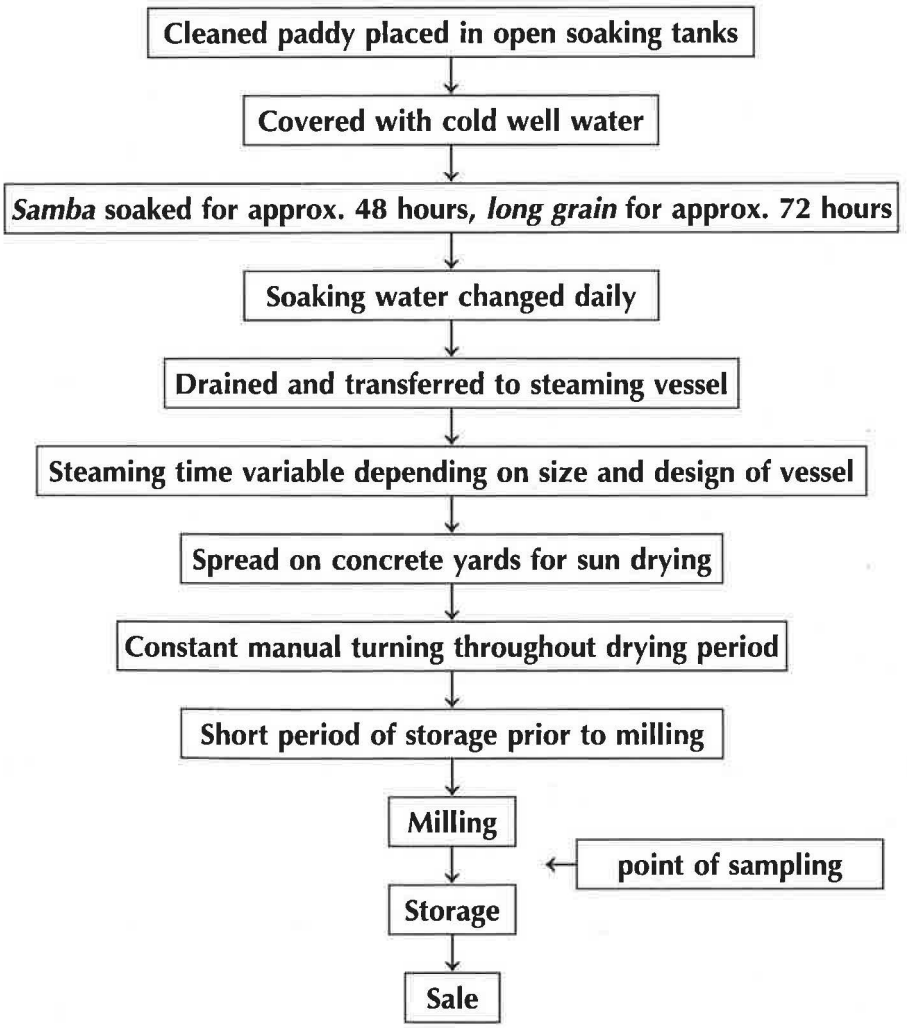
- quantify quality attributes;
- examine the relationship between measurable quality attributes and those perceived to be of importance by traders; and
- determine the relationship between quality attributes and value.

Rice

Samples of milled parboiled rice were obtained from commercial producers. Two types were selected: *samba* rice, defined by SLSI as 'short white type – white pericarped rice having a grain length less than 4.5 mm' and *long grain*, defined in its white form as 'long white type – white pericarped rice having a grain length above 6.0 mm'.

Sampling

Six parboiled rice processors were selected, taking into account process technology and rice types. All processors had a capacity of 1–5 tonnes per day and used similar production systems. A typical process is outlined below:



In most, but not all, cases, the processor produced both types of rice required for the study. The processors were designated Processor 1 to Processor 6.

Samples of freshly milled *long grain* and *samba* milled rice were collected from the processors over 10 intervals, roughly half-monthly. The period of the study ran from September 1994 to January 1995; sampling periods were designated T1 -T10.

Samples (increments) were taken by spear from three positions in each bag of parboiled rice: left, centre and right; or top, middle and bottom. The combined quantity (bulk sample) drawn from all bags totalled approximately 1 kg.

The processors provided details of the sale of the sample lots; the wholesale price expectation, the market, destination, lot size and date of sale of the milled rice.

Each *samba* or *long grain* bulk sample was divided by *Boerner* divider into eight sub-samples, two for laboratory observation of quality, and six for test marketing.

Quality assessment methodology

Moisture content

Moisture content was determined by air-oven method (AACC 1990a).

Colour

The colour of the milled rice was determined by a *Kett* C-300 digital whiteness meter which measures colour by reflectance; the higher the reading, the whiter the rice. One of the main visual objectives for milled parboiled rice is the elimination of white centres through optimal gelatinization. This must be achieved without catalysed colour changes or pigment absorption.

Odour

The odour of milled rice is a subjective assessment. Individuals have their own perception of good and bad odour. In this study, a small quantity of boiling distilled water (approximately 50 ml) was added to the sample (approximately 25 g) to release the odour. A minimum of three experienced panellists responded on a 1–5 hedonic scale; a low score indicated good odour, a high score indicated poor odour.

Grain refractions

The following refractions were determined by manual sorting and visual assessment:

- **foreign matter** — All matter other than rice, including sand, stones, weed seeds fragments of paddy stalk, husk and dust
- **live insects**
- **black grains (peck)** — Kernels, whole or broken, in which more than one quarter of the surface is dark brown or black
- **damaged grains** — Kernels which are identified as having been affected by insects, moisture, disease or any other cause but excluding black grains.

- **paddy** Rice retaining its husk.
- **type admixture** Grains of rice, whole or broken, which are different from the majority of the sample when classified by kernel length and colour of pericarp.
- **broken grains** Broken kernels of rice which are less than $^{3}/_{4}$ of average grain length

Equilibrium moisture content on soaking (EMC-S)

EMC-S of milled parboiled rice is an indication of the degree of gelatinization of the starch in the parboiled rice; it is related to the severity of heat treatment during processing (Bhattacharya, 1979).

Approximately 10 g of milled parboiled rice was soaked in 100 ml distilled water at ambient conditions for 24 h. After 24 h, the soak-water was decanted, and surface moisture removed carefully from the grain with a filter paper or paper tissue. Moisture content of the soaked grain (the EMC-S value) was determined by the two-stage method (AACC 1990b).

Degree of milling

Well-polished rice, that is rice with all traces of bran removed, is preferred by many consumers. The degree of milling (DOM) of the rice was determined by a differential staining technique using methylene blue/eosin Y reagent which enables the endosperm and bran fractions of the grain to be quantified by visual assessment (Barber and Barber 1976). Endosperm is stained pink and bran stained blue/green.

Statistical methods

Analysis of variance was used to examine the effects of three factors: rice type; processor; and sampling times on rice quality. Since parboiled rice production was not constant throughout the study period, the data was 'unbalanced' necessitating the use of adjusted means for making comparisons. For some measurements, statistical transformation was required in order to satisfy the assumption of constant variance. For log transformations, a constant of 0.1 was added before taking logarithms to avoid problems with zero values. In such cases, the means resulting from the analyses are discussed in terms of de-transformed values.

Multiple regression was used to examine the relationship between price and quality.

Test marketing

Identification of traders

Six large-scale wholesalers, selling a broad range of rice and buying directly from millers were selected for the study. The traders' opinions were sought concerning the price they would pay for rice of the quality of each sample presented in normal trading quantities for the particular market; and the characteristics which influenced their valuation of each sample. Valuation was based on a one-tonne lot size.

Organization of samples for trader evaluation

Each sampling interval generated up to 36 samples of *samba* rice and 36 samples of *long grain* rice; i.e. 6 samples of each type of rice for each of six traders. Each trader valued both types of rice.

Collection of routine price data

As a check on seasonal market movement for each sampling interval, the wholesale prices of identified grades of rice were obtained from the weekly price data published by the Agrarian Research and Training Institute (ARTI).

RESULTS

Quality characteristics

Table 1 shows the means and standard deviations (SD) of the observed quality characteristics for all processors. Results from individual processors are detailed in Appendix 2.

Table 1 Average quality characteristics (all processors)

	Samba		*Long grain*	
	Mean	SD	Mean	SD
Moisture content (%m/m)	14.20	*1.20*	15.20	*1.39*
Colour (Kett units)	24.62	*2.08*	21.76	*4.06*
Odour (Hedonic score)	1.82	*0.57*	2.72	*1.01*
Foreign matter (%m/m)	0.04	*0.10*	0.16	*0.25*
Live insects (no./kg)	0		1.73	
Black grain (%m/m)	1.01	*0.46*	1.77	*0.84*
Damaged grain (%m/m)	1.80	*0.93*	2.55	*1.99*
Paddy (no./kg)	16.44	*23.92*	8.33	*19.20*
Type admixture (%m/m)	1.86	*1.15*	2.14	*2.00*
Broken grain (%m/m)	11.52	*6.59*	17.42	*6.96*
EMC-S (%m/m)	38.85	*2.44*	41.10	*3.81*
n	41		42	

Note: %m/m – percentage by mass.

Unless otherwise stated all effects mentioned are statistically significant at $P<0.05$ (at least).

Moisture content

The average moisture content of all samples was 14.7%, ranging from 11.1% to 17.9%.

The moisture content of *long grain* rice was more than 1% higher than that of *samba* on average ($P<0.001$). The moisture content of *long grain* rice was between 2.9% and −0.3% greater than the moisture content of *samba* rice, depending on processor.

There was a time trend which was similar for both rice types. Overall, the mean moisture content rose from an initial value of 13.2% to a peak of 16.2% at time 7 before falling to 15.5% by time 10. The trend was not altogether unexpected in that it reflects the timing of the rainy season in the study area.

Individual trends for the two rice types are shown in Figure 1.

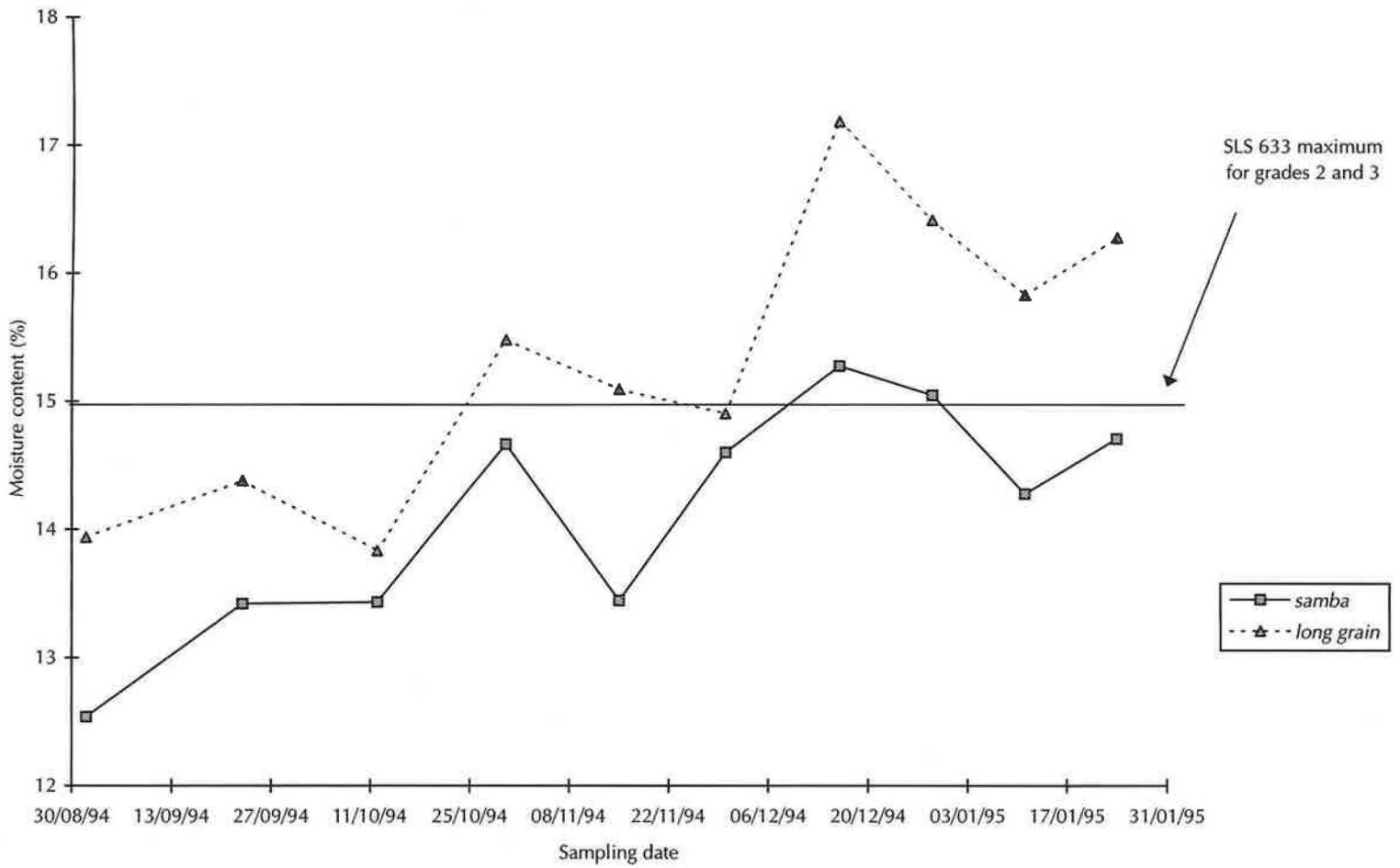


Figure 1 Moisture content (%) for *samba* and *long grain* rice at different sampling times

The mean moisture content of pooled samples at all intervals after time 3 was above 14%, the value generally accepted as a maximum for safe storage in the humid tropics and the maximum requirement of SLSI.

Colour

The overall mean colour value was 23, with a range from 14 to 31.

Samba was whiter than *long grain* rice by 2.5 units ($P<0.001$).

There were differences between processors which depended on the type of rice ($P<0.001$). For *samba* rice, the processor means ranged from 23.7 to 27.7 and for *long grain* rice ranged from 16.6 to 25.0. Processor variation was much greater for *long grain* than for *samba*.

There were no significant differences between sampling times.

Odour

The mean odour score was 2.27 although values ranged from one to five.

Samba rice had a better mean odour score than *long grain* rice by 0.8 of a score unit. ($P<0.001$), probably related to its lower moisture content.

Differences between processors depended on the type of rice ($P<0.001$) with the processors' mean scores for *long grain* rice ranging from 1.96 to 3.85 and for *samba* from 1.34 to 2.09.

There was a time trend for *samba* rice; poor odour corresponded with peak moisture content at T7 and then improved over T9 and T10. *Long grain* rice did not show this trend.

Foreign matter

SLSI requirements for Grade 2 parboiled milled rice stipulate a maximum foreign matter content of 1%.

The percentage foreign matter averaged 0.10% with a skewed distribution, ranging from zero to 1.25%, but with 75% of samples having values less than the mean. For analysis of variance a log transformation was used.

Long grain rice had a three-fold higher incidence of foreign matter than *samba* ($P<0.001$).

There were differences between processors, with geometric means varying from zero to 0.3% and these differences depended on the type of rice ($P<0.001$)

There were no significant differences between sampling times.

Black grain

SLSI does not specify a tolerance for black grain in its specification.

Percentage black grain in individual samples ranged from 0.3% to 4.2% with a mean of 1.4%.

Long grain rice had 0.7% more black grain on average than *samba* ($P<0.001$).

There were differences between processors which depended on the type of rice ($P=0.004$). For *long grain* rice, processors' means ranged from 1.0% to 2.4% and for *samba* ranged from 0.6% to 1.1%.

There were no significant differences between sampling times.

Damaged grain

SLSI requirements for Grade 2 parboiled milled rice stipulate a maximum damaged grain content of 4%.

Percentage of damaged grain had a mean of 2.2% with a skewed distribution ranging from 0.3% to 8.7%. For statistical analysis a log transformation was used.

There was little difference overall between the two rice types in terms of damaged grain with their geometric means differing by less than 0.3% (P=0.07).

There was some evidence of differences between processors (P=0.014) with these differences depending on the type of rice (P=0.035). The geometric means for processors ranged from 1.3% to 4.3% for *long grain* rice and from 1.4% to 2.1% for *samba*, with *samba* being less variable than *long grain* rice.

There were differences between sampling times (P=0.024). However, there was no continuous trend and geometric means ranged from 1.1% to 2.8%.

Average percentages of damaged grains are shown in Figure 2.

Paddy

SLSI requirements for Grade 2 parboiled milled rice stipulate a maximum paddy content of 25 grains per kilo.

The score for paddy had a skew distribution, ranging from zero to 105 grains per kilo, with a mean of 12.

This was not significantly affected by rice type, processor or sampling time.

Average paddy contents (number of grains per kilo) are shown in Figure 3.

Type admixture

SLSI requirements for Grade 2 parboiled milled rice stipulate a maximum admixture content of 6%.

The percentage of type admixture in individual samples ranged from 0% to 10.2% with a mean of 2.0%. A square root transformation was used prior to analysis of variance.

There was no significant effect of rice type or processor.

There was some indication of differences between sampling times but no obvious trend (P=0.084).

Average values for type admixture are shown in Figure 4.

Broken rice

SLSI requirements for Grade 2 parboiled milled rice stipulate a maximum broken rice content of 15%.

The mean value for broken grain was 14%, ranging from 2% to 35%. A square root transformation was used prior to analysis of variance.

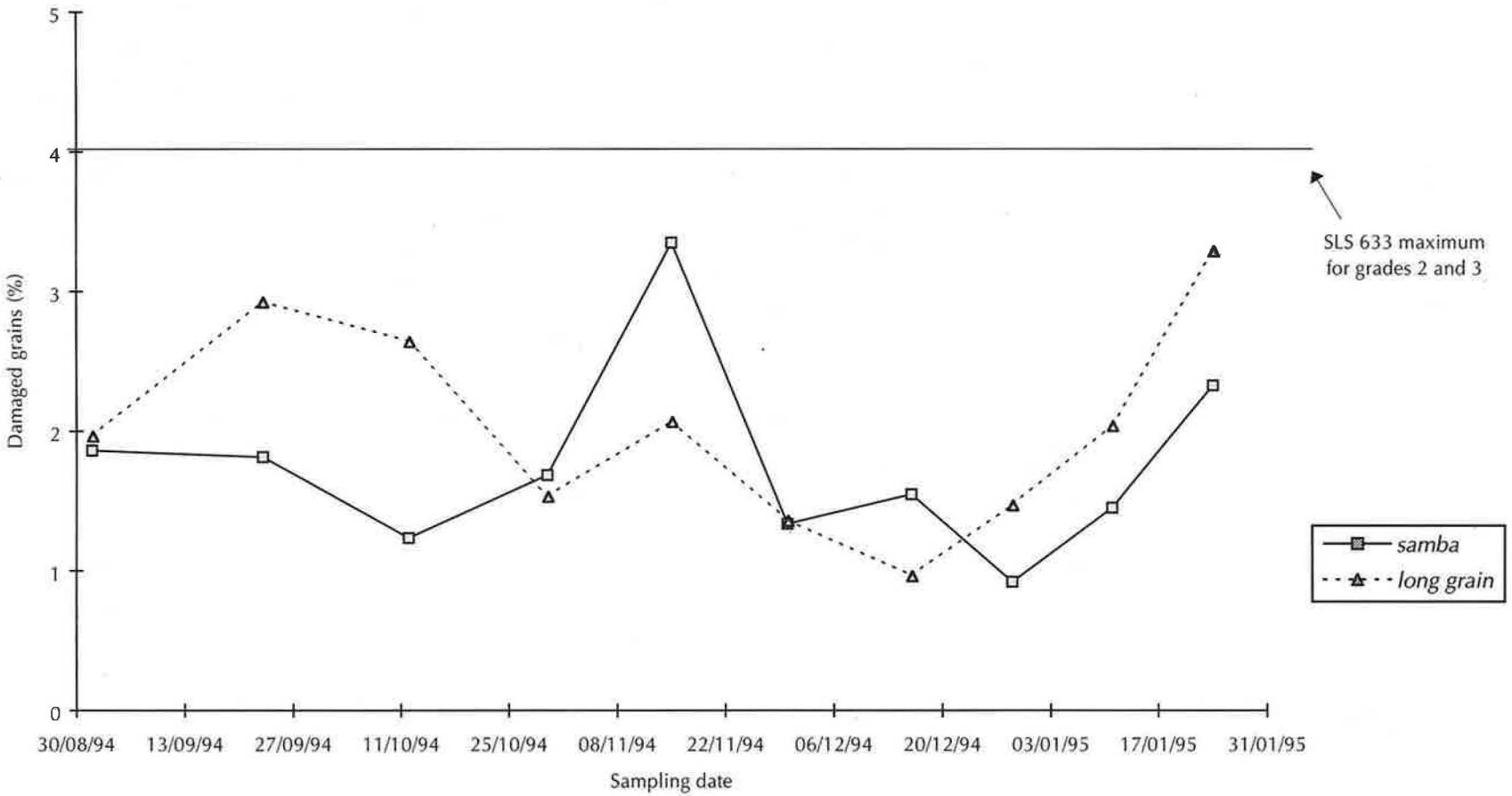


Figure 2 Percentage damaged grains for *samba* and *long grain* rice at different sampling times

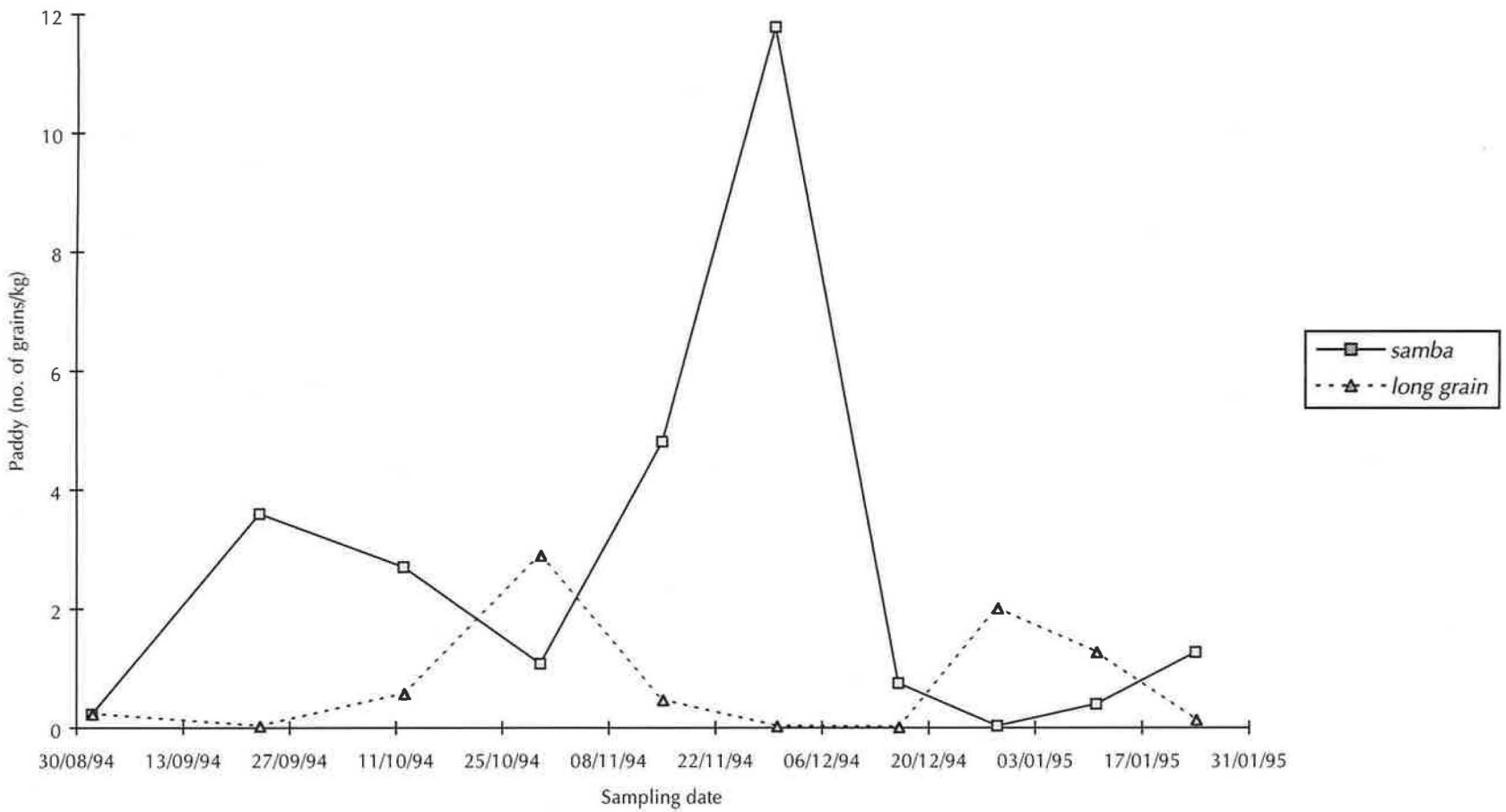


Figure 3 Paddy content (no. of grains per kg) of *samba* and *long grain* rice at different sampling times

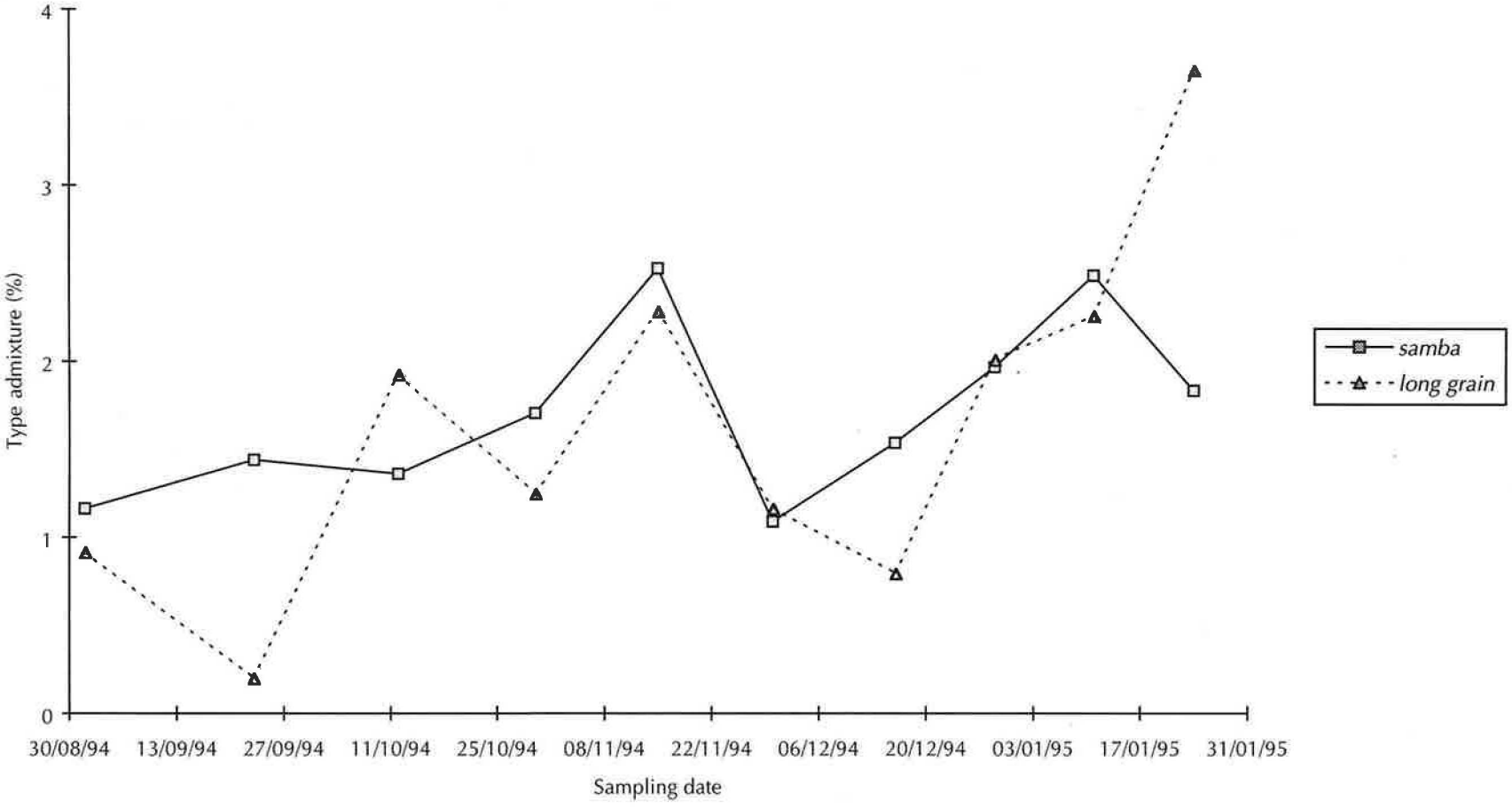


Figure 4 Type admixture (%) for *samba* and *long grain* rice at different sampling times

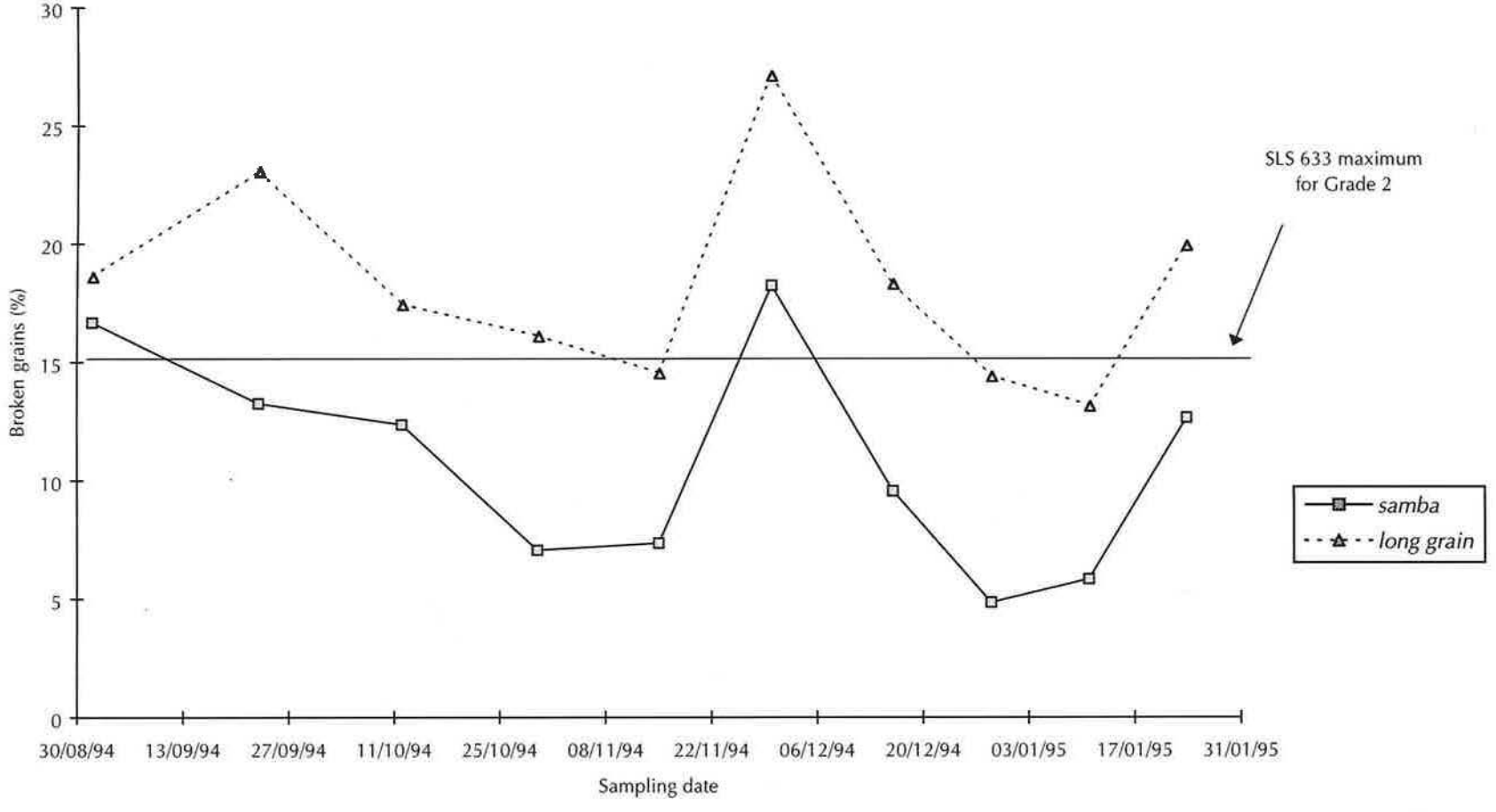


Figure 5 Percentage of broken grains for *samba* and *long grain* rice at different sampling times

Samba had less broken grain than *long grain* rice, the difference being 8% on the de-transformed scale. (P<0.001).

Differences between processors depended on rice type (P<0.001). Of the processors evaluated, one processor produced *long grain* rice with the lowest proportion of brokens while also producing *samba* rice with the highest proportion of brokens (*see* Appendix 2). For *samba*, de-transformed processor means ranged from 6.6% to 14.6% and for *long grain* rice ranged from 11.3% to 23.3%.

There were differences between sampling times (P<0.001) but no continuous trend. Means (de-transformed) ranged from 9% to 22%.

Mean values of broken grains are shown in Figure 5.

Equilibrium moisture content on soaking

The mean equilibrium moisture content on soaking (EMC-S) was 40.5, ranging from 34.7 to 64.4. In general, EMC-S values in the range 38-48% are considered to represent medium parboiled rice.

There was no significant difference between the two rice types in EMC-S.

There were significant differences between processors, and these depended on the type of rice. For *samba*, processors means ranged from 36.6 to 42.0 and for *long grain* rice ranged from 37.8 to 46.4.

There were differences between sampling times (P=0.008), but no continuous trend. Means ranged from 38.4 to 44.7.

Mean values for EMC-S are shown in Figure 6.

Market characteristics

Market valuation

Table 2 shows the results of price evaluation by processors and traders compared to published market value over the period of the study. *Samba* rice commanded the better price, approximately Rs 5 per kilo higher than *long grain*.

Table 2 Average price estimates (Rs/kg) from processors and traders, adjusted prices

Processor	*Samba* rice					*Long grain* rice				
	n	Processor valuation	SD	Trader valuation	SD	n	Processor valuation	SD	Trader valuation	SD
Processor 1	10	20.49	*1.14*	18.37	*0.59*	10	16.22	*1.20*	13.87	*0.50*
Processor 2	5	20.81	*1.82*	19.14	*1.09*	5	14.77	*1.70*	14.01	*0.66*
Processor 3	10	20.77	*1.21*	18.37	*0.81*	9	14.88	*1.33*	13.42	*0.66*
Processor 4	3	19.41	*0.91*	18.03	*0.94*	6	15.13	*1.53*	13.93	*0.49*
Processor 5	5	20.02	*1.12*	17.99	*0.44*	3	14.70	*0.18*	13.89	*0.18*
Processor 6	8	19.66	*1.24*	18.49	*0.33*	9	13.87	*1.77*	12.70	*0.60*
Average	41	20.30	*1.28*	18.41	*0.73*	42	14.99	*1.58*	13.55	*0.72*
Market (Grade 2)			19.65					14.34		

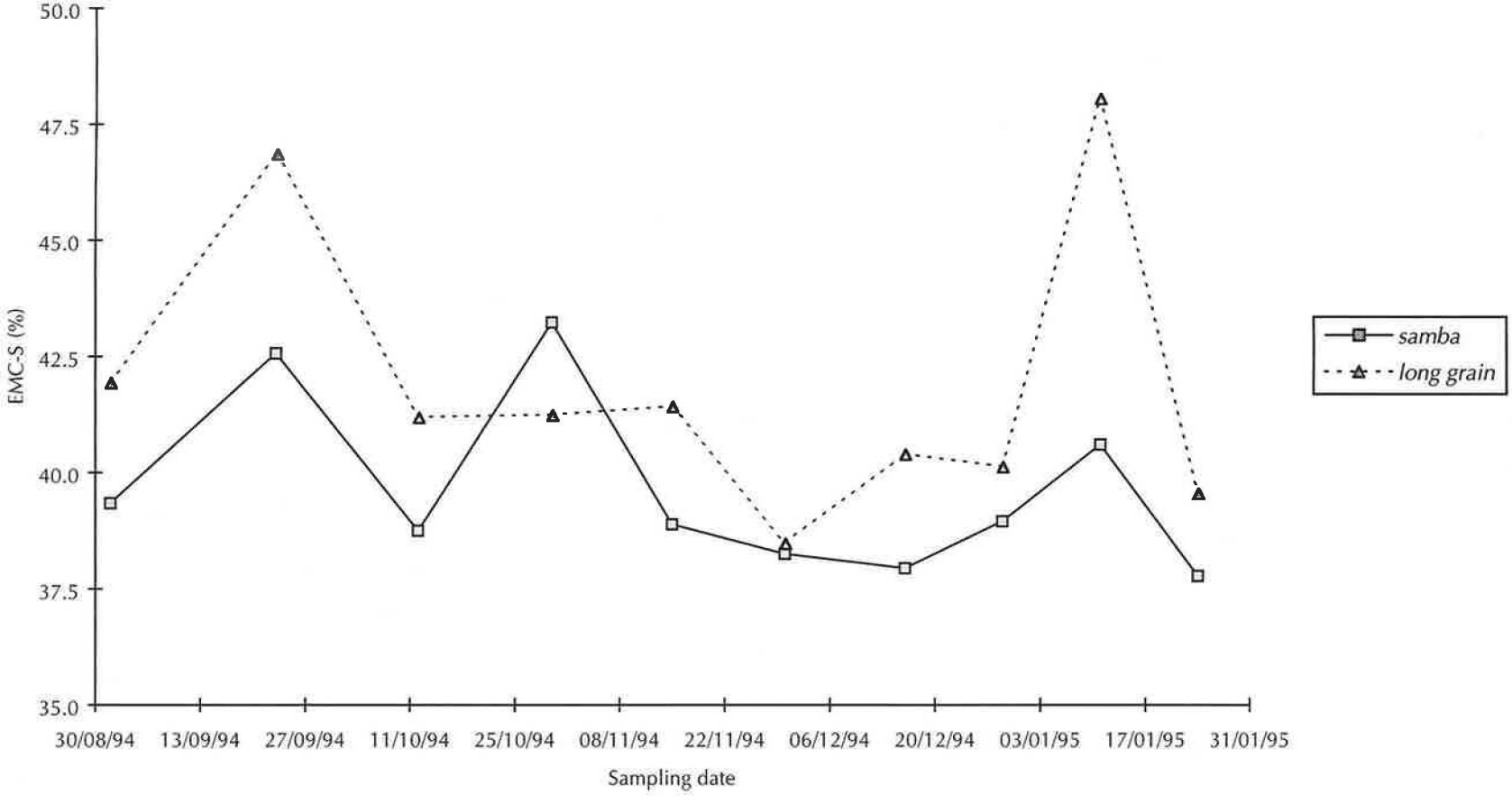


Figure 6 Mean equilibrium moisture content on soaking (EMC-S, %) for *samba* and *long grain* rice at different sampling times

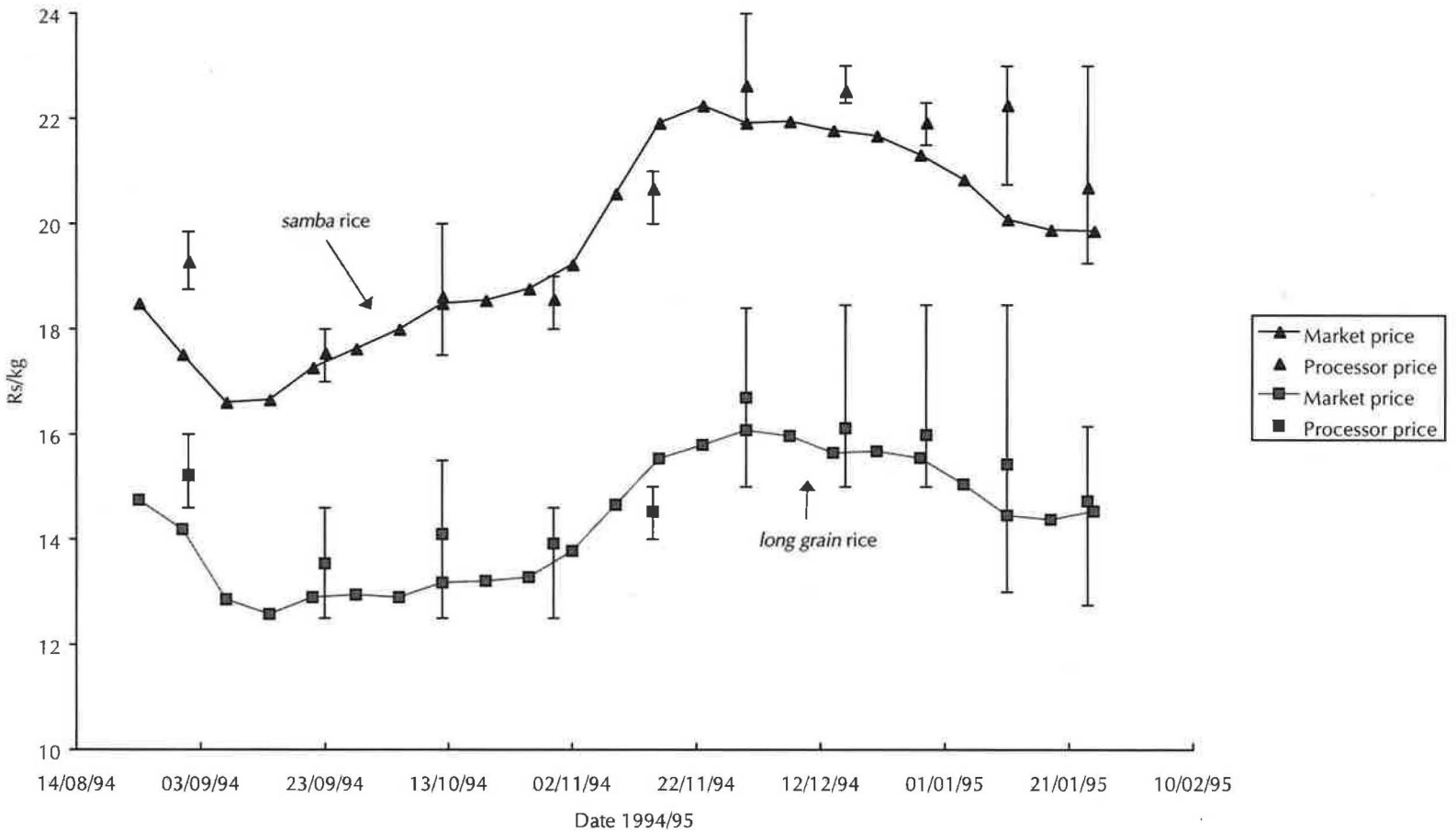


Figure 7 Processors' price vs wholesale market price
Processor price: unadjusted mean and range. Market price: Grade 2 unadjusted time series.

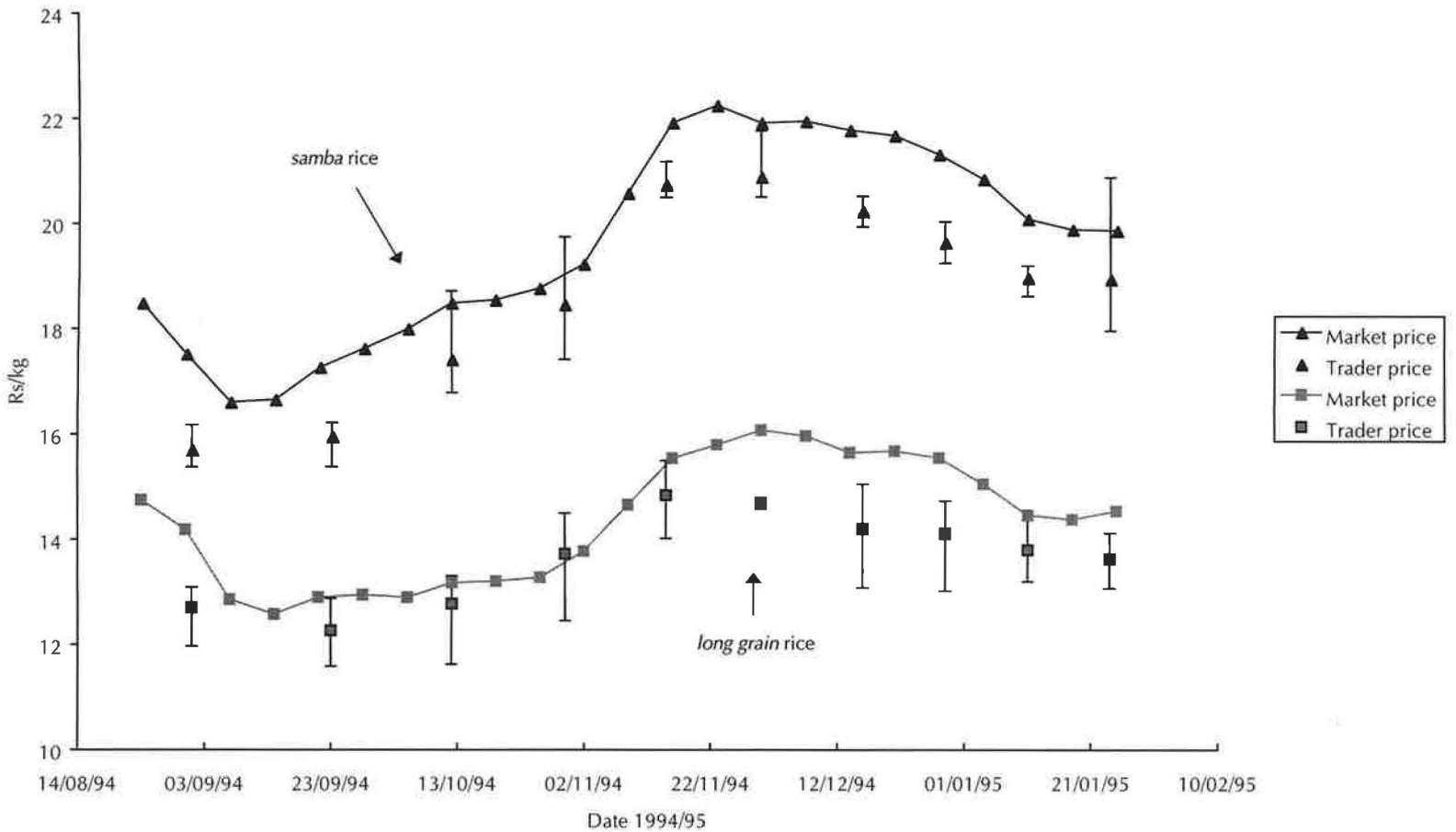


Figure 8 Traders' price vs wholesale market price
Trader price: unadjusted mean and range. Market price: Grade 2 unadjusted time series.

The processors gave an estimate of the market value of their own samples; they did not see nor evaluate samples from other processors. There was a range of Rs 1.40 per kg in *samba* rice means, representing 7.1% of adjusted market value, and Rs 2.35 per kg in *long grain* rice, or 15.8% of the adjusted market value.

The movement of prices over time was shown by market survey data published by the ARTI.

The wholesale price series for the nominal Grade 2 (undefined) of *samba* and *long grain* were used to plot against the processors valuation shown in Figure 7. These data were not adjusted before plotting, and therefore represent market movement during the study. As may be expected, the processor's valuation of his own product, in the main, was slightly optimistic, however both types of rice reflected market movement. An analysis of the data showed that the processors overvalued the product (both *samba* and *long grain*) by approximately 50 cents per kg on average compared with the latest available market price.

When compared with the processors' valuation, the traders were shown to be less generous, but followed a similar pattern. Where divergence occurred it was very slight.

The range in *samba* rice means was Rs 1.15 per kg, equivalent to 5.9% of adjusted market price, and Rs 1.31, (8.8%) for *long grain* rice.

The traders' valuation against market movement over time is shown in Figure 8. These data were not adjusted before plotting, and are comparable with the processors' data shown in Figure 7.

The traders' bias is evident, however both types of rice reflected market movement. Traders undervalued the product (both *samba* and *long grain*) by approximately one rupee per kg on average compared with the latest available market price.

Relationship between price and quality

The relationship between the trader valuation of samples and their quality as determined by the laboratory analyses. This was studied using stepwise multiple regression. The trader valuations were adjusted to eliminate overall market movements.

For *samba* rice, the best relationship used only colour, damaged grain and foreign matter, giving the equation:

$$\text{Value} = 14.48 + (0.176 \times \text{colour}) - (0.184 \times \text{foreign matter}) - (1.534 \times \text{damaged grain}) \quad (R^2 = 0.38)$$

For *long grain* rice, the best equation involved colour, moisture content and foreign matter. The equation was:

$$\text{Value} = 13.02 + (0.104 \times \text{colour}) - (0.515 \times \text{foreign matter}) - (0.108 \times \text{moisture content}) \quad (R = 0.50)$$

Colour, as measured in this study describes the 'whiteness' of the rice. For both varieties, rice with a relatively high level of colour or whiteness commanded a higher price. Conway *et al.* (1992) found that colour was also an important factor in rice pricing in Indonesia.

CONCLUSIONS

- Study methodology for examining quality/value relation ships in rice was successfully transferred to, and implemented in, Sri Lanka.

- Significant differences were found in the observed qualities of the two types of rice examined in the study. *Long grain* rice was of lesser quality than *samba* rice in respect of moisture content, colour, odour, foreign matter, damaged grain, black grain, broken grain and EMC-S.
- Both types of rice had a range in moisture content which could cause concern over storage stability.
- *Samba* type commanded a premium of approximately Rs 5 per kg over *long grain*. The producers of both types of rice on average valued them higher than did the traders, but both processor and trader shadowed the market trend.
- The range in mean valuation was greater between processors than between traders. The latter showed only about a 5% range as a percentage of adjusted market price.
- On the basis of the regression equations, traders considered grain colour, foreign matter and damaged grain to affect the price of *samba* rice; and grain colour, foreign matter and moisture content to affect the price of *long grain*.

As noted in the introduction, the three main factors to be considered in improving the market quality of rice are:

- the quality of paddy for milling must be improved;
- rice milling techniques must be improved; and
- a rice grading system should operate in the country which would not only standardize and rationalize a pricing system, but above all encourage the producer and processor to produce a superior quality rice.

Fernando and Palipane (1995) evaluated the quality of paddy produced in Anuradhapura District during 1993, and found that 74% of their samples would not have met any of the Grade Standards (SLS 632: 1984) and 22% would have fallen into Grades III and IV, considered to be inferior grades. Low grades were mainly due to high levels of moisture and foreign matter. The high moisture contents are attributable to inadequate drying at farm level, and the high levels of foreign matter to improper threshing (Fernando and Palipane, 1984). Pricing of paddy according to the existing Grade Standards would encourage farmers to improve paddy quality. However, there was competition between mills for the available paddy, creating a sellers market, and prices were negotiated on an *ad hoc* basis, without reference to quality standards. This provided an incentive for farmers to sell as much foreign matter in their paddy as possible (Day, 1996).

Since the rice millers were unable to affect paddy quality, their response has been to invest in precleaning and destoning equipment, in order to meet demand for destoned rice, and to remain competitive in the market (Day, 1996). This backs up the finding that (a lack of) foreign matter is a key quality factor in determining price.

Millers were also aware that price is closely related to colour, and cited colour as the quality factor they would most like to improve. Many millers have invested in rice polishers and improved steaming vessels to improve colour, or were considering doing so. This also supports the findings of this investigation.

Action to encourage the use of Grade Standards, and hence to improve farmer-level processing would improve the situation. Given the millers' awareness of quality, and their ability to invest in quality enhancing technology, any cost-effective improved parboiling or milling technology that enhanced rice colour would stand a good chance of uptake.

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Appendices

APPENDIX 1 SRI LANKA STANDARD: SPECIFICATION FOR MILLED RICE

Sri Lanka Standards Institution
SLS 633:1984

1 Scope

This specification prescribes the requirements and methods of sampling and test for raw milled rice and parboiled milled rice (*Oryza satvia* L).

2 References

CS	102	Presentation of numerical values
SLS	448	Analysis of food grains
		Part 1 Moisture
		Part 2 Refractions
SLS	528	Sampling of food grains

3 Definitions

3.1 Milled rice: shall be whole/head grains with or without broken kernels of rice (*Oryza satvia* L) from which the husk, germ and at least the outer coats of the kernel (outer bran) layers have been removed.

3.2 Parboiled rice: rice obtained after soaking paddy in water, steaming and drying before milling so as to gelatininse all or part of the starch in the grain mass.

3.3 Head rice: kernels of rice, which are three-fourths and more than three-fourths of whole kernels in length.

3.4 Red rice: kernels having red pericarp.

3.5 White rice: kernels having a white or cream coloured pericarp.

3.6 Germ: embryo situated at one end of the grain.

3.7 Rice bran: the outer covering of brown rice, which is removed during the polishing process. It is composed of the pericarp, seed coat, aleurone layer and the germ (bran may also contain parts of the outer endosperm).

3.8 Broken grain: broken kernels of rice which are less than three-fourths of the length of whole kernels.

3.9 Damaged grain: kernels which are distinctly identified as having been visibly affected by insects, heat, water, diseases or any other causative agent other than those caused by the milling process. Such grains could

have a substantial discoloration and include stained, spotted and yellow grains. This includes the grains of *Madi paddy* (damaged and discoloured).

3.10 Degree of milling: the extent or degree of bran removal (based on mass of paddy) as a result of milling. Rice can be under-milled, reasonably well-milled or well-milled as given below:
a) under-milled – below 4% bran removal;
b) reasonably well-milled – 4% to 7% bran removal;
c) well-milled – above 7% bran removal.

3.11 Commercially objectionable foreign odour: odours which are entirely foreign to rice and which because of their presence render rice unfit for its normal commercial usage.

3.12 Insect-infested grain: rice which contains live or dead weevils, insects, mites, their webbing or their refuse.

3.13 Adulteration: alteration of the composition of the milled rice by any means whatsoever with the resulting mixture not of the nature prescribed, its quality or flavour adversely affected or its bulk or mass changed.

3.14 Foreign matter: all matter other than rice (whole or broken) or paddy. Foreign matter includes such things as sand, stones, seeds of weed, fragments of paddy stalk, husk and dust.

4 Types

4.1 Rice shall be classified into the following types on the basis of the length of the kernels and colour of the pericarp. The basis of classification is as follows.
a) Long red (LR) – red pericarped rice having a grain length above 6.0 mm.
b) Long White (LW) – white pericarped rice having a grain length above 6.0 mm.
c) Medium Red (MR) – red pericarped rice having a grain length between 4.5 mm and 6.0 mm.
d) Medium White (MW) – white pericarped rice having a grain length between 4.5 mm and 6.0 mm.
e) Short White (SW) or *samba* – white pericarped rice having a grain length less than 4.5 mm.
f) Mixed type – mixed rice which contains less than 90% by mass of any one of the above types.

Note: Short red type has not been included in this specification, as it is not cultivated widely in Sri Lanka. The Department of Agriculture of Sri Lanka has discontinued the production of seed paddy of this type.

5 Grades

Milled rice and parboiled milled rice shall be classified into the following 4 grades as prescribed in Tables I and II:

a) Premium;
b) Grade 1;
c) Grade 2; and
d) Grade 3.

6 Requirements

6.1 Rice shall be free from commercially objectionable odour and insect infestation when examined as prescribed in Appendix A.

6.2 Rice shall not contain pesticide residues in excess of the limits laid down under the Food Act No. 26 of 1980.

Note: It is not necessary to carry out this determination as a routine for all the samples. It should be tested in case of dispute and when required by the purchaser or vendor.

6.3 Parboiled rice shall be of uniform colour and translucence.

6.4 Parboiled rice shall be reasonably well-milled or well-milled as defined in 3.10.

6.5 Raw milled rice shall conform to the requirements specified in Table 1 and parboiled milled rice shall conform to the requirements specified in Table 2 when tested by the relevant methods given in Column 7 of each table.

Table I Requirements for raw milled rice

Sl No.	Characteristics	Grades				Methods of test reference
		Premium	1	2	3	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i	Moisture, % max.	14.0	14.0	14.0	14.0	SLS 448: Part 1
ii	Foreign matter, % max.	0.2	0.5	1.0	1.5	SLS 448: Part 2
iii	Type admixture, % max.	0	2.0	6.0	10.0	Appendix C
iv	Damaged grain, % max.	0	1.0	2.0	4.0	Appendix C
v	Broken grain, % max.	10.0	20.0	35.0	45.0	Appendix C
vi	Paddy seeds, no./kg max.	0	10.0	30.0	50.0	Appendix B

Table II Requirements for parboiled milled rice

Sl No.	Characteristics	Grades				Methods of test reference
		Premium	1	2	3	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i	Moisture, % max.	14.0	14.0	15.0	15.0	SLS 448: Part 1
ii	Foreign matter, % max.	0.2	0.5	1.0	1.5	SLS 448: Part 2
iii	Type admixture, % max.	0.2	2.0	6.0	10.0	Appendix C
iv	Damaged grain, % max.	0.5	2.0	4.0	5.0	Appendix C
v	Broken grain, % max.	1.0	5.0	15.0	20.0	Appendix C
vi	Paddy seeds, no./kg max.	0	10.0	25.0	50.0	Appendix B

7 Packaging and marking

7.1 Packaging

Rice shall be packed in clean jute bags, woven polypropylene or coarse cloth bags. The mouth of each bag shall be securely stitched.

7.2 Marking

Each bag shall be marked legibly and indelibly or a label shall be attached to the bag with the following information:

a) name and address of the producer or trader;
b) trade mark, if any;
c) type;
d) grade;
e) net mass in kg; and
f) Month and year of harvest.

Note – When bags are being re-used, the existing markings shall be crossed out with indelible ink or dye.

8 Sampling

9 Methods of test

10 Conformity to standard

Not reproduced here.

APPENDIX 2 MEAN VALUES (ADJUSTED) OVERALL AND FOR INDIVIDUAL PROCESSORS FOR *SAMBA* AND *LONG GRAIN* RICE

	n	Moisture content	Colour	Odour	Foreign matter		Broken grain		Black grain	Damaged grain		Paddy		Type admixture		EMC-S
					log (x+.1)	de-trans.	√	de-trans.		log (x+.1)	de-trans.	log (x+.1)	de-trans	√	de-trans	
Samba	41	14.1	24.9	1.77	−2.05	0.03	3.22	10.3	0.97	0.56	1.65	0.29	1.24	1.30	1.68	39.6
Long grain	42	15.3	22.5	2.56	−1.56	0.11	4.25	18.1	1.68	0.70	1.91	−0.74	0.38	1.22	1.49	41.9
Samba																
Processor 1	10	14.1	23.8	1.84	−2.27	0.00	2.95	8.7	1.40	0.42	1.43	1.46	4.20	1.30	1.70	38.0
2	5	13.3	27.7	2.09	−2.22	0.01	3.01	9.0	0.59	0.66	1.84	0.48	1.52	1.57	2.48	40.3
3	10	14.9	24.3	2.07	−2.30	0.00	3.44	11.8	0.88	0.56	1.64	−1.06	0.25	1.17	1.38	41.7
4	3	14.1	25.0	1.45	−2.25	0.01	3.51	12.3	1.07	0.77	2.06	−2.36	−0.01	0.99	0.98	42.0
5	5	15.1	24.9	1.83	−1.05	0.25	2.57	6.6	0.79	0.41	1.41	3.57	35.47	1.25	1.55	39.2
6	8	13.5	23.7	1.34	−2.23	0.01	3.82	14.6	1.07	0.53	1.60	−0.36	0.60	1.48	2.20	36.6
Long grain																
Processor 1	10	15.0	24.9	2.07	−2.26	0.00	3.94	15.5	1.46	0.36	1.33	−1.79	0.07	1.59	2.52	37.8
2	5	16.2	24.9	2.01	−1.56	0.11	4.82	23.3	1.71	0.36	1.33	−1.54	0.11	1.09	1.19	39.8
3	9	14.6	20.0	3.44	−2.04	0.03	4.77	22.7	2.22	0.63	1.78	−0.17	0.75	1.29	1.66	40.7
4	6	15.6	23.7	1.96	−1.64	0.09	3.79	14.3	1.21	0.73	1.98	−1.43	0.14	0.85	0.73	41.5
5	3	15.4	25.0	2.03	−0.91	0.30	4.82	23.2	1.04	0.62	1.77	0.81	2.15	1.06	1.11	46.4
6	9	15.2	16.6	3.85	−0.99	0.27	3.37	11.3	2.42	1.49	4.34	−0.29	0.65	1.46	2.14	45.4
Residual SD		0.950	1.878	0.581	0.376		0.711		0.587	0.509		2.500		0.547		3.825
F-test probabilities																
Rice type (R)		<0.001	<0.001	<0.001	<0.001		<0.001		<0.001	0.074		–		–		0.017
Sampling time (T)		<0.001	–	–	–		<0.001		–	0.024		0.081		0.087		0.008
Processor (P)		–	<0.001	<0.001	<0.001		0.083		0.011	0.014		0.083		–		0.042
R × T interaction		–	–	–	–		–		–	–		–		–		–
R × P interaction		0.004	<0.001	<0.001	<0.001		0.001		0.004	0.035		0.108		–		0.002

Note: – signifies $p > 0.1$.

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As grain markets become more liberalized, quality and price become more important for producers and traders in securing market share. A previous NRI Bulletin (No. 55) reported methodology and quality/value relationships for raw paddy. This publication, **Quality Perceptions of Parboiled Rice marketed in Sri Lanka**, describes the evaluation of quality/value relationships for parboiled rice.

This Bulletin will be of use to researchers in developing countries looking to evaluate these relationships, and to influencing cost-effective quality improvements.