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Staff Paper

**PROCESSING AND PREPARATION COSTS FOR RICE
AND COARSE GRAINS IN URBAN MALI:
SUBJECTING AN *IPSE DIXIT* TO EMPIRICAL
SCRUTINY**

by David Dibley, Duncan Boughton, and Thomas Reardon

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Processing and Preparation Costs for Rice and Coarse Grains in Urban Mali: Subjecting an *Ipse Dixit* to Empirical Scrutiny

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Abstract: This paper uses household survey data from Bamako, Mali, to address three questions, important in the policy debate concerning the determinants of the substitution from coarse grains to rice in West African diets, and policy options. The questions are: (1) What are the relative costs of rice and coarse grain-based dishes, with and without complementary sauce costs? (2) What are the shares in total cost of individual processing and preparation stages? (3) Are pre-processed coarse grains (e.g., dehulled grain or flour) cheaper to consume than coarse grains processed in the household? Contrary to prevailing opinion, the paper shows that despite higher processing costs, coarse grain-based dishes are cheaper than rice-based dishes. The main contributory factors to the higher cost of rice-based dishes are sauce cost, cereal cost and preparation (cooking and sauce preparation) time. The result holds true over a wide range of rice and coarse grain prices, and opportunity costs of women's time, suggesting that the finding applies more generally to the urban Sahel and not just Bamako. Moreover, coarse grain-based dishes need not take longer to process and prepare than rice-based dishes if the dehulling step is mechanized. However, pre-processed coarse grains are not competitive with household processing given present technology and opportunity costs of women's time. Nor will coarse grains be able to retain the extent of their cost advantage over rice as incomes and labor opportunity costs rise without improvements in the efficiency of processing services.

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PROCESSING AND PREPARATION COSTS FOR RICE AND COARSE GRAINS IN URBAN MALI: SUBJECTING AN *IPSE DIXIT* TO EMPIRICAL SCRUTINY

In recent decades, consumption patterns in the Sahel have been shifting from traditional coarse grains (millet, sorghum, and maize), to non-traditional grains, particularly rice (Delgado and Reardon, 1987). The shift has occurred primarily, although not exclusively, in urban areas (Reardon, 1993). Unable to meet increased demand for rice through local production, Sahelian countries have been obliged to rely instead on imports, aggravating balance of payments deficits in the region. The low observed substitutability between rice and coarse grains (e.g., see Rogers and Lowdermilk, 1992) is a major constraint to the effectiveness of policy initiatives to change this long-term trend. In the short run, weak substitutability of local for imported foodgrains will accentuate the real income consequences and diminish the intended balance of payments improvement resulting from the recent CFA franc devaluation (Boughton and Sanogo, 1994; Staatz et al., 1994).

Attempts to measure and explain the degree of substitution between rice and coarse grains are usually predicated on neoclassical consumption theory that predicts that consumption of different goods and services will depend on their relative costs. The cost of consuming a given cereal is made up of four components: (i) the cereal purchase price, (ii) processing costs, (iii) preparation costs, and (iv) costs of sauce ingredients.¹ While many authors who seek to explain constraints to higher urban consumption of coarse grains in the Sahel emphasize that coarse grains are more costly and time consuming to process and prepare than rice (e.g., Thiombiano, 1986; Bricas and Sauvinet, 1989; Holtzman et al., 1991), there is to our knowledge no published empirical study that compares the complete set of costs for rice- and coarse grain-based dishes from purchase of raw grain through to final consumption of the prepared dish counting all processing and preparation stages in between.

¹ We define processing costs to include all resource expenditures (cleaning, dehulling, washing, milling, sieving) used to convert raw grain into the form in which it goes into the cooking pot; preparation costs include all resource expenditures to transform fully-processed grain into an edible dish.

Rogers and Lowdermilk (1992) examine the relative cost of cooked rice and coarse grains for urban areas of Mali. They take account of milling costs and processing losses, but leave out fuel costs and labor costs for processing and preparation (the opportunity cost of women's time for these tasks). Kennedy and Reardon (1994) incorporate proxy variables for the opportunity cost of women's time in quantitative analysis of cross-section determinants of household rice expenditures for Kenya and Burkina. They find that as the opportunity cost of women's time rises, so does consumption of convenience foods (rice and wheat). This correlation implies that processing and preparation costs make rice more attractive and coarse grains less attractive as the opportunity cost of women's time rises.

But would a full accounting of rice and coarse grain processing and preparation costs confirm these explanations for low observed substitution? If sauce costs are much higher for coarse grains than for rice, then a policy emphasis on reducing processing costs might be misplaced. Alternatively, if sauce (in the dish, accompanying the prepared cereal base) costs are lower for coarse grains, perhaps even more emphasis should be accorded to processing issues. If processing costs are not a major component when the opportunity cost of women's time is accounted for, perhaps more research on the way consumer preferences evolve in the urban environment is needed. If processing costs are a major component, then attention can be directed to opportunities to provide processing services at a lower cost. At the very least, a detailed breakdown of costs will help tailor the design of research and policy to the underlying structure of disincentives to increased utilization of coarse grains.

As a preliminary attempt to fill this gap in research, we undertake an empirical study of the importance of processing and preparation costs in the total cost of rice and coarse grain consumption using detailed observations of food preparation by households in Bamako, Mali. Specifically, we address three key questions:

- 1) What are the relative costs of rice and coarse grain-based dishes, with and without sauce costs?
- 2) What are the shares in total cost of individual processing and preparation stages?

- 3) Are pre-processed coarse grains (e.g., dehulled grain or flour) cheaper to consume than coarse grains processed in the household?

Contrary to prevailing opinion, our results show that, despite higher processing costs, coarse grain-based dishes are cheaper than rice-based dishes. The main contributory factors to the higher cost of rice-based dishes are sauce cost, cereal cost and preparation (cooking and sauce preparation) time. Although sauce costs magnify the difference in cost between rice- and coarse grain-based dishes, the latter are still cheaper when differences in sauce cost are ignored (i.e., comparing only the costs of the prepared cereal). The result holds true over a wide range of rice and coarse grain prices, and opportunity costs of women's time, suggesting that the finding applies more generally to the urban Sahel and not just Bamako. Coarse grain-based dishes need not take longer to process and prepare than rice-based dishes if the dehulling step is mechanized. However, pre-processed coarse grains are not competitive with household processing given present technology and opportunity costs of women's time. Nor will coarse grains be able to retain the extent of their cost advantage over rice as incomes and labor opportunity costs rise without improvements in the efficiency of processing services.

Differential sauce costs are an important determinant of relative total dish costs. Flexibility in rice sauce composition and quality provides households with the option to absorb increases in rice prices in part through lower expenditure on sauce. This may be a contributory factor to low observed substitution between rice and coarse grains.

The paper proceeds as follows: (i) discussion of research methods and measurement of women's opportunity cost of time, (ii) comparison of processing and preparation costs for coarse grains and rice at the household level, (iii) comparison of costs for home and pre-processed coarse grains, and (iv) conclusions.

Research Methods

To estimate the cost of coarse grain-based dishes we focus on the example of "toh", the dish which accounts for the major share of coarse grains consumed in Bamako.² To make toh, the outer layer of the grain (pericarp) must first be removed by a process called dehulling. Although mechanical (Engleberg-type) custom dehullers are available in the city, the majority of women dehull manually with pestle and mortar. The grain is then winnowed to separate it from the bran, and washed. The clean, dehulled grain (now at approximately 80 per cent of the original whole-grain weight) is then ground into flour. Although this task can also be accomplished manually, the practice of taking dehulled grain to a local custom plate mill is almost universal. The flour is taken back to the home, sieved, and boiled into a thick paste. The cooked toh is eaten by dipping little cakes or patties of toh into an accompanying sauce. Rice, by contrast, need only be cleaned before cooking (hand-removal of small stones and other foreign material followed by washing), then eaten in combination with sauce.

Our study was undertaken during the second quarter of 1993 with 30 Bamako households, a representative subset of a larger sample participating in a maize consumption survey.³ A female enumerator observed and timed all aspects of the processing and preparation of 18 toh and 12 rice dishes, one in each household.⁴ All costs incurred from market purchase to final consumption were measured

² Rice is the most commonly consumed midday meal, with 97% of a Bamako survey sample reporting that they consume rice regularly at home, 18% reporting toh. In the evening, toh was consumed by 63% of the households, rice by 26% of the households (Nutrisset S.A., 1993).

³ The objectives and sampling methods of this study are described in Témé and Boughton (1992).

⁴ Although toh and rice dishes were not prepared by the same households, the households are located in the same areas of the city and hence have similar socio-economic characteristics. The reason for the larger number of observations for toh is the higher expected variability in total cost for this dish due to multiple processing tasks.

in terms of money and time. These include the cost of grain, potash,⁵ sauce ingredients, fuelwood used to prepare the dish, dehulling, cleaning, milling, sifting, and cooking. Transport costs were recorded but are ignored in the analysis because all cereals and ingredients are available in the same local market and hence do not vary by dish. These costs are grouped into four cost categories for the analysis: cereal, processing, preparation and sauce.⁶

COST CATEGORY	CEREAL		CASH SPENT		TIME SPENT
	RICE	COARSE GRAIN	GOOD	SERVICE	
CEREAL	✓	✓	✓		
PROCESSING					
Dehulling/winnowing		✓			✓
Cleaning	✓	✓			✓
Milling/sieving		✓		✓	✓
PREPARATION					
Preparation	✓	✓			✓
Fuelwood	✓	✓	✓		
Potash	✓	✓	✓		
SAUCE	✓	✓	✓		

For each dish and component of expenditure we calculate the average time or cash outlay per kilogram of uncooked cereal prepared for the whole sample, weighted by the quantity of uncooked cereal prepared in each household. Labor input (time) per kilogram of uncooked cereal prepared is valued at

⁵ Potash is used to improve and preserve the consistency of toh, a portion of which may be kept overnight for consumption the following morning.

⁶ Differences in the amortization of kitchen equipment used to prepare rice and toh are insignificant and therefore ignored. Additional equipment needed for coarse grains are a wooden mortar, pestle and sieves. Sieves are replaced annually at a cost of 250 CFA F, while a mortar and pestle lasts a minimum of ten years, replaced at 2500 CFA F. Differential amortization amounts to less than one CFA F per meal.

the opportunity cost of women's time (see below). A "basic sauce" accompanies each dish,⁷ to which meat and fish can be added according to the level of the household income. We include only expenditures for the basic sauce.

Toh was prepared from sorghum in 10 cases, maize in six, and millet in two. The purchase price, processing, and preparation costs did not differ widely among the three cereals. We therefore pool observations on toh prepared from different coarse grains.⁸

Three methods of valuing the opportunity cost of women's time were considered: (i) the legal minimum wage, (ii) the cost of domestic help, and (iii) women's reported earnings in the informal sector. The legal minimum wage was rejected for two reasons. First, it is only relevant to a minority of women working in the formal sector. Second, even for this group, the minimum wage does not accurately reflect opportunity cost since the four salaried employees in the sample all hired a maid to prepare and cook meals. Average remuneration for domestic help of 9000 CFA F per month (wage plus board) implies an opportunity cost of time of 50 CFA F per hour.⁹ This figure is similar to earnings in the informal sector more generally. Sample women engaging in petty commerce, for example (the most common secondary activity), reported an average daily income of 300 CFA F (range 125 CFA F to 500 CFA F).

⁷ Rice sauces are prepared with a greater variety of ingredients than toh sauces. Rice sauces typically include tomato concentrate, onions, other vegetables (eggplant, cabbage and okra), seasonings and water. Additionally, peanut sauce requires peanut butter and onion sauce requires cooking oil. Ingredients for the toh sauce are typically okra, powdered leaves, seasonings and water. This is referred to as a 'green sauce'. A second 'red sauce', similar to the onion sauce for rice, may accompany the meal. One third of households preparing toh also prepared the 'red sauce'. We therefore calculate the cost of toh with one- and two-sauce options.

⁸ Maize must be soaked for about four hours after dehulling and before the grain is milled. This does not preclude other activities and hence is not counted as a time cost. Nevertheless, the added inconvenience is one factor limiting more widespread consumption of maize in urban areas.

⁹ Wages are 4000 CFA F per month. We value board at 200 CFA F per day, the cost of two meals. Assuming 25 days worked per month, the total wage is 9000 CFA F per month, or 45 CFA F per hour based on eight hours work per day. We adjust up to 50 CFA F per hour. 9000 CFA F per month is roughly equal to one-third of the minimum wage.

Assuming six hours of commerce daily, the opportunity cost of time is again 50 CFA F per hour. Thus, whether a maid is hired to prepare food or whether income from informal sector activities is foregone an estimate of 50 CFA F/hour seems reasonable.

Processing and Preparation Costs for Coarse Grains and Rice

Table I presents the average cost of *toh* and prepared rice dishes, expressed in CFA F per 1,000 kcal of consumable cereal.¹⁰ Figure I displays the shares in total dish cost of cereal, processing, preparation and sauce costs for *toh* and rice.

The total cost of prepared rice is higher than *toh*, although the share of processing and preparation in total cost is lower. The price of uncooked rice is nearly 1.7 times that of coarse grains, whereas the cost of prepared rice (ignoring sauce costs) is only 1.3 times that of *toh*. This reflects the higher processing costs of coarse grains (accounting for 16 per cent of the total cost of *toh* compared to less than 3 per cent for rice). Taking account of sauce costs (including both *toh* sauces), the price of prepared rice rises slightly to just over 1.3 times that of *toh*.

The finding that prepared rice is more expensive than *toh* is robust with respect to sensitivity analyses for changes in the opportunity cost of labor and relative cereal prices. A doubling of the opportunity cost of labor reduces, but does not eliminate, the cost disadvantage of prepared rice from 1.26 to 1.21 (excluding sauce costs). Halving the opportunity of labor (appropriate to the availability of unemployed family members or children for processing tasks) increases the cost disadvantage to 1.30.

¹⁰ The denominator of consumable energy is the most objective basis of comparison. Comparing the costs of cooked rice and *toh* per kilogram of raw grain consumed would ignore the processing losses for coarse grains and underestimate their true cost. Comparing the costs of cooked rice and *toh* per kilogram of cooked cereal would be determined in part by relative water absorption rather than nutritional content.

Sensitivity analysis for relative cereal prices reveals that prepared rice is more expensive than *toh* for all combinations of cereal prices observed during the cereal marketing year December 1992 to November 1993 (Boughton and Sanogo, 1994). Following devaluation in January 1994, rice prices in Bamako rose sharply to nearly 200 CFA F/kg for high quality and 170 CFA F/kg for low quality rice by March. Coarse grain prices ranged from 70 - 75 CFA F/kg, close to their level at the time of our study (OPAM/SIM, 1994). At these post-devaluation prices, the cost disadvantage of rice increases from 1.26 to a minimum of 1.33. Further widening of the gap between rice and coarse grain prices will continue to increase the cost disadvantage of rice.

Figure 2 illustrates results of the sensitivity analyses graphically. The two lines represent all combinations of rice and coarse grain prices that equate the cost of prepared rice and *toh* (the lower line including, and the upper line excluding sauce cost).¹¹ For all combinations of prices above and to the left of a given line, prepared rice is more expensive than *toh*. For prices below and to the right, prepared *toh* is more expensive than rice. The shaded area above and to the left of the upper line is the region in which retail prices for rice and coarse grains in Bamako fluctuated during the 1992/1993 cereal marketing year. The entire area is above and to the left of the upper line, indicating that at no time in the 1992/1993 cereal marketing year was prepared rice less expensive than *toh*, even excluding the higher sauce costs of rice.

The difference between the two lines reflects the difference in the cost of ingredients for the basic sauce. The additional ingredients required for rice sauces are generally more expensive than the ingredients common to both rice and *toh* sauces. Households can vary the quality of sauces and this provides an option to keep the relative cost of rice- and coarse-grain based dishes stable in the face of fluctuating relative cereal prices, contributing to low substitutability between rice and coarse grains.

¹¹ This approach is equivalent to Rogers and Lowdermilk (1992). Their analysis could be represented by a line lying slightly below and to the right of the upper line in figure 2 since they exclude fuelwood and the opportunity cost of women's time, as well as sauce costs.

The conclusion of the foregoing analyses is that processing costs are not a sufficient reason to explain the secular decline in consumption of traditional cereals in the urban Sahel over the past two decades. However, the present cost advantage of prepared coarse grains will be gradually eroded over time as the opportunity cost of women's time increases unless processing costs can be reduced. This leads us to examine the competitiveness of pre-processed versus household-processing of coarse grains under varying opportunity costs of women's time.

Cost Competitiveness of Processed and Unprocessed Coarse Grains

Table 2 presents the cost of *toh* prepared from home- and pre-processed coarse grains. Two pre-processed products are included in the analysis: grain purchased in dehulled form and grains purchased in the form of flour.¹² Purchasing grain in dehulled form enables the consumer to avoid the time and processing losses incurred in dehulling and cleaning. Purchasing flour enables the consumer to avoid the time and expense of milling as well. Because processing services are embodied in the products, these products cost more. Starting with either dehulled grain or purchased flour, *toh* can be made as quickly as a rice dish. At a price of 70 CFA F/kg for raw grain, corresponding retail prices would be 115 CFA F/kg for dehulled grain and 150 CFA F/kg for refined (dehulled and degermed) flour given existing technology (Boughton et al., 1993).

At the estimated opportunity cost of women's time (50 CFA F/hour), *toh* prepared from grain purchased in dehulled form is 7 per cent, and from purchased flour 13 per cent, more expensive than *toh* prepared from home-processed grain (bottom line of Table 2). At a lower opportunity cost of 25 CFA

¹² Dehulled coarse grains are available in several Bamako markets. The volume is small relative to unprocessed grain (less than 5%), and the main clientele are street vendors and working housewives (Boughton et al., 1993). No commercially manufactured coarse grain flour is available in Bamako at the present time. Market pre-tests of maize flour, in collaboration with potential flour manufacturers and the IER-MSU maize subsector study, are at the analysis phase.

F/hour for women's time (applicable to families with unemployed members or children available to perform processing tasks), toh prepared from grain purchased in dehulled form is 12 per cent more expensive, and from purchased flour 23 per cent more expensive, than toh prepared from home-processed grain. The opportunity cost of labor would have to rise to 100 CFA F/hour for grain purchased in dehulled form to become competitive with home-processed grain given existing dehulling technology.¹³

The conclusion from this analysis is that coarse grains will not be able to retain their existing cost advantage over rice as incomes and labor opportunity costs rise without improvements in the efficiency of processing services. Boughton et al. (1993) estimate that cost savings of 10 per cent in the provision of dehulling services are possible through technological innovation and changes in market organization.¹⁴ The only way to significantly reduce the cost of flour in the near term is through the use of whole grain maize (which avoids the cost of dehulling and has a 98 per cent extraction rate). This product is gaining widespread acceptance in urban areas of southern and eastern Africa (Jayne and Rubey, 1993; Mukumbu and Jayne, 1994).

Conclusions

The study reveals that, in Bamako, toh, a typical coarse grain based-dish, is cheaper than rice over a wide range of relative cereal prices even when all dish- or cereal-specific processing and preparation costs are accounted for, and with or without the cost of sauce ingredients. Higher processing

¹³ Given generally higher incomes in urban areas, this finding is consistent with that of a 1991 study of coarse grain processing in rural areas of Mali which found that milling charges were three times the opportunity cost of women's time (Fischer et al., 1992).

¹⁴ Holtzman et al. (1991) recommend the promotion of more efficient abrasive disc dehullers in place of Engleberg dehullers (designed for rice). Boughton et al. (1993) further advocate the re-location of dehulling services at wholesaler instead of retail level to save on transport and energy costs, and permit more effective utilization of by-products for livestock feed.

costs for coarse grains cannot by themselves, then, explain the secular decline in urban consumption of traditional cereals in the Sahel. Rather, this suggests that rice has one or more attributes, in addition to ease of preparation, that give consumers a high level of satisfaction from rice consumption. Examples might include taste preferences or image (association with affluent or modern consumption patterns). A better understanding of the structure and evolution of preferences with economic and urban development in the Sahel is needed to determine what food technology or policy initiatives could increase substitutability between rice and coarse grains.

One possible contributory factor to low observed substitution between rice and coarse grains may be flexibility in (accompanying) sauce costs. By varying the number and quality of sauces, households can keep the relative costs of rice- and coarse grain-based dishes stable even when relative cereal prices fluctuate. This needs to be verified empirically.

Coarse grain-based dishes can be prepared just as quickly as rice-based dishes using either grain purchased in dehulled form or purchased flour. However, grain purchased in dehulled form and purchased flour are not competitive with home-processed coarse grain at prevailing opportunity costs of women's time given existing processing technologies and market organization. To improve, or even retain, the cost advantage of coarse grains as the opportunity cost of women's time rises, it will be necessary to enhance the efficiency and availability of processing services. In Mali, the introduction of abrasive disk dehullers at wholesaler level could significantly reduce the cost of dehulling services. Subject to consumer acceptability, one possibility for a significant reduction in the cost of coarse grain flour would be the use of whole-grain maize, a product gaining widespread consumer acceptability in urban areas of eastern and southern Africa (Mukumbu and Jayne, 1994; Rubey, 1993).

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TABLE 1: Costs of prepared rice and toh (CFA F/1000 kcal)

Cost Item	RICE (N = 12)	TOH (N = 18)	RICE/TOH
CEREAL COST	41.3	25.3	1.64
PROCESSING COSTS			
Dehulling time	0	3.6	
Cleaning time	1.6	0.9	
Milling time	0	2.7	
Milling cost	0	3.6	
SUB-TOTAL PROCESSING COST	1.6	10.7	0.15
PREPARATION COSTS			
Preparation time	13.1	7.4	
Fuelwood cost	9.4	7.5	
Potash cost	0	1.1	
SUB-TOTAL PREPARATION COSTS	22.5	16.0	1.41
TOTAL COST PREPARED STAPLE	65.4	51.9	1.26
Sauce cost (with second toh sauce)	40.2	15.3 28.1	2.63 1.43
TOTAL COST PREPARED DISH			
With one toh sauce	105.6	67.2	1.57
With two toh sauces	105.6	80.0	1.32

Notes:

1. Based on an energy content of 3630 kcal/kg for rice and 2810 kcal/kg for coarse grains, adjusted for processing losses (Kelly et al., 1993)

2. Based on the following average household labor time (minutes) and cash (CFA F) costs per kilo of cereal prepared:

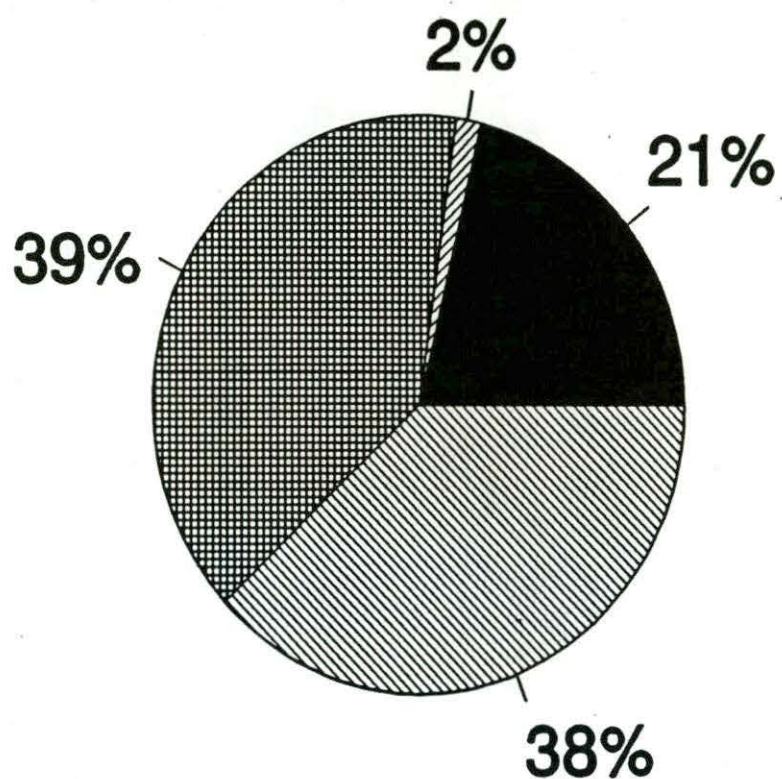
	RICE	TOH
Cereal purchase price (CFA F)	150	71
Milling charges (CFA F)	-	10
Firewood (CFA F)	34	21
Potash (CFA F)	-	3
Sauce ingredients (CFA F)	146	43
Second toh sauce ingredients (CFA F)	-	36
Dehulling time (minutes)	-	12
Cleaning time (minutes)	7	3
Milling time (minutes)	-	9
Preparation time (minutes)	57	25

3. The price of rice used in this analysis applies to "low quality" rice, locally produced and dehulled by small scale dehullers. Using a price for higher quality rice (i.e. imported or factory-processed) would only reinforce the conclusions.

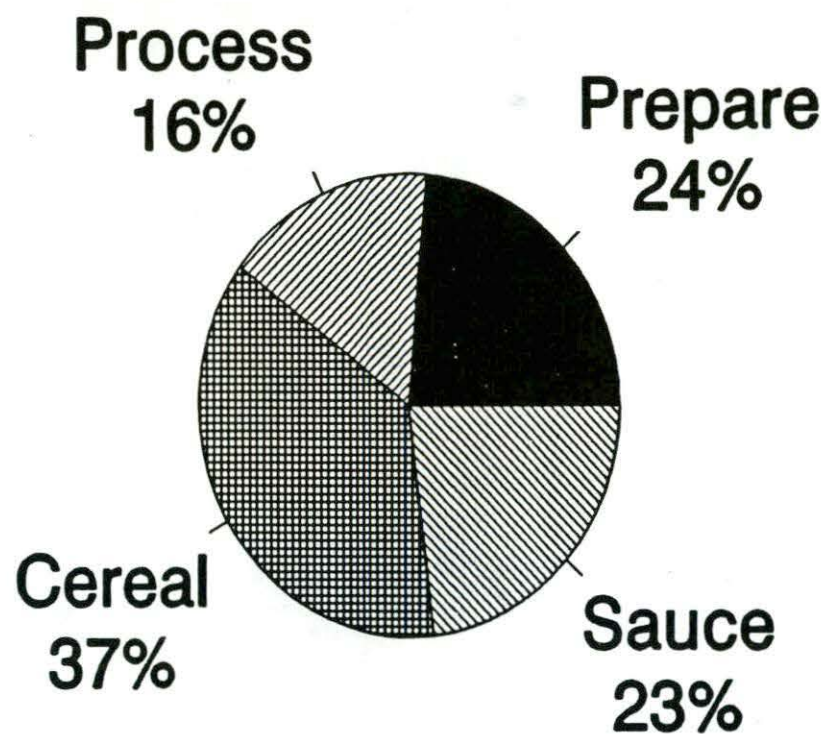
TABLE 2: Relative costs of toh prepared from whole grain, dehulled grain and flour (CFA F/1000 kcal)

Cost Item	WHOLE GRAIN (A)	DEHULLED GRAIN (B)	RATIO B/A	FLOUR (C)	RATIO C/A
CEREAL COST	25.3	32.6	1.29	42.5	1.68
PROCESSING COSTS					
Dehulling time	3.6	0		0	
Cleaning time	0.9	0.9		0	
Milling time	2.7	2.7		0	
Milling cost	3.6	3.6		0	
SUB-TOTAL PROCESSING COST	10.7	7.1	0.67	0	0
PREPARATION COSTS					
Preparation time	7.4	7.4		7.4	
Fuelwood cost	7.5	7.5		7.5	
Potash cost	1.1	1.1		1.1	
SUB-TOTAL PREPARATION COSTS	16.0	16.0	1.00	16.0	1.00
TOTAL COST PREPARED STAPLE	51.9	55.7	1.07	58.4	1.13

FIGURE 1: SHARES OF CEREAL, PROCESSING, PREPARATION AND SAUCE IN TOTAL COST

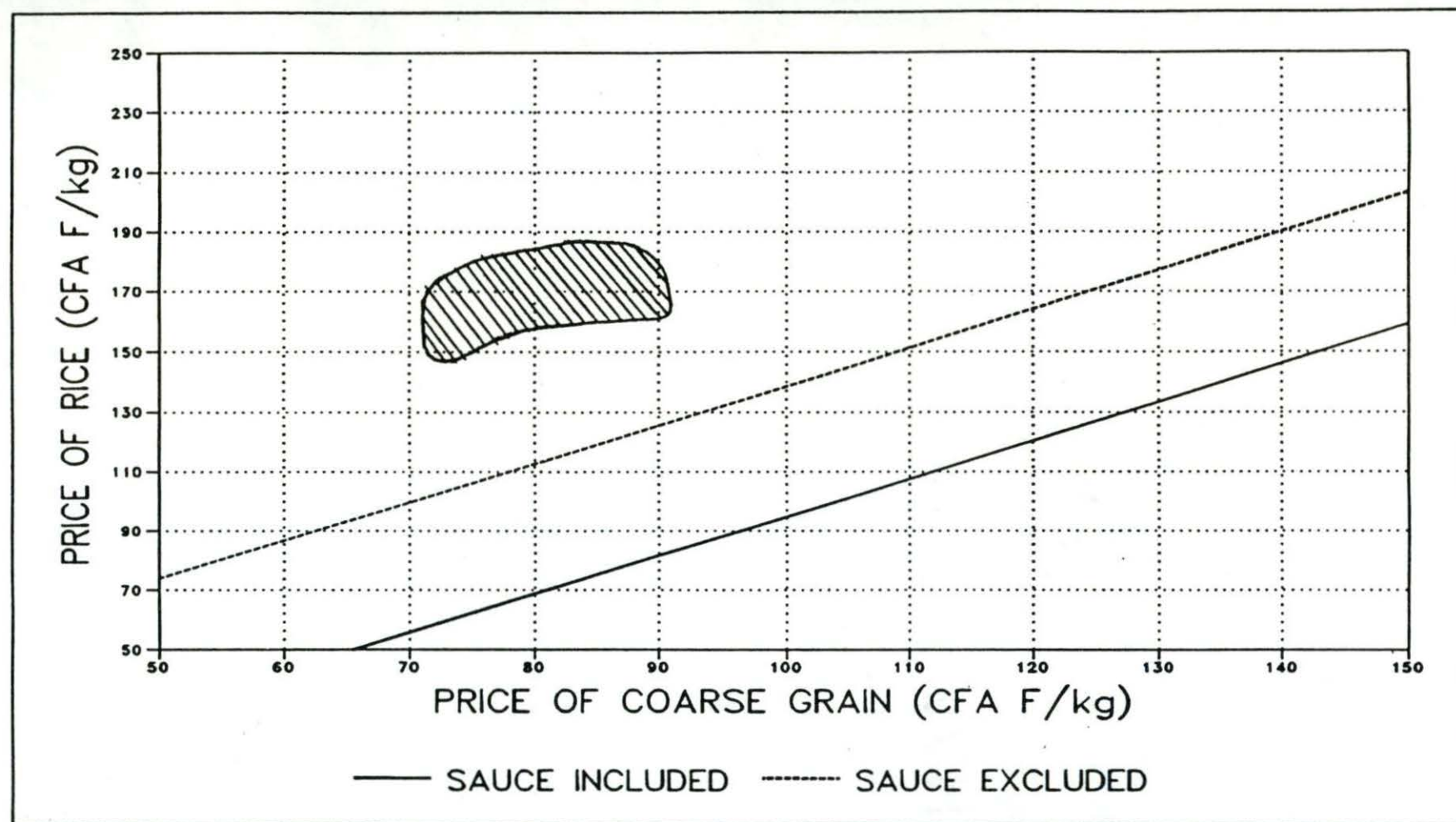


RICE



TOH

FIGURE 2: RELATIVE COST OF RICE- AND COARSE GRAIN-BASED MEALS FOR DIFFERENT CEREAL PRICES



Notes:

1. For toh, the cost of sauce includes the basic green and optional red sauce.
2. The hatched area represents cereal prices observed during the 1992/1993 cereal marketing year.