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**Cereal Consumption Shifts and Policy Changes in Developing Countries:  
General Trends and Case Studies  
from the West African Semi-Arid Tropics**

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## I. INTRODUCTION

One of the central aspects of food policy in the developing world is the growing disarticulation between what food staples the tropical areas produce and what they consume. This is especially true of the tropical areas that have traditionally relied upon the three major coarse grains: maize, sorghum, and millet. This paper focuses on sorghum, but in practice it is difficult to separately analyze the roles of sorghum and millet where these two crops are both used for human nutrition.<sup>1</sup>

After showing that other cereals have tended to outpace sorghum in production and consumption in most parts of the developing world over the past twenty years, the paper will show that sorghum continues to play a dominant role in human nutrition in the West African Semi-Arid Tropics (WASAT), alone among the world's regions. Yet even in the WASAT major changes are occurring. The rest of the paper will examine consumption trends and their determinants in detail in the major producing and consuming area for sorghum in the WASAT. This will provide a case study of the economic policy issues involved in the increasing substitution in consumption patterns of imported wheat and

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<sup>1</sup> The weakness of statistical services in the countries concerned and the frequent practice of intercropping make the separation of millet and sorghum in national-level statistics difficult in many countries and impossible in some.

rice for domestic millet and sorghum. The paper will conclude with consideration of some broader issues raised by the overall patterns.

## 2. THE SHIFTING PLACE OF SORGHUM IN THE WORLD

Sub-Saharan Africa stands out as the only major region of the world where sorghum and millet have the dominant role in cereals production. The two crops account for a four times larger share of total 1988 cereals production in that region than is the case in Latin America, and a nine times larger share than in Asia, as shown in Table 1. In 1988, Sub-Saharan Africa was also the absolute largest producer of sorghum and millet. At 22.4 million metric tons, production in the region just exceeded the total for Asia (excluding China).

Furthermore, the only major region where sorghum output growth has outstripped population growth over the 1961 to 1988 period is in Latin America, due to the spectacular successes in feed grain production in Brazil. With this exception in mind, Table 1 also shows that the output growth rates both of maize (a competitor) and of all cereals exceeded those of sorghum/millet.

Net trade flows need to be added to production trends to get a rough idea of consumption patterns by region. The country categories involving Africa in the analysis of world sorghum trade in Table 2

reflect FAO practice, which are different from the IFPRI categories in Table 1.<sup>2</sup>

Asia (excluding China) is the major importing region of the world; the main commodity involves feed sorghum for the rapidly growing economies of East Asia such as Taiwan, Japan, and Korea. Net trade flows were 20 percent higher in the 1985/87 period than in the late 1960s. Latin America has gone from being a clear net exporter to being a marginal importer, even though the volume of trade in sorghum has doubled since the late 1960s. As a whole, developing countries are marginally net importers, and developed countries as a whole are modest net exporters.<sup>3</sup>

Despite the important role of sorghum in cereals production in the "developing market economies" category of Africa, the region as a whole is a net importer, which is indicative of the important role of the crop as a human food source in that region, since the use of grain sorghum as a feed is relatively limited in Africa. Yet major changes are occurring in the use of sorghum for human nutrition in Africa, especially in the WASAT.

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<sup>2</sup> World exports and imports seem not to fully cancel each other out because of the omission of a few countries and a slightly overlapping classification of countries.

<sup>3</sup> Although of course some individual developed countries export en masse to some individual developing countries.

### 3. SHIFTING CEREALS PATTERNS IN WEST AFRICA

As elsewhere in the tropics, policy attention in the WASAT has turned to the major imbalance between the composition of cereals consumption and that of production. Annual per capita rice and wheat consumption in West Africa as a whole rose by more than 16 kilograms from the early 1960s to the early 1980s, whereas millet and sorghum consumption fell by more than 22 kilograms. Maize consumption increased by less than 1 kilogram per person per year over the same period.

Besides the growing drain on foreign exchange, policymakers are concerned about the outlook for production of coarse grains. They account for four-fifths of cropped area in a Sahelian agricultural sector that continues to employ roughly three-quarters of the overall population. The prospects for decreasing unit production costs for coarse grains in the WASAT appear good. However, Sahelian wheat production prospects remain poor, and rice production growth has lagged behind consumption growth (15 percent of cereals production in the early 1980s and 21 percent of consumption).

To improve on estimates of the sources of growth in sorghum production in the WASAT over the 1961 to 1989 period, World Bank data sets for three producing countries are analyzed in Table 3. Sorghum grew at about the same rate as overall cereals production over the period, which was less than the approximately 3 percent rate of population growth, leading to a decline in per capita production. Furthermore, approximately two-thirds of the growth in production over the period came from growth in area harvested.

The use of the FAO Supply Utilization Accounts data permits an estimate of the growth of consumption of sorghum and millet in West Africa from the late 1960's to the mid 1980's, following the disappearance concept. In the major countries of the WASAT, as in West Africa as a whole, the growth in human consumption of all cereals clearly exceeded the growth in sorghum consumption as food. Even so, the consumption of all cereals grew more slowly than population in Burkina Faso and Mali, and human consumption of sorghum per capita appears to have fallen for all major countries in the region, as shown in Table 4.

The use of cereals as feed in the region has grown at about the same rate as human consumption, but from a very much smaller base. Except for Niger and Senegal, where sorghum has kept up with other cereals in this regard, other cereals have contributed more than sorghum to growth in feed use. Since the feed growth rates include by-products, it should be noted that the growth in feed use in the region is accounted for largely by the use of wheat by-products from flour mills and rice by-products!

The greater rates of growth in human consumption of other cereals relative to millet and sorghum suggest that the relative share of food supply accounted for by millet and sorghum in West Africa has declined since the late 1960s. The major shares of sorghum and millet in human consumption of all food staples<sup>4</sup> in the region, especially in the interior countries such as Burkina Faso, are shown in Table 5. It can be seen that the proportions have fallen distinctly since the late

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<sup>4</sup> including roots and tubers, starchy tree crops, pulses and legumes.

1960s. For all of West Africa, the share of sorghum and millet in human food staple consumption has fallen from 36 percent to 31 percent. On the other hand, the shares remain high, and the available data confirm the dominant role of sorghum over millet.

The share of cereals consumption accounted for by sorghum and millet fell by about one-sixth in all of West Africa from the late 1960s to the second half of the 1980s. Details by WASAT country and West Africa as a whole, by food and feed, are given in Table 6. At the same time as the share of sorghum and millet declined by 11 percent of total cereals consumption, the share of rice and wheat grew by the same amount. Maize made relatively little progress in the region over the same period. Since wheat can only be produced in the region under cold season irrigation at high cost, and rice production is certainly not likely able to expand to meet demand at current world price levels, these trends have raised considerable concern in the region with respect to the future of imports (Delgado and Miller, 1985).

#### 4. DETERMINANTS OF CHANGING PATTERNS OF CEREAL USE IN WEST AFRICA

##### AGGREGATE-LEVEL EVIDENCE

Some observers posit that the rise of rice and wheat consumption in West Africa over the 1970's and 1980's is the consequence of the declining domestic production of coarse grains, thus attributing shifting consumption patterns to deficiencies in sorghum and millet supply. Excess demand was met by imports, on this account, and it is primarily rice and wheat that are available on international markets.

However, it seems more likely that changes in cereal consumption patterns in the WASAT have primarily been driven by demand. Despite bumper harvests in the Sahel in 1985 and 1986, and a consequent fall in coarse grain prices to one-third to one-tenth their 1984 levels, commercial imports of wheat and rice continued at high levels. In Mali, for example, commercial rice and wheat imports still accounted for 8 percent of total imports in 1986, a year of bumper domestic stocks of coarse grains.

Commercial rice and wheat imports in Burkina Faso over the past twenty years are not significantly correlated with coarse grain production. Reardon, Delgado, and Thiombiano (forthcoming) regressed rice and wheat imports from 1970 to 1986 against an index of self-sufficiency in coarse grains, population, share of population living in urban areas, and the world price of rice in real terms. Only the degree of urbanization had a significant effect (positive). Work on rice imports in Senegal, which grew steadily over the last two decades, shows that they were not significantly correlated with movements in domestic cereal production (Lombard 1988).

If changing cereals patterns are primarily demand-driven, then the question arises as to the role of relative cereals prices. Some observers believe that the changing cereals demand patterns are caused by relatively low rice and wheat prices, especially in the mid-to late-1980's. From 1970 to 1986, world cereals prices as a group fell about one-third relative to the price of manufactures. However, rice prices fell 1.5 times as fast as coarse grain prices, implying that rice was getting cheaper relative to both coarse grains and manufactures on

international markets. Similar trends could be observed in national rice and wheat prices relative to coarse grains and manufactures in most of West Africa.

The world price of rice was more than one-third cheaper relative to the world price of sorghum in the 1982-86 period than in the late 1960s, as shown in Table 7. Even though there was a substantial recovery in 1988, it can be seen that rice appears to be cheaper for the long-haul relative to sorghum after the 1985 U.S. Farm Bill. Similarly, the consumer price of rice relative to coarse grains fell greatly in West Africa through 1986, but has recovered more recently to levels that are comparable to (or presently exceed) the "normal" levels of the late 1960s. A major factor in this evolution has been the escalating cost of coarse grains in West Africa during the 1984 drought and the bumper crops (and thus falling prices) thereafter.

On the other hand, the experience with wheat in West Africa is very diverse; adding Ghana and Nigeria to Table 7 would only amplify this conclusion. As in the case of the relative price of rice, wildly fluctuating prices for local staples in the denominators have been responsible for much of the variation in price ratios among countries. Nevertheless, wheat pricing policy in the 1960s and 1970's was very different across the region, with high subsidies in Senegal, especially in the earlier part of the period, and some taxation in Burkina Faso. Since the mid-1980s, with the growing share of wheat in consumption and the increased concern for fiscal austerity, there has been considerably more uniformity within the region in fixing the nominal price of bread at a level not very different from world import parities.

Given the possibly temporary nature of the world price dip, many fear that low cereals prices in the WASAT will induce cereal production resources to permanently leave the agricultural sector. Therefore, given the view that changing relative prices have both promoted past substitution in cereals consumption patterns and that the process could even be reversed if rice and wheat prices were raised, they have advocated commercial policies to increase domestic rice and wheat prices in the WASAT relative to all other prices. Nigeria, for example, has attempted to ban all rice and wheat imports. The Club du Sahel has urged creation of a regional protected zone for cereals in West Africa, characterized by a high common external tariff for cereals imports from outside the region (Delgado 1991).

One approach to assessing the role of prices in promoting the change in West African consumption patterns in sorghum producing areas is to examine national level annual data on average consumer prices (in the capital city), GDP per capita, consumption (total disappearance) by cereal, and non-cereal expenditures in a theoretically-consistent framework. This would allow the role of various long-term trends in relative price in influencing consumption patterns to be considered in detail.

Such a framework is provided by the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980). This was estimated separately for secondary aggregate annual data from 1966 to 1986 for Mali, Senegal, and Burkina Faso.<sup>5</sup> Key results are given in Table 8. In addition to the

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<sup>5</sup> See Delgado (1989) for a discussion of data sources.

tenuous nature of secondary national-level data in the WASAT, it should be borne in mind that such estimations implicitly assume that many other factors remain constant. An example of pertinence would be the distribution of income, since the use of the level of GDP per capita assumes that income was not becoming increasingly concentrated in towns over the period (which is most probably not true). Disclaimers aside, the aggregate results seem useful for looking at long-term trends.

The results show inelastic demand response of the expected sign to changes in own-price for coarse grains. For example, a long term rise of 1 percent in the price of sorghum in Mali, other things equal, is associated with a 0.07 percent decrease in the quantity demanded for coarse grains. These compensated elasticities represent long-term adjustments, and can be expected to be considerably more elastic than short-run responses.

Cross-price elasticities measure the substitution effects of changes in the prices of other crops on the quantity demanded of coarse grains. They show virtually no impact of wheat prices and very little impact of rice prices on coarse grains consumption.<sup>6</sup> Finally, coarse grains appear to be income-inelastic in the long run. The estimated negative or insignificant expenditure elasticities are surprising in view of the basic poverty of the region.

The results for rice suggest that the quantity demanded is somewhat responsive to the price of rice in the long-run, and quite responsive to income. On the other hand, there is little substitutability with wheat

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<sup>6</sup> Except for a small impact in Mali, which is a major rice producer as well as consumer.

(near-zero cross-price elasticities). For Mali and Burkina Faso, two interior countries, the quantity of rice demanded is responsive in the expected positive manner to the price of coarse grains (in Mali, for example, a 1 percent increase in coarse grains prices is associated with a 0.75 percent increase in the quantity demanded of rice.)

The aggregate results are somewhat misleading for assessing the impact of policy-induced changes in relative cereals prices in the short to medium run on consumption patterns. The price changes and responses modeled are in fact long-term trends arising from various exogenous as well as endogenous forces. They are not really comparable to the responses that governments could expect from sectoral price policies in the short to medium run.

Primarily, this is because in the long-run WASAT countries are no longer able to deliberately keep domestic price relatives for importable and domestic cereals at levels far different from world price relatives, because of the fiscal cost of the subsidies involved. Furthermore, taxation of importable cereals to raise their relative prices cannot be maintained under austerity conditions for very long, due to the welfare and political costs in the areas now heavily dependent on imports (Delgado 1991; Reardon, forthcoming).

In addition, the aggregate results do not sufficiently capture the effects of structural change on consumption coming from changes in non-price factors, such as income distribution. Therefore, diagnosis of what is really pushing consumption behavior in the WASAT and of what can feasibly be done about it requires detailed micro-level work that takes into account the relevant non-price factors.

### MICRO-LEVEL EVIDENCE<sup>7</sup>

The careful household-level surveys available do not support the notion that major shifts in cereals consumption patterns in the Sahel are driven by price changes. Three household-level studies provide consumer price elasticities for the Sahel: the Purdue University/SAFGRAD study, and the IFPRI/Centre d'Etudes, de Documentation, et de Recherches Economiques et Sociales (CEDRES)--University of Ouagadougou study, and the Tufts University/Direction Nationale de la Statistique et de l'Informatique (DNSI) study of Bamako and secondary Malian cities.

Each of the surveys covered one year, with frequent re-interviewing of the same households. Therefore, they each provide considerable depth as to household behavior, but they do not allow for major adaptations over time to fundamental changes in incentives.

Savadogo (1986), based on the Purdue University survey of 65 households in Ouagadougou in 1982/83, found a negative cross-price elasticity (-1.1) between rice (grain-form only, excluding prepared-rice purchases) and wheat on one hand, and all coarse grains combined on the other. He surmised that the negative elasticity was caused by very low variation in the rice price over the study period. Only the own-price effects on rice consumption appeared to be significant, however, and these were relatively high (-2).

Reardon, Delgado, and Thiombiano (forthcoming), based on the IFPRI/CEDRES survey in Ouagadougou in 1984/85, with a sample of 125 households, found that own-price elasticities for rice expenditures were

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<sup>7</sup>. This section draws heavily on section 2 of Reardon (forthcoming).

not significant. Cross-price elasticities between rice (grain-form and prepared-form purchases) and millet/sorghum, and between rice and maize, were negative and significant (-1.7 for maize/rice, and -3.2 for rice/millet-sorghum). Hence, when the when coarse grain prices increased, rice expenditure fell. However, they found no significant cross-price elasticity between wheat products and coarse grains.

Rogers and Lowdermilk (1988), using data from a survey conducted in 1985/86 by the DNSI in seven regional capitals in Mali, with a sample of 576 households, found that rice (grain-form only, excluding prepared-rice purchases) expenditure had a negative and significant (but inelastic) own-price elasticity (-.68), as did millet/sorghum (-.53). Yet they found that the price of rice did not significantly influence millet/sorghum expenditure; nor did the price of millet/sorghum significantly influence rice expenditure.

Although limited in time dimension, the survey results above suggest the predominance of urbanization in explaining the shift to rice in the national diets. Urbanization changes employment patterns, the value of women's time, and increases the cost of returning home for the midday meal. These factors make rice, and in particular "fast-food" or street vendor rice, very attractive to poor consumers.

## 5. URBANIZATION AND CHANGING CONSUMPTION PATTERNS<sup>8</sup>

Imported rice and wheat are consumed mainly in urban areas in most of the Sahel. Moreover, the share of rice and wheat is high not only in Sahel coastal cities, but also in urban areas far inland. The population of the Sahel doubled from 1965 to 1983, but the urban population more than quintupled; the average share of the urban population was 12 percent in 1965, and 22 percent in 1983 (Gabas and Giri, 1987). It is clear that urban consumption patterns have had and will have increasing impact on national diet and import patterns.

Frequent-interview household surveys contradict the belief that it is mainly the richer consumers that eat imported cereals, even if this was perhaps true during and immediately after the colonial era. In general, they show that rice is very important in the diet of the urban Sahelian -- particularly the poorest third of the population. A survey of the literature shows that the share of rice in urban cereal consumption ranges from 37 to 66 percent, with an average of 52 percent. On the other hand, consumption of wheat products such as bread and noodles is far less prevalent than that of rice; the average share of wheat products in cereal expenditures varies from 7 to 17 percent.

In the surveys where the data collected permitted stratification by income group, households in the poorest third of the urban population were found to spend at least as high a share of income on rice as did the richest third of households. However, richer consumers spent a much

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<sup>8</sup> This section draws heavily on section 2 of Reardon (forthcoming).

greater share of their cereal expenditures on wheat products than did the poor.

The great success of rice in street-restaurant sales of prepared foods is also an important factor in the increase in importance of rice in general in the urban Sahel (Reardon and Delgado, 1987; Sautier et al. 1989). Reardon, Thiombiano, and Delgado (1988) showed the importance of purchases of prepared rice from street vendors in overall rice purchases in Ouagadougou -- especially for the poor. 50 percent of the poor tercile's rice expenditure went to prepared rice dishes consumed in roadside shacks, versus only 10 percent for the richest tercile. These results concur with results from rapid-reconnaissance surveys in Niamey, Bamako, and Dakar, reviewed in Bricas and Sauvinet (1989). Relatively poor urban workers are typically far from home at midday, and need to buy a cheap but filling meal near the worksite. The richer consumers usually can return home to eat rice or coarse grain dishes prepared in their own kitchens, with better access to transport and typically living closer to the main business centers of town.

Furthermore, at home in the kitchen, the lower processing/preparation costs of rice appear to be an incentive for its consumption (Thiombiano, 1985; Sautier et al. 1989.). The opportunity cost of women's time is increasing due to their increasing involvement in the labor market. This trend is part of a larger trend in the Third World toward "convenience foods" often made from fine cereals such as wheat (Byerlee 1983; Senauer, Sahn, and Alderman 1986).

In sum, the switch to rice consumption in the WASAT appears to be driven by structural factors rather than shorter-run factors such as

harvest shortfalls or price dips. This makes the substitution tendency persist despite short-run increases in the relative price of rice (due, for example, to bumper harvests of millet and sorghum in 1986).

The assessment of changing grain patterns in the urban WASAT would not be complete without considering maize. The present importance of maize in urban consumption patterns in the WASAT is low: the share of maize in total cereal consumption is rarely greater than one-seventh in Sahelian cities.

Yet maize appears to be attractive to urban consumers. There is a high degree of substitutability among the various coarse grains in many typical Sahel dishes (Reardon, Delgado, Thiombiano, 1988; Sautier et al. 1989). Furthermore, the ratio of maize to sorghum prices tends to dip in the hot/dry and rainy seasons. This is because of the timing of humid coastal maize harvests and Sahel sorghum harvests. Reardon, Delgado, and Thiombiano (forthcoming) found for Ouagadougou that the cross-price elasticity of millet/sorghum expenditure with respect to the price of maize was significant and positive (.6), indicating that they are substitutes and that consumers are sensitive to their relative price. Moreover, maize is easier to process than either millet or sorghum.

## 6. CHANGING CERELAS DEMAND PATTERNS IN RURAL AREAS OF THE SAHEL<sup>9</sup>

A survey of the literature shows very little rice and wheat consumption in rural areas, where millet, sorghum, and maize reign supreme. The exceptions to this rule -- where rice is an important item -- are found in three types of areas: (i) highly monetized or semi-urban rural zones -- especially where households produce cash crops or have substantial off-farm activity (e.g. northern Peanut Basin of Senegal; (ii) rice-growing areas (e.g. Casamance in Senegal); (iii) drought areas receiving food aid, principally of wheat, but also of rice (for example, see Reardon and Matlon (1989) for the case of Burkina).

The "conventional wisdom" is that, except in 'cash cropping' areas, Sahel peasants are subsistence farmers, depending mainly on their farms for 'food entitlement', and thus buy very little of their food (Kowal and Kassam, 1978; CILSS/Club du Sahel, 1981; Giri, 1983; OECD, 1988). But household survey evidence shows that: (i) WASAT farm households purchase a substantial share of the coarse grains they consume. Some examples: Dione (1989) found in 1985/86 in rural Mali that 39 percent of sample households were net buyers; Kelly et al. (1990) found in 1988/89 for Senegal that 75 percent of caloric intake came from purchased grain in the Sahelian zone, and 20 percent in the Sudanian zone; Reardon and Matlon (1989) found in 1984/85 for Burkina that 43 percent of caloric intake came from purchased grain in the Sahelian zone, and 37 percent in the Sudanian zone.

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<sup>9</sup> This section draws heavily on section 2 of Reardon (forthcoming).

The implication is that price policy affects real incomes from the demand side and not just the supply side (Weber et al. 1988). The localized importance of cash cropping (Weber et al. 1988), as well as the generalized substantial importance of non-farm activities to household income (Reardon, Delgado, and Matlon, 1991), are key determinants of the importance of purchased grain in the rural diet.

Maize consumption is in general not yet substantial, but one finds it important in certain zones, at certain times and places -- in maize production zones such as in parts of Mali (Dione (1989)); and in zones where it is "imported" into the zone from higher potential zones, mainly in drought years, such as the Sahelian and Sudanian zones of Burkina Faso in the drought year 1984/85 (Reardon and Matlon, 1989); and in Northwestern Niger, during drought years (Hopkins and Reardon, 1989).

Yet, maize consumption and production have made important progress over the last decade in Mali, Burkina Faso, and Senegal, starting from a small base (Sautier et al. 1989). On the demand side, maize appears attract rural WASAT consumers because it is cheaper than millet and sorghum in most zones, especially during drought years (Reardon, Delgado, and Matlon, 1987), and it is usually available in drought years in the Sahelian and Sudanian zones from regions with better rainfall such as the Guinean zone in the southern belt of the Sahel (CRED, 1987).

## 7. CONCLUSIONS WITH RESPECT TO CHANGING CONSUMPTION PATTERNS IN THE WASAT

In sum, we argue four related sets of points. First, changes in cereals consumption patterns in the major sorghum-producing areas of the WASAT are demand-driven. Second, these changes are widespread. The urban poor in at least several Sahel capitals are major consumers of rice, mostly in cooked form outside the household. The rich eat substantial quantities of rice at home. Third, long-run changes in relative prices may have played a role in changing consumption patterns, but they probably have not been the leading factor of change. Non-price factors, such as household income and employment patterns, are important. Price policies to reverse the trends of the past twenty years would need to be sustainable in the long-run to work, and they cannot be unless the needs of the burgeoning urban populations for a convenient source of cheap calories are met. Fourth, rice and wheat prices would have to increase very substantially over those of millet and sorghum before encouraging shifts in consumption back to these cereals. In the short term, such policies could be associated with severe negative welfare effects on the urban poor.

We suggest three areas of policy emphasis. First, a careful assessment should be made of the best potential for decreasing unit production costs for different cereals. Coarse grains can soak up a large share of demand for rice for consumption in the home, but only if they are kept very cheap relative to everything else. If rice production costs can be significantly and sustainably lowered, the

problem diminishes, however it is doubtful that this could ever be a full solution to the problem on the scale required.

Second, even with progress in lowering coarse grains production costs, better processing technologies are required to permit coarse grains to better meet the needs of urban food consumers. These needs involve shorter and less arduous preparation times, better storability and suitability for commercial preparation.

Third, there needs to be a way to soften the impact of higher rice prices on the urban poor. Cheaper and easier to prepare sorghum, millet and maize food dishes, from imports or own production, are likely to be a major component of any solution.

#### **8. SOME GENERAL POLICY AND ECONOMIC RESEARCH ISSUES INVOLVING SORGHUM**

The discussion above highlights that the central issue in taking advantage of the opportunities offered by sorghum for grain and biomass production increases in semi-arid areas is to keep the unit price of grain low relative to competing grains. This means that major and sustained yield increases will be a necessary, if not a sufficient, condition for using sorghum as a major rural development tool.

On the demand side, sorghum must compete with maize for rural food demand in traditional preparations, and for industrial and feed demand. With respect to urban demand, sorghum faces the unavoidable handicap of requiring better processing technologies in order to be a contender for the dynamic part of Third World markets for direct human consumption of grain.

Sorghum utilization research is of great value in diagnosing those areas where additional processing technologies, or improved marketing policies, can assist in providing sorghum producers with viable long-term markets. However, such research cannot be a substitute for a basic push on lowering per unit production and distribution costs for grain sorghum. Without this, the crop will be left behind, even in those remote parts of the world where high transport costs presently afford traditional cereals a high degree of natural protection against imported cereals.

On a more upbeat note, it appears that many of the areas of the Third World where smallholder sorghum production is important are on the verge of a rebirth of rapid demand growth for livestock products. This process was well underway in the 1970s, and was largely choked off by the debt problem and international dumping of the 1980s. The semi-arid areas have always had a special advantage in producing livestock products under low animal husbandry technology conditions. Use of sorghum technology as a fundamental motor of development of smallholder farming in the WASAT and in the semi-arid areas of Eastern and Southern Africa will probably require more serious consideration of the use of livestock feeding as a way to minimize transport costs to market for bulky commodities, and to add value on the farm. Relative prices and costs remain a central issue. Farm-household level research into the specific issues and options in different zones is highly indicated.

**Table 1--The place of millet/sorghum in world food/feed production  
by region 1988 and growth 1961-88**

(millions of metric tons and %)

	Millet/Sorghum			Maize			All Cereals		
	m.m.t.	Annual Growth Rate 1961-88	Share of all cereals (%)	m.m.t.	Annual Growth Rate 1961-88	Share of all Cereals (%)	m.m.t.	Annual Growth Rate 1961-88	Share of all Major Food Staples <sup>a/</sup> (%)
Asia excl. China	21.3	0.8	7	30.1	3.2	9	319.6	3.1	87
China	11.6	-0.5	4	73.8	5.6	23	317.8	4.1	87
North Africa/Middle East	6.6	0.7	8	7.7	2.4	9	84.8	2.5	92
Sub-Saharan Africa	22.4	1.1	44	18.9	2.3	37	51.4	1.7	56
Latin America	11.1	7.4	11	54.8	2.9	53	103.8	3.2	82
Developed Countries	20.3	1.2	3	220.1	3.0	29	768.8	2.2	93

Source: Data are from the FAO Production Tape 1989, with aggregation and calculation by IFPRI.

Notes: <sup>a/</sup> Includes total cereals plus roots and tubers, pulses, peanuts, bananas and plantains.

Table 2--World trade in sorghum by region 1966/68 and 1985/87

(volume in 000 MT)

Region	Trade Activity	1966-68 Avg.	1985-87 Avg.
Asia excluding China	Export	88	249
	Import	4,100	5,252
	net exports	-4,012	-5,003
China	Export	0	501
	Import	1	678
	net exports	-1	-178
Latin America	Export	871	2,107
	Import	51	2,206
	net exports	820	-99
Near East (developing market economies)	Export	45	191
	Import	7	30
	net exports	39	161
Africa (developing market economies)	Export	4	10
	Import	59	221
	net exports	-54	-211
Developing countries	Export	1,008	3,058
	Import	1,466	3,381
	net exports	-458	-323
Developed countries	Export	5,971	6,898
	Import	4,896	5,904
	net exports	1,075	993

Source: Underlying data are from the 1988 FAO Agricultural Trade Tape.

Notes: Country groupings (FAO)

(1) Asia (excluding China) - Afghanistan, Bangladesh, Brunei, Burma, Cyprus, Hong Kong, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Democratic Kampuchea, Democratic People's Republic of Korea, Republic of Korea, Kuwait, Laos, Lebanon, Macau, Malaysia, Maldives, Mongolia, Nepal, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Syria, Thailand, Turkey, United Arab Emirates, Vietnam, Yemen Arab Republic, Democratic Yemen

(2) Latin America - Antigua, Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, St. Christopher and Nevis, St Vincent, Suriname, Trinidad and Tobago, Uruguay, Venezuela

(3) Near East - Afghanistan, Cyprus, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Saudi Arabia, Sudan, Syria, Turkey, United Arab Emirates, Yemen Arab Republic, Democratic Yemen

(4) Africa (developing market economies) - Algeria, Angola, Benin, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, Swaziland, Tanzania, Togo, Tunisia, Uganda, Burkina Faso, Zaire, Zambia, Zimbabwe

(5) Developing countries - Includes all developing market economies in Africa, Latin America, Near East, Far East and other developing market economies as well as centrally planned economies in Asia

(6) Developed countries - Includes developed market economies (8) and centrally planned economies in Eastern Europe and USSR

(7) Developed market economies - North America (Canada, United States)  
Western Europe - Austria, Belgium-Luxembourg, Denmark, Faeroe Islands, Finland, France, Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, Yugoslavia  
Oceania (Australia and New Zealand)  
Other developed market economies (Israel, Japan, South Africa)

Table 3--Performance of sorghum relative to total cereals in selected West African producing countries 1961 - 1989

(in %)

Country	Annual Growth Rate of Sorghum Production	Annual Growth Rate of Total Cereals Production	Annual Growth Rate of Sorghum's Share in Cereals Production <sup>a/</sup>	Share of Yield in Growth of Sorghum Production <sup>b/</sup>	Share of Area Harvested in Growth of Sorghum Production <sup>c/</sup>
Burkina Faso	2.32	2.45	-0.14	31	68
Mali	2.28	2.09	0.18	57	42
Senegal	1.43	1.8	-0.37	21	78

Source: The data used is from a World Bank data set, distinct from the more usual FAO data, provided by an operational division of the Bank dealing with agricultural issues. This permitted more consistent estimates for sorghum as distinct from millet, and a longer time period for regression work. The compound annual growth rates are estimated using regression techniques.

Notes:

- (a) "Cereals" includes the following: rice, millet, maize, sorghum, and wheat.
- (b) The ratio of the growth rate of sorghum yield to the growth rate of sorghum production, and
- (c) The ratio of the growth rate of sorghum area harvested to the growth rate of sorghum production.
- (d) The last two columns may not sum to 100 due to rounding error.

**Table 4--Annual growth in use of millet/sorghum compared to total cereals in West Africa 1966/70 - 1982/86**

(in % per annum)

	FOOD		FEED	
	All Cereals	Millet/Sorghum	All Cereals	Millet/Sorghum
Burkina Faso	2.5	1.6	4.1	1.6
Mali	2.7	2.1	2.7	2.1
Niger	3.2	2.6	2.4	2.6
Senegal	3.6	2.4	3.8	4.0
Nigeria	4.0	2.7	2.9	2.5
All West Africa (16 countries)	3.4	2.2	3.9	2.3

Source: Compound growth rates between mid-points calculated from data in the 1988 FAO Supply Utilization Accounts tape.

**Table 5--Share of sorghum and millet in human consumption of all major food commodities in West Africa 1966/70 and 1982/86**

	Avg. Annual Consumption per Capita of Millet/Sorghum 1966/70	Share of Millet/Sorghum 1966/70	Share of Millet/Sorghum 1982/86
Burkina Faso	139 kg <sup>a/</sup>	60 %	53 %
Senegal	65 kg	37 %	34 %
Nigeria	71 kg <sup>b/</sup>	39 %	36 %
All West Africa (16 countries)	66 kg	36 %	31 %

Sources: Calculated from data taken from the 1988 FAO supply utilization accounts tapes and Delgado and Miller (1985)

Notes:

a/ Millet 52.4 kg/capita and sorghum 86.4 kg/capita

b/ Millet 29.9/capita and sorghum 41.4 kg/capita

Table 6--Changing cereals use patterns in West Africa 1966/70 - 1982/86

% Shares

	Millet/ Sorghum		Maize		Rice		Wheat	
	66/70	82/86	66/70	82/86	66/70	82/86	66/70	82/86
<u>Crop Share of All Cereals Used as Food</u>								
Burkina Faso	74	64	8	9	3	7	2	2
Mali	74	67	10	11	12	17	1	3
Niger	96	88	--	3	3	5	1	4
Senegal	46	38	8	9	38	43	8	9
Nigeria	78	64	15	10	4	14	3	10
All West Africa	61	50	14	12	14	21	4	8
<u>Share of All Cereals Used as Feed</u>								
Burkina Faso	92	60	6	5	--	--	--	3
Mali	81	73	10	11	4	3	1	11
Niger	98	95	--	1	2	2	13	12
Senegal	76	77	4	7	7	4	13	12
Nigeria	80	74	14	9	1	1	6	15

Sources: Calculated from data in the 1988 FAO Supply Utilization Accounts Tape.

Note: Shares are of cereals use during the period in question in the country in question. Cereals use is calculated using FAO's disappearance concept. Rows will not sum to 100 because consumption of minor cereals, either domestic imported

**Table 7--Indices of relative consumer food prices in the West African Francophone 1966/70 - 1987/88**

(1974/78 = 100)

Country	Price of Rice/Price of Traditional Staple (a)				Price of Wheat Bread/Price of Traditional Staple (a)			
	Annual Averages	1966/70	1982/86	1987/88	1987/88 ratio <sup>d/</sup>	1966/70	1982/86	1987/88
Burkina Faso	148	105	134	2.5	150	222	278	5
Côte d'Ivoire	142	67	n/a	n/a	94	94	n/a	n/a
Mali	105	84	120	2.3	100	81	116	3.7
Niger	129	81	131	2.8	200	96	150	3.5
Senegal	67	67	78	1.4	46	96	104	2.7 <sup>b</sup>
World Market	106	68	91	3.1	94	98	118	1.5 <sup>c</sup>

Sources: See Delgado (1989)

Notes:

(a) All indices are computed by comparing the average of the ratios of consumer prices are per kg. in the years in question to the average of the 1974-1978 period. Traditional staples are millet for Mali, Niger and Senegal; sorghum for Burkina Faso; cassava for Côte d'Ivoire. World prices are f.o.b. export prices.

(b) 1987 only.

(c) For the world wheat market, the price of grain (US N° = 1 soft red winter, f.o.b.) was used, therefore, the absolute ratio for the world market should not be directly compared to the ratios for individual countries, which have bread prices in the numerators.

(d) Average of the actual ratios of consumer prices for 1987 and 1988.

n/a = not available

**Table 8--Demand elasticities for grain from aggregate data in three Sahelian countries 1966 - 1986**

(Cell values are compensated demand elasticities: a 1 % change in the variable in the left hand column is associated with the % change in demand indicated in the corresponding row)<sup>£/</sup>

	Mali	Senegal	Burkina Faso
<u>% change in Sorghum/Millet/Maize<sup>a/</sup></u>			
<u>demand with Respect to a 1 % Change in:</u>			
Own-price	-0.07	-0.11	-0.50
Wheat price	0.05	-0.03	0.02 <sup>b/</sup>
Rice price	0.24	0.13 <sup>b/</sup>	0.05
Income	-0.28 <sup>b/</sup>	-0.24	1.13 <sup>b/</sup>
<u>Rice Demand</u>			
Own-price	-1.50 <sup>b/</sup>	-0.66	-0.96
Wheat price	-0.08 <sup>b/</sup>	0.01	-0.39
Sorghum/Millet/Maize price	0.75	0.13 <sup>b/</sup>	0.48
Income	0.91 <sup>b/</sup>	-0.17	1.71
<u>Wheat Demand</u>			
Own-price	-0.20	0.36	-0.51
Rice price	-0.26 <sup>b/</sup>	0.02 <sup>b/</sup>	-0.60
Sorghum/Millet/Maize price	0.47	-0.06 <sup>b/</sup>	0.32
Income	2.44	0.51	0.73 <sup>b/</sup>

Notes: <sup>a/</sup> Burkina Faso estimates are for millet/sorghum only  
<sup>b/</sup> Not statistically significant at 10 %  
<sup>£/</sup> Estimated by separate complete demand systems regressions by country, 21 years of annual data with sources detailed in Delgado (1989). The Almost-Ideal Demand System (AIDS) estimator was used and homogeneity and symmetry were imposed.

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