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This paper describes the use of improved (mechanized) coarse grain processing in Senegal. It discusses various types of processing equipment in widespread and experimental use, and identifies what donor, local research and non-governmental organizations are doing in the area of grain processing. The report also examines prices, import and tax policies that affect the competitiveness of coarse grains vis-a-vis rice. Finally, an action plan of policy dialogue to remove duties and value-added taxes on imports and sales of processing equipment, promotion of private sector grain processing and repair/maintenance services, and selective applied research is proposed for USAID and GOS consideration.

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Coarse Grain Processing in Senegal:

Issues, Constraints, and Policy and Program Options

By: John Holtzman

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Coarse Grain Processing in Senegal:

Issues, Constraints, and Policy and Program Options

John S. Holtzman

Agricultural Marketing Improvement Strategies Project (AMIS)

Abt Associates

4250 Connecticut Ave., N.W.

Suite 500

Washington, D.C. 20008-1173

Tel. (202) 362-2800

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ABBREVIATIONS AND ACRONYMS

ALTERSIAL	Alternatives Technologiques et Systèmes Alimentaires
ATI	Appropriate Technology International
ADO	Agriculture Development Office/Officer, USAID
ABP	Associations de Base des Producteurs (SODEFITEX farmer organizations)
AMIS	Agricultural Marketing Improvement Strategies Project (USAID)
BCEAO	Banque Centrale des Etats de l'Afrique de l'Ouest
CAR	Central African Republic
CEEMAT	Centre d'Etudes et d'Expérimentation du Machinisme Agricole Tropical
CILSS	Comité Inter Etats de Lutte Contre la Sécheresse au Sahel
CMDT	Compagnie Maliènne de Développement des Textiles
CNCAS	Caisse Nationale de Crédit Agricole du Sénégal (National Agricultural Credit Fund)
CNRA	Centre National de Recherches Agronomiques de Bambey (ISRA)
CRS	Catholic Relief Services
CRSP	Collaborative Research Support Program
CSA	Commissariat à la Sécurite Alimentaire
ENDA TM	Environnement et Développement Africain du Tiers-Monde
FAC	Fonds d'Aide et de Coopération (France)
FAO	Food and Agriculture Organization of the United Nations
FCFA	Francs Centrafricaines (Senegalese currency)
FENU	Fonds d'Equipement des Nations-Unies
GIE	Groupement d'Intérêt Economique
GP	Groupement de Producteurs (SODEVA farmer organizations)
GOS	Government of Senegal
GRET	Groupe de Recherche et d'Echanges Technologiques
GTZ	Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)

IDRC	International Development Research Centre
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture (Nigeria)
ILO	International Labour Organization
IRR	Internal rate of return
ISRA	Institut Sénégalais de Recherches Agricoles
ITA	Institut de Technologie Alimentaire
MDS	Ministère du Développement Social
MDR	Ministère du Développement Rural
NPA	Nouvelle Politique Agricole (New Agricultural Policy)
NGO	Non-Governmental Organization
MSU	Michigan State University/Department of Agricultural Economics
OPS	Opérateurs privés stockeurs
PROCELOS	Programme Régional de Promotion des Céréales Locales au Sahel
PSA	Programme de Sécurite Alimentaire (GTZ)
PVO	Private Voluntary Organization
SERRIAL	Société d'Etudes, de Recherche et de Réalisation pour l'Industrie Agro-Alimentaire
SISCOMA	Société Industrielle Sénégalaise de Construction de Matériels Agricoles.
SISMAR	Société Industrielle Sahélienne de Mécaniques, de Matériels Agricoles et de Représentations.
SODAR/ SDE	Société de Distribution Africaine et de Représentation/Sénégalaise de Distribution et d'Equipement
SODEFITEX	Société de Développement des Fibres Textiles
SODEVA	Société de Développement et de Vulgarisation Agricole
USAID	U.S. Agency for International Development
UNCC	Union Nationale des Coopératives de Crédit
UNICEF	United Nations International Children's Education Fund
VITA	Volunteers in Technical Assistance

Executive Summary

Processing of coarse grain is often cited as a key constraint to expansion of coarse grain production and consumption in Senegal. Rice is by far the preferred cereal in urban areas and appears to be making inroads in rural consumption patterns. The NPA calls for expanding production (and consumption) of coarse grains but does not address processing issues. The Common Fund is funding subprograms on industrial, semi-industrial and rural/artisanal processing under the Local Cereals Transformation program. The semi-industrial subprogram is just getting underway, and the rural/artisanal subprogram has not yet begun.

Hand-powered threshing, dehulling and milling of coarse grains are arduous tasks demanding hours of female labor in most rural households, which detracts from participation in income-generating activities. Low-cost technologies exist for shelling maize and milling coarse grains by human (hand and bicycle) power and animal traction. These improved human-powered and animal-powered processing technologies have the advantage of not requiring costly imported fossil fuels, but they do not appear to be widespread. This is probably because many Senegalese villages have received motorized dehullers and mills since Independence from the Government of Senegal (GOS), UNICEF, FENU (Fonds d'Equipement des Nations-Unies) and many other organizations. Many of these units have been collectively managed, and performance has been mixed.

Approximately two-thirds of the mills and nearly all of the threshers are privately owned and operated. Private investors purchase equipment, generally with their own funds, pay all import duties and value-added taxes, and receive no subsidies. In contrast, most GOS, NGO and donor-funded projects and programs provide processing units as gifts to village organizations and often subsidize repair services and distribution of spare parts. While some may argue that this is consistent with the NPA objective of "responsabilisation" of farmer organizations, it confers an unfair advantage on village groups vis-a-vis private entrepreneurs.

There is no evidence that collective management of mechanized processing equipment is superior to private management. Nor has there been any attempt to compare costs and returns and hence economic viability of privately vs. collectively managed processing units. It would seem appropriate in the capital-scarce Senegalese context, and after five years of the NPA and longer periods for grain processing projects that work through rural organizations, to do a comparative assessment of the performance of privately and collectively managed investments. Furthermore, the historical bias favoring village groups could be offset by providing more and larger loans to private entrepreneurs and removing import duties and value-added taxes on processing equipment.

Numerous projects and experimental programs which promote mechanical coarse grain processing have been initiated in Senegal. SISMAR, ISRA and IDRC have collaborated in developing a dehuller which is being tested in

nine sites in Senegal. The FAC and PSA/CSA are planning to install 10-12 semi-industrial units in key cities outside of Dakar in Senegal. These units are equipped with dehullers, hammer mills, and cleaning and bagging machinery. The FENU program, implemented by the Ministère du Développement Social, has placed diesel powered mills in 468 villages throughout Senegal since 1983. These mills are managed by women's groups, which follow a strict accounting and management system established by FENU. These women's groups are monitored by MDS agents. Loans extended by the USAID Rural Enterprise Project in Kaolack and CNCAS have financed the repair or acqusition of grain threshers and mills. The limited duration of such loans (12 months maximum) is a disincentive to investment in new processing equipment, which requires a 4-5 year payback period.

Although attention was paid to economic considerations at the time these programs, experiments and investments were initiated, rigorous and timely monitoring and evaluation have lagged. Despite the considerable sums spent on these programs, and significant effort allocated to data collection, analysis of the economic viability of these programs has been inadequate to date. There is a need to improve upon data collection, entry, management, and analysis so as to better monitor and assess the performance of ongoing experiments and the feasibility of expanding at least some of these efforts.

Most of the experiments and programs underway do not relate processing issues to policy issues and constraints. The recent decline in the rice price to 130 FCFA per kilogram will likely have a negative effect on coarse grain consumption in urban areas. Onerous taxes on imported processing equipment and sales of domestically produced equipment constrain investment by private entrepreneurs and make it more difficult for those who are able to make the initial investment to replace defective parts or entire units. Hence, sustaining the investment over longer periods of time is problematic.

USAID is likely to have the most impact on promoting coarse grain transformation in Senegal and on identifying the most economically viable alternatives by:

1. Advocating removal of import duties and value-added taxes on processing machinery, spare parts and raw and intermediate inputs used in the manufacturing and artisanal fabrication of machinery.

2. Promoting private sector investment in grain processing equipment by :

   a) providing funds to the Caisse Nationale de Crédit Agricole du Sénégal (CNCAS) earmarked for loans for purchase and repair of processing equipment;

   b) encouraging the GOS and other donors to provide equipment to private agents as well as village organizations via loans rather than through subsidized give-away programs; and

   c) channeling more credit, via the Kaolack Rural Enterprise Project, to

private entrepreneurs wishing to invest in processing equipment. This will require loaning funds for longer periods than one year.

Items 2.a. and 2.c. would require active solicitation of loans and technical assistance in preparing business plans and loan requests. USAID could consider providing further TA or training to increase the numbers of trained financial analysts.

3. Providing resources, as well as training of diesel mechanics and repairers of processing equipment, for the establishment of centers for the repair and maintenance of grain processing equipment in secondary towns. These centers could also stock and sell spare parts. This would increase the supply of trained mechanics and lower the cost of repair services. It would also expand competition in supplying spare parts with the limited existing sales outlets.

4. Insisting on and, where appropriate, funding objective and rigorous evaluations of the financial and economic viability of different types of processing equipment under both collective and private management.

5. Assisting ongoing projects in collection, entry, management and analysis of data used in economic assessments.

1.0 Introduction

Technology is often held out as a panacea to developing countries, promising to increase productivity and wealth with minimal change of policies, institutions and management systems during the process of transfer. Appropriate technology is even more seductive, as the term implies that the technology to be transferred has already been adapted and tailored to local needs and requirements. This report emphasizes how important it is to consider technology in a broader systems context, where macroeconomic, tax and import policies (and hence incentives), institutions, and systems for effectively managing technology need to be in place for technological change to succeed. Some observers go so far as to argue that changes in output/factor price relationships induce changes in institutions, which then develop suitable technology (Hayami and Ruttan, 1985). That is, technological change is essentially a response to economic incentives, hastened by institutions which develop improved technology in response to changed relative prices.

An important feature of Senegal's New Agricultural Policy (NPA), announced in May 1984, is the promotion of coarse grain production and consumption, as well as liberalization of the marketing of locally produced cereals.[1] Partly in response to incentives offered by market liberalization and partly due to good rainfall, Senegalese farmers have increased coarse grain production since 1984-85. The growth in maize area and production has been most dramatic, particularly in Kaolack, Tambacounda and Kolda Regions (see Holtzman, Goetz and Diagana, 1988).

Despite these auspicious developments on the supply side, a number of studies have identified processing of coarse grains as a constraint to increasing coarse grains consumption. Rice is important in the diets of many rural households and rural rice consumption appears to be rising. At the same time, millet, sorghum and maize are sold increasingly in semi-processed form in urban markets. Most coarse grains are sold in unprocessed (only threshed) form in rural areas, however. Dehulling and milling are required to bring coarse grains to a stage of preparation comparable to rice. Even when coarse grains are often sold in dehulled form in urban areas, further processing (milling) and time-consuming preparation are required before these cereals can be consumed. In contrast, rice is ready-to-cook at the time of purchase. Preparation of meals with coarse grains as a base involves further time-consuming cooking.

The objectives of this report are severalfold. First, the paper will describe the use of improved (mechanized) coarse grain processing in Senegal. It will discuss various types of processing equipment in widespread and experimental use, and identify what donor, local research and non-governmental organizations are doing in the area of grain processing. The report will also examine price, import and tax policies that affect the competitiveness of coarse grains vis-a-vis rice. Finally, an action plan of policy dialogue to remove duties and value-added taxes on imports and sales of processing equipment, promotion of private sector grain processing and repair/maintenance services, and selective applied research is proposed for USAID and GOS consideration.

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[1] Coarse grains refer to millet, sorghum and maize. National and regional area, production and yield statistics are found in Annex 7.

2.0 A Description of Mechanized Technology for Coarse Grain Processing

This section will describe existing mechanized coarse grain processing technology in use in Senegal. It will assess how widespread each type of equipment is, likely profitability, constraints to expanded use of different types of equipment, and the effectiveness of efforts to promote adoption.

2.1 Threshers

Mechanized threshing of coarse grain, especially millet, is quite widespread in grain surplus regions of Senegal, such as the Kaolack Region. In a November 1983-December 1984 survey of grain processing equipment in Diourbel and Thies Regions, Hyacinthe Mbengue (1986) enumerated 39 threshers, of which 28 were functioning. All of these units were privately owned and operated. Most of these units were SISCOMA BS 1000s, which are large capacity threshers capable of processing up to one metric ton per hour and costing approximately 10-11 million FCFA along with the necessary tractor at least 35 HP which powers and transports the thresher. To be profitable, these high capacity threshers need to be used heavily during a 4-6 month period after the millet harvest. They are hauled from village to village in more densely populated, agriculturally productive regions, such as Kaolack. The BS 1000 is manufactured by SISMAR and currently sold for 5.5 million FCFA.

The proportion of the national millet and sorghum crop that is mechanically threshed is unknown, but it is unlikely to exceed marketed surplus, which probably is no greater than 10%. In fact, it is likely to be significantly less than 10%. Assuming that marketed surplus is 10% and that half of marketed surplus is threshed, quantities ranging from 23,500 to 47,500 metric tons were likely mechanically processed each year during the past four years (1984-85 to 1987-88). If we assume that one thresher can average five metric tons of processed grain per day over at least four 25-day months, an average of 500 metric tons would be threshed per machine per year. Hence, 47-95 threshers, operating at about 63% of their theoretical capacity, could have threshed 5% of the total coarse grain production in Senegal over the past four years. Although the exact number of functioning large-scale threshers in use in Senegal is unknown, it is estimated that over 100 have been sold since 1973 (R. Mbengue et al., 1988).

Most rural households in Senegal do not thresh their grain mechanically. The cost of 700-1000 FCFA/100 kg. sack is too high for many households, and storage of threshed grain presents technical problems. There is some evidence that better off, more productive and more commercially oriented households are more likely to thresh their grain than less productive households. Furthermore, grain that is mechanically threshed is, for the most part, destined for sale or consumption within a relatively short period (one-two months). Threshed grain is more susceptible to insect attacks, and it needs to be stored more carefully than grain on the stalk, which is the most common storage method and, by most reports, effective in minimizing losses (Mbengue and Havard, 1986; Yaciuk and Yaciuk, 1980). In addition, some households report that it is tempting to sell mechanically threshed grain, which is supposed to remain in storage, in order to meet cash needs and to procure "luxury" items on impulse. This can deplete household grain stocks more rapidly than if grain is stored on the stalk and threshed as needed for household consumption (R. Mbengue et al., 1988).

The owners of high capacity threshers are typically well-off private entrepreneurs or marabouts. These machines are well-suited for use in densely populated, productive zones such as Kaolack Region, where millet is surplus in most

years. In less productive and densely populated areas, smaller capacity machines are likely to be better suited and more easily amortized, but there is no hard evidence to document this hypothesis. SISMAR has recently begun to manufacture a smaller capacity thresher for millet, capable of processing up to 300 kg./hr. SISMAR plans to sell it mainly to NGOs, but no units are operational yet under field conditions. This smaller thresher does not require a tractor to be hauled or operated, unlike the large capacity machines. No assessment of the performance of this machine was possible, but its introduction merits careful monitoring.

Another lower capacity thresher, which is imported from France and marketed by MATFORCE, is the Bourgoin "Bamba," best suited for maize threshing. MATFORCE, the exclusive distributor of the Bamba, reports that about 200 units have been sold mainly to NGOs and village groups since it was introduced in 1982. Private entrepreneurs interviewed in the Kaolack Region do not seem to be interested in the lower capacity Bamba, which can thresh over one ton of maize per hour, but is more likely to average half a ton over several hours, and can be transported by traction animals. They report that the machine is not well-suited to high capacity throughput, that it breaks down frequently, and that it cannot effectively cover as much territory as the large capacity thresher transported by tractor. Despite these assertions, there are few data available on the throughput, costs and returns of operating the Bamba in Senegal.[2] A number of in-depth case studies (minimum of ten), carried out over one or more post-harvest periods, would generate useful information with which to assess its economic viability. This monitoring could begin during the 1988-89 post-harvest period.

2.2 Dehullers

Mechanized coarse grain dehulling is uncommon in Senegal. The vast majority of women hand-pound the grain to remove the pericarp, an arduous operation that generally requires ½-1 hour per day per household.[3] In urban areas, working women and grain traders often pay other women, typically women from lower income households who have recently migrated to urban areas, to dehull coarse grain. Mechanical dehullers were

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[2] Three maize threshers, the Richon 520 Junior, the Bourgoin Bamby, and the Bourgoin Bamba have been tested in the CMDT zone of Mali since 1977/78. The Bamba has proved to be the best adapted thresher, since it threshes all three coarse grains (maize, millet and sorghum) well, yielding high-quality, clean grain with few brokens. It is reported to be simple to operate, maintain, and transport, robust and less costly to operate than the other machinery (CMDT presentation, PROCELOS workshop, 1988). See Annex 6 for a preliminary analysis of the profitability of the Bamba, using Malian data on technical parameters.

[3] There is some disagreement as to the exact length of time. Yaciuk and Yaciuk (1980) interviewed 800 households in eight areas of Senegal in 1976-77. Of 750 female respondents, 7% reported dehulling time of under 15 minutes, 33% reported 15-30 minutes, 38% reported 30-60 minutes, and 22% claimed taking over one hour to dehull. Women interviewed during the AMIS consultancy reported spending no more than one hour and typically about 45 minutes. It is worth pointing out that women in the household take turns in doing this task. Any one woman might do the dehulling of the grain required for one day's household consumption (4-6 kg.) every third day. Nonetheless, the task is physically demanding and competes with other household management, food production and income-generating activities.

introduced in Senegal beginning in 1964 by French entrepreneurs and by UNICEF in collaboration with the MDS during the first half of the 1980s (FAO model). Mbengue estimates that only 15 of the 450 dehullers installed since 1962 are still functioning (Mbengue, 1986). These experiences were failures, as the machines were poorly adapted to coarse grain processing in Senegal, not well-serviced or supported, and ended up operating very few hours before falling out of use for long periods. The higher cost of dehulling than grinding also proved to be a key constraint. The abrasive disks which actually dehull the grain wear out very quickly with the FAO model. Mbengue found that only one of 29 dehullers in rural areas of Diourbel and Thies Regions was functioning in his 1983-84 survey.

Although manual dehulling is generally considered to be as physically demanding as grinding or milling of coarse grains, women report a strong preference for mechanical milling over mechanical dehulling. This is due to several factors. First, few women have seen mechanical dehulling, and only 0.6% of women surveyed use or have used this technology (R. Mbengue et al., 1988), whereas mills are widespread and appreciated. Hence, questions regarding the desirability of mechanized dehulling are of a hypothetical nature, and women are skeptical of the effectiveness of this technology. Second, when these machines have been introduced, they have generally not worked well or for long, and some women report that mechanically dehulled grain is inferior in quality to manually dehulled grain. Some allege that the dehullers introduced earlier produced an inferior quality grain, laden with foreign matter and undehulled kernels. Third, where available, mechanized dehulling costs more (typically 5 FCFA/kg. more) than mechanized milling. Since disposable incomes are limited, particularly in rural areas, women prefer to pay for lower cost milling, which is also perceived as more physically demanding than dehulling. Finally, and probably most importantly, hand-pounding coarse grain to obtain flour requires repeated sifting, which makes manual grinding more time-consuming than dehulling.

It is interesting to note that mechanical dehulling is often done in large batches of 50-100 kilograms in rural areas.[4] These larger batches are processed for consumption at social ceremonies, such as baptisms, or for commercial sale. Women in two villages in Diourbel Region, where prototype dehullers have been installed, reported dehulling the grain, transporting it to Dakar, and selling it at attractive prices.

Since 1984, SISMAR, ISRA and IDRC have collaborated in an experiment to adapt a Canadian dehuller (Prairies Regional Laboratories, Hill Industries, Saskatchewan) to Senegalese conditions. The dehuller has been adapted to batch processing of quantities ranging from two to ten kilograms, which correspond to amounts brought by rural women for processing to meet 1-3 days of household consumption. IDRC has provided funding and a prototype, which SISMAR has modified (five prototypes) and manufactured in limited quantities. ISRA has monitored the introduction of nine units for nearly two years at nine sites in Senegal, all of which are rural except the town of Bignona in Lower Casamance. Detailed monthly data on throughput, costs and returns have been collected, but limited analysis has been completed, primarily because ISRA's Post-Harvest Technology Program is awaiting a computer for data entry and processing (see Mbengue, PROCELOS paper, 1988).

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[4] In the village of Khandiar where ISRA is monitoring the operation of a SISMAR dehuller, 95.2% of the millet processed during the July-November period of 1988 was processed in batches of 50 kilograms or more.

Preliminary indications are that the SISMAR machines are too little utilized for most rural use. The only machine that clearly appears to be profitable is the Bignona unit. The investment costs of 1.0 million FCFA for the dehuller and diesel engine are too high for most villages and rural entrepreneurs. Throughput needs to be at least 200 kilograms per day to amortize this investment.[5]

The SISMAR dehuller has the disadvantage of processing grain only in discrete batches. This reduces its applicability for commercial processing, where a continuous throughput would greatly increase productivity and the uniform quality of the product. While the SISMAR dehuller embodies good engineering, it does it does not successfully degerm sorghum and millet. This means that the flour produced will not have the long-term storability of grain that has been degermed (personal communication, Carl Bielenberg).

The underutilization of the SISMAR machines by rural women for household consumption is discouraging, but the commercial use of the dehullers by small-scale women cereals traders is encouraging. The Diourbel Region is not a grain surplus region, yet several women traders are dehulling grain for shipment to Dakar. This type of operation might be more economically viable in small towns and large villages in grain surplus zones where grain acquisition costs are lower, such as Kaolack Region, or in productive pockets of Tambacounda Region (e.g., Maka Arrondissement) or Kolda Region (e.g., Medina Yoro Foula Arrondissement).[6] Given very high financial transport costs in Senegal, dehulling of grain before shipment to urban markets makes good economic sense. The weight is reduced approximately 20% in dehulling, leading to a proportional reduction in transport costs and at least marginally improving the competitiveness of coarse grains in urban areas. As noted above, however, grain which is semi-processed using the SISMAR dehuller is not suitable for long-term storage.

Even if the SISMAR dehullers are unlikely to be economically viable in most Senegalese villages, mechanical dehulling should not be dismissed completely. Dehullers developed for rural use in the Gambia by CRS (with IDRC funding), using artisans and locally available materials, may be better suited to rural needs. Further monitoring of the throughput, operating costs, and repair incidence and costs of the CRS Gambia dehuller is required before introducing it to rural areas in Senegal. It appears as if the lower investment cost of the Gambia dehuller might be offset by its shorter working life and higher repair costs than the SISMAR model (personal communication, Freudenberger).

The question of willingness and ability to pay for dehulling remains fundamental in rural areas. In the short run, the answer is probably no, particularly for grain deficit zones where rural incomes (and income-generating opportunities) are limited (Freudenberger, 1988). In more agriculturally productive zones, where rural households dispose of greater incomes, installing smaller-capacity dehullers is worth trying and

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5 Assuming that the dehuller operates 25 days per month on average, annual throughput would be five metric tons per month or 60 MT per year. The monthly throughput of five MT can be achieved easily after the harvest but is probably less attainable during the growing season in many areas.

6 The price advantage offered by grain acquired in Kaolack, Tambacounda and Kolda Regions is offset in part by the greater transport costs from the surplus zones to urban centers in western Senegal such as Dakar and Thies.

carefully monitoring in selected villages. It may be advisable to choose villages in zones of significant cotton or peanut production (and disposable income). The experience of introducing dehullers in CMDT villages in Mali is very promising in this regard (see Kantao et al., 1988).

Another recent experience in grain dehulling is the SERRIAL/SODAR and CSA/PSA experiment in semi-industrial transformation of 1987-88.[7] The SISMAR/ISRA/IDRC dehuller was adapted by SERRIAL, a Senegalese PVO, for use as part of a semi-industrial unit in Dakar. SODAR, a private marketing firm, undertook the commercialization of the dehulled, milled, cleaned and bagged millet. CSA loaned subsidized millet to SERRIAL/SODAR, which was transformed but not effectively marketed in Dakar. Significant arrears remain and are unlikely to ever be paid off.

Following up on this experiment, CSA/PSA plans to test ten more semi-industrial units in large cities in Senegal other than Dakar in 1989-90. These units will include the SISMAR/ISRA/IDRC dehullers, along with mills and cleaning and bagging equipment. The units will produce two types of millet flour (sankhal and soungouf), which will be bagged and sold both wholesale and retail. This is a promising experiment which merits careful monitoring and evaluation. CSA/PSA has contracted with ENDA to carry out monitoring of these units. It is not clear whether ENDA has the capacity to do rigorous financial and economic analysis of this experiment, however. This initiative is part of the Common Fund's subprogram on semi-industrial transformation of local cereals.

When asked about opportunities for investing in grain dehullers, private entrepreneurs showed little interest during the AMIS consultancy. The discouraging experiences since the 1960s have led to the perception that investment in dehulling is risky. Entrepreneurs prefer to invest money in mills and threshers, or in other commercial activities, such as trading of grain (including imported rice), cement, corrugated iron, and consumer goods. Their limited knowledge of and exposure to the technology, particularly the better performing and adapted SISMAR models, is a serious constraint. Encouraging the private sector to invest in dehullers is not advisable at this point, however. More information needs to be gathered from the CSA/PSA and FAC experiments to determine the viability of dehulling, as part of a semi-industrial processing operation, before considering promoting these units to the private sector. If the experimental units are profitable, and if demand for high-quality mechanically processed grain is sufficiently strong in urban areas, CSA/PSA and FAC could consider selling the semi-industrial operations to private investors, most likely on credit. Successful experiments in ten cities would provide a positive demonstration effect.

It is important to note that the medium-sized IDRC abrasive dehuller developed in Botswana has proven very successful in Botswana, an arid country where sorghum is the principal crop and cereal in local diets. CMDT has received a model of this dehuller and is testing it in CMDT zones of Mali, where it is used primarily to process maize. Last, VITA is experimenting with an adapted hammer mill in the Central African Republic, which "dehulls" and mills coarse grain simultaneously "in a fashion" (personal communication, C. Bielenberg). This innovation is being tested in several CAR villages and could be tried in Senegal if the CAR findings are encouraging. If this experimental unit is technically successful, and if CAR consumers judge that the processed grain is an

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[7] See Wittung and Bricas, CSA/PSA and ENDA, "Evaluation d'une opération d'appui à une unité semi-industrielle de transformation du mil," Février 1988 for a more detailed assessment.

adequate substitute for hand-pounded grain, the mill-cum-dehuller could process grain for half the cost of the current technology, where two separate machines are used and two charges are incurred.

2.3 Mills

Mbengue (1986) estimates that there are over 5,000 mechanized grain mills in Senegal, of which more than 3,000 are operational. Most of them are hammer mills, powered by electricity in urban areas and by diesel motors in rural areas.

Mills are often a profitable investment in urban areas, because investment costs are lower (electric motors are cheaper than diesel motors), repair costs are lower, spare parts are more readily available, throughput is higher, and demand among urban consumers is stronger than in rural areas. Women's time also generally has a higher value than in rural areas, and women are generally willing and able to pay for milling. There is also less variability in processed throughput across seasons than in rural areas.

Mills may also be a profitable investment in small towns or large villages, or in villages located in densely populated areas (such as much of the Kaolack Region), or where there is a lively weekly market. As shown in Annex 4, milling of at least 70 metric tons of coarse grains per year is necessary for financial viability in rural areas where diesel engines power mills. Profitability is ensured, however, only with careful maintenance and management of the mill and the diesel engine that powers it. Good maintenance and management are not always practiced. Private management is generally but not necessarily superior to management by village groups. Many mills managed by village groups were received as gifts from donor funded projects, NGOs or the GOS. It is also reported that some private mills are gifts to rural communities (or a group of related people) by wealthier urban businessmen, government officials or urban relatives. As such, the mills are primarily intended to generate employment for relatives or villagers, and to lighten women's workload. Financial considerations often appear to be secondary.

How widespread these types of investments are relative to those mills installed by owner/operators for commercial purposes is unknown. Indirect evidence of the employment generation hypothesis for urban mills is the finding that mills in eight large towns in Senegal are utilized at only approximately 20% of their theoretical capacity (personal communication, W. Wittung). An alternative explanation might be that urban entrepreneurs have overinvested in mills, forcing down rates of utilization and lowering profitability. Without more detailed information regarding utilization rates during different periods of the year and motivations for making the investment in urban mills, it is difficult to make any judgements. It is also important to note that milling grain intermittently in small lots, characteristic of the requirements of individual households, depresses actual utilization rates well below estimated capacity.

An interesting experiment underway in rural areas is financed by FENU, monitored by the Condition Féminine of the Ministry of Social Development, and managed by women's groups in local areas. The FENU project has provided mills and engines (generally diesel) to 468 women's groups in villages throughout Senegal since 1983. Women's groups have provided significant resources (an estimated 200,000 - 300,000 FCFA per mill) for construction of a corrugated iron milling shed on a cement slab. According to FENU and the Condition Féminine, most of the units are still

functioning, despite periodic breakdowns. FENU coordinatrices monitor the financial management of women's groups, and FENU mechanics provide maintenance at below market cost.[8] FENU manages spare part inventories at both the departement and regional levels, which are supplied by a central warehouse in Dakar.

An unknown though reportedly significant percentage of women's groups have saved enough money (or are on schedule to save enough money) to reinvest in a diesel engine, which typically has to be replaced after five years. Postal savings accounts have been opened by nearly all women's groups managing mills. Fifty percent of net monthly earnings are deposited in these accounts, where funds earn 6% interest per annum. Funds cannot be used until at least 500,000 FCFA have been saved; any savings over this amount can be invested in other social and income-generating activities (e.g., vegetable production, cattle and sheep fattening, transport, wells).

The FENU experience merits a careful assessment. Monthly records are available and FENU has recently acquired computers (though they were not yet operational as of December 1988). Hence, there has been no data entry or analysis, although there was a preliminary evaluation of the project in 1985, which calculated the internal rate of return (IRR) at 37% for some 100 mills that had been operating in the Louga, St. Louis and Ziguinchor Regions for 15 months (République du Sénégal, 1985). Mill acquisition cost and some indirect costs were not included in this calculation, so the IRR was clearly overestimated. FENU officials believe that the project is economically viable and welcome a more in-depth assessment. They state that the mills which have been installed in Kaolack, Fatick, Diourbel, and Thies Regions since the 1985 evaluation are more economically viable than those installed earlier in Louga, St. Louis and Ziguinchor Regions, primarily due to higher population densities and rates of mill utilization.

In addition to these factors, a critical factor in sustaining the investment in a village mill is good maintenance and uninterrupted levels of operation far exceed one hour per day, a frequently cited mean level of use. A diesel engine mplex and unknown technology to most women's groups and the millers whom . Although FENU provides week-long training in mill/diesel engine operation aintenance, millers have limited understanding of maintenance requirements, and they may try to economize on regular maintenance (oil and filter changes), leading to costly repairs.[9] Diesel mechanics appear to be in short supply in many rural areas, and there is evidence that town-based mechanics demand high prices to service rural mills.[10]

An alternative to mechanically powered mills are animal-drawn mills, which were first introduced by the Germans, modified by ATI (by mechanical engineer Carl Bielenberg), and manufactured by Cheikh Gueye, a famous Gossas artisan. These mills

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8 FENU negotiates maximum rates that the affiliated département level mechanics are allowed to charge for different types of repairs.

9 Millers are paid 25% of net revenues from milling operations, so they have a short-run financial incentive to change oil and oil filters on the diesel engines and to do other critical maintenance less frequently than recommended.

10 In one unfortunate anecdote, related by a Peace Corps volunteer, an urban-based mechanic was asked to repair a seemingly broken-down diesel engine in one village by the women's management committee. The mechanic demanded 50,000 FCFA as an upfront payment to come to the village, diagnose the problem and make repairs. The problem was a relatively minor one, which probably would have cost less than 10,000 FCFA to correct in a competitive market for repairs and servicing.

are low-capacity units which can process up to 25 kg. per hour, provided animals powering the unit are changed frequently. They are suitable for smaller villages in isolated and/or sparsely populated areas. The technology appears to be well-adapted to rural needs, yet the investment cost of 300,000 FCFA is still considerable. Most animal-drawn mills do not generate income; rather, rural women bring grain for processing along with traction animals in order to do their own processing. Bielenberg (personal communication) estimates milling costs to be only 3-4 FCFA per kilogram, assuming five-year amortization, replacement costs of 25,000 FCFA per year for parts (tire and grinding disks), 3-4 hours of operation per day, and no incremental cost to providing animals, which are assumed to be already owned by users of the mill.

Despite the seeming economic attractiveness of animal-powered mills, there are several potential problems to extending the technology on a wide scale. First, sustaining the investment is problematic without an assured source of funds for replacement. Second, women may have limited access to traction animals during the rainy season, when the animals are used heavily for field operations and the demands on female labor are greatest. Third, it is reported that the technology is viewed as second-rate by many rural people, most of whom have at least seen and often used mechanized mills. Nevertheless, the technology is well-adapted to villages of 10-15 households which are far from mechanized mills. Given the dispersion of population and mechanized mills in semi-arid Africa, further development and promotion of the technology of animal-powered mills in Senegal would likely have significant benefits throughout the Sahel.

3.0 Cereals Prices and Price Policy

This section will discuss possible impacts of the decline in the imported rice price on the competitiveness and supply of locally produced coarse grains, and indirectly on the viability of mechanized processing.

3.1 Welfare Impacts of the Lower Rice Price

The 30 FCFA/kg. reduction in the price of rice is the GOS policy which has and will have the most profound impact on the competitiveness of coarse grains relative to rice. Reducing the rice price has had positive welfare impacts on both urban and rural consumers. It has increased the real income of urban consumers and probably increased the consumption of imported rice (both substitution and income effects) among low-income consumers. Rice is the cheapest source of calories in urban areas and the easiest, least costly food to prepare. Grain-deficit rural consumers benefit as well from the lower rice price. They are able to buy rice cheaply to make up for coarse grain production deficits.[11] Imported rice is likely to substitute increasingly for coarse grains in the diets of many rural households, particularly once coarse grain stocks have been drawn down (typically by planting of the next year's crops, which begins the so-called hungry season). This trend is likely to be exacerbated by years of significant grain production shortfall, such as those of 1978-79 and 1984-85.

3.2 Comparative Prices of Coarse Grain Products and Rice

Table 1 shows the prices of millet and maize products in Dakar, Kaolack and Bambey. The most striking observation from the table is the high prices of semi-processed and processed coarse grain products, relative to rice. These prices reflect real processing and preparation costs plus a modest return to processing and marketing. To the extent that coarse grains and rice are substitutes in consumption, analysis of price relationships needs to be done for grain products at comparable stages of processing/preparation. On price grounds, millet and maize cannot compete with imported rice in urban markets. Millet and maize are consumed more widely in rural areas, where they are produced by rural consumers; they can be acquired more cheaply, and most rural households do their own processing. During years of production shortfall and coarse grain scarcity in rural areas, rice purchases and consumption will likely increase at the lower imported rice price.

3.3 Dampening Effect of the Lower Rice Price on Seasonal Coarse Grain Price Increases

Coarse grain prices rise seasonally to reflect storage costs and increasingly short grain supplies. If rice and coarse grains were perfect substitutes in consumption, the rice price of 130 FCFA/kg. would represent a de facto price ceiling for milled coarse grain.

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[11] Note that the rice price of 130 FCFA/kg. is a pan-territorial, pan-seasonal price. The Food Security research program implemented by ISRA and Michigan State University in 1986-87 found that rice consumption was surprisingly high, even following a year of record coarse grain production in the study areas of Southeastern Senegal. 93% of the survey rural households in Kounghuel Arrondissement of Kaolack Region and Maka Arrondissement of Tambacounda Region purchased an average of 148 kg. of rice in 1986-87. 69% of the rural households in survey villages of Kolda Region bought an average of 123 kg. of rice during the same period (Goetz, 1988).

Table 1

Retail Prices of Processed Millet and Maize Products in Selected Locations in 1988
(FCFA/kilogram)

MILLET	FAC/CEGOS Study Dakar (March '88)	SERRIAL, SODAR Dakar (Dec. '87)	Bambey, Semi-Industrial Unit (Dec.-Sept. '88)	Bambey, Market (12/13/88)	Sentenac, Operation 500 Tons	Dakar March '89	Kaolack Feb. '89
Unprocessed	80		50-75				
Dehulled	125	135-145	105-110	80			95
Semoule (Sankhal)	250	175-200	140-150	162	175-200		130
Farine (Soungouf)	350	175-200	140-150	364	175-200	300	120
Bran		50					
Cous-Cous Semi-Fini				103			140

MAIZE	Projet Mais: Keur Samba Guèye	Projet Mais: Delivered to Dakar	Tambacounda, Retailers Supplied by FAC Semi-Industrial Unit (August-September 88)
Brokens	-	144	165-185
Semoule	130	164	165-185
Farine	80	114	
Bran	50	84	

Assuming coarse grain processing costs 35-40 FCFA per kilogram of processed grain and assuming dehulling losses of 20%, the unprocessed coarse grain price ceiling would be effectively reduced to 72-76 FCFA/kg. With a rice price of 160 FCFA/kg., unprocessed coarse grain prices could rise seasonally to 96-100 FCFA/kg. and still be competitive with rice.

In the Senegalese context, rice and coarse grains are quite imperfect substitutes, so the rice price will in no way constitute a price ceiling for coarse grains.[12] During the 1988-89 marketing season, millet prices had risen to 80 FCFA in Kaolack and 100 FCFA in Tambacounda by the end of January 1989, according to CSA data. Nevertheless, the lowering of rice prices may reduce the extent to which coarse grain prices can rise seasonally in those towns (and rural areas) where imported rice supplies are readily available. (See seasonal price indices for coarse grains sold at the retail level in Dakar generated from April 1984 to January 1989 data, a period over most of which retail rice prices were 160 FCFA per kilogram and higher.) Low-income consumers will buy the cheapest source of calories when faced with a strict budgetary constraint. Lower seasonal price rises would lower returns to coarse grain storage over longer periods, which would represent a disincentive to interseasonal stockholding by private traders.

3.4 Impacts of the Lower Rice Price on Urban Consumption of Coarse Grains

In attempting to explain why coarse grain prices in urban areas were lower in the immediate post-harvest period of 1988-89 than one year earlier, several factors are plausible. As stated above, lower rice prices probably have dampened the extent to which coarse grain prices are able to rise (and remain competitive with rice) in towns. Through the substitution effect, lower rice prices also reduce urban demand for local cereals. Other influences that need to be factored into the analysis are the arrivals and distribution into commercial channels of food aid and commercial imports of wheat, sorghum and maize. Greater efficiency and competitiveness in marketing of local cereals (in year 5 of the NPA) may also be a factor in dampening coarse grain prices in urban markets, as scale increases (for at least some traders) and competitive pressure forces marketing costs and margins down.

Whatever the relative magnitudes of the above forces in shaping supply, demand and prices of local cereals, a 19% reduction in the rice price will definitely make it tougher for local cereals to compete with rice in urban areas. Local cereals will have trouble capturing the Dakar market, and industrial schemes funded by the Common Fund in 1988-89 have failed and will probably continue to fail.[13] Dehulling losses and industrial processing costs of over 50 FCFA/kg. push the prices of dehulled, milled, cleaned and packaged coarse grains to levels above the current rice price of 130

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12 ISRA/IFPRI is carrying out 18 months of survey research in ten villages in the Kaolack and Tambacounda Regions of Senegal during which detailed production, transactions, consumption and market price data are being collected. These data will be used to estimate price and income elasticities of demand and elasticities of substitution in consumption.

13 The Millet Supply Study, conducted by Louis Berger Intl. in 1985-86 concluded that industrial milling of millet was not economically viable, principally due to the variability of millet supply from year to year and across seasons in any given year. As a result, an industrial plant could not be kept running at a sufficiently high rate of capacity utilization without incurring prohibitively high storage costs.

FCFA/kg. Further processing is necessary for preparation of cous-cous and lakh. Cooking time and energy costs are higher than for rice. Urban women lack time to prepare dishes from local cereals, and in many cases they lack the knowledge and expertise.[14] This increases economic opportunities for women food processors in urban areas, but they sell cous-cous at prices of 140 FCFA/kg. or more in order to earn an economic return. At these prices, rice's cost advantages and ease in preparation appear to favor increased rice consumption in urban areas. There is still a seemingly inelastic residual demand for using local cereals in preparing traditional dishes and foods required for many important social and religious ceremonies, but lower income urban households with very limited budgets will have an incentive to increase rice consumption at the lower rice price.

3.5 Impacts of the Lower Rice Price on Rural Consumption and Processing of Coarse Grains

In rural areas, where women generally do not buy processed coarse grain products, changes in rice consumption depend on several factors. Those households which need to buy grain to meet food requirements, especially during the hungry season, will buy the cheapest source of calories. In low-income households where the opportunity cost of female labor is low, most rural households will buy coarse grains and process them manually, even if coarse grain prices approach rice prices in unprocessed form. If the opportunity cost of women's time is high enough, as in areas where income-earning enterprises are more common and remunerative, women will have an incentive to buy rice, which requires no further processing. The price at which buying coarse grains is no longer attractive will depend primarily on the opportunity cost of female labor. Other important variables are the cost of mechanized milling in rural areas (typically 15 FCFA/kg.), where milling is a feasible alternative, as well as time and transport costs associated with going to a mill and waiting for grain to be milled. The issue is complex, and the set of factors is likely to vary from year to year, depending on the magnitude of food and cash crop harvests, the availability and intertemporal distribution of household income flows, dry season employment opportunities and demand for goods and services produced in off-season enterprises (largely a function of rural incomes), the number of months of household coarse grain consumption which are satisfied by own production, and rice supply (and prices) in rural areas.

3.6 Some Additional Considerations

Examining coarse grain and rice substitutability in consumption is fraught with potential pitfalls. It is a complex issue meriting careful study. Several important issues and considerations, which will not be discussed in depth in this report but that need to be addressed include:

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[14] Several informants reported that younger urban women have lost, in many cases, the knowledge and skill to prepare coarse grain dishes. In many quarters of towns there are a handful of older women who have become specialists in preparing cous-cous and lakh. They are often hired to produce large quantities for social and religious ceremonies, such as baptisms. They may also prepare these millet-based foods for retail sale. The extent to which these women prepare food on a regular basis for other households, where working women are too busy to prepare the evening meal, or where single working males lack the time and expertise to cook, is unknown, but it may be quite significant. Posner (1983) discusses the importance of food preparation as a source of income for women in Ziguinchor.

- the seasonal peaks in demand for coarse grains, particularly millet and millet products during Moslem holy days, especially the month of Ramadan and the festival of Tabaski;

- weight, moisture content and volume changes that coarse grains undergo at various stages of processing (dehulling, steaming) and under different processing technologies, and consumer perceptions of calories and satisfaction provided by the same weight of different coarse grain products and rice;

- the costs and availability of complements to both coarse grain and rice in grain-based dishes, and consumer perceptions of the necessity of including these complements in different dishes;

- food preparation costs in terms of fuel and labor for rice and coarse grain dishes;

- consumer observations, particularly in urban areas, regarding the texture, taste and disgestibility of coarse grain products relative to rice.

- urban food consumption patterns, particularly for the mid-day meal, which may not be eaten at home, and the grain-based products prepared by food vendors to sell to urban workers. As in Ouagadougou, vendors may prefer to prepare rice dishes, due to ease and lower cost of preparation. (see Reardon, Thiombiano and Delgado, 1989).

In-depth and structured informal interviews would be appropriate for eliciting valid information on these issues. These interviews will be a useful complement to the data collection and analysis of the ISRA/IFPRI surveys of rural households.

4.0 Other Important Policy Issues Affecting the Viability of Coarse Grain Processing

Import (32%) and value added (20%) taxation of agricultural equipment and diesel, gasoline and electrical motors increase acquisition costs and is a clear disincentive to private investment in processing machinery. The economic viability of processing equipment is highly sensitive to acquisition cost (see Annexes 3-6). NGOs and village/women's groups are usually exonerated from paying these duties and taxes, which confers an unfair advantage over private entrepreneurs. Removing these taxes would "level the playing field."

Yet there are ideological and equity arguments for exonerating village groups. An important socialist tenet of the New Agricultural Policy (NPA), which has guided GOS agricultural policy since May 1984, is the "responsabilisation" of farmer organizations. Allowing these organizations to gain access to processing equipment provides opportunities for collective management and economic benefits from successful use of the technology, which can then be reinvested in other productive enterprises. Furthermore, farmer organizations will presumably be able to acquire processing equipment in villages where private entrepreneurs are unwilling to invest or where they may exercise localized monopolies, thereby having a favorable equity impact. Collective ownership and management may also improve the access of lower income households to mechanized grain processing in cases where collectively run mills charge less for milling than private mills. In many cases this may be a false economy, however, as some village organizations charge too low a price to sustain the investment in processing equipment. When the units break down, the groups lack funds to purchase spare parts or pay a mechanic to repair the diesel engine. Hence, the potential equity benefit is offset in the medium to long run by pricing of milling services below their real economic cost.

Taxes on tools and intermediate inputs for the production of agricultural equipment also increase financial costs of processing equipment for both industrial manufacturers (SISMAR) and local artisans. Removing these would lower the costs of raw materials and manufactured equipment, and hence improve entrepreneurs' access to processing units, the financial viability of these units, and the ease of reinvestment. The budgetary implications of reducing import and value added taxes on raw materials, tools and final products need to be estimated, particularly in light of the decline in revenues from duties on rice imports.

Another way to lower financial operating costs would be to lower taxes on fuel consumption. Unfortunately, this is likely to be politically impossible, as fuel taxes are an important source of GOS revenue. These taxes affect both productive activities (processing, transport of foodstuffs), as well as superfluous consumption (e.g., private motor car use). The significant difference in official diesel and gasoline prices (210 FCFA/liter vs. 350 FCFA/liter) reflects this distinction.

5.0 Institutions and Coarse Grain Processing

This section will discuss strengths and weaknesses of institutions which develop, promote and finance mechanized coarse grain processing in Senegal. It is a selective rather than exhaustive treatment.

5.1 FENU Mill Program

As noted above, women's groups managing mills under the FENU program merit closer study. Management and maintenance of mills remain a problem in some cases. Providing mills as gifts may undermine incentives to maintain mills properly and represents an unfair advantage vis-a-vis the private sector. The FENU management/accounting system is generally well-designed but not without flaw. Millers earn 25% of net revenues from grain processing. Since maintenance costs reduce net revenues, millers have an incentive to change diesel engine oil and filter and to lubricate moving parts less frequently. Women managers need to be familiar enough with maintenance requirements and firm enough with millers, who are mostly males, to prevent this from happening. The problem is less likely to arise if women millers are identified and trained from within the women's groups. Female millers would probably take a longer term view, recognizing that inadequate maintenance would threaten the longevity of an important income-generating activity. Use of women millers in the FENU mill program in the Gambia has proven quite successful (see FENU, 1987). Women managers of CRS grain processing centers in the Gambia have also worked out well (personal communication, Freudenberger).

Where the FENU management system has worked well, and rural mills have generated significant revenues, the FENU program has had a dramatic effect on the income-generating opportunities of rural women. Labor demands on women decrease and opportunities to earn income from milling (collectively managed) and other productive investments (e.g., vegetable production, water and wood hauling, etc.) expand. Dakar-based managers of the FENU program report that many women's groups have saved well over 500,000 FCFA in their postal savings accounts and used incremental funds to make other productive investments. Evidence appears anecdotal, however, and careful analysis of the program is required in order to relate variables such as net revenues and cumulative postal savings to grain throughput, prices charged per kilogram for processing, maintenance and repair costs and frequency, village and surrounding area population and estimated grain production, and distance to the nearest competing mill.

5.2 NGOs

Non-governmental organizations (NGOs) are very active in Senegal, but they have limited capacity to absorb resources and often ineffective management. Several NGOs are involved in far too many appropriate technological introduction and dissemination efforts to be effective. Others appear to emphasize technological and non-economic factors (political, social) over economic considerations, jeopardizing sustainability of investments in rural areas. Furthermore, when equipment is provided as a gift, rural people are not fully "responsabilized." Nevertheless, NGOs can play an effective grass roots demonstration and extension role. They can place experimental processing units in villages to test their technical suitability, financial viability and likely sustainability over long periods. In addition, NGOs could transport processing units from village to village in an extension effort to demonstrate the effectiveness and attractiveness of the new technologies.

Nevertheless, the limitation of NGOs need to be kept in mind, particularly with respect to objective and rigorous evaluations of the economic viability and sustainability of appropriate technologies. By way of example, it appears that ENDA is understaffed and overcommitted. CSA/PSA plans to work with ENDA in monitoring and promoting semi-industrial units, but it is not clear that ENDA has sufficiently well-trained economists or financial analysts to design useful data collection efforts and conduct rigorous assessments. This is not to condemn ENDA and other NGOs, such as CRS and SERRIAL. Rather, there may be a positive role for USAID to play in strengthening their capacity to collect data, more effectively monitor ongoing appropriate technology experiments, and improve the quality and depth of their analyses of the economic viability of processing investments. The same USAID support could also be provided to strengthen Common Fund initiatives and the ISRA/IDRC dehulling experiment.

Other village organizations [groupements des producteurs (GPs), Associations de base des producteurs (ABPs) and sections villageoises] have received gifts of improved grain processing technology. SODEVA, the parent organization of the GPs, has experimented with the Bamba maize threshers, which were moved from one village GP to another following the 1986-87 and 1987-88 harvests. All three threshers broke down during the second year, and only one had been repaired by early 1989. SODEVA officials report that the Bamba is not a high capacity unit able to process large volumes of grain in a concentrated period after the harvest. The roles of SODEVA, SODEFITEX and the UNCC (the parent or funding organizations to the above farmer organizations respectively) in promoting mechanized processing merits further study.

The Caisse Nationale de Crédit Agricole du Sénégal (CNCAS) is able to make loans available to another form of village organization, the GIEs (groupements d'intérêt économique), as well as to private entrepreneurs. The CNCAS office in Kaolack has made loans to two GIEs for the purchase of threshers and to five individuals for the purchase of mills. Since the loans were extended recently, no information is yet available on the financial performance of the borrowers. CNCAS does not appear to be monitoring the performance of the threshers and mills closely.

5.3 USAID Funded Private Enterprise Project, Kaolack

One interesting and successful innovation to date is the USAID funded Private Enterprise and Local Collectivities in Rural Areas Project, implemented since 1986 in Kaolack Region. This project is doing what an agricultural lending agency such as CNCAS should be doing (but for the most part is not yet doing). The Private Enterprise component of the Kaolack project has successfully provided short-term loans (6-12 months) to private entrepreneurs who have invested in grain mills, as well as repairs of motors for these mills, tractors, and large-capacity threshers. The individuals chosen and their demonstrated ability to repay reflect a prudent credit strategy. This activity could be expanded successfully and interest rates raised to higher levels than the current 22% could be changed in order to defray a higher proportion of administrative costs.[15] Loans could also be provided for periods of over one year, as the payback period on most agricultural processing equipment is likely to be two to five years. The project could

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15 There are official interest rate ceilings, which formal financial institutions in Senegal must respect, that are set by the BCEAO in consultation with the French Treasury. Trying to relax these ceilings, particularly for agro-enterprise investments, calls for a regional -- rather than country by country -- USAID strategy.

also grant loans to entrepreneurs wishing to acquire other types of processing equipment, such as dehullers and the Bamba or small SISMAR threshers.

Using the project as a vehicle for testing technologies unproven under Senegalese conditions is preferable to give-away programs that use village groups. Private entrepreneurs are required to put up at least some funds in order to get the balance of resources required to make the investment, and they need to repay loans over short periods at market interest rates. As the capital base of this component increases, the project might consider longer term loans (2-4 years) for acquisition of processing equipment. This would entail greater risk, of course, and may not be appropriate for the USAID project. Over time one would hope that an agricultural lending institution such as CNCAS could play this role. Unfortunately, CNCAS seems to have had an inordinately long gestation period, and it prefers to work through GIEs (Groupements d'Intérêts Economiques--farmer organizations), which have not yet demonstrated the same repayment capacity and management discipline as private firms. Some GIEs in Kaolack Region have received loans from CNCAS for acquisition of processing equipment, but it is too early to evaluate their performance.

5.4 Association of Artisans

Another noteworthy institutional innovation is the recent formation of an association of Senegalese artisans and metal workers, presided over by Cheikh Gueye. The artisans, who fabricate grain mills, oil presses, well construction equipment, and agricultural tools, hope to attract greater donor and NGO resources in order to finance the development of modifications of existing technologies (e.g., the SISMAR/ISRA/IDRC dehuller) and new technologies with positive rural development impacts. This is a promising development for several reasons. First, scarce donor and NGO resources for the promotion of local artisans can be better coordinated and directed to what they perceive to be the most promising projects. Second, the artisans can undertake risky ventures which they could not consider taking with their limited resources. Third, alternative designs can be tested, improved and later standardized among association members.

Senegalese artisans are among the most inventive and skillful in Africa. In order to expand the supply of trained artisans and the lower cost equipment that they produce, funding might be provided so that the limited number of talented artisans become trainers and technology developers rather than copiers and reproducers. Over the longer run, issues of copyright protection and taxation may become important, particularly as local artisans grow in scale and market share relative to SISMAR and importers of foreign equipment. Artisans do not pay for copyright protection or value-added taxes, nor are their equipment sales subject to value-added taxes, unlike SISMAR.

6.0 Further Research Needs

As argued above, more rigorous and timely financial and economic analysis would strengthen the effectiveness of technology experiments and developments already underway or planned. It would allow development agencies to specify more rigorous criteria for use in providing processing equipment, or loans for equipment, in particular villages. As a result, there would be fewer errors in siting equipment in economically unviable locations, where costly investments cannot be sustained. Misallocation of scarce donor resources for grain processing would be minimized and funds could be reprogrammed for more effective use.

Related to this point, it is important to evaluate and compare the performance of privately and collectively managed processing equipment. The historical bias of donor agencies, PVOs and the GOS has been a preference for working through village level organizations which manage equipment collectively. The record has been mixed and a rigorous assessment of comparative performance is overdue. It is likely that too many scarce development resources have been channeled through rural organizations with more often than not weak performance and limited accountability. If poor performance and management were substantiated empirically, donors, PVOs and the GOS would be advised to direct far more resources to the private sector. At a minimum, resources made available to village organizations would need to be provided more selectively and monitored more carefully.

Specific monitoring and evaluation which economists, agricultural economists or financial analysts could assist in carrying out would include:

1. Monitoring the proposed CSA/PSA/ENDA experiment which promotes semi-industrial units in ten secondary cities of Senegal. Data need to be collected consistently across the sample and analyzed systematically for the following variables: investment cost, working capital reserves, grain purchase and storage quantities and costs, processed throughput and conversion/wastage factors, variable processing costs (fuel, oil, grease, spare parts and labor), other material costs (bags), sales of primary products and by-products, net revenues, and use/savings of net revenues/retained earnings. Monitoring over two years is recommended. An acid test of economic viability would include at least one year following a mediocre to poor harvest.

2. More timely and in-depth analysis of the SISMAR/ISRA/IDRC experiment introducing locally manufactured dehullers. Many of the same variables as in point no. 1 should be monitored, as well as the effectiveness of collective management by women's groups, the opinions of users of the dehullers with regard to processed grain quality and processing cost, and factors which constrain broader use of mechanical dehullers in rural areas. Information about the purpose for which dehulled grain is to be used should also be collected, so as to differentiate between commercial dehulling for trading, dehulling for social ceremonies requiring large quantities of processed coarse grain, and dehulling for normal household consumption. Tracing the market channels through which traded (dehulled) grain moves, as well as marketing costs and acquisition/sales prices, could also provide useful information about the economics of this promising development. Several trader case studies, rather than exhaustive coverage, are advised.

3. Development of a computerized data base for the FENU mills, data entry for at least a sample of the mills, and rigorous analysis of costs and returns to the cooperatively managed enterprises. It would be useful to account carefully for indirect project (and management) costs and to analyze financial and economic returns to individual mills as well as the entire project. Data analysis would permit establishment of more rigorous criteria for mill placements, as well as enabling the project to monitor the progress of individual mills more effectively.

4. Monitoring of costs and returns to smaller-scale threshers (Bamba and SISMAR models) in use, particularly in the Kaolack, Tambacounda and Koïda Regions. This would assist lenders and investors to develop better financial and economic guidelines.

5. Assessment of the most effective means of promoting the investment in and use of processing equipment. Monitor ongoing experiments to assess their demonstration effect, the opinions of users of technologies as to their costs (processing price per unit), quality and time savings, and the effectiveness of promotional efforts by the implementing agencies.

7.0 A Proposed USAID Action Plan for Coarse Grain Processing

Many organizations and donors are financing or carrying out grain processing experiments, some of which are quite promising. Often these experiments are not very effectively monitored and evaluated. Given the proliferation of donor efforts, USAID's comparative advantage lies more in the areas of economic and policy analysis, information system management, marketing, and private enterprise promotion than in technology development and adaptation.

USAID should consider its top priority the removal of duties and taxes which impede private sector investment. The single most binding constraint to private investment in mechanized agricultural processing equipment in Senegal is import duties and value-added taxation, which raises acquisition cost 32% and 20% respectively. In a capital-starved commercial environment such as Senegal, these taxes are too onerous a burden for potential investors to bear. Furthermore, private investors are greatly disadvantaged vis-a-vis village organizations which have either received the technology free of charge or without having paid duties or taxes. Removing the taxes would put the private sector and collectively managed units on a more equal footing. The demand for processing machinery (and power sources) is probably quite elastic, and taxes impose a heavy burden relative to other, less taxed and less penalized investments (such as livestock, real estate and trading). If the GOS wishes to retain some revenue from taxes on equipment, it could cut their magnitude by, say, two-thirds. Depending on the elasticity of demand for processing machinery, tax revenues might even increase.

The second most important element in the Action Plan should be promotion of private sector grain processing. This can be accomplished by:

1. Providing funds to the CNCAS which are earmarked for private investment in grain processing equipment, and insisting that CNCAS give special attention to the private sector, rather than GIEs. This would require that they actively solicit private sector clients and provide assistance in preparing business plans and loan requests. USAID could assist CNCAS in these tasks by providing tehnical assistance.

2. Encouraging other donors, PVOs and the GOS to make more resources available to private agents rather than to collectively managed village organizations for investment in processing equipment.

3. Insisting that the Common Fund Semi-Industrial and Rural/Artisanal Subprograms of the Local Cereals Transformation Program work through private individuals and firms rather than collectivities and village organizations. This would offset a heavy historical bias in favor of collective management.

4. Continuing to fund the Private Enterprise component of the USAID credit project in the Kaolack Region. USAID should contemplate providing credit for longer terms to private individuals and firms, so they can make investments in costlier machinery with a longer payback period.

A third set of elements necessary for promoting mechanized coarse grain processing in Senegal is strengthening of small business management practices and repair and maintenance services for support of processing units. FENU has taken important steps in these areas by training women's management committees and village millers, and by providing a spare parts distribution network and fairly priced and carefully monitored

repair services. The training and services provided to women's village groups through FENU are subsidized and not made available to the private sector. Private millers, particularly those based in rural areas, often pay substantial premia for parts and repairs. Spare parts for imported models are only sold by manufacturers' representatives in Dakar or hardware/parts distributors in principal cities, such as Kaolack, Thies, St. Louis and Ziguinchor. Clearly, private operators of processing equipment would benefit from more widely available and competitive parts distribution and repair services. Better preventitive maintenance is one way to lower repair frequency and costs, and there is scope for training of operators of private processing units.

Establishment of repair and service centers in towns would increase the supply, lower the cost and likely improve the quality of repair services, which would obviate the need for the type of policing of mechanics done under the FENU mill program. Trained mechanics could be dispatched to isolated villages to do repairs as well. As these centers increased their scale of business, they could stock at least common replacement parts for mills, dehullers and threshers, competing with the parts suppliers in towns outside Dakar. AID/RHUDO/West Africa is increasingly focusing on investments in market towns that serve to support urban-rural linkages. New businesses like these service centers -- promoting off-farm employment and doing so in the context of increasing agricultural productivity -- should be pursued with RHUDO. Before making this type of investment, further analysis and a feasibility study are recommended.

Other key elements of an Action Plan, which would be needed to monitor and evaluate the comparative performance of privately and collectively managed processing units are as follows:

1. Assist in the computerized entry, processing and analysis of existing data sets.

2. Assist in the timely and rigorous monitoring and evaluation of ongoing experiments in technology adaptation and promotion, and in the design of M&E information systems for planned experiments.

3. Assist in improving the depth and quality of analysis of technology alternatives, marketing strategies and policy issues associated with technology adaptation and promotion.

4. Assist in disseminating information about economically viable grain processing technologies.

USAID also has a potentially important role to play in the Common Fund cereals transformation subprogram on rural/artisanal processing.[16] USAID could consider providing technical assistance to do the following:

1. Training Senegalese analysts and staff in NGOs (such as ATI) to assist in the field-level monitoring and promotion of improved cereals processing methods.

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[16] It is reported that significant resources, on the order of 300,000,000 FCFA, are available for this subprogram but not yet programmed or dispersed.

2. Use qualified local consultants, outside contractors, or possibly third-year Peace Corps volunteers, to assist ongoing research programs and monitoring and evaluation efforts, and perhaps in more timely, economically rigorous, and widely disseminated analysis of existing data sets.

3. Provide additional financial and/or analytical support to the SISMAR/ISRA experiment with locally manufactured dehullers to supplement limited IDRC resources. Funds for computer hardware and software acquisition, and training in using microcomputers and relevant software are most imperative.

4. Fund further, selected field research in rural areas, particularly on the economic viability of small-scale threshing equipment (Bamba, SISMAR model).

5. Provide support for centralization, cataloguing and analysis of available reports, product information (on technologies that are available or being tested), and data sets on improved coarse grain cereals processing.

6. Analyze budgetary impacts of measures designed to promote the use of improved grain processing equipment.

7. Provide support for synthesis of research results and cross-project or cross-program analysis of related issues and impacts. Examine interrelated issues of grain import magnitudes, timing and policies, cereal price policies and competitiveness of different cereal products, agricultural marketing costs and margins, and the costs and returns to improved grain processing.

In conclusion it is proposed that USAID abide by several general principles:

1. After initial experimentation with improved technologies, USAID should insist that economically viable technologies be promoted via private entrepreneurs as well as through village organizations or NGOs.

2. USAID should encourage the GOS, donors and PVOs to subsidize the introduction of mechanized processing only in those semi-urban and rural areas where the probability of sustaining the investment is high.

3. Finally, USAID should discourage the use of technologies to promote transformation and increased consumption of coarse grains that rely on heavy subsidization and appear likely to require indefinite subsidies to remain viable. (The best example of this is probably the Sentenac industrial milling of coarse grains experiment supported by the Common Fund).

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This workshop was organized jointly by:

ENDA TM - Relais Technologique
BP 3370
Dakar - Sénégal
Tél: 21 60 27 our 22 42 29
Télex: 456 ou 51456 SG

ALTERSIAL - GRET - CEEMAT
213, rue La Fayette
75010 Paris - France
Tél: 42 39 13 14
Télex: 212 890F

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Annex 1

Selected List of Individuals Contacted During the Consultancy

In the United States

Donna Bickford, documentalist, IDRC, Ottawa, Canada.

Carl Bielenberg, independent consultant and mechanical/appropriate technology engineer, RFD, Marshfield, Vermont 05658.

Carol Kramer, Research Associate, Resources for the Future, Washington, D.C.

John Lewis, Sahel Regional Affairs Officer, Africa Bureau, USAID.

Carl Lindblad, Project Officer, VITA, Washington, D.C.

Melanie Marlett, USAID/PPC/PDPR, Washington, D.C.

Wayne Nilsestuen, Agricultural Development Officer, USAID/Senegal.

Edward Perry, West Africa Projects Officer, Appropriate Technology International, Washington, D.C.

Lloyd Rooney, Cereal Quality Laboratory, Department of Soil and Crop Science, Texas A&M University, College Station, Texas 77843 (International Sorghum and Millet Collaborative Research Support Program).

Martin Satin, Chief, Food and Agricultural Industries Service, Agricultural Services Division, FAO, Rome.

William Spencer, Department of Agricultural and Resource Economics, Colorado State University, Fort Collins, Colorado 80523.

Ron Tribelhorn, Research Associate, Department of Agricultural and Chemical Engineering, Colorado State University, Fort Collins, Colorado 80523.

In Dakar, Senegal

Fallou Dieye, consultant to USAID.

Birame Ngoye Fall, Marketing Director, SISMAR.

Joachim Gromotka, Economist, CSA/PSA (Programme de Sécurité Alimentaire).

Michael Hambdy, Technical advisor to ITA, Transformation de Niébé project.

Taofik Jomni, USAID/Food for Peace.

Moribadjan Keita, USAID/Agricultural Development Office.

Valerie Kelly, IFPRI researcher, ISRA/Hann.

Doudou Kondé, Marketing Manager, MATFORCE, Département de Nosoco, Sénégal, Nouvelle Société Commerciale Sénégalaise.

E. Leuchtmann, Projet Encouragement de la Culture du Mais, Hann.

Desaix Myers, Project Development Officer, USAID/Senegal.

Dr. Ababacar S. Ndoye, Directeur Technique, Institut de Technologie Alimentaire (ITA), Hann.

O. Neuendorf, Projet Encouragement de la Culture du Mais, Hann.

Ismael Ouedraogo, ISRA/MSU Agricultural Research and Planning Project, Département Systèmes, ISRA/Hann.

Anne-Marie Preira, Projet Promotion Economique des Groupements Féminins, Ministère du Développement Sociale.

Cynde Robinson, Associate Director, Peace Corps.

Karen Schoonmaker Freudenberger, IDRC.

Marc Soquet, ILO Expert and Principal Technical Advisor, Projet Promotion Economique des Groupements Féminins, Ministère du Développement Sociale.

Lamine Thiam, USAID/Agricultural Development Office.

Philippe Vivier, Conseiller Technique, Fonds Commun.

Wolfgang Wittung, Cereals Processing Expert, CSA/PSA (Programme de Sécurité Alimentaire).

Rufisque

Mamour Dieng, Commercial Director of ARAFAT bakery cooperative.

Alioune Fall, Miller, Rufisque.

Diourbel Region

Sane Abdoulaye, Regional Inspector, Ministry of Social Development, Diourbel Region, Diourbel.

Ndeye Awa Diongue, Coordinator, FENU Project, Department of Diourbel, Diourbel.

Abouda Houcine, Directeur Technique, SETUNA (Société Sénégalo-Tunisienne de Nutrition Animale), Diourbel.

Marra, Owner/operator of a semi-industrial coarse grain processing unit, Bambey.

Hyacinthe Mbengue, Director of the Post-Harvest Technology Program, ISRA/CNRA, Bambey.

Enumerators in the the Post-Harvest Technology Program, ISRA/CNRA: Magatta Dieye, Malick M'Bodj and Khoussaye Diagne, Bambey.

Mechanic in the Post-Harvest Technology Program, ISRA/CNRA, Bambey.

Fatick Region

Cheikh Gueye, artisan and director, Unité de Production et de Perfectionnement Artisanale (UPPA), Gossas.

Kaolack Region

Amadou Gueye Diouf, Credit Director, USAID Development of Local Collectivities and Private Enterprise in Rural Areas Project, Kaolack.

Andrew Dorow, Peace Corps volunteer, Keur Coumba Daga.

Matar Gaye, ISRA researcher, ISRA/Kaolack.

Bertrand Laurent, Head of Management Unit, USAID Development of Local Collectivities and Private Enterprise in Rural Areas Project, Kaolack.

Mansour Mbaye, Regional Director, Ministry of Social Development, Kaolack Region.

Ousmane Thiam, artisan, Entreprise Darou Minam, Kaolack.

Selected loan recipients: grain traders, millers, threshers.

Annex 2

List of Senegalese Artisans Who Fabricate Agricul Agricultural Processing Equipment

Location/Artisan

Louga - Bailo Thiam

Kebemer - Makha Diack, Daouda Seck

Gueoul - Cheikh Seck

Thies - Mamadou Pene, Assane Diaongue

Mekhe - Daouda Seck

Mbacke - El Hadji Thiam

Diourbel - Thiam

Gossas - Cheikh Gueye

Kaolack - Ousmane Thiam

Annex 3

Analysis of the Financial Viability of a Semi-Industrial Grain Processing Unit in Tambacounda

The following budgets and IRR calculations are based on data from Alain Salcedo's paper "Transformation Villageoise des Céréales au Sénégal," presented at the PROCELOS (Programme Régional de Promotion des Céréales Locales au Sahel) workshop of October 24-28, 1988. The FAC is financing a semi-industrial processing experiment in Tambacounda, using a SISMAR/ISRA/IDRC dehuller (prototype no. 4). The semi-industrial unit consists of a dehuller, a hammer mill, a bagging unit, a scale, sifters (tamis), bagging material and machine mount, installed in a building on the grounds of SODEFITEX in Tambacounda. Three alternative power sources are considered: entirely electric operating from an urban power grid, electric motors powered by generators, and a diesel engine with a small generator (for running the bagging unit). The first two alternatives are likely to be suitable for urban areas, while the last option would be best suited for rural use.

The unit has operated since July 1988 and data presented by the author represent observations during a three-month period (July through mid-September 1988), as well as extrapolations to a one-year period. It is not clear, however, which power source is actually used with the Tambacounda unit. The documentation regarding investment and operating costs is excellent, which permits an in-depth analysis of financial costs and returns. Key variable operating costs are assumed to be constant per metric ton of processed throughput, as shown in Table C-1.

Table C-1

Variable Operating Costs for Three Alternative Power Sources Used to Run a Semi-Industrial Unit in Tambacounda (in FCFA/metric ton)

Variable Cost Item	Urban Electric	Generator Electric	Diesel
Energy			
Consumption kwh/t	60	364	202
Cost of kwh	80.46	20.76	20.76
Cost of Energy	4827.6	7556.6	4193.5
Other Variables			
Lubricant Cons.		0.47	0.47
Cost of Lubricants		583	583
Bags	7500	7500	7500
Abrasive Disks	1943	1943	1943
Maintenance	522	1989	1557
Day Laborers	1500	1500	1500
Total	16292.6	21071.6	17276.5

This section uses Salcedo's data to do a financial analysis of the

product, which assumes an 80% dehulling rate and 5% impurities in the dehulled grain (5% of 80% is 4%, resulting in 76% as the remaining product). 250 kilograms of bran would be produced per metric ton of processed grain (or per 1316 kilograms of raw grain). I assume sales prices of 132.5 FCFA/kg. for semoule, 110 FCFA/kg. for brisures, and 25 FCFA/kg. for bran. The semoule and brisures prices assume that half of the output would be sold in 40 kilogram sacks (wholesale) and the other half would be sold in 1 kilogram packets (retail). The prices used in the analysis are therefore ex-factory prices, which are a weighted average of wholesale and retail prices quoted by Salcedo. The base run yields acceptable internal rates of return for two of the three power options. Results of changing some of the key parameters are shown below.

Table C-2

Sensitivity of the Financial IRR to Selected Parameter Changes (in %)

#	Run	Power Source: Option 1	Option 2	Option 3
0	Base : 150 MT	78.7	Negative	17.7
1	100 MT Throughput	9.9	Negative	Negative
2	200 MT Throughput	261.6	20.1	69.3
	Semoule/Brisure Sales Price			
3	Price Increase to 140/115	229.7	27.8	68.1
4	Price Decrease to 125/105	14.8	Negative	Negative
5	Semoule=125/Brisure=110	49.4	Negative	Negative
	Bran Sales Price			
6	Price Increase to 35 FCFA	116.5	Negative	34.9
7	Price Decrease to 15 FCFA	32.5	Negative	5.4
8	Without Repair Contingencies	121.9	18.1	45.0
	Maize Acquisition Price			
9	Price Increase to 72 FCFA	77.0	Negative	16.8
10	Price Increase to 75 FCFA	36.3	Negative	Negative
11	Price Decrease to 65 FCFA	362.6	40.3	91.6

The IRR is highly sensitive to grain acquisition prices and sales prices for processed products. Decreasing sales prices of semoule to 125 FCFA/kg. and brisures to 105 FCFA causes the IRR to become negative except in the case of the electric powered, urban option. Increasing sales prices raises the IRR strongly. IRR is also quite sensitive to throughput. If throughput drops 33% to 100 tons, the IRR drops to 9.9% for the unit powered by urban electricity and becomes highly negative for the other two options. Increasing throughput 33% has an equally strong positive effect. Raising the price of bran from 25 to 35 FCFA/kg. increases the IRR quite signficantly as well.

Breakeven levels of processed throughput, using all the assumptions present in the base run, are approximately 90 metric tons for power option 1, 160 tons for option 2, and 130 tons for option 3. Clearly, the most financially viable option is the one that employs urban electricity, primarily because investment costs are so much lower than for the other two options. The least viable option is the electric one in which a generator is the power source. Investment and replacement costs are simply too high for the unit to recover, unless throughput is significantly greater than 160 metric tons. The diesel-driven unit, the more viable choice for rural areas, needs to operate at a quite high level to be profitable. A semi-industrial unit using this option would need to be located in a highly productive and cereals surplus zone to be viable. Depending on the unit's location relative to the road network, grain assembly and distribution costs could be very significant. It is also necessary to note that the track record for sustaining operation of diesel engines used to power mills in Senegal is not encouraging. Setting up a semi-industrial unit in a town is generally preferable to installation in a rural area.[3]

The FAC experiment and Salcedo report raise several interesting questions. First, Salcedo reports that 64% of a sample of consumers (of unknown representativeness) are willing to pay 125 FCFA/kg., though it is not clear whether this is for semoule, brisure or both. 21% are willing to pay 100 FCFA/kg. and the remaining 15% are willing to pay less than 100 FCFA/kg. Salcedo also reports that Tambacounda traders who bought maize products at the factory received wholesale prices of 150-162.5 FCFA/kg. and retail prices of 165-187.5 FCFA/kg.[4] Total sales of maize processed at the semi-industrial unit during the July to mid-September 1988 period were 8841 kilograms to wholesalers, 3470 kilograms to retailers, and 4236 kilograms to SODEFITEX employees. Traders paid 110 FCFA/kg. for 40 kilogram sacks and 115 FCFA/kg. for 1 kilogram sacks.

Wholesale and retail sales prices above 150 FCFA/kg. suggest that at least some consumers are willing to pay substantially more than 125 FCFA/kg. Trader gross margins ranged between 36% and 70%. No attempt was made to estimate net returns, but they are likely to be quite attractive. If quantities of 150 metric tons and more could be processed and sold in Tambacounda per year without dampening retail prices of processed maize, factory gate prices of maize products processed at the semi-industrial unit could probably be raised to levels used in the base run (132.5 FCFA/kg. on average for semoule and 110 FCFA/kg. on average for brisures), thus

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[3]Private grain traders could supply a semi-industrial unit, perhaps on contract. Or they could be encouraged to invest in processing, perhaps forming partnerships or companies, and thereby achieving economies of scope.

[4]These price levels may be influenced more by price levels of maize products distributed by GMD (Grands Moulins de Dakar) and Sentenac than by supply and demand forces, particularly if sales of maize products processed by the semi-industrial unit represent a small proportion of total supply on the Tambacounda market.

ensuring profitable operation.

The FAC experiment is very promising and deserves to be carefully monitored and evaluated over a two or more year period. It should also be instructive for the monitoring of ten additional units to be funded and installed by CSA/PSA in collaboration with ENDA. The detailed information on the operation of the semi-industrial unit needs to be supplemented with information on trader sales, prices received by traders, and costs incurred (transport, storage, interest, place of sale, taxes) in marketing processed maize products. Further consumer surveys could be used to assess willingness to pay, as well as opinions regarding the quality of processed products (color, texture, moisture level and storability, packaging, etc.). To the extent possible, FAC and CSA/PSA data collection and analysis should be coordinated to ensure comparability across towns of different sizes and characteristics (ethnicity, consumer preferences and purchasing power, proximity to Dakar, etc.).

Shifting from financial to economic analysis increases the profitability of the semi-industrial unit. Equipment acquisition costs would drop 32% for imported equipment (less import taxes) and 20% for locally manufactured equipment (less value-added taxes), significantly decreasing upfront investment costs and replacement costs in later years. The unit would be profitable even if throughput decreased, acquistion prices increased and sales prices declined. The implication for policy is that these taxes should be removed to promote semi-industrial and artisanal coarse grain processing in Senegal. (Note that we lack sufficient information with which to convert fuel, lubricant and electricity costs from financial to economic prices).

It is important to note that the findings presented here are preliminary and illustrative. It is hoped that the presentation and analysis of the data, however tentative, can encourage other analysts who are monitoring and evaluating the introduction of processing equipment in Senegal to do further financial and economic analysis. For semi-industrial units, more thought needs to go into whether grain transport and storage costs should be included in the analysis. Adding these costs would tend to depress rates of return.

Table C-3

Financial Cost and Revenue Streams Used in Calculating Internal Rates of Return for the Semi-Industrial Maize Mill in Tambacounda

Investment Costs	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
Building	2000000					200000					400000			
Equipment														
Dehuller	500000							500000						
Hammer Mill	400000							400000						
Bagging Unit	322000			322000			322000			322000			322000	
Scale	350000							350000						
Sifters/Bagging Material	150000					150000					150000			
Mounting	100000							100000						
Subtotal	1822000			322000		150000	322000	1350000		322000	150000		322000	
Motors														
1 - Electric	350000							350000						
2 - Electric + Generator	3430000							3430000						
3 - Diesel + Sm. Generator	2240000				2240000				2240000				2240000	
Total Inv Costs - 1	4172000	0	0	322000	0	350000	322000	1700000	0	322000	550000	0	322000	0
Total Inv Costs - 2	7252000	0	0	322000	0	350000	322000	4780000	0	322000	550000	0	322000	0
Total Inv Costs - 3	6062000	0	0	322000	2240000	350000	322000	1350000	2240000	322000	550000	0	2562000	0
Fixed Costs														
Labor														
Storekeeper	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000
Miller	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000
Municipal Taxes	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Total Fixed Costs	1438000	1438000	1438000	1438000	1438000	1438000	1438000	1438000	1438000	1438000	1438000	1438000	1438000	1438000
Annual Tonnage	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Variable Costs														
Energy														
Option 1	724140	724140	724140	724140	724140	724140	724140	724140	724140	724140	724140	724140	724140	724140
Option 2	1133496	1133496	1133496	1133496	1133496	1133496	1133496	1133496	1133496	1133496	1133496	1133496	1133496	1133496
Option 3	629028	629028	629028	629028	629028	629028	629028	629028	629028	629028	629028	629028	629028	629028
Lubricants (2-3)	87450	87450	87450	87450	87450	87450	87450	87450	87450	87450	87450	87450	87450	87450
Bags	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000
Abrasive Disks	291450	291450	291450	291450	291450	291450	291450	291450	291450	291450	291450	291450	291450	291450
Maintenance														
Option 1	98100	98100	98100	98100	98100	98100	98100	98100	98100	98100	98100	98100	98100	98100
Option 2	406050	406050	406050	406050	406050	406050	406050	406050	406050	406050	406050	406050	406050	406050
Option 3	315150	315150	315150	315150	315150	315150	315150	315150	315150	315150	315150	315150	315150	315150
Repair Contingency														
Option 1	24525	49050	73575	98100	122625	147150	171675	24525	49050	73575	98100	122625	147150	171675
Option 2	101513	203025	304538	406050	507563	609075	710588	101513	203025	304538	406050	507563	609075	710588
Option 3	78788	157575	236363	315150	393938	472725	551513	78788	157575	236363	315150	393938	472725	551513
Day Laborers	225000	225000	225000	225000	225000	225000	225000	225000	225000	225000	225000	225000	225000	225000
Total Variable Costs														
Option 1	2575665	2600190	2624715	2649240	2673765	2698290	2722815	2575665	2600190	2624715	2649240	2673765	2698290	2722815
Option 2	3369959	3471471	3572984	3674496	3776009	3877521	3979034	3369959	3471471	3572984	3674496	3776009	3877521	3979034
Option 3	2751866	2830653	2909441	2988228	3067016	3145803	3224591	2751866	2830653	2909441	2988228	3067016	3145803	3224591
Grain Acquis. Cost														
Cost per Kg.	65	65	65	65	65	65	65	65	65	63	65	65	65	65
Kg Grain = 1 MT of Finished Product	1316	1316	1316	1316	1316	1316	1316	1316	1316	1316	1316	1316	1316	1316
Total Cost	12831000	12831000	12831000	12831000	12831000	12831000	12831000	12831000	12831000	12831000	12831000	12831000	12831000	12831000
TOTAL COSTS														
Option 1	21016665	16869190	16893715	17240240	16942765	17317290	17313815	18544665	16869190	17215715	17468240	16942765	17289290	16991815
Option 2	24890959	17740471	17841984	18265496	18045009	18496521	13570034	22418959	17740471	18163984	18493496	18045009	18468521	18248034
Option 3	23082866	17099653	17178441	17579228	19576016	17764803	17815591	18370866	19339653	17500441	17807228	17336016	19976803	17493591
Gross Revenues														
Semoule Quantity	102.8	102.8	102.8	102.8	102.8	102.8	102.8	102.8	102.8	102.8	102.8	102.8	102.8	102.8
Semoule Price	132500	132500	132500	132500	132500	132500	132500	132500	132500	132500	132500	132500	132500	132500
Semoule Revenue	13614375	13614375	13614375	13614375	13614375	13614375	13614375	13614375	13614375	13614375	13614375	13614375	13614375	13614375
Brisures Quantity	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3	47.3
Brisures Price	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000	110000
Brisures Revenue	5197500	5197500	5197500	5197500	5197500	5197500	5197500	5197500	5197500	5197500	5197500	5197500	5197500	5197500
Bran Quantity	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Bran Price	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000	35000
Bran Revenue	1312500	1312500	1312500	1312500	1312500	1312500	1312500	1312500	1312500	1312500	1312500	1312500	1312500	1312500
TOTAL REVENUES	20124375	20124375	20124375	20124375	20124375	20124375	20124375	20124375	20124375	20124375	20124375	20124375	20124375	20124375
NET REVENUES														
Option 1	-892290	3255185	3230660	2884135	3181610	2807085	2810560	1579710	3255185	2908660	2656135	3181610	2835085	3132560
Option 2	-4766583	2383904	2282392	1858879	2079367	1627854	1554342	-2294583	2383904	1960392	1630879	2079367	1655854	1876342
Option 3	-2958490	3024722	2945935	2545147	548360	2359572	2308785	1753510	784722	2623935	2317147	2788360	147572	2630785

Annex 4

Analysis of the Financial Viability of a Representative Grain Hammer Mill

Mechanical grain milling using hammer mills, which are far more common than plate mills in Senegal, is widely regarded as a profitable enterprise in Senegal, particularly in urban areas. In this annex representative budgets for urban (electrically powered) and rural (diesel driven) mills are prepared. The following assumptions are used in doing the analysis:

1. All of the milling is custom milling in which the owner/operator buys, transports, stores and sells no raw or processed grain as part of the processing enterprise.

2. All of the equipment is purchased in cash at the outset. No loans are required to finance the investment.

3. The analysis is carried out over a fourteen year time horizon, during which the hammer mills are replaced once (every seven years) and the electric and diesel motors twice (every five years).

4. Although grinding conversion ratios are somewhat under 100%, we assume that there are no milling by-products, as in dehulling, which would provide additional revenue.

5. Throughput is assumed to be five metric tons per month, or 60 MT per annum. This is based on mean daily throughput of 200 kilograms per day of operation and 25 days of operation per month.

6. All the grain processed is millet. Milling charges per kilogram are 20 FCFA/kg. in urban areas (where electric powered mills are used) and 15 FCFA/kg. in rural areas (where diesel powered mills are used).

7. Repair contigencies are included to reflect high real repair and spare parts costs. Since the electric motor is assumed to operate for seven years, the repair contingency is calculated as 25% of estimated maintenance costs (taken from Salcedo's budget) and expands by 25 percentage points a year through year 7 (0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75), at which point the equipment is renewed and repair costs again increase over five years at the same rate. The repair contingency for the diesel option begins at the same point and increases in the same increment through year 5 (0.25, 0.5, 0.75, 1.0, 1.25); the cycle is repeated in years 6-10 and 11-14 since the diesel engine is replaced after five years of operation.

8. Variable operating costs are assumed to be constant per unit of throughput (metric ton). These are displayed in the table below.

Table D-1

Variable Operating Costs for Electrical and Diesel Powered Hammer Mills in Senegal

(in FCFA/metric ton)

Variable Cost Item	Electric	Diesel
Energy		
Consumption in kwh/t	30	
or liters of diesel/t		9.5
Cost per kwh/liter	95.46	210
Cost of Energy	2863.8	1995.0
Lubricant Cons.		
Consumption (l/ton)		1.0
Cost per Liter		950
Cost of Lubricants		950
Repairs/Maintenance	500	1500
Divers/Transport		300
Total Var. Costs	3363.8	4745.0

The data for the budgets are pieced together from several sources: published papers, reports, data from several FENU mills, informal interviews and best guesstimates of key informants. It is possible that the variable costs, particularly energy, maintenance and repair costs, are underestimated. The estimates could be refined by analyzing data collected over 4-5 years by the FENU/Condition Féminine program, and by collecting further data about the costs and returns of privately owned mills in both urban and rural areas. As in Annex 3, the data and accompanying analysis are illustrative rather than definitive.

Financial internal rate of return calculations are made for a base run and four combinations of power source and mill type (electric vs. diesel power source and artisanally produced vs. imported hammer mill). The calculations are financial rather than economic in that the cost of the imported mill and electric/diesel engines include the import duty, electrical power and diesel fuel are costed at official prices, and maintenance and repair costs are financial costs, unadjusted for import taxes. Using economic prices/costs would increase the IRR in all cases.

As shown in Table D-2, the IRR is highly sensitive to variations in annual processed throughput. In the base run, where throughput is 60 MT per year, the IRR is negative for the diesel mill. When througput is increased 33% to 80 MT per year, the IRR becomes positive and acceptable. Increasing throughput to 100 MT per year boosts the IRR to very attractive levels. The

calculations illustrate how important it is to keep the mills running at as high a level of throughput as possible to ensure profitability.

The IRR is also very sensitive to the magnitude of the milling charge. Decreasing the milling charge per kilogram significantly lowers the IRR. If the milling charge were cut to 10 FCFA/kg. in rural areas, the IRR for the diesel power option becomes highly negative. Since milling charges as low as 10 FCFA/kg. are not uncommon in villages, it is not surprising that many rural investments in hammer mills and diesel power sources cannot be sustained.

Table D-2

Financial IRR Calculations for Mechanical Grain Milling in Senegal (in %)

Run	Electric/ Artisanal Mill	Electric/ Imported Mill	Diesel/ Artisanal Mill	Diesel/ Imported Mill
Base : 60 MT	29.8	11.7	Negative	Negative
80 MT Throughput	171.3	78.0	26.7	14.3
100 MT Throughput	Super +	233.6	61.7	39.2
50 MT Throughput	Negative	Negative	Negative	Negative
Without Repair Contingencies	34.5	15.1	6.3	Negative
Milling Price Decrease				
10 FCFA/Kg. for Diesel Option			Negative	Negative
15 FCFA/Kg. for Elect. Option	Negative	Negative		
Milling Price Decrease by 10%	0.0	Negative	Negative	Negative
Milling Price Increase by 10%	64.4	32.7	10.7	1.4
Increased Energy Costs by 10%	25.5	8.7	Negative	Negative
Increased Repair Costs by 10%	28.6	10.8	Negative	Negative
Decreased Repair Costs by 10%	31.1	12.5	Negative	Negative

If the investment were financed by a loan at the prevailing interest rate of 22%, paid over, say, a five-year period, the IRRs would decline in all cases. Some mill owners run more than one piece of equipment, such as a second grinder for processing peanuts, using the same electrical or diesel motor that powers the hammer mill. This is more common in urban areas. In such cases energy costs need to be apportioned to the different processing enterprises, which would marginally improve the financial viability of the grain processing enterprise.

Table D-3

Financial Cost and Revenue Streams Used in Calculating Internal Rates of Return for a Representative Hammer Mill

Investment Costs	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14
Building	300000													
Hammer Mill	400000					100000					100000			
Scale	50000							400000						
Motors								50000						
1 - Electric	200000													
2 - Diesel (Hatz)	905000					200000					200000			
						905000					905000			
Total Inv Costs - 1	950000	0	0	0	0	300000	0	450000	0	0	300000	0	0	0
Total Inv Costs - 2	1655000	0	0	0	0	1005000	0	450000	0	0	1005000	0	0	0
Fixed Costs														
Miller														
Electric/Urban (1)	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000
Diesel/Rural (2)	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000
Municipal Taxes (1)	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000
Total Fixed Costs														
Electric/Urban (1)	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000	714000
Diesel/Rural (2)	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000
Variable Costs														
Energy														
Electric (1)	171828	171828	171828	171828	171828	171828	171828	171828	171828	171828	171828	171828	171828	171828
Diesel (2)	119700	119700	119700	119700	119700	119700	119700	119700	119700	119700	119700	119700	119700	119700
Lubricants (2 only)	57000	57000	57000	57000	57000	57000	57000	57000	57000	57000	57000	57000	57000	57000
Maintenance/Repairs														
Electric (1)	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000
Diesel (2)	90000	90000	90000	90000	90000	90000	90000	90000	90000	90000	90000	90000	90000	90000
Repair Contingency														
Electric (1)	7500	15000	22500	30000	37500	7500	15000	22500	30000	37500	7500	15000	22500	30000
Diesel (2)	22500	45000	67500	90000	112500	22500	45000	67500	90000	112500	22500	45000	67500	90000
TOTAL VARIABLE COSTS														
Electric (1)	209328	216828	224328	231828	239328	209328	216828	224328	231828	239328	209328	216828	224328	231828
Diesel (2)	289200	311700	334200	356700	379200	289200	311700	334200	356700	379200	289200	311700	334200	356700
TOTAL COSTS														
Electric (1)	1873328	930828	938328	945828	953328	1223328	930828	1388328	945828	953328	1223328	930828	938328	945828
Diesel (2)	2244200	611700	634200	656700	679200	1594200	611700	1084200	656700	679200	1594200	611700	634200	656700
GROSS REVENUES														
Milling Charge/Kg.														
Electric/Urban (1)	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Diesel/Rural (2)	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Throughput	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Total Revs (1)	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000	1200000
Total Revs (2)	900000	900000	900000	900000	900000	900000	900000	900000	900000	900000	900000	900000	900000	900000
NET REVENUES														
Electric (1)	-673328	269172	261672	254172	246672	-23328	269172	-188328	254172	246672	-23328	269172	261672	254172
Diesel (2)	-1344200	288300	265800	243300	220800	-694200	288300	-184200	243300	220800	-694200	288300	265800	243300

Annex 5

Analysis of the Financial Viability of a BS 1000 Millet Thresher

The SISCOMA BS 1000 millet/sorghum thresher is a high capacity machine which can thresh over one ton of grain per day. The BS 1000s are found mainly in the Diourbel, Thies and Kaolack Regions. They require a tractor of at least 35 HP to transport and power the thresher. Hence, upfront investment costs are over 10 million FCFA. Nevertheless, the BS 1000 is believed to be a highly profitable investment for those individuals who can afford to make the investment. The perception of profitability is due in part to the high levels of throughput and gross revenues generated by the BS 1000. Repair costs can be formidable, however, and net revenues are not as great as perceived.[5]

In carrying out the financial analysis, the following assumptions are made:

1. Both the thresher and the tractor are purchased with cash rather than financed through a loan.

2. A ten-year time horizon is used, assuming that both the thresher and the tractor need to be replaced every five years.

3. Daily throughput is assumed to be five metric tons, based on five hours of operation and one ton per hour throughput. Assuming 25 days of operation per month and four months of utilization, annual throughput is 500 metric tons.

4. Two full-time operators are employed to run the thresher during the four-month threshing period after the harvest. Each is paid a monthly salary of 40,000 FCFA.

5. The base threshing charge is 900 FCFA per 100 kilogram bag or 9000 FCFA per metric ton. This charge is at the high end of the range of prices currently charged (7500-9000). It is assumed that those who have their millet threshed provide bags, not the enterprise itself.

7. Six to ten day laborers are hired (in each village) to assist the two operators in threshing and bagging the grain. As a group, they are paid 1500 FCFA per ton of throughput.

8. Fuel, lubricant and maintenance/repair costs are assumed to be a constant function of throughput, as shown in Table E-1.

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[5]The USAID-funded Private Enterprise credit project in Kaolack Region has loaned money to several entrepreneurs who own BS 1000s and tractors which had fallen into disrepair. The loan application for one individual included a SISMAR estimate (facture) for spare parts for the three BS 1000s, which totaled 7.5 million FCFA.

Table E-1

Variable Operating Costs for Millet Threshing Using a BS 1000 Thresher

(in FCFA/metric ton)

Variable Costs Per Ton	
Energy	
Liters of diesel/ton	5
Cost per liter	210
Cost of Energy	1050
Lubricant Cons./Ton	
Consumption (l/ton)	0.2
Cost per Liter	950
Cost of Lubricants	190
Repairs/Maintenance	2100
Day Laborers (10)	1500
Total Var. Costs/Ton	3490

9. A repair contingency is added to variable costs; it is also a function of machine usage or throughput. The contingency is calculated as an increasing proportion of the base maintenance and repair costs, beginning at 30% of the base in year 1 and expanding by 30 percentage points a year over the first five-year period (0.3, 0.6, 0.9, 1.2, 1.5). The same cycle is repeated for the second five-year period, reflecting the fact that the both the thresher and tractor are replaced at the beginning of year 6.

10. Although the tractor purchased to pull and power the tresher is used for other income-generating purposes, such as rural transport and preparation of land for farmers who are willing and able to pay for it, we have not attributed any other additional benefits and costs to tractor use. This use outside of the threshing season may contribute positively to the profitability of the enterprise. We are unable to quantify the costs and benefits of additional tractor operations, however.

The results of the financial analysis are shown in Table E-2. The first column shows the financial IRRs while the second column shows the IRR when economic prices for purchased equipment are used. The prices are economic (rather than financial) in that the import duty (on tractors) and the value added tax (on the BS 1000) are netted out. Using economic prices has a strong positively impact on IRR. As with other processing equipment, the IRR is sensitive to the volume of processed throughput and the price charged for processed output. Removing the repair contingency also increases the IRR.

The author has estimated maintenance and repair costs very crudely, and he does not have a high degree of confidence in the estimates. In order to establish more accurate estimates, the operating costs of several BS 1000s need to be monitored and recorded for a several year period. Alternatively, one year of monitoring of BS 1000s put in service during different years (and hence reflecting different stages of depreciation) would probably generate reliable enough estimates of operating and repair costs.

Table E-2

Financial IRR Calculations for Mechanical Grain Threshing in Senegal (in %)

	Financial IRR	Economic Prices for Equipment
0 Base : 750 MT	5.9	21.5
1 1000 MT Throughput	30.0	56.0
2 500 MT Throughput	Negative	Negative
3 Without Repair Contingencies	23.4	44.1
4 Threshing Price Decrease 800	Negative	Negative
5 Threshing Price Increase 1000	25.6	48.9
7 Increased Repair Costs by 10%	0.6	14.7
8 Decreased Repair Costs by 10%	11.1	40.3

The results of the financial IRR calculations are not very encouraging (5.9%) for the base run, which reflects rather optimistic assumptions about processing charges, throughput levels and utilization rates. It should be emphasized that the threshing charge per ton used in the base run is on the high end of the range (9,000 FCFA/ton). Threshing charges have trended downwards over the past decade from 1000-1200 FCFA/ton in the late 1970s to 7500-9000 FCFA/ton (personal communication, Matar Gaye). Furthermore, relatively high levels of throughput, 150 MT per month over a five-month threshing season, are assumed over the useful life of the equipment. During threshing seasons following poor harvests, it is unlikely that this much grain could be threshed. Mechanical breakdowns in the tresher or tractor can also reduce the number of months of effective operation and lower annual throughput. Finally, as noted in assumption #10, use of the tractor in other income-generating activities, such as land preparation and rural transport, may raise returns to the enterprise above levels estimated in this section.

Table E-3

Financial Cost and Revenue Streams Used in Calculating Internal Rates of Return for a BS 1000 Multi-Purpose Thresher

(all figures in FCFA)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Investment Costs										
35 HP Tractor	5000000					5000000				
BS 1000 with Diesel	5500000					5500000				
Total Inv Costs	10500000	0	0	0	0	10500000	0	0	0	0
Fixed Costs										
Operators (2 perm.)	320000	320000	320000	320000	320000	320000	320000	320000	320000	320000
Variable Costs										
Fuel (Diesel)	787500	787500	787500	787500	787500	787500	787500	787500	787500	787500
Lubricants	142500	142500	142500	142500	142500	142500	142500	142500	142500	142500
Maintenance/Repairs	1417500	1417500	1417500	1417500	1417500	1417500	1417500	1417500	1417500	1417500
Repair Contingency	141750	283500	425250	567000	708750	141750	283500	425250	567000	708750
Day Laborers (6)	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000	1125000
Total Variable Costs	3614250	3756000	3897750	4039500	4181250	3614250	3756000	3897750	4039500	4181250
TOTAL COSTS	14434250	4076000	4217750	4359500	4501250	14434250	4076000	4217750	4359500	4501250
GROSS REVENUES										
Milling Charge/Ton	9000	9000	9000	9000	9000	9000	9000	9000	9000	9000
Throughput	750	750	750	750	750	750	750	750	750	750
Total Revenues	6750000	6750000	6750000	6750000	6750000	6750000	6750000	6750000	6750000	6750000
NET REVENUES	-7684250	2674000	2532250	2390500	2248750	-7684250	2674000	2532250	2390500	2248750

Annex 6

Analysis of the Financial Viability of a Bamba Maize Thresher

The Bamba is a promising multi-purpose thresher, which has been used primarily for threshing maize. The Bamba has been marketed by MATFORCE in Senegal since 1982, and it was introduced in Mali by CMDT during the late 1970s and early 1980s.

During the AMIS consultancy, the author was unable to obtain reliable estimates of the Bamba's operating costs. The financial analysis presented in this section is, therefore, likely to be the least reliable of the analyses done for processing equipment (in Annexes 3-6). A report presented at the PROCELOS workshop, entitled "Expériences sur les Egreneuses dans la Zone CMDT," provided some information on technical coefficients and operating costs. The results of the ensuing analysis should be viewed as very tentative, however. In particular, the estimates of maintenance and repair costs are crude and need to be verified or modified through empirical observation.

In doing the financial analysis of the Bamba's viability, the following assumptions were made:

1. The useful life of the Bamba is assumed to be ten years. The Hatz diesel engine that powers the thresher is replaced after five years.

2. The Bamba is stored in a simple shelter during the eight months of the year when it is not in use. The costs of the shelter and repairs after five years are added to the cost stream.

3. Two full-time operators are employed to run the Bamba during the four-month threshing period after the harvest. Each is paid a monthly salary of 40,000 FCFA.

4. Two donkeys are used to haul the Bamba from village to village at a cost of 60,000 FCFA/month.

5. In the base run it is assumed that the Bamba threshes an average of 500 kilograms of maize per hour, and operates an average of six hours per day, 25 days per month over a four-month period. The base monthly processed throughput is 300 metric tons.

6. The base threshing charge is 800 FCFA per 100 kilogram bag or 8000 FCFA per metric ton. It is assumed that those who have their maize threshed provide bags, not the enterprise itself.

7. Four day laborers are hired (in each village) to assist the two operators in threshing and bagging the grain. They are paid 600 FCFA per ton of throughput as a group.

8. Fuel, lubricant and maintenance/repair costs are assumed to be a constant function of throughput, as shown in Table F-1.

Table F-1

Estimated Variable Operating Costs for Maize Threshing Using the Bamba Thresher (FCFA per metric ton)

	FCFA
Energy	
Liters of diesel/ton	5
Cost per liter	210
Cost of Energy	1312.5
Lubricant Cons./Ton	
Consumption (l/ton)	0.2
Cost per Liter	950
Cost of Lubricants	190.0
Maintenance/Repairs	1500
Day Laborers (4)	600
Total Var. Costs/Ton	3602.5

9. In response to informal interview findings that the Bamba breaks down frequently when used heavily, I have included a repair contingency, which is also a function of machine usage or throughput. The contingency is calculated as an increasing proportion of the base maintenance and repair costs, beginning at 30% of the base in year 1 and expanding by 30 percentage points a year over the first five-year period (0.3, 0.6, 0.9, 1.2, 1.5). The same cycle is repeated for the second five-year period, reflecting the fact that the diesel engine is replaced at the beginning of year 6. Since our estimates of maintenance/repair costs are tentative, the IRRs are calculated both with and without the repair cost contingency and reported in Table F-2 to give an idea of the variability of potential returns.

Summary results of the financial analysis are reported in Table F-2. IRR figures are reported both with and without the repair cost contingency estimate, primarily because the author does not have a lot of confidence in the accuracy of the estimates used in the analysis. The magnitude of the difference between the with and without cases shows how sensitive the IRR is to repair and maintenance costs. Clearly, accurate data need to be collected over at least one threshing season to test the reliability of our assumptions.

Throughput of 300 metric tons is required to yield a barely positive IRR of 2.3%. When the repair cost contingency is removed, the IRR jumps to 30.1%. Increasing throughput to 400 metric tons a year signficantly increases the IRR, while decreasing throughput to 200 MT yields negative

returns both with and without the contingency. The IRR is also very sensitive to the threshing price charged. Raising (lowering) the charge by 1000 FCFA per metric ton has the effect of increasing (decreasing) the IRR by some 20-25 percentage points.

Table F-2

Financial IRR Calculations for the Bamba Maize Thresher
(in %)

	Financial IRR (in %)	
	With Repair Contingency	Without Contingen
0 Base : 300 MT	2.3	30.1
1 400 MT Throughput	37.1	75.5
2 200 MT Throughput	Negative	Negative
3 Threshing Price Decrease 7000	Negative	9.3
4 Threshing Price Increase 9000	27.1	53.7
5 Increased Repair Costs by 10%	Negative	26.9
6 Decreased Repair Costs by 10%	9.4	33.3
7 Increased Fuel Costs by 25%	Negative	24.5

Table F-3

Financial Cost and Revenue Streams Used in Calculating Internal Rates of Return for a Bamba Multi-Purpose Thresher

(all figures in FCFA)

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Investment Costs										
Simple Shelter	150000					75000				
Bamba with Diesel	2950000					905000				
Total Inv Costs	3100000	0	0	0	0	980000	0	0	0	0
Fixed Costs										
Operators (2 perm.)	320000	320000	320000	320000	320000	320000	320000	320000	320000	320000
Animal Traction	240000	240000	240000	240000	240000	240000	240000	240000	240000	240000
Total Fixed Costs	560000	560000	560000	560000	560000	560000	560000	560000	560000	560000
Variable Costs										
Fuel (Diesel)	315000	315000	315000	315000	315000	315000	315000	315000	315000	315000
Lubricants	57000	57000	57000	57000	57000	57000	57000	57000	57000	57000
Maintenance/Repairs	450000	450000	450000	450000	450000	450000	450000	450000	450000	450000
Repair Contingency	135000	270000	405000	540000	675000	135000	270000	405000	540000	675000
Day Laborers (4)	180000	180000	180000	180000	180000	180000	180000	180000	180000	180000
Total Variable Costs	1137000	1272000	1407000	1542000	1677000	1137000	1272000	1407000	1542000	1677000
TOTAL COSTS	4797000	1832000	1967000	2102000	2237000	2677000	1832000	1967000	2102000	2237000
GROSS REVENUES										
Threshing Charge/Ton	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
Throughput	300	300	300	300	300	300	300	300	300	300
Total Revenues	2400000	2400000	2400000	2400000	2400000	2400000	2400000	2400000	2400000	2400000
NET REVENUES	-2397000	568000	433000	298000	163000	-277000	568000	433000	298000	163000

Annex 7

Statistical Tables

Table G-1 The Evolution of Millet and Sorghum Production in Senegal, 1961-1988

Table G-2 The Evolution of Maize Production in Senegal, 1961-1988

Table G-3 Millet Acquisition Prices Paid by Bambey Semi-Industrial Unit, 1984-88

Table G-4 Coarse Grain Processing Throughput for Nine Experimental Dehullers in Nine Villages of Senegal

Table G-5 MATFORCE Sales of Skiold Hammer Mills, 1974-87

Table G-1 : The Evolution of Millet and Sorghum Production in Senegal, 1961-1987.

(Production in 1,000 MT; Yield in Kg./Ha.; Area planted in 1,000 Ha.)

Year(1)	Casamance Production	Casamance Yield	Casamance Area Planted	Diourbel Production	Diourbel Yield	Diourbel Area Planted	Saint-Louis Production	Saint-Louis Yield	Saint-Louis Area Planted	Louga Production	Louga Yield	Louga Area Planted	Sine-Saloum Production	Sine-Saloum Yield	Sine-Saloum Area Planted	Tambacounda Production	Tambacounda Yield	Tambacounda Area Planted	Thies Production	Thies Yield	Thies Area Planted	Total Senegal Total Production	Total Senegal Average Yield	Total Senegal Total Area Planted
1961	62.1	858	72.4	30.2			38.6	498	77.50	25.2	231	109.3	156.6	641	244.4	34.6	672	51.5	44.4	351	126.5	391.7	575	681.6
1962	62.0	769	80.6	59.4	666	89.2	51.5	469	109.7	26.3	231	113.8	127.2	479	265.5	34.2	656	52.1	45.4	355	128.0	406.0	484	838.9
1963	68.3	878	77.8	54.4	414	131.4	54.9	482	113.8	22.0	246	89.6	141.7	525	270.1	35.1	659	53.3	46.7	368	127.0	423.1	490	863.0
1964	72.5	839	86.4	69.5	523	132.8	39.2	354	110.6	50.6	332	152.2	157.1	539	291.5	37.9	714	53.1	51.4	389	132.1	478.2	499	958.7
1965	83.7	813	102.9	73.9	574	135.0	65.2	522	125.0	51.0	340	150.0	172.8	579	298.5	41.8	703	59.5	43.1	310	139.0	531.5	526	1,009.9
1966	94.4	840	112.4	72.5	487	149.0	52.7	432	122.0	51.8	332	156.0	184.1	584	315.0	46.6	696	67.0	52.7	359	147.0	554.8	519	1,068.4
1967	76.0	861	88.3	22.8	154	148.0	52.9	430	123.1	31.0	281	110.3	148.5	481	308.5	50.0	698	71.6	41.9	287	145.9	423.1	425	995.7
1968	114.0	911	125.1	84.8	577	147.0	72.6	518	140.1	73.5	480	153.0	187.8	533	352.5	53.5	729	73.4	68.3	419	163.1	654.5	567	1,154.2
1969	88.0	779	113.0	38.4	299	128.3	37.8	354	106.7	39.3	308	127.5	155.6	448	347.3	45.0	625	72.0	45.1	285	158.1	449.2	427	1,052.9
1970	121.4	1,002	121.2	56.3	511	118.1	63.8	612	104.2	41.7	337	123.9	204.2	631	323.7	69.0	785	87.9	77.6	471	164.9	634.0	607	1,043.9
1971	100.2	812	123.4	27.2	269	101.0	29.0	318	91.1	27.1	210	129.2	133.5	465	287.0	30.6	382	80.1	33.4	219	152.4	381.0	395	964.2
1972	90.9	986	92.2	59.1	597	99.0	49.4	417	118.4	49.6	462	107.3	197.6	618	319.7	54.9	754	72.8	81.0	506	160.1	582.5	601	969.5
1973	74.8	789	94.8	43.8	423	103.5	1.1	22	49.5	8.3	60	138.5	140.7	440	320.0	40.1	545	73.6	13.2	85	155.9	322.0	344	935.8
1974	83.7	843	99.3	58.5	400	146.2	27.4	317	86.5	43.2	240	179.9	160.4	468	343.1	32.5	454	71.6	103.4	589	175.6	509.1	462	1,102.2
1975	101.9	1,067	95.5	103.6	639	162.2	53.2	441	120.6	82.2	526	156.4	332.2	787	422.0	38.2	611	62.5	83.5	676	123.5	794.8	696	1,142.7
1976	74.1	817	90.7	88.7	529	167.8	41.1	434	94.6	74.0	498	148.7	179.1	683	262.3	60.0	861	69.7	98.1	763	128.5	615.1	639	962.3
1977	75.9	833	91.1	100.6	623	161.5	23.1	231	99.9	39.8	301	132.4	200.0	710	281.8	18.3	308	59.5	49.4	406	121.6	507.1	535	947.8
1978	64.5	740	87.3	37.8	253	149.2	8.6	113	76.1	27.6	203	135.7	165.8	498	333.0	34.2	584	58.6	21.5	211	102.0	360.1	382	941.9
1979	30.8	298	103.2	128.0	794	161.2	37.6	410	91.6	88.6	550	161.0	296.6	809	366.8	52.4	869	60.3	117.7	1,070	110.0	751.7	713	1,054.1
1980	81.4	779	104.5	95.6	555	172.4	12.0	312	38.5	47.0	330	142.5	192.4	585	328.9	29.6	446	66.4	62.4	548	113.8	520.4	538	967.0
1981	58.8	565	104.1	32.9	447	145.6	227.9	2,638	86.4	66.2	427	155.1	236.1	575	410.8	36.1	641	56.3	66.1	422	156.8	744.1	667	1,115.1
1982	79.6	804	99.0	96.9	294	174.5	26.7	474	56.3	52.8	284	185.9	314.1	712	441.0	50.6	845	59.9	115.7	722	160.3	736.4	626	1,176.9
1983	90.8	949	95.7	58.4	379	130.7	4.3	140	30.8	50.7	288	176.3	220.2	650	338.7	55.8	849	65.7	104.4	687	151.9	584.6	591	989.8
1984	67.6	802	84.3	31.8	294	108.2	6.9	283	24.4	8.1	386	21.0	169.1	483	349.8	23.5	381	61.7	44.8	334	134.1	351.8	449	783.5
1985	58.2	1,041	55.9	58.7	379	154.7	0.8	364	2.2	4.8	33	145.1	239.1	594	402.2	43.6	566	77.0	66.3	400	165.6	471.5	470	1,002.7
1986	89.9	846	106.3	153.4	749	204.8	16.2	572	28.3	117.0	581	201.3	322.3	637	506.3	111.7	1,004	111.3	139.1	785	177.2	949.6	711	1,335.5
1987	90.9	932	97.5	51.9	420	123.5	9.2	507	18.2	37.5	300	124.8	290.6	769	378.1	89.1	833	106.9	68.0	475	143.2	637.2	642	992.2
1988	85.1	905	94.0	37.4	296	126.4	15.0	573	26.2	26.7	193	138.4	300.4	702	428.1	98.5	906	108.7	30.6	610	50.2	594.2	581	1,023.3
Period 1972-1988																								
AVERAGE	76.4	823.3	93.8	73.9	474.8	146.6	33.0	485.2	61.7	48.5	333.0	144.1	232.7	630.5	366.6	51.1	673.9	73.1	74.4	546.4	137.1	590.1	567.5	1026.0
STD.DEV	16.4	175.3	11.2	33.6	158.5	27.5	51.3	559.1	36.3	29.4	156.7	38.4	62.2	109.9	60.3	25.4	201.4	17.6	34.7	228.2	31.2	164.4	109.8	119.0
CV	4.7	4.7	8.4	2.2	3.0	5.3	0.6	0.9	1.7	1.6	2.1	3.8	3.7	5.7	6.1	2.0	3.3	4.2	2.1	2.4	4.4	3.6	5.2	8.6
MAX	101.9	1067.0	106.3	153.4	794.0	204.8	227.9	2637.7	120.6	117.0	581.2	201.3	332.2	808.6	506.3	111.7	1003.6	111.3	139.1	1070.0	177.2	949.6	713.1	1335.5
MIN	30.8	298.0	55.9	31.8	253.0	99.0	0.8	22.2	2.2	4.8	33.1	21.0	140.7	439.7	262.3	18.3	307.6	56.3	13.2	84.7	50.2	322.0	344.1	783.5

N o t e : The Dakar Region is not included; this is a minor Millet and Sorghum growing Region.

Table G-2: The Evolution of Maize Production in Senegal, 1961-1988

(Production in 1,000 MT; Yield in KG/HA; Area Planted in 1,000 HA)

Year(1)	Casamance Production	Casamance Yield	Casamance Area Planted	Saint-Louis Production	Saint-Louis Yield	Saint-Louis Area Planted	Sine-Saloum Production	Sine-Saloum Yield	Sine-Saloum Area Planted	Tambacounda Production	Tambacounda Yield	Tambacounda Area Planted	Total Senegal Total Production	Total Senegal Average Yield	Total Senegal Total Area Planted
1961	13.1	985	13.3	3.3	767	4.3	1.8	783	2.3	9.2	860	10.7	27.4	895	30.6
1962	13.1	956	13.7	4.3	782	5.5	1.8	857	2.1	9.2	860	10.7	28.4	888	32.0
1963	11.8	959	12.3	2.4	490	4.9	1.9	864	2.2	10.6	883	12.0	26.7	850	31.4
1964	12.1	877	13.8	1.5	366	4.1	2.0	833	2.4	11.1	902	12.3	26.7	819	32.6
1965	16.2	910	17.8	8.1	559	14.5	1.9	792	2.4	10.9	872	12.5	37.1	786	47.2
1966	19.2	850	22.6	7.8	488	16.0	1.7	810	2.1	12.1	890	13.6	40.8	751	54.3
1967	19.9	905	22.0	8.4	579	14.5	0.3	375	0.8	13.2	795	16.6	41.8	776	53.9
1968	32.1	953	33.7	9.1	467	19.5	0.9	750	1.2	14.7	850	17.3	56.8	792	71.7
1969	16.6	765	21.7	3.7	529	7.0	0.6	667	0.9	4.4	647	6.8	25.3	695	36.4
1970	28.2	953	29.6	7.0	686	10.2	0.6	857	0.7	13.1	879	14.9	48.9	883	55.4
1971	18.5	734	25.2	5.3	631	8.4	0.4	667	0.6	8.9	536	16.6	33.1	652	50.8
1972	16.2	831	19.5	6.6	653	10.1	0.6	857	0.7	14.2	768	18.5	37.6	770	48.8
1973	9.7	745	13.0	0.2	500	0.4	0.4	500	0.8	9.9	544	18.2	20.2	623	32.4
1974	13.9	986	14.1	2.7	587	4.6	1.0	1,429	0.7	16.2	818	19.8	33.8	862	39.2
1975	16.5	1,078	15.3	5.7	740	7.7	2.0	1,667	1.2	19.0	779	24.4	43.2	889	48.6
1976	14.9	1,096	13.6	0.0	0	5.7	5.6	1,931	2.9	23.4	863	27.1	43.9	890	49.3
1977	19.4	1,213	16.0	0.0	0	3.0	16.3	1,264	12.9	7.2	456	15.8	42.9	899	47.7
1978	11.4	713	16.0	1.2	480	2.5	10.0	781	12.8	10.6	475	22.3	33.2	619	53.6
1979	19.1	838	22.8	4.1	732	5.6	14.4	1,426	10.1	16.5	922	17.9	54.1	959	56.4
1980	23.5	911	25.8	3.5	1,250	2.8	2.9	191	15.2	16.3	682	23.9	46.2	682	67.7
1981	19.1	783	24.4	4.7	797	5.9	20.0	800	25.0	13.0	568	22.9	56.8	726	78.2
1982	23.7	801	29.6	4.5	682	6.6	27.3	1,909	14.3	12.0	2,308	5.2	67.5	1,212	55.7
1983	22.8	894	25.5	3.3	375	8.8	29.3	1,085	27.0	26.8	1,076	24.9	82.2	954	86.2
1984	[illegible]	1,311	27.0	1.6	421	3.8	7.4	532	13.9	16.2	630	25.7	60.6	861	70.4
1985	54.2	1,527	35.5	2.3	2,091	1.1	15.0	1,000	15.0	26.9	900	29.9	98.4	1,207	81.5
1986	59.5	1,263	47.1	2.3	793	2.9	46.9	1,508	31.1	37.7	1,252	30.1	146.4	1,317	111.2
1987	46.2	1,154	40.0	1.1	2,500	0.4	27.7	1,165	23.8	31.2	1,073	29.0	106.2	1,139	93.2
1988	44.3	926	41.0	0		0	39.7	839	33.3	39.2	908	35.6	123.3	895	110.3
Period 1980-1988															
AVERAGE	36.5	1063.3	32.9	2.6	1113.6	3.6	24.0	1003.3	22.1	24.4	1044.2	25.2	87.5	999.2	83.8
STD.DEV	14.2	245.6	7.8	1.5	734.0	2.8	13.5	478.2	7.2	9.8	495.6	8.0	31.7	215.0	17.7
CV	0.39	0.23	0.24	0.57	0.66	0.79	0.56	0.48	0.33	0.40	0.47	0.32	0.36	0.22	0.21
MAX	59.5	1527.0	47.1	4.7	2500.0	8.8	46.9	1909.1	33.3	39.2	2307.7	35.6	146.4	1316.5	111.2
MIN	19.1	783.0	24.4	0.0	375.0	0.0	2.9	190.8	13.9	12.0	567.7	5.2	46.2	682.4	55.7

Table G-3

Millet Acqusition Prices Paid by Bambey
Semi-Industrial Unit, 1984-88

(in FCFA/kilogram)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1984	115	100	100	110	115	115	115	110	120	90	85	85
1985	90	110	110	110	125	125	130	140	150	120	70	70
1986	70	75	75	80	75	72.5	95	105	105	100	72.5	87.5
1987	97.5	97.5	95	95	100	100	90	95	75	62.5	50	47.5
1988	75	70	67.5	65		50	57.5	85	75	62.5	50	47.5

Source : Marra, Owner/manager of the Semi-Industrial Unit at Bambey

Note : Prices such as 72.5, 87.5 and 97.5 are averages of reported price ranges (70-75, 85-90, 95-100).

Table G-4

Coarse Grain Processing Throughput for Nine Experimental Dehullers in Nine Villages of Senegal

(quantities of grain in kilograms)

Site	Population	1987 June	July	August	September	October	November	December	July '88 to March '88 Total	1988 April	May	June	July	August	7/87-6/88 Total	Mo Mean	Mean Mo for All Mo
Baila	1,400	754.5	1584.5	1458	1283.5	1862	535	236.5	8378.5	557	1027	226	556	625.5	10189	849	81
Bamba Tialene	1,700	1246.5	2322.5	2274.5	1359	2380.5	1401	2167	13151	756	1717	1005	676.5	366	16629	1386	126
Bignona	2,400	3213	8502.5	6483.5	5229	4510.5	3581.5	3056.5	42122	4937	3781	2838.5	3434	3946	53679	4473	436
Bandallaye Tessan	1,000	809	1380	1186.5	811.5	720	929.5	934	7113.5	1034.5	667	819.5	245	64.5	9635	803	71
Kartack	2,300	693	736	656	684	580	272	150	4982	1300	1300	177	416	114	7759	647	59
Keur Samba Kane	3,700			196.5	658	2838.5	2264	3949	18195	3567.5	2448	457			24660	2055	
Khandiar	700		189	2194.5	4798.5	1996	5793	3599	22561	2864	1449	1902	1510	6095	28776	2398	259
Lambaye	4,000		323	689	505.5	793.5	1396	1548	8056.5	1013	99	1354.5	1442.5	117.5	10523	877	86
Mont Rolland	5,000		88.5	642.5	237	354.5	558.5	516.5	5436.5	1086.5	682.5	115	458	616	7321	610	60
Averages	2467	1343	1871	1753	1730	1603	1858	1795	14444	1982	1463	988	1092	1493	18797	1566	147

Source : Hyacinthe N. Mbengue. Director, Post-Harvest Technology Program, ISRA/CNRA, Bambey

Comments : The only dehuller operated at close to an economically viable level is the Bignona unit, which average 4.4 metric tons of throughput per month or 52.8 tons per year. The second most heavily operated unit at Khandiar averaged 2.6 metric tons per month or only 31.2 metric tons per year. At this level of operation the village group that manages the mill will not be able to sustain the investment without subsidization. All of the other units except one processed less than one metric ton per month, a gross underutilization of this rather costly investment.

Table G-5

MATFORCE Sales of Skiold Hammer Mills
1974-87

Year	Units
1974	4
1975	27
1976	124
1977	121
1978	262
1979	184
1980	180
1981	244
1982	275
1983	325
1984	100
1985	306
1986	212
1987	192
TOTAL	2556
MEAN	183/yr.

Annex 8

Seasonal Price Analysis for Coarse Grains

USAID/Dakar has collected five-years of retail price data in eight markets in the Dakar metropolitan area for a variety of staple foodstuffs, including:

- o rice - long, medium and broken grain;
- o millet - whole grain and "broken" grain (or dehulled millet);
- o sorghum - whole grain and "broken" grain (or dehulled sorghum);
- o maize - whole grain and "broken" grain (or dehulled maize); and
- o cowpeas.

In this section, we examine the seasonality of retail prices of whole grain millet, sorghum and maize, as well as dehulled millet. The time-series for dehulled sorghum and maize had several month gaps, which made it impossible to generate seasonal price indices.

Although Dakar is the only market in Senegal for which price data were available in at least a four-year series, it is not the ideal choice of market for analysis. This stems from several factors, among which :

- o Dakar is the largest market for imported rice. Arrivals of imported rice are likely to affect the seasonality of coarse grain prices in a significant way.
- o Following years of coarse grain production shortfall, such as 1984-85, food aid arrivals of grain (including maize and sorghum) are likely to affect coarse grain prices. Food aid tends to arrive at mid-year, depressing prices which are typically at their seasonally highest level.
- o The Dakar series is a retail price series. This is useful in examining price seasonality facing urban consumers. It is not necessarily representative of price seasonality facing consumers in rural areas and secondary cities.
- o CSA sales of coarse grains in Dakar, or from CSA warehouses in the interior of Senegal (e.g., Kaolack, Tambacounda), to private wholesalers and retailers based in Dakar during the June-October period may also dampen price seasonality in Dakar.

Despite these limitations, it is useful to examine the available Dakar retail price series. We use the Seasons subroutines of the software program M-STAT, developed by Michigan State University in collaboration with the University of Norway, to calculate the grand seasonal indices for four commodities, as well as corrected standard errors associated with each monthly index. The corrected standard error is a measure of dispersion of

monthly prices (across years) around the mean index value. The larger the standard error, relative to the index value, the greater the dispersion or variability of prices around the average index value. High levels of price variability are associated with high levels of risk in storing grain from harvest for sale some eight to nine months later. The greater the risk, the weaker are private incentives to store grain.

General Observations on Seasonality of Coarse Grains in Senegal. The seasonality of coarse grain prices follows, for the most part, a typical pattern for a storable commodity. Prices are seasonally lowest after harvest, during the November-March period, and rise to their highest levels during the soudure, particularly during the July-September period. Potential factors contributing to any divergence from a smooth seasonal price rise from November to August would be :

1. Concentration of farmer coarse grain sales shortly after the grain harvest but before the peanut and cotton marketing campaigns, and after the conclusion of the marketing campaigns for cash crops. Hence, one would expect to observe a higher volume of sales (and hence lower farm and rural market level prices) during November-December, a lower volume of sales (and hence higher prices) during January-March, and greater sales of cereals again by April. Since the marketing campaigns open and close on different dates during different years, a regular pattern may not be evident. The fact that cereals can be stored by private traders (and the CSA) for later sale on urban markets may result in this pattern not appearing in urban retail price series.

2. Concentrated farmer sales of coarse grain (and livestock) immediately before the growing season (especially June), as farmers use the revenues generated to buy peanut seed and other agricultural inputs (equipment, fertilizer).

3. It is also important to note that a factor reinforcing seasonal price peaks during the years under observation (1984-88) is the timing of the Moslem holy days. The demand for coarse grains, particularly millet, increases during the month of Ramadan and during the hadj (Tabaski) holiday. The Moslem holidays shift forward 10-11 days in accordance with an unadjusted lunar calendar. During 1988 the month of Ramadan fell during late April through mid-May, and Tabaski was celebrated at the end of July.

Whole-Grain Millet. The millet price indices for Dakar (Exhibit 1) show flat prices from November through June, and then large price increases in July and August. The flat prices from November through June are probably due to the timing of rice and/or food aid arrivals and release on the Dakar market, or the timing of CSA sales from storage. The exceptionally low price index value for the month of June is also likely a result of farmer sales of grain with the intent to use the cash to buy peanut seed.

Prices are seasonally highest during the month of August, but the August price index is associated with the highest degree of price variability. The index value varies 43.8 percentage points around the mean value of 123.5% (down to 79.7% and up to 167.4%) in seven out of ten years. Storing grain purchased at the beginning of the market year in November and selling it from storage in Dakar during August is therefore a risky undertaking, subject to

variable returns.

Dehulled or "Broken" Millet. Seasonal price movements for dehulled millet are similar to those for whole millet grain (see Exhibit 2). The seasonally lowest prices during the month of February may be explained by the seasonal migration patterns of rural women to Dakar. It is reported that rural women come to Dakar seeking dry season employment. A common income-generating activity is hand-pounding of coarse grain. Large numbers of women pound grain for urban women (housewives) and vendors near the major retail markets.

Whole Sorghum Grain. Price seasonality mirrors that for millet whole grain, as shown in Exhibit 3.

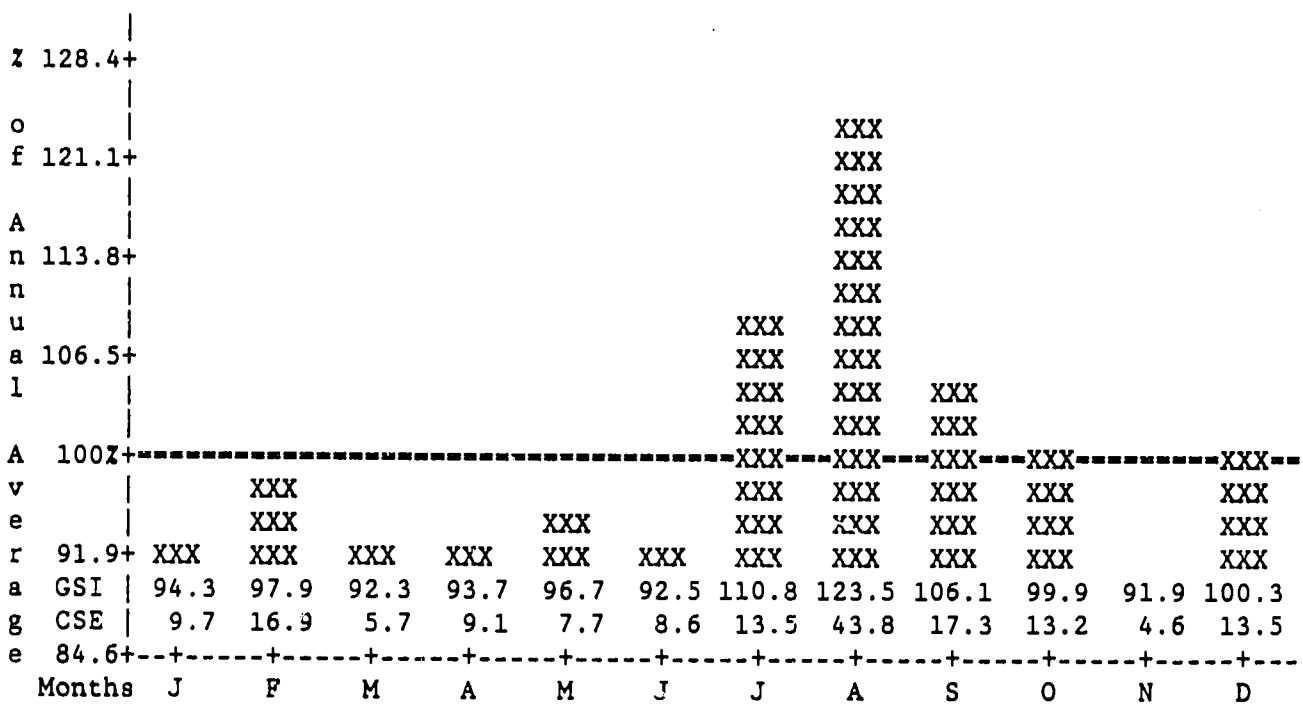
Whole Maize Grain. With the exception of the month of June, which is surprisingly the seasonally lowest price for maize on the Dakar market, maize follows most closely the smooth seasonal movement of prices that one would expect *a priori*. Prices are seasonally lowest in January and rise to their highest levels in August (see Exhibit 4). The astonishingly low June price index may be due to heavy arrivals of maize in the form of food aid on the Dakar market at mid-year in several years during the 1984-88 period. Without further data on the timing and volume of food aid and commercial imports of cereals, this is [illegible]lation, however. Perhaps the June index value would rise to the level of May and July indices if data were available in a longer time-series.

Concluding Observation. The analysis of grain price seasonality in the Dakar market would be improved if estimates of volumes offered for sale or actually transacted each month were available, and if data on the arrivals and release of food aid and commercially imported grain could be examined. ISRA, in collaboration with the Department of Agricultural Economics at Michigan State University, has collected price and volume data in rural and secondary city markets in the Peanut Basin since 1984 and in Tambacounda and Kolda Regions (from September 1986 through November 1987). The volume data are very useful in interpreting seasonal price patterns. It would be useful to estimate volumes offered or transacted on markets in Dakar, although this would involve significantly greater resources than USAID is able to commit to price data collection in Dakar at this time.

EXHIBIT 1 - GRAND SEASONAL INDEX FOR MILLET

GRAND SEASONAL INDEX
FOR
MILLET IN DAKAR, APRIL 1984 TO JANUARY 1989

MONTH	AVERAGE SEASONAL INDEX	STANDARD ERROR	GRAND SEASONAL INDEX	CORRECTED STANDARD ERROR	GSI + CSE	GSI - CSE
JAN	94.12	9.71	94.25	9.74	104.00	84.51
FEB	97.73	16.83	97.87	16.88	114.75	80.99
MAR	92.21	5.65	92.35	5.67	98.02	86.68
APR	93.54	9.09	93.68	9.11	102.79	84.56
MAY	96.58	7.72	96.72	7.74	104.46	88.98
JUN	92.39	8.62	92.52	8.65	101.17	83.87
JUL	110.63	13.41	110.79	13.45	124.24	97.34
AUG	123.37	43.68	123.55	43.81	167.36	79.74
SEP	105.98	17.23	106.13	17.28	123.42	88.85
OCT	99.74	13.13	99.88	13.17	113.05	86.71
NOV	91.79	4.60	91.92	4.62	96.54	87.31
DEC	100.18	13.46	100.33	13.50	113.83	86.83



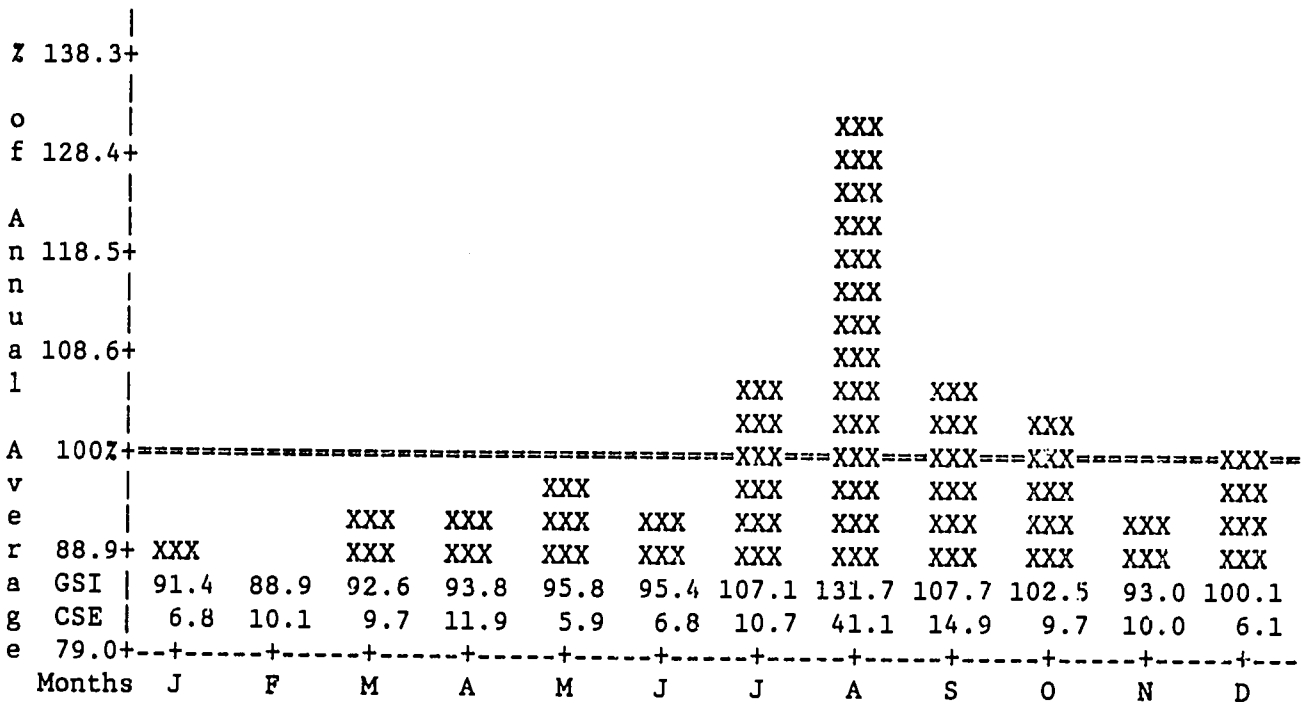
GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 118.174 CURRENCY UNITS OVER THE 5 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA.
THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.
THE STANDARD ERROR OF 9.7 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 9.7 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS

EXHIBIT 2 - GRAND SEASONAL INDEX FOR DEHULLED MILLET

GRAND SEASONAL INDEX
FOR
DEHULLED MILLET IN DAKAR, APRIL 1984 TO JANUARY 1989

MONTH	AVERAGE SEASONAL INDEX	STANDARD ERROR	GRAND SEASONAL INDEX	CORRECTED STANDARD ERROR	GSI + CSE	GSI - CSE
JAN	91.81	6.86	91.39	6.80	98.18	84.59
FEB	89.29	10.15	88.88	10.06	98.94	78.82
MAR	93.01	9.81	92.58	9.72	102.30	82.87
APR	94.24	12.06	93.80	11.94	105.75	81.86
MAY	96.28	5.97	95.83	5.92	101.75	89.91
JUN	95.89	6.87	95.45	6.81	102.26	88.64
JUL	107.58	10.83	107.08	10.73	117.81	96.34
AUG	132.30	41.50	131.68	41.12	172.80	90.57
SEP	108.23	14.99	107.73	14.85	122.58	92.88
OCT	102.97	9.76	102.50	9.67	112.17	92.82
NOV	93.43	10.11	93.00	10.02	103.02	82.98
DEC	100.56	6.16	100.09	6.11	106.20	93.98



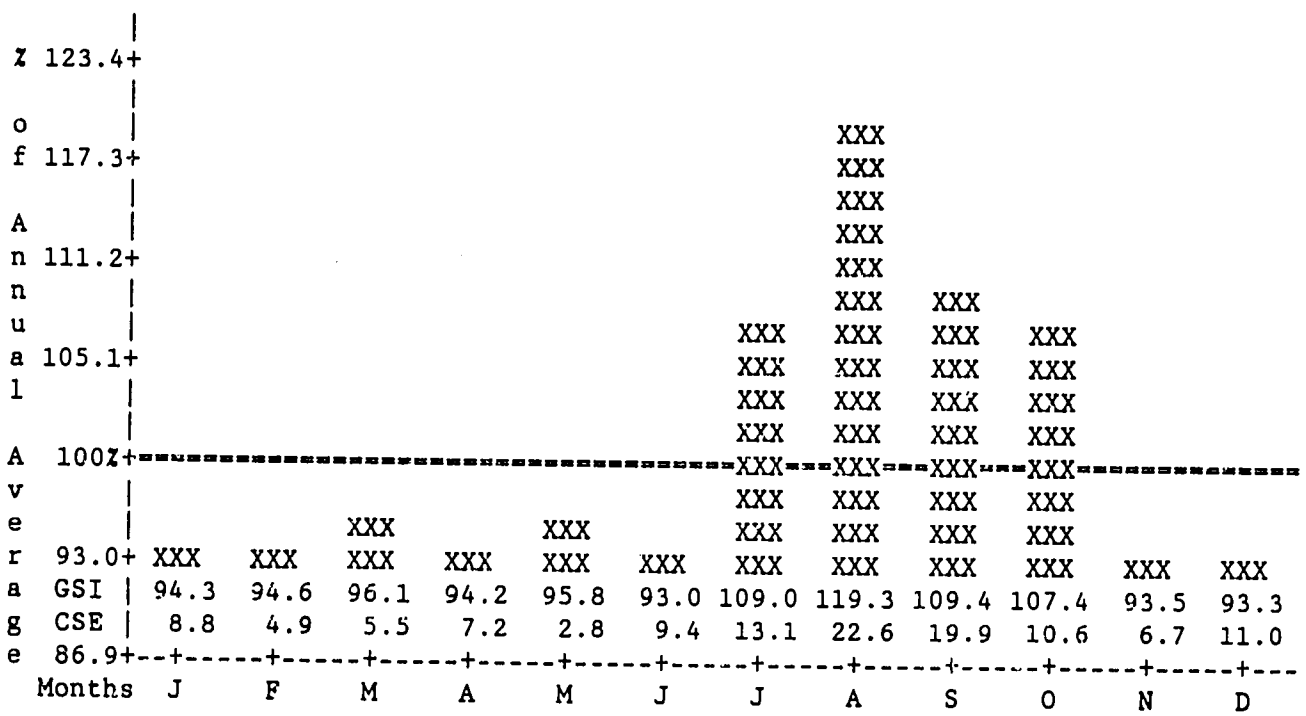
GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 156.239 CURRENCY UNITS OVER THE 5 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA.
THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.
THE STANDARD ERROR OF 6.8 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 6.8 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS

EXHIBIT 3 - GRAND SEASONAL INDEX FOR SORGHUM

GRAND SEASONAL INDEX
FOR
SORGHUM IN DAKAR, APRIL 1984 TO JANUARY 1989

MONTH	AVERAGE SEASONAL INDEX	STANDARD ERROR	GRAND SEASONAL INDEX	CORRECTED STANDARD ERROR	GSI + CSE	GSI - CSE
JAN	94.34	8.84	94.34	8.84	103.18	85.51
FEB	94.57	4.89	94.58	4.89	99.47	89.69
MAR	96.13	5.54	96.13	5.54	101.68	90.59
APR	94.19	7.15	94.20	7.15	101.35	87.05
MAY	95.81	2.76	95.82	2.76	98.58	93.06
JUN	92.94	9.38	92.95	9.39	102.34	83.57
JUL	109.02	13.10	109.03	13.10	122.13	95.92
AUG	119.30	22.56	119.31	22.56	141.87	96.75
SEP	109.42	19.92	109.43	19.92	129.35	89.51
OCT	107.41	10.58	107.42	10.58	118.00	96.84
NOV	93.49	6.71	93.50	6.71	100.21	86.79
DEC	93.29	11.04	93.30	11.04	104.34	82.25



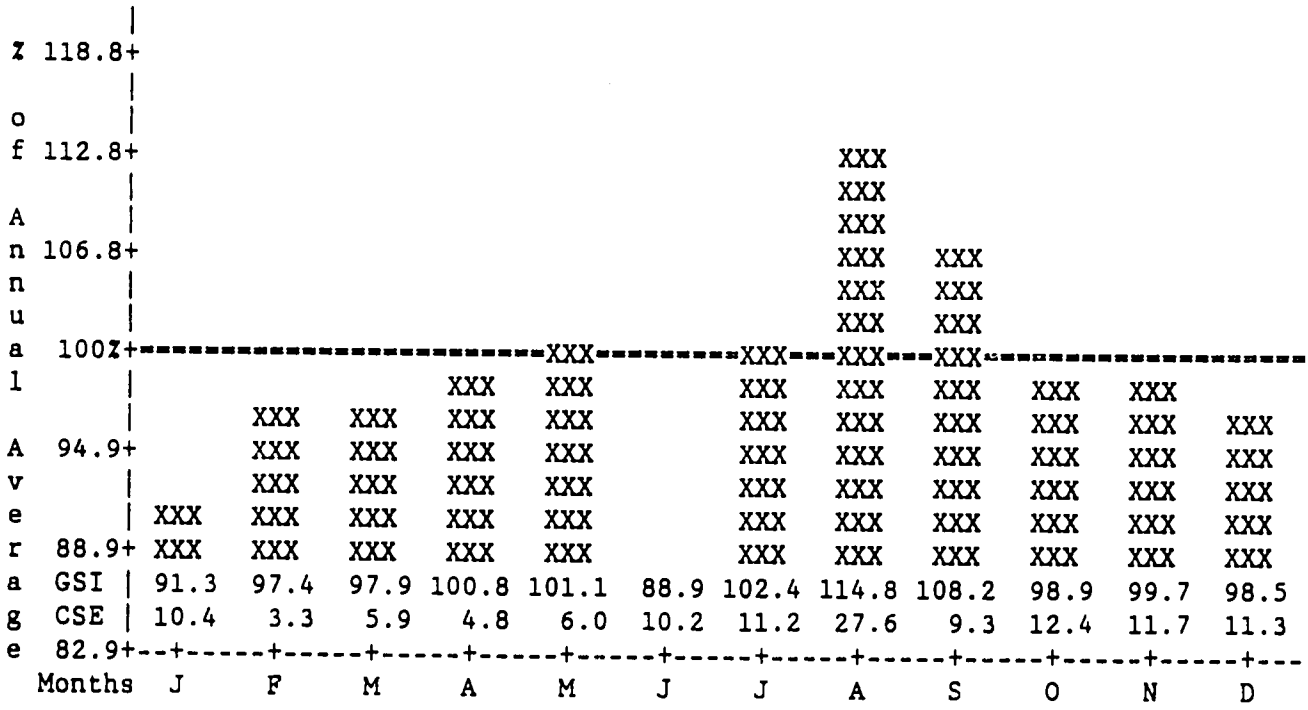
GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 105.043 CURRENCY UNITS OVER THE 5 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA.
THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.
THE STANDARD ERROR OF 8.8 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 8.8 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS

EXHIBIT 4 - GRAND SEASONAL INDEX FOR MAIZE

GRAND SEASONAL INDEX
FOR
MAIZE IN DAKAR, APRIL 1984 TO JANUARY 1989

MONTH	AVERAGE SEASONAL INDEX	STANDARD ERROR	GRAND SEASONAL INDEX	CORRECTED STANDARD ERROR	GSI + CSE	GSI - CSE
JAN	90.60	10.22	91.31	10.38	101.69	80.94
FEB	96.63	3.22	97.39	3.27	100.66	94.12
MAR	97.14	5.83	97.90	5.92	103.83	91.98
APR	100.02	4.76	100.80	4.83	105.64	95.97
MAY	100.35	5.86	101.14	5.95	107.09	95.19
JUN	88.23	10.03	88.92	10.19	99.11	78.73
JUL	101.62	11.06	102.42	11.24	113.66	91.19
AUG	113.90	27.21	114.80	27.64	142.44	87.16
SEP	107.36	9.18	108.20	9.33	117.53	98.87
OCT	98.15	12.20	98.92	12.40	111.32	86.53
NOV	98.91	11.50	99.69	11.68	111.37	88.01
DEC	97.72	11.11	98.49	11.28	109.77	87.21



GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

THE 100% LINE IN THE BARCHART REPRESENTS THE AVERAGE OF 125.283 CURRENCY UNITS OVER THE 5 YEAR PERIOD OF ANALYSIS OF COMMODITY PRICE DATA.
THE MONTH INDEX VALUE INDICATES BY HOW MANY PERCENTAGE POINTS EACH MONTH'S VALUE LIES ABOVE OR BELOW THE ANNUAL AVERAGE.
THE STANDARD ERROR OF 10.4 FOR JANUARY INDICATES THAT THE JANUARY VALUE WILL LIE WITHIN PLUS OR MINUS 10.4 PERCENTAGE POINTS OF ITS MEAN IN 7 OUT OF 10 YEARS.