PN. ABL-131
76862

AGRICULTURAL MARKETING IMPROVEMENT STRATEGIES PROJECT

Sponsored by the

U.S. Agency for International Development

Assisting AID Missions and Developing Country Governments
to Improve Agricultural Marketing Systems

Prime Contractor: Abt Associates Inc.

Subcontractors: Postharvest Institute for Perishables, University of Idaho,
Deloitte Haskins & Sells,

AID Contract No. DHR-5447-Z-00-7074 AID Project No. 936-5477

PN-ABL-131

ECONOMICS OF

COARSE GRAINS MILLING

IN MALI

COARSE GRAINS MARKETING STUDY,

PHASE II

DECEMBER 1991

AGRICULTURAL MARKETING IMPROVEMENT STRATEGIES PROJECT

Under contract to the Agency for International Development, Bureau for Science and Technology, Office of Rural Development
Project Office 4800 Montgomery Lane, Suite 600, Bethesda, MD 20814 • Telephone: (301) 913-0500 • Telex: 312636

ECONOMICS OF COARSE GRAINS MILLING IN MALI

COARSE GRAINS MARKETING STUDY, PHASE II

Submitted to:

U.S. Agency for International Development

By:

The Agricultural Marketing Improvement

Strategies Project (AMIS)

Malik Ashraf

DELOITTE & TOUCHE MANAGEMENT CONSULTANTS
386 Woolwich Street, Guelph, Ontario, Canada

December 1991

Prime Contractor: **Abt Associates Inc.**, 4800 Montgomery Lane, Suite 600, Bethesda, MD 20814 • (301) 913-0500

Subcontractor: **Postharvest Institute for Perishables**, University of Idaho. Moscow, Idaho 83843 • (208) 885-6791

Deloitte & Touche, 386 Woolwich Street, Guelph, Ontario N1H 3W7 Canada • (519) 822-2000

TABLE OF CONTENTS

		PAGE
INDEX OF TABLES		i
APPENDICES		iii
GLOSSARY		v
MAP OF STUDY AREA		vi
PART 1:	INTRODUCTION	1
PART 2:	TERMS OF REFERENCE	3
PART 3:	SURVEY METHODOLOGY	4
PART 4:	ON-GOING DEVELOPMENT PROGRAMS IN MALI	7
	4.1 PRMC Program	7
	4.2 FED Program	8
	4.3 CMDT Program	8
PART 5:	SETTLEMENT PATTERN	10
PART 6:	COARSE GRAINS PRODUCTION IN MALI	15
PART 7:	RURAL WOMEN'S ACTIVITIES	19
PART 8:	GRAIN PROCESSING MILLS IN THE SIKASSO REGION	21
	8.1 Alternative Mills	25
	8.2 Mill Users and Their Preferences	25
	8.3 Milling Work Load	26
	8.4 Uses of Mill Revenues	26
	8.5 Types of Problems Experienced by Mill Owners	28
	8.6 Milling Capacity	29
	8.7 Milling Fee	29
	8.8 Milling Throughput and Revenues	30
	8.9 Estimates of Grain Processing Demand	32
	8.9.1 Regional Cities and Towns	32
	8.9.2 Sample Villages	35
	8.10 Analysis of Milling Cost	36
PART 9:	FINANCIAL ANALYSIS	42
PART 10:	CONCLUSIONS	46
REFERENCES		47

INDEX OF TABLES

Table 1	Number and Type of Sample Mills Surveyed in the Koutiala and Bougouni Areas	5
Table 2	Number of Circles, Arrondissements, and Villages by Region in Mali	10
Table 3	Population of Cities, Towns and Arrondissements in Different Circles of the Sikasso Region	11
Table 4	Population, Number of Arrondissements and Villages in the Sikasso Region by Circle	12
Table 5	Population and Number of Grain Processing Mills in Sample Villages of the Koutiala and Bougouni Areas	13
Table 6	Total Cereal Production in Mali by Region (Avg of 1985/86 to 1990/91)*	16
Table 7	Total Cereal Production in the Sikasso Region by Circle (Avg of 1985/86 to 1990/91)*	17
Table 8	Average Rainfall in Different Circles of the Sikasso Region	17
Table 9	Area, Production and Value of Cotton Produced in the CMDT Koutiala and Bougouni Areas*	18
Table 10	Makes of Engine for the Sample Mills	24
Table 11	Year of Installation of Sample Mills by Region	25
Table 12	Uses of Mill Revenues by the Mill Owners	27
Table 13	Computed Average Milling Fee (Fcfa/Kg)by Region and Type of Mill	30
Table 14	Milling Throughput and Revenues by Type of Sample Mills	31
Table 15	Throughput in Relation to Milling Fee	33
Table 16	Estimated Annual Demand for Milling Coarse Grains in Sample Villages/Arrondissements	36
Table 17	Average Cost of Mill, Energy and Disk Repair Costs by Type of Mills	37
Table 18	Average Cost for Repair and Replacement of Mill Equipment for New and Used Mills	40

INDEX OF TABLES ... (continued)

Table 19 Average Fixed, Variable, and Total Costs per Kilogram of Throughput by Type of Mill 41

Table 20 Net Present Value and IRR for Grain Processing Mills . 43

Table 21 Sensitivity of the Net Present Value to Selected Parameter Changes (in Thousand Fcfa) 44

Table 22 Sensitivity of the Financial IRR to Selected Parameter Changes (in %) 45

APPENDICES

APPENDIX A: QUESTIONNAIRE

APPENDIX B: MILLET PRODUCTION (TONS) IN MALI BY REGION AND BY YEAR

APPENDIX C: SORGHUM PRODUCTION (TONS) IN MALI BY REGION AND YEAR

APPENDIX D: RICE PRODUCTION (TONS) IN MALI BY REGION AND YEAR

APPENDIX E: MAIZE PRODUCTION (TONS) IN MALI BY REGION AND YEAR

APPENDIX F: FONIO PRODUCTION (TONS) IN MALI BY REGION AND YEAR

APPENDIX G: MILLET PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

APPENDIX H: SORGHUM PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

APPENDIX I: RICE PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

APPENDIX J: MAIZE PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

APPENDIX K: FONIO PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

APPENDIX L: SUMMARY OF THROUGHPUTS, REVENUES AND COSTS FOR THE PRIVATE RURAL AND URBAN MILLS IN THE KOUTIALA REGION

APPENDIX M: SUMMARY OF THROUGHPUTS, REVENUES AND COSTS OF NEW AND USED PRIVATE MILLS IN THE BOUGOUNI REGION

APPENDIX N: SUMMARY OF THROUGHPUTS, REVENUES AND COSTS FOR THE NGO MILLS

APPENDIX O: SUMMARY OF THROUGHPUTS, REVENUES AND COSTS FOR THE CMDT MILLS

APPENDIX P: MILLING FEE AND ESTIMATED MILLING THROUGHPUT IN BOUGOUNI CITY AND M'PESSOBA TOWN

APPENDIX Q: CEREAL CONSUMPTION PER PERSON IN THE SIKASSO REGION

APPENDICES (cont.)

APPENDIX R: FINANCIAL NET PRESENT VALUE AND IRR FOR RURAL MILLS IN THE KOUTIALA REGION

APPENDIX S: FINANCIAL NET PRESENT VALUE AND IRR FOR URBAN MILLS IN THE KOUTIALA REGION

APPENDIX T: FINANCIAL NET PRESENT VALUE AND IRR FOR THE FAMILY OPERATED NEW MILLS IN THE BOUGOUNI REGION

APPENDIX U: FINANCIAL NET PRESENT VALUE AND IRR FOR THE USED MILLS IN THE BOUGOUNI REGION

APPENDIX V: FINANCIAL NET PRESENT VALUE AND IRR FOR THE VILLAGE ASSOCIATION MILLS

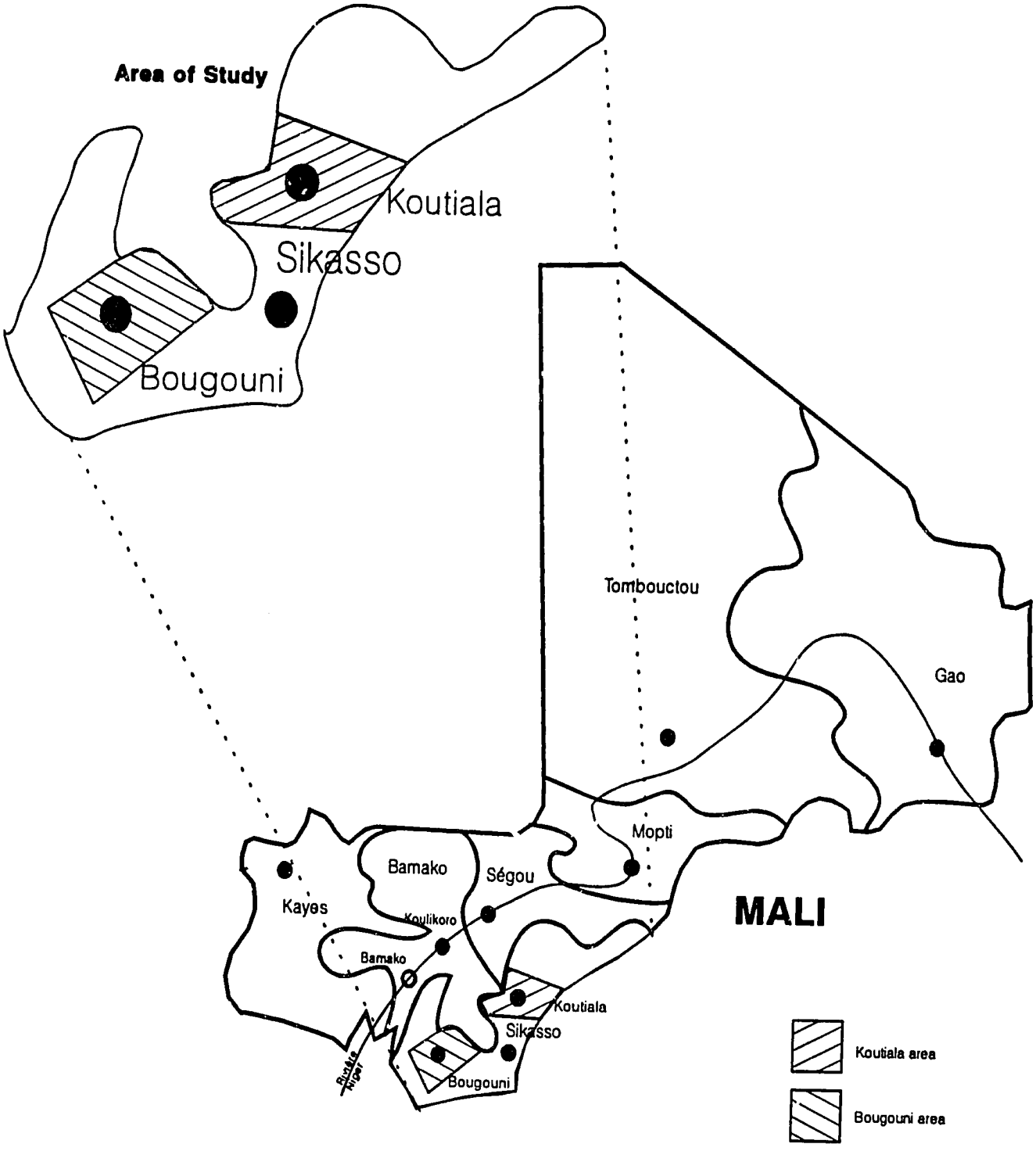
APPENDIX W: FINANCIAL NET PRESENT VALUE AND IRR FOR THE CMDT/BLACKSMITH MILLS

APPENDIX X: LIST OF PERSONS CONTACTED

GLOSSARY

AMIS	Agricultural Marketing Improvement Strategies Project
ATI	Appropriate Technologies International
BNDA	Banque Nationale de Développement Agricole
CMDT	Compagnie malienne pour le développement des textiles
FAO	Food and Agriculture Organization of the United Nations
Fcfa	CFA Francs (Malian Currency $1 = 275 fcfa in October 1991)
FED	Fonds Européens de Développement
IRR	Internal Rate of Return
NGO	Non-Government Organisation
NPV	Net Present Value
OPAM	Office des Produits Agricoles du Mali
PRMC	Programme de restructuration du marché céréalier au Mali
SE	Small Enterprise
SIM	Système d'informations sur les marchés céréaliers
UNIFEM	United Nations Institute for Women
UNU	Université des Nations Unites
USAID	U.S. Agency for International Development
VA	Village Association
WHO	World Health Organisation

MAP OF STUDY AREA



1.0 INTRODUCTION

Mali is a landlocked country in francophone West Africa. It has an area of 1.24 million square kilometres with more than 8 million people. In spite of a steady 5% growth in urban population, close to 80% of Mali's population live in rural areas, largely dependent on rain-fed agriculture. Millet and sorghum are the dominant subsistence crops. The industrial sector is small and is dominated by relatively low value-added agro-processing, although it has recently experienced a large annual growth rate of 8.1 percent (USAID/Mali,1991).

Interactions between the urban and rural sectors are limited due to: (a) lack of rural infrastructure and high cost of transportation, (b) lack of agro-industries and commercialization, and (c) limited private sector activities. Cash flow is small due to lack of industry, limited public sector employment, and little or no value addition to the local raw material. The transport service industry is limited by a lack of roads and the high cost of motor vehicles and energy. Koutiala is a relatively rich town with a population of about 55,000 located in the centre of cotton producing region.

Because of a restrictive monetary policy and low rate of inflation, the general price level, especially that of agricultural commodities, is low. People are relatively under-nourished due to lack of purchasing power. High input from women in grain processing in Mali is seen as having an adverse effect on the consumption of coarse grains and reduces the availability of women to work in different areas of farm production and other income generating activities.

In the past, there has been no formal policy to alleviate this constraint and bring about a shift in the focus of women's labour from low-value processing activities to high-value production and marketing activities. Limited government support for rice hullers in the Niger delta areas and credit subsidies for installing diesel-powered welding machines and grain mills in the cotton producing areas have been provided. International NGOs have also extended limited financial support for grain processing mills.

Small-scale agro-industries that generate rural employment and create demand for local food grains are now given high priority by the government of Mali and by the donor community as a strategy for development and improving the well-being of Malian people. In this respect a marketing feasibility study was undertaken by ATI and the AMIS Project to advise the donors and government of Mali on the appropriate strategy on grain processing technologies.

The overall objective of the project was to identify efficient technologies to reduce the cost of grain processing. These appropriate technologies for rural households were considered with a view to reduce the drudgery of women's labour, and encourage coarse grain consumption in the country. A team of two agricultural engineers, a rural sociologist and an agricultural economist contributed to the second phase of the

project. This report focuses on the economic elements of the second phase of study and deals with the issues affecting the demand for mechanical technologies and the economic viability of motorised grain processing mills in Mali.

2.0 TERMS OF REFERENCE

The terms of references provided by ATI and the AMIS Project were discussed by the team members at Bamako. Given the broad scope of study and significant overlaps in the individual terms of references it was jointly decided that the agricultural economist would devote his entire time to developing quantitative economic information for the grain processing mills, regional coarse grain production, and settlement patterns in Sikasso region. Information related to mill users and consumers and other related information at the household and farm level were handled by the other team members.

The purpose of this study was to develop information for the AMIS Project implemented by Abt Associates Inc., Deloitte & Touche and the University of Idaho's Post-Harvest Institute for Perishables (Holtzman, 1991). Economic data were collected to analyze the present grain processing situation, evaluate the economic viability of mechanised grain processing, and assess the feasibility of reducing milling fees through the existing technology in rural Mali. Primary data on different aspects of grain processing was developed through the survey of mills, which had the following objectives:

1. Type and capacity of mills, availability of support services, and cost of running the mills in rural areas,

2. Throughput, revenues and profitability in relation to the level of throughput, milling cost, and size of community,

3. Financial analysis of grain processing mills, including net present value and internal rates of return analyses, and

4. Ownership and operational management of rural mills, sources of financing, and uses of mill revenues.

3.0 SURVEY METHODOLOGY

This survey study was organised to develop economic information on the present state of coarse grain processing mills in Mali. Although there exists a general impression that the agricultural machinery and grain processing mills are more common in Sikasso region, there is no formal information on the number, location, and types of mills in the country. Thus within the short time available to the team, this survey was undertaken in Sikasso region where the cotton crop provides a considerable cash flow to the rural economy.

Consultations with experts and visits to a few mills in Koutiala and Sikasso cities revealed that while mills are common in cities, few surrounding villages have grain processing mills. Most mills perform a single process of grinding the flour. Hullers are installed mainly in the rice producing areas like Sikasso circle. Koutiala and Bougouni circles of Sikasso region, representing the most common examples of grain processing in Mali, were selected as study areas. Although private mills are common in cities and towns, the detailed survey focused mainly in the rural areas where most of the grain processing problem exists. This survey sample was supplemented with a short survey of all mills in Bougouni city and in M'pessoba, a secondary town, to assess the total processing demand and the level of throughput necessary to sustain the private mills.

A standardised questionnaire was developed for the detailed survey to obtain quantitative economic and qualitative information from the mill owners/operators (Appendix A). Quantitative information sought referred to the investment cost, repair and replacement costs, fuel and lubricant consumption, and milling revenues. Most of the mill owners/operators are not literate and do not keep written records. An exception to this practice is found among village association mills, where the non-governmental funding agency imposes record-keeping as a condition to providing a subsidised mill.

In the absence of written records, milling throughput, energy consumption and revenues were estimated by constructing monthly budgets and then aggregating for the year. Mill operators were asked to indicate months of high, medium, and low milling seasons and average milling revenue and energy consumption by month. This information was readily recalled by the mill operators. Milling throughput was estimated indirectly from the total revenue received, milling fee charged per cup and the weight of the measuring cup used at each mill. Each of the surveyed mill sites was visited at least once to interview the owner/operator and note information on engine and mill type, engine horse power and the condition of mill. The measuring cups used by the mill operator to assess milling charges were weighed. It took about two to three hours to complete the interview for the detailed survey and 15 to 20 minutes for the short survey. The detailed findings for the 56 mills (28 each for the detailed and short surveys) surveyed are given in Table 1.

Table 1

Number and Type of Sample Mills Surveyed in the Koutiala and Bougouni Areas

Type of Mill		Koutiala		Bougouni		Total
		Rural	Urban	Rural	Urban	
a. Private:	New[a]	9	12[b]	5	21[c]	47
	Used[a]	--	--	2	2	4
b. NGO/VA		1	--	2	--	3
c. CMDT/private		1	--	1	--	2
	Total	11	12	10	23	56

[a] New and used mills refer to the condition of engine and mill at the time of installation.

[b] Nine mills of a secondary town are also classified as urban mills because of greater similarity with urban mills than with village mills. Only five mills were included in the detailed survey and limited information was obtained for the remaining 7 mills.

[c] A short survey seeking information on mill financing, milling fee, throughput, revenue, and so forth, was conducted for these mills.

Source: Based on data collected in field survey.

The economic and financial analyses of data are organised according to the three broad categories of: private mills, NGO mills and CMDT mills. Analysis of private mills is reported separately for Koutiala and Bougouni areas. Koutiala area analysis is further separated out for urban and rural mills, and Bougouni area is separated out for new and used mills. Although two of Bougouni's mills belonged to the urban area, analysis of data is not reported according to rural/urban division because of small sample size and close similarity of urban mills to used mills.

The above analytical format was chosen in order to detect regional or rural/urban differences and to facilitate the reading of this report, in conjunction with the Sociologist and the Agricultural Engineers' reports. The reports of the Sociologist and Engineer refer to only a small sub-set of mills covered in this report and there may be some differences in the average values of certain parameters used in different reports.

The field survey of 56 mills was conducted by a team of two Malian researchers and the agricultural economist during a four week period from September to October 1991. Mr. Souleymane Kone, the Malian researcher, has extensive rural development experience, owned a grain mill, and had previously lived and worked in the Koutiala and Bougouni areas. He was a valuable source of information to the team and meticulously performed the

survey work. Mr. Sungalo Dagnoko, a young graduate from the survey area, provided excellent translation service and was quick to learn survey techniques.

4.0 ON-GOING DEVELOPMENT PROGRAMS IN MALI

Although the Government of Mali has no clear policy on grain processing and marketing it is highly receptive to new ideas, initiatives, and programs from the donor community. Recently, donors have proposed a package to transform and commercialise local cereals. This includes research and development, marketing, and a cereal processing credit program for the village associations.

The research and development component will support engineering research to develop appropriate grain processing technologies and research on the utilization of local cereals. The marketing activities will include testing of small-scale mills, technical assistance on marketing, management, and engineering work through a team of three experts. An expert team of three members will be recruited locally by the PRMC (programme de restructuration du marche cerealier au Mali) and will initially be funded by the donors. The proposed credit program will provide incentives in rural areas for the installation of mills. The credit subsidy will be for a period of five years with an interest charge of 8%. The credit line will cover 80% of the investment capital and the remaining 20% equity capital will be contributed by the village community.

Donors are currently formulating the above proposal which will be sent to the PRMC management committee and to the Ministry of Finance for approval. Mr. Coelo, Adviser to the Finance Minister, is involved in the development of this proposal, and it is expected that the program will be approved.

4.1 PRMC Program

The PRMC's coordinated program was first initiated in 1981/82; the first phase development program lasting over 6 years. The program focused on the commercialisation of local cereals through the liberalisation of markets and removal of tight government controls on the commodity prices and their inter-regional movements.

The second phase of PRMC's coordinated program started in 1987/88 to include the program activities to reinforce the private sector by encouraging the development of small and large scale trading businesses and by promoting the establishment of cooperatives and village associations. The role of OPAM, a government cereal production program, has been focused on national food security aspects of food stocks and storage, and the distribution/sale of food in the regions experiencing scarcity due to drought or other natural calamities.

The third phase of PRMC's program began in 1990/91, and will last 3 years. The third phase focuses on modifying interventions to strengthen the private sector, and transforming local cereals through methods of market commercialization and processing activities.

PRMC and BNDA (Banque Nationale de Développement) are providing support to the "Office du Niger" for the production of rice. The programme support is channelled through village associations, which receive rice hullers to process paddy in order to receive higher market prices. The number of rice hullers financed by the BNDA has grown from 30 to 150.

PRMC, being a donor-funded coordinating institution, has plans to experiment in new market and institutional innovations to encourage development of the agriculture sector in Mali. PRMC is willing to support any technology or innovation that may not have been fully tested and shows a good promise of success. Technologies which improve the transformation and utilization of local cereals will maintain a high priority for support from the PRMC.

4.2 FED Program

The FED (Fonds Européens de Développement) started a small enterprise (SE) credit program in 1988, and during the first phase funded 500 SE units in the regions of Segou, Sikasso, Mopti, Tombouctou, and Bamako areas. About 40% of the loans were provided to the agriculture sector, financing mainly irrigation pumps and grain trading activities. The average loan size has been Fcfa 5 million, bearing a subsidised interest rate of 8%, with a duration of 18-24 months for traders and up to 4 years for the irrigation pumps.

The loan recovery rates reported by FED are not encouraging. About 75% of all loans have been fully paid back while 20% of the loans were rescheduled due to problems experienced by small businesses; 5% of the loans have defaulted.

The first phase of the FED project finished in December 1991, and the new financing will start in January 1992, with a total fund commitment of $16 million for a period of three years. The new phase will reorient activities to include transportation, packaging, storage, and other market logistics. The credit duration will be extended and the interest rate increased to 12%.

4.3 CMDT Program

CMDT (Compagnie malienne pour le développement des textiles), a government parastatal has the most active agricultural development program covering most of Sikasso region, 4 circles of Segou and one circle of Koulikoro region. The programme primarily focuses on cotton, and food grain crops including sorghum, millet and maize, which benefit from the provision of production inputs. The production program activities include provision of fertilisers, insecticides, spraying equipment, donkey carts, and welding equipment on credit. In addition it constructs and maintains service roads to provide extended coverage in the Sikasso region. In the Koutiala area, CMDT has provided 10 grain processing mills and welding

equipment to the village blacksmith. In the Bougouni area, a similar program is currently underway. Welding equipment and flour mills operate by a diesel powered generator. The cost of mill, welding equipment, and generator is Fcfa 2 million, 90% of which is financed through the CMDT interest free credit of five year terms. CMDT imports, transports, and installs the equipment in the villages. Grain milling is an add-on to the welding operation for the CMDT-supplied equipment.

In the Koutiala area, where a blacksmith-based welding/milling programme has been fully implemented, the loan recovery has been somewhat slow. Whereas the entire loan of Fcfa 18 million should have been recovered by 1989, by January 1991 only Fcfa 15 million had been recovered. Eight blacksmiths have fully paid back their loans, and two are in arrears. According to the CMDT engineering department, the milling program ties up too many CMDT staff resources and, due to the seasonal demand for milling and welding, blacksmiths lack cash to pay back the loan instalments in time. Although CMDT is currently considering support of the Karite oil extraction equipment for existing mills, it has no plans to finance additional mills.

In the Sikasso region, CMDT is the major source of cash income to farmers through the production, marketing, and processing of cotton. There are 8 cotton ginning factories installed by the CMDT in the Sikasso region (2 in Sikasso, 3 in Koutiala, and 2 in Bougouni), 2 in the Segou and one in the Koulikoro area. A majority of farmers in the Koutiala area have benefitted from cotton over the past 10 years, and the CMDT operation in Bougouni area has started to expand the programme. The value of cotton produced in the Koutiala area averages Fcfa 6366 million and Fcfa 2009 million in Bougouni area over the past 5 years. The indirect effect of CMDT's market link road program can be observed in the growth of private mills in the Sikasso region. One would expect to observe the number of mills increasing in the future as more villages gain access to fuel supplies and repair facilities.

5.0 SETTLEMENT PATTERN

Mali is a country of about 8 million people and consists of eight administrative regions of Kayes, Koulikoro, Sikasso, Segou, Mopti, Tombouctou, Gao, and Kidof. Each region is divided into administrative circles and arrondissements, the latter contains 30 to 50 villages. There are a total of 11192 villages in the country (see Table 2).

Table 2

Number of Circles, Arrondissements, and Villages by Region in Mali

Region	# of Circles	# of Arrondissement	# of Villages
Kayes	7	51	1522
Koulikoro	7	40	1854
Sikasso	7	46	1789
Segou	7	39	2100
Mopti	8	46	1777
Tombouctou	5	32	1220
Gao	5	24	930
Total	46	278	11,192

Source: Summarised from Recensement Générale de la Population et de L'Habitat, Direction Nationale de la Statistique et de L'Informatique, Ministère de Plan, 1987.

The Sikasso region, which is our area of study, contains 7 circles, 46 arrondissements, and 1789 villages with a total population of 1.31 million according to the 1987 population census. More than 85% of the Sikasso population lives in rural areas. There are only three cities in Sikasso region (Sikasso, Koutiala and Bougouni) with significant commercial activity. Most arrondissements are no different than large villages. They contain limited commercial activity including a weekly market, two to three shops, a meat stand, a government office, a school and in some cases a trader selling petrol/diesel. Because of their relatively large size, many arrondissements, especially those located along a road side or having access to the diesel fuel, also have one or more grain processing mills. While arrondissements have the future potential of having a similar function to a small rural town, at present they lack significant commercial activity. The population of 43 arrondissements and 3 towns is less than 21% of total population in Sikasso region (Table 3).

Table 3

Population of Cities, Towns and Arrondissements in Different Circles of the Sikasso Region

City/Town/ Arrondissement	1987 (actual)	1992 (esti)
Circle: SIKASSO		
Sikasso	73,859	83,565
Blendio	2,343	2,651
Danderesso	1,875	2,121
Dogni	1,830	2,070
Finkolo	2,590	2,930
Kignan	5,443	6,158
Kelela	4,003	4,532
Lobougoula	4,105	4,644
Niena	4,524	5,118
N'Kourala	1,916	2,168
sub-total	102,491	115,959
Circle: BOUGOUNI		
Bougouni	22,374	25,314
Dogo	634	717
Faragouaran	1,834	2,075
Garalo	3,398	3,845
Keleya	1,692	1,914
Koumantou	3,270	3,700
Manankoro	1,982	2,242
Sanso	2,036	2,304
Zantiebougou	1,217	1,377
sub-total	38,437	43,488
Circle: KOUTIALA		
Koutiala	48,698	55,097
Konseguela	3,366	3,808
Kouniana	1,775	2,008
Molobala	4,038	4,569
M'pessoba	6,266	7,089
Zangasso	1,696	1,919
sub-total	65,839	74,491

Arrondissement	1987 (actual)	1992 (esti)
Circle: KADIOLO		
Kadiolo	6,876	7,780
Fourou	1,890	2,138
Loulouni	2,957	3,346
Misseni	1,370	1,550
sub-total	13,093	14,814
Circle: KOLONDIEBA		
Kolondieba	5,850	6,619
Fakola	2,049	2,318
Kadiana	2,140	2,421
Kebila	2,071	2,343
Toussekela	1,445	1,635
sub-total	13,555	15,336
Circle: YANFOLILA		
Yanfolila	4,995	5,651
Doussoudiana	1,179	1,334
Filmana	628	711
Guelaninkoro	1,118	1,265
Kalana	4,089	4,626
Kangare	4,537	5,133
Siekorole	3,393	3,839
Yorobougoula	1,400	1,584
sub-total	21,339	24,143
Circle: YOROSSO		
Yorosso	3,182	3,600
Boura	2,004	2,267
Kouri	5,356	6,060
Manou	6,852	7,752
sub-total	17,394	19,680
Total Sikasso region	272,148	307,910

* Population for the year 1987 is actual and for 1992 projected at the annual growth rate of 2.5%

Source: Direction Nationale de la Statistique et de l'Informatique, Recensement Générale de la Population et de l'Habitat, Ministère du Plan, République du Mali, 1987.

The population by circle and number of villages in the Sikasso region is provided in Table 4. More than 67% of region's population resides, and two-thirds of all village settlements are located, in the circles of Sikasso, Koutiala, and Bougouni. Villages are generally small, located in compact blocks of mud houses with thatched or tin roofs. According to 1987 population census, 56% of Sikasso villages are less than 500 people, 27% between 500 and 999 people, 9% between 1000 and 1499 and only 8% with more than 1500 people. The sizes of arrondissements in the Sikasso region vary between under 750 people to about 7800 people. All households in the arrondissements and villages practice farming. Non-farming productive activities are negligible. The majority of the households are poor and lack regular cash income.

Table 4

Population, Number of Arrondissements and Villages in the Sikasso Region by Circle

Circle:	Sikasso	Bougouni	Koutiala	Kadiola	Kolondieba	Yorofolla	Yorosso	Total
Rural population:								
Male	142,760	96,125	108,421	43,769	46,816	57,566	43,801	539,258
Female	153,125	103,913	113,364	47,916	51,689	60,974	45,241	576,222
Sub-total	295,885	200,038	221,785	91,685	98,505	118,540	89,042	1,115,480
Urban population:								
Male	39,948	11,037	30,375	3,466	2,859	2,434	7,723	97,842
Female	39,354	11,337	30,168	3,410	2,991	2,561	7,667	97,488
Sub-total	79,302	22,374	60,543	6,876	5,850	4,995	15,390	195,330
Total population	375,187	222,412	282,328	98,561	104,355	123,535	104,432	1,310,810
% of total	29	17	22	8	8	9	8	100
# of Arrondissement	10	9	7	4	5	8	4	47
# of Cities	1	1	1	0	0	0	0	3
# of Villages with:								
< 500 people	272	340	83	50	139	91	30	1,005
500 to 999	153	102	70	41	48	50	23	487
1000 to 1499	32	13	47	13	11	19	18	153
> 1500 people	32	12	41	15	8	14	22	144
Total Villages	489	467	241	119	206	174	93	1,789

Source: Direction Nationale de la Statistique et de l'Informatique, Recensement Générale de la Population et de l'Habitat, Ministère du Plan, République du Mali, 1987.

Given the present location pattern of grain processing mills in the Sikasso region (Table 5), it is obvious that the private sector first installs mills in cities and towns, and then in arrondissements and large villages with 1500 people or more. Only a few of the medium sized villages, which have population of between 1000 and 1500 and have access to fuel sources, receive a private mill. There are 144 large villages and arrondissements and 153 medium-size villages in the Sikasso region. The present mechanical mills are unlikely to be installed by the private sector in the remaining 1492 small villages where more than 60% of rural population live.

Table 5

Population and Number of Grain Processing Mills in Sample Villages of the Koutiala and Bougouni Areas

Village	1987 (Actual)	1992* (Estimated)	# of Mills
a) Koutiala area:			
Baramba	2070	2342	5
Niewwouma	1174	1328	1
Nigountjina	1435	1624	1
Sinsina	3605	4079	1
Sirakele	2238	2532	2
M'pessoba[1]	6266	7089	9
Zamblala[2]	703	795	1
Zanzoni[3]	2023	2289	2
b) Bougouni area:			
Denie	643	727	1
Madina	780	882	2
Faragoura	1834	2075	1
Keleya	1692	1914	2
Zantiebougou	1217	1377	1
Dissan[2]	599	678	1
Kologo[2]	855	967	1
Sido[3]	1620	1933	2

* Estimated based on an annual compound growth rate of 2.5%.

1 M'pessoba is a secondary town and an arrondissement.

2 Indicates villages with NGO financed village association mills.

3 Indicates villages with one CMDT and one private mill.

Source: Director Nationale de la Statistique et de l'Informatique, Recensement Générale de la Population et de l'Habitat, Ministère du Plan, République du Mali, 1987.

As the village population grows and the cash income of rural households (especially those of women) increases, mills will become feasible for the medium-sized villages. In sum, the future rate of installation of private mills will depend upon the disposable cash income of rural households, village size, and the availability of diesel fuel and repair services within the area. Thus, for the foreseeable future, manual processing of grains will continue to be a way of life for a majority of the rural population living in small villages and hamlets, unless a technology is developed that can be sustained by the smaller communities.

6.0 COARSE GRAINS PRODUCTION IN MALI

Cereal production in Mali is adapted to varied climatic conditions in the country. Mali Sud, where rainfall is high in the range of 1000 to 1200 mm, produces the largest quantities of sorghum and maize. The Central region receives rainfall of 600 to 1000 mm and produces the largest quantity of millet and fonio and the second largest quantity of sorghum. The third and fourth largest producing regions of coarse grains are West and Seno Plateau Dogon. Rice production is concentrated in the Delta region. In the Sahel region, modest quantities of millet and sorghum are produced.

Cereal production in Mali shows a high degree of fluctuation from year to year mainly due to interannual changes in rainfall patterns. Over the past six years the production of all cereals except rice has remained stagnant. The rice acreage in the low-lying delta areas of river Niger, mainly in Segou and Mopti regions, has lead to a steady increase in paddy production from 75,700 tons in 1985/86 to 282,400 tons in 1990/91. However, the increase in rice production is recent and occurs predominantly in the commercial sector of the Segou region, which has a donor credit support program for the activities of production, marketing and hulling of paddy.

On average, Mali produces 1.75 million tons of all cereals; 47% millet, 32% sorghum, 11% maize, 8% paddy rice and only 1% Fonio (Table 6). Segou and Sikasso are the largest cereal producing regions, contributing 28% and 27% respectively to total production. Koulokoro and Mopti together produce another 33% of the overall cereal production. More than 41% of all millet is produced in Segou region, followed by 23% produced in Mopti and 17% in the Sikasso region. Similarly 32% of all sorghum is produced in the Sikasso region, 27% in the Koulikoro region and 18% in the Segou region. More than 65% of all maize is produced in the Sikasso region and 28% is produced in the two regions of Koulokoro and Keyes. Although 50% and 30% of all fonio is produced respectively in the Segou and Sikasso regions, the overall quantity is insignificant, when compared to other grains, to warrant any consideration for post-harvest technology. Also, the local food preparation for fonio does not require milling into flour, thus limiting the processing activity to hulling only (see Appendices B - F).

Table 6

Total Cereal Production in Mali by Region (Avg of 1985/86 to 1990/91)*

Cereal	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total	%
					(Tons)				
Millet	16,601	120,798	141,506	335,626	187,911	22,204	239	824,884	47
Sorghum	92,131	152,757	179,005	100,643	17,321	19,702	3,371	564,930	32
Maize	22,699	30,312	126,819	14,564	372	0	0	194,765	11
Fonio	1,532	523	5,719	9,504	1,755	0	0	19,033	1
Rice	139	1,766	12,774	33,183	57,825	17,082	20,386	143,155	8
Total	133,102	306,155	465,823	493,519	265,184	58,988	23,996	1,746,767	100
%	8	18	27	28	15	3	1	100	

* Refer to appendices B to F for yearly crop analysis.

Source: Ministère du Plan, Enquête Agricole de Conjoncture, République du Mali.

Based on the regional analysis of cereal production in Mali, it is obvious that the greatest demand for processing lies in the regions of Segou, Sikasso, and Koulikoro. In the Segou region the processing demand is for millet, sorghum and paddy, and in the Sikasso and Koulikoro regions for sorghum, millet, and maize. In the Mopti region the greatest processing demand is for millet and paddy, and in the Kayes region it is for sorghum and maize. These regional differences in grain composition should be taken into consideration while testing and adapting improved technologies for grain processing in Mali. Also, a single processing technology that can handle various types of grains will have a better chance of acceptance in the country.

The Sikasso region produces on an average 465,000 tons of cereal grains per annum. Of all cereals, 38% is sorghum, 30% millet, 27% maize and only 3% and 1% paddy and fonio grains respectively (Table 7). Among the various circles in the Sikasso region, Koutiala produces 32% of all cereals, followed by 21% in Sikasso, and 14% each by Bougouni and Yonfolila circles. About 42% of the region's millet and 34% of the sorghum is produced in the Koutiala circle. About 25% of the region's maize is produced in the Sikasso circle, 22% in the Koutiala circle, and 15% each in the Bougouni and Yonfolila circles. More than 50% of the minor cereal crops of paddy and fonio is produced in the Sikasso circle, and about 54% in the Bougouni and Yonfolila circles respectively. The Koutiala and Bougouni circles were selected for the survey because they represent different climatic (Table 8) and socio-economic conditions within the Sikasso region. (See also Appendices G - K).

Table 7

Total Cereal Production in the Sikasso Region by Circle
(Avg of 1985/86 to 1990/91)*

Cereal	Sikasso	Bougouni	Kadiolo	Kolondieba	Koutiala	Yonfolila	Yorosso	Total	%
				(tons)					
Millet	20,359	14,289	11,755	4,186	58,844	697	31,378	141,507	30
Sorghum	40,180	27,800	8,892	8,588	61,039	5,431	27,076	179,005	38
Maize	32,184	19,044	15,926	7,667	27,988	18,855	5,155	126,818	27
Fonio	126	3,060	849	1,033	0	610	42	5,719	1
Rice	6,297	2,035	1,961	123	60	1,949	0	12,425	3
Total	99,145	66,229	39,383	21,596	147,930	27,541	63,651	465,474	100
%	21	14	8	5	32	6	14	100	

* Refer to appendices G to K for yearly crop analysis.

Source: Ministère du Plan, Enquête Agricole de Conjoncture, République du Mali.

Table 8

Average Rainfall in Different Circles of the Sikasso Region*

Month	Koutiala	Yorosso	Bougouni	Yonfolila
		(millimeters)		
April	0	0	11	39
May	46	30	85	90
June	108	87	141	104
July	202	168	216	213
August	219	220	292	248
September	137	125	260	202
October	24	35	61	61
	---	---	---	---
Total (mm)	736	665	1066	957
Rainy Days	60	46	80	64

* Averages refer to years 1980 to 1990 for Koutiala and Yorosso Circles, and the years of 1986, 1987, and 1990 for Bougouni and Yonfolila Circles.

Source: Annual Reports, CMDT regional offices in Koutiala and Bougouni.

The Koutiala and Bougouni circles (CMDT regions) have a considerable cash economy due to the extensive market opportunities in selling seed cotton to CMDT. Table 9 shows the area and production of cotton for the two regions. Cotton is a well-established crop in the Koutiala area,

while the cotton acreage is steadily increasing in the Bougouni area with the recent opening of road and market outlets in the area. Over the past five years, the Koutiala area has realised an average cotton sale of Fcfa 6,300 million; the Bougouni area more than Fcfa 2,000 (Table 9).

Table 9

Area, Production and Value of Cotton Produced in the CMDT Koutiala and Bougouni Areas*

Year	Koutiala area		Value (Fcfa Million)	Bougouni area		Value (Fcfa Million)
	Area (Ha)	Production (Tons)		Area (Ha)	Production (Tons)	
1986/87	53,472	66120	5620	10,093	14,319	1,217
1987/88	51,536	61804	5253	14,537	19,394	1,648
1988/89	69,283	84928	7219	19,484	25,091	2,133
1989/90	61,243	70791	6017	23,207	27,105	2,304
1990/91	66,342	90814	7719	25,731	32,287	2,744
Average	60,375	74,891	6,366	18,610	23,639	2,009

* Koutiala and Bougouni areas refer to the CMDT regions and not to the administrative regions.

Source: Annual Reports, CMDT regional offices in Koutiala and Bougouni.

7.0 RURAL WOMEN'S ACTIVITIES

Within the Malian household, there is a fairly strict division of labour and responsibility between men and women. Men manage and provide labour for the production of millet, sorghum, and maize, as well as for the cash crops of tobacco and cotton. They manage and care for animals and equipment used in animal traction, and they market bulk grains or cash crops. The Malian women produce their separate cash and consumption crops in addition to providing labour for the family and/or village communal fields. Women contribute to the production of fruits, vegetables, meat, milk, cheese, and cooking oil for family consumption. They transport and market farm products in local markets. From their meagre cash earnings they pay for medicines, clothing, utensils, and dowries for their daughters. They contribute food for family and religious celebrations. Processing food grains and preparing food is the sole responsibility of women. A brief list of major activities that the women undertake is given below:

a. Agricultural Production activities:

- Seeding, weeding, harvesting from own fields and from family and village fields;
- Own and milk livestock, especially small animals

b. Transformation of Agricultural products:

- Clean, card, and spin cotton
- Hull rice
- Threshe, hull and grind millet, sorghum, maize
- Produce shea butter, palm oil, groundnut oil
- Make soap
- Prepare condiments
- Produce millet beer
- Produce milk products
- Transportation and marketing of farm products in a weekly markets

c. Artisanal Activities:

- Pottery
- Basket and mat weaving
- Cloth dying
- Leather working

d. Household Work

- Collect firewood
- Carry water
- Prepare meals and carry to the field

On a daily basis women spend considerable time on the manual processing of food grains. Women's ability to use grain processing mills at present is quite limited due to meagre cash earnings (see Karen Freudenberger's report for an in-depth analysis). However, where mills are available, more women tend to use them during the busy farming seasons. In rural areas, income-generating activities outside the farming sector are quite limited and therefore present a low opportunity cost for women. Only very few women in villages engage in small business activities.

8.0 GRAIN PROCESSING MILLS IN THE SIKASSO REGION

As stated above grain processing is the responsibility of women who undertake the time-consuming transformation of grains to prepare food. The transformation of grains involves hulling to remove the husk or hull, and grinding or pounding to make flour. Traditionally, these tasks have been performed manually using a mortar and pestle. Over the past few years, international donors and the private sector have introduced mechanical small mills to alleviate the drudgery of manual processing. To what extent the mechanical mills are available and used by Malian rural households is not known.

This survey was undertaken in the relatively richer Sikasso region, where grain processing mills are said to be more common than other areas. In the absence of any formal list of rural mills, we visited all those villages which were known to have at least one mill and could be reached by motor vehicle. A brief of sample mills is given below.

A quick survey of grain processing mills/equipment in Koutiala and Bougouni cities and discussions with knowledgeable people in Sikasso city revealed that about 23% are hullers and 77% are flour mills. Very few hullers are installed in combination with the flour mills. Those individuals who have both a huller and a flour mill are operating them on separate engines, thus not realising the economy of processing operations. Even though cities have electricity, only a few mills are run with an electric motor due to frequent black outs. All village mills in Koutiala and Bougouni circles are diesel powered and none of the mills has hulling equipment.

Based on our survey, we estimate that, at the present time, there are more mills in the three cities than in all the villages of the Sikasso region. Bougouni city has 30 mills and 5 hullers. Similarly we estimate 45 mills and 3 hullers in Koutiala city and about 50 mills and 30 hullers in Sikasso city. On this basis the total number of motorised grain processing equipment comes to 125 mills and 38 hullers in three cities.

Rural mills are present mainly in large rural communities. We estimate that there are about 80 to 90 mills in villages, arrondissements and secondary towns of the Sikasso region. Rice hullers were not found in rural areas of the Koutiala and Bougouni circles. Thus, if there are any hullers in rural areas they are in the rice-growing areas of the Sikasso Circle. Given the small number of rural mills, it is obvious that the majority of the Sikasso villages are without motorised mills. On this survey, a motorised mill is presently available to every 1500 to 1600 people in the cities, compared to 12,000 to 13,000 people in the rural areas.

Typically, a diesel engine, mill, two to four water tanks, and a small diesel tank are installed in one room measuring about 35 to 45 square metres. Mill buildings in villages are generally mud walled with a tin roof and dirt floor. In the towns, mill buildings are of similar size and in most cases made from bricks, with cemented floors. Most mill

rooms are attached to the household compound with one door opening to the street and the other to the compound. A few mills in the villages are located in rented buildings. This is especially true in situations where mill owners are from other villages or nearby towns. In most cases, resident village entrepreneurs have installed the mills but a new trend is emerging whereby outsiders set up mills in roadside villages. There does not seem to be any major social constraint for those communities to accept outsiders.

With the exception of three mills, all mills we visited were owned and operated by men. Of the three mills owned by women, two are located in towns and a third in a village. The town mills are operated by the women and the village mill is operated with the help of a hired male operator. All three female owners have been traders in the past. Two other variations to the norm exist; at one mill a woman is hired to operate the mill, and at a few other mills, both husband and wife jointly operate the mill. Running the mills with an hired operator is more common in cities and towns than in villages. Only 17% of private mills in villages were run with a hired operator as compared to 36% of mills in cities and towns.

All private mills[1] in the Koutiala area were new at the time of installation. In the Bougouni area, however, about 45% of the private mills were installed as used mills. The source of used mills is cities like Bamako, Koutiala, and Bougouni, which have reached a saturation point, due to returning immigrants from Côte d' Ivoire. In the Bougouni area, a few of our sampled mills (both new and used) were owned by business men residing in Bamako city.

All mills in Koutiala and Bougouni cities are privately owned. In the past decade, about 10 village mills in the Koutiala area have been financed through the CMDT credit subsidy program, and few others by the International NGOs. Similarly in the Bougouni area, CMDT has recently undertaken to finance 10 rural mills and few mills have already been financed and installed by NGOs.

Three major common sources of financing for private mills in the Koutiala area were farming or the sale of cotton and livestock (57%), retirement funds (29%), and informal loans in addition to farming income (14%). In the Bougouni area, income from farming financed 33% of the mills in the survey sample, trading and business incomes each financed 22% of mills, and informal loan and retirement funds each financed 11% of mills in the survey sample. None of the private mills used formal credit.

---

[1] The word mill is used broadly to include both the engine and the plate mill. Used mill refers to the condition of engine and mill at the time of first installation in the survey area.

Private investment in grain processing mills is considered to be most attractive for enterprising businessmen, and is among the few investment opportunities that exist in rural Mali. Business enterprises include:

	Rural Business Enterprise	Investment(Fcfa)
1.	Grain hulling mill	1,500,000
2.	Grain processing mill	1,000,000
3.	Livestock rearing	300,000*
4.	Donkey cart for transportation	100,000
5.	Gasoline/diesel oil stands	50,000
6.	Carpentry	50,000
7.	Mechanics	50,000
8.	Blacksmith	50,000
9.	Trading	50,000
10.	Tailoring	40,000
11.	Fuel wood extraction and marketing	25,000
12.	Charcoal	25,000
13.	Road side meat stand	10,000
14.	Barber	10,000
15.	Motor cycle/bicycle repair stands	10,000
16.	Karite/cotton seed oil extraction	5,000

* This figure is variable. Livestock prices are approximately 40,000 - 75,000/head of cattle 5,000 - 15,000/small ruminant (sheep or goat)

Most of the above listed business enterprises are labour intensive or require specialised training. The grain milling business does not require much training, is less labour intensive, and cash outlay is within reach of many rich farmers in the Sikasso region.

The most common reason given by mill owners for investing in a grain processing mill is the profitable nature of the enterprise. Many wanted their sons or younger brothers to have a better occupation than farming and uplift the economic status of their families in the community. Thus mills are considered to be a stepping stone for the families who want to move up the economic ladder, find an alternative to farming, or an occupation after retirement. A few rich families considered investing in a mill to secure their surplus cash savings in a productive business.

In towns, most mill owners share a common background of performing white collar jobs. They are either retired or nearing retirement from a fixed salary job or they are returning immigrants from other African countries. Many mill owners left their previous jobs to start personal businesses. Village mill owners are from two distinct backgrounds; one, from the local farming families and two, relatives or friends who are resident in cities like Bamako, Koutiala, and so forth. The second category is found in villages located along a paved road with easy access to the town.

All mills in Bougouni and M'pessoba towns were installed privately and 78% of the private mills surveyed in villages were also owned individually or by a single household. A survey of all village mills indicates that about 13% of all mills are installed jointly by the village community through the financial and technical assistance of international and national NGOs and 9% of mills were installed with the financial and technical assistance of CMDT. The CMDT mills consisted of a diesel powered electric generator, welding equipment and a flour mill. Milling is an add-on to the welding operation.

Three types of diesel engines were common among village mills, although many more types exist in Bougouni city (Table 10). In villages, private mills are mostly of Indian manufacture, while CMDT uses British Lister and NGOs have introduced the German Hatz make. Most private mills were run with a 7 to 8.5 horse power engine. The CMDT diesel powered generators have a 12 to 16 horse power. Of the 28 mills (21 rural and 7 urban) covered in the detailed survey, 20 have a water cooling system and 8 have a air cooling system for the mill engine.

Table 10

Makes of Engine for the Sample Mills

Brand/ Manufacture of Mill Engine	Koutiala		Bougouni		Total
	Rural	Urban	Rural	Urban	
Indian	8	10	7	11	36
Lister	2	2	1	4	9
Hatz	1	--	2	3	6
Other	--	--	--	5	5
Total	11	12	10	23	56

Source: Based on data collected in field survey.

There has been a steady growth of private mills in the Koutiala and Bougouni areas, noticeably within the past 5 to 6 years. While mill installation in Koutiala began in the late seventies, in the Bougouni area mills were introduced during the eighties (Table 11). The growth of private mills initially seems to be related to the availability of funds, which increased as a result of the expansion of cotton acreage. It now appears that the increase in mills is directly related to the effective demand for milling service by the village community and access to diesel fuel and repairing facilities. The demand for milling service is also a function of increased rural incomes, in large part due to higher revenues from growing cash crops, such as cotton, in southern Mali. Large villages located near towns or along motorable roads have at least one flour mill. Small villages with similar characteristics and large villages in remote areas lack flour mills.

Table 11

Year of Installation of Sample Mills by Region

Year	Koutiala		Bougouni		All
	Rural	Urban	Rural	Urban	
1973-80	3	1	--	2	6
1980-85	1	2	1	3	7
1986-87	1	3	1	4	9
1988-89	4	4	2	7	17
1990-91	2	2	6	7	17
Total	11	12	10	23	56

Source: Based on data collected in field survey.

8.1 Alternative Mills

Mill owners/operators were asked about their likely interest in alternative smaller mills, which would be either less costly or mobile, or could be animal-driven (see Agricultural Engineers' report for alternative mills). Unfortunately, there was no time to question individuals in villages without a mill. Many mill owners expressed interest in knowing more about such mills, but did not show great enthusiasm. They did not like the idea of a smaller mill with slower milling capacity, thinking that they would lose their customers because of long waits. With respect to mobile mills, owners/operators were concerned about the difficulty of transportation due to lack of private transport and roads between villages. Regarding animal powered mills, owners/operators expressed concern about the additional work in feeding and caring for these animals.

Most mill owners expressed satisfaction with their present mills. Only four mill owners wanted to try the mobile mill. One liked the idea of a smaller/slower mill that would cost less than his present mill. Two mill owners wanted to try an animal-driven mill. Discussions with few village groups currently without mills revealed that they are aware of motorised mills and have little idea about mobile or animal-driven mills. They would like to cooperate with any agency providing milling assistance. Thus the existing milling subsidy program focusing on motorised mills may have distorted the picture with respect to the most appropriate mill type for Malian socio-economic conditions.

8.2 Mill Users and Their Preferences

According to the information provided by the mill operators, the majority of mill users come from the same village. About 70% of the mills reported users from neighbouring villages as far as 2 to 8 kilometres away. Many of these individuals have a bicycle or a mobylette. However,

outside users have declined recently due to an increase in the number of mills in the areas. Resident village mill users are women of all ages and girls as young as 8 to 10 years age. Outside mill users increase in busy farming seasons and are predominantly men. Mill users rarely drop off grains at the mill to return later for their flour, although this practice is quite common with Karite processing in the Bougouni area. Operators charge milling fee in cash and in-kind payment does not exist due to the absence of a market for flour.

According to mill operators, women prefer milling wet grains throughout the year, and some prefer milling dry grains during busy periods. At busy planting and harvesting periods, 43% of mill operators reported that users prefer milling dry grains to enhance storability of flour. Normally, users soak and hull their grains before milling to meet daily consumption requirements. During busy periods grains are not hulled, and relatively large quantities sufficient to last for a few days are brought for milling. In M'pessoba, an arrondissement of 7089 people in the Koutiala area, one of the major tribal groups prefers milling dry maize that is not hulled. Users are very satisfied with the quality of milling.

Mill operators also prefer milling wet grains due to the ease of milling hulled grains, savings in energy costs, and less mechanical wear of the disks. Milling of dry grains that are not hulled is slow and usually takes two milling runs to achieve the fine flour quality required. Most mill owners charge an additional 20% for milling dry grains. As most of village mill operators are from farming families, they close the mill for few days a week during planting and harvesting peaks to attend to their crops.

8.3 Milling Work Load

In the Koutiala area, one-fifth of the mills reported an increase in work load, while two-fifths reported a decrease in work load over the past year. In the Bougouni area, more than 40% of the mills reported an increase in work load; 33% reported a decrease. The decrease in work load resulted from mill installation in the area which has reduced the number of users from neighbouring villages and a slow growth rate in the number of users. It appears that the high profit margins in the past contributed to the growth of the private milling sector in the Sikasso region.

8.4 Uses of Mill Revenues

The regular cash income generated from the milling of grains is used by mill owners for a variety of purposes. They use mill revenues to meet the family's cash expenses and invest in farming inputs or other productive uses (Table 12). Other positive effects to mill owners have accrued in the form of increased farm sizes and increased number of livestock animals. For the majority of mill owners both men and women have become busier than before and only few reported the work load

remaining the same. Thus the rural mills have multiple positive effects on the economy in the form of generating demand for durable, increased use of fertiliser and labour inputs by mill owners.

Table 12

Uses of Mill Revenues by the Mill Owners

Type of Use	Koutiala	Bougouni	Total	%
a) Meet family expenses	14	8	22	79
b) Pay back loans	3	2	5	18
c) Invest in durable	4	2	6	21
d) Hire farm labour	4	4	8	29
e) Purchase fertiliser	3	1	4	14
f) Purchase livestock	3	2	5	18
g) Invest in other business	--	2	2	7
h) Other	2	1	3	11

Source: Based on data collected in field survey.

Very few mill owners deposit their cash with the bank due to the cumbersome procedures and delays to withdraw the cash from the bank, especially for illiterate persons. Mill owners don't like to risk repair delays due to lack of handy cash. They hold their mill revenues at home, and a few give some to other family members for business.

All mill owners surveyed lacked prior skills or information about operating and managing mechanical equipment. Although the owners of the first series of mills in large villages illustrate good business judgement, more recent installations in smaller villages or additional mills in large villages indicate lack of business acumen and information for new entrants. The two most often cited reasons by the mill owners for the potential high milling demand are the very laborious nature of manual processing of grains, which ties up a major portion of women's time, and the severe labour constraint for farming, which can be reduced only through women's labour. Local entrepreneurs considered that most households would seek and pay for milling services. This is also true for CMDT and many NGOs who initially anticipated unlimited demand for milling service. Factors like seasonal cash flow, especially for women, the division of labour within the household, opportunity costs of women's time, the ability of the husband to contribute to milling costs, and income distribution in a community which affect the demand for milling were not considered.

8.5 Types of Problems Experienced by Mill Owners

Asked about the problems experienced in operating a mill, about one-half of our sample which had recently installed mills reported no major problem. For operators of older mills, the most common problems mentioned were the frequent repairs and high repair costs of disks, piston rings, fuel pumps, bushings, and cylinder heads. A few mentioned the lack of skills to operate the mill and the high cost of diesel fuel. Still others mentioned the poor quality of parts, and mill users bringing small quantities of grains and arriving in small numbers as the major problems. We observed many mills running as little as 10 minutes and then waiting for the users to arrive. Presently mills have 8 to 10 starts and stops in a day.

Most mills did not experience any long-term major breakdowns. In most cases, breakdowns were repaired within 1 to 2 days. Only in three cases did breakdowns last over a 10 day period, and in one case over 6 months for lack of funds. Only one mill operator mentioned the lack of available technicians for repair jobs.

Although not explicitly mentioned, one of the common difficulties that operators experience in the outlying villages is the long distance to towns to purchase diesel fuel and sharpen disks. They travel 2 to 4 times a month to the town through the bush road/path to purchase diesel. Mill operators located within 2 to 3 kilometres from the town travel on foot, those within 5 to 20 kilometres travel on bicycle and those beyond this distance travel on mobylette. In other words, access to fuel sources and means of transport affect the decision regarding the installation of a village mill. Thus, while the mill located in or near a town involves investment only in a mill, villages in remote areas require an investment of Fcfa 75,000 for a bicycle, or Fcfa 275,000 for a mobylette.

Our mill sample was located within the radius of 5 to 50 kilometres from the town. More than one-half of the mills have a bicycle to transport diesel, about 30% have a mobylette, and the rest of the operators bring supplies on foot.

A survey of bicycle and mobylette dealers in Koutiala town revealed that the dealership has grown from 2 in 1980 to 4 in 1991. The number of mobylettes sold every year has increased from 50 in 1980 to more than 100 per year. More mobylettes and bicycles are sold to the villagers than to town people.

An informal discussion with 5 petrol pump operators at Koutiala confirmed the importance of personal transport for running a mill in interior villages. According to pump operators, about 20 to 30 villagers buy 10 to 20 litres diesel every week and transport it on bicycles and mobylettes. These figures correlate with the information obtained from the mill operators. Mill operators from within the town buy 3 to 5 litres of petrol and carry it on foot. Only a few purchase 50 to 200 litres and transport it by donkey carts or by public transport, the latter being the village traders who retail diesel in village markets.

8.6 Milling Capacity

Mills are operated regularly throughout the year, except on national holidays, on alternate days during busy planting and harvesting seasons[2], and when mills have breakdowns. Few mill operators reported closing down due to lack of milling demand during the slack farming season when women are least busy and during period of low food supply or hungry season. We estimate that most mills operate an average of 310 days a year in the Koutiala area, and about 338 days a year in the Bougouni area. Mills are more busy on weekly market days as village women spend more time on trading activities and women from adjoining villages bring grains for milling. Thus the milling hours vary from as low as one to two hours a day in the low season, to 6 to 8 hours in a busy season, depending upon the milling load. Most mills are operated in the morning hours and late afternoons when mill operators are not attending to farming work or other chores.

Although motorised small mills in the Sikasso region have the capacity to easily mill 500 to 600 kilograms of grains, the quantity presently milled is less than 300 kilograms in a day. In most cases the seasonal highs are 150 to 200 kilograms per day. For one village association mill, which was located in a relatively richer community, milling fees were highly subsidised and the throughput varied from 120 kilograms in low season to 380 kilograms per day in high season. Thus, due to the highly seasonal nature of milling demand, the capacity utilization varies throughout the year. However, low capacity utilization should not be viewed as a justification for designing a lower capacity mill without considering other socio-economic factors. At many mills, the team found users unwilling to wait, wanting their grains to be milled quickly after spending so much time hulling the grains, and many users bringing grain to a mill just before the cooking time.

8.7 Milling Fee

Milling charges vary among mills but the major differences lie among mill and grain types. Milling charges for sorghum and millet are low but high for corn, beans, and groundnuts. Milling fees are higher in the Koutiala area than those in Bougouni area. In general, the farther away the private mills are from fuel sources, the higher the milling fee. In both regions, CMDT mills charged higher milling fees than privately installed mills. One NGO mill surveyed in the Koutiala area charged competitive milling fees to private mills, while the two NGO mills in the Bougouni area charged one-half the fees for milling sorghum, millet and corn and about three-fourths the milling fees for beans and groundnuts.

---

[2] In the busy farming season, women seek milling service for large quantities of grains to last for a few days, rather than milling every day, in order to spare days for farm work. Though there are more days of mill closures in the busy season, the overall quantity milled is greater due to the increased number of mill users.

Only one newly installed private mill was charging a low milling fee of 7.1 Fcfa/Kg to attract users from the NGO mill.

Although milling fees were estimated after measuring the weighing cups, these could not be directly used in the economic analysis, as mill operators lacked information on the quantity of grains milled. Milling fees measured in this way do not always reflect the rates mill operators actually charge. This problem was circumvented by obtaining information on milling revenues, and then estimating the volume of milling throughput based on the cup weight and the mill owner's estimate concerning the composition of grains milled throughout the year. The composite milling fees, using the above procedure, are given in Table 13.

Table 13

Computed Average Milling Fee (Fcfa/Kg) by Region and Type of Mill

Region	Mill Type	# of Mills	Milling Fee - Fcfa/Kg: Range	Mean*
Koutiala	Rural	9	12.5 - 25.0	19.2
Koutiala	Urban	5	10.0 - 17.9	14.0
Bougouni	New	5	11.8 - 14.3	13.0
Bougouni	Used	4	7.1 - 20.0	13.5
Both	NGO	3	6.3 - 15.0	8.5
Both	CMDT	2	19.2 - 23.1	20.8

* Average milling fee is computed by dividing the total mill revenue by the estimated throughput of all types of grains. Thus, the computed milling fees reflecting a mixture of grains and legumes will be somewhat higher than the milling fees of coarse grains used by other members of the team.

Source: Based on data collected in field.

8.8 Milling Throughput and Revenues

The quantity of grains milled by each surveyed mill was estimated indirectly from the milling revenues received during the year as discussed in the methodology section. Annual throughput for each of the 28 mills is given in Appendices L to O, and averages are summarised in Table 14. The composition and level of throughput is seasonally variable reflecting the availability of food grains, amount of cash available to women, and the opportunity cost of women's labour. On an average, throughput per mill is somewhat higher in the Bougouni area than in the Koutiala area because of less milling competition, more user population per mill, and milling of karite, groundnuts, and beans in addition to the usual coarse grains. Although milling throughput for private mills varies from 14 to 58 tons per year, most mills have a throughput of over 30 tons. One of the NGO mills charging the higher milling fee of 15 Fcfa/Kg has a throughput of 17

tons per year, and the other two mills charging 6.3 Fcfa/Kg have much higher (25 tons and 63 tons) throughputs. The milling throughput for the CMDT mills is lowest due to competition from private mills and the CMDT mill devoting considerable time to welding tasks, especially during the high milling season. The weight of throughput refers to fresh or wet hulled grains which contain about 18% to 25% moisture.

Table 14

Milling Throughput and Revenues by Type of Sample Mills

Region	Mill Type	Throughput - Tons/Yr:		Revenue - (000 Fcfa/Yr):	
		Range	Mean	Range	Mean
Koutiala	Rural	14.2 - 38.6	28.2	308.6 - 731.7	566.8
Koutiala	Urban	18.5 - 58.2	36.4	325.2 - 769.8	537.7
Bougouni	New	24.2 - 57.0	37.6	421.0 - 728.8	513.9
Bougouni	Used	29.1 - 47.0	34.8	252.3 - 636.9	489.7
Both	NGO	17.1 - 63.1	39.0	281.6 - 421.1	356.8
Both	CMDT	13.3 - 19.3	16.3	327.4 - 387.6	357.5

Source: Based on data collected in field survey.

The gross cash revenue, on average, was significantly lower for the NGO mills (Fcfa 356,800) compared to private mills mainly due to the lower milling fee charged (Table 14). Although gross cash revenues for the CMDT welding and milling was the highest (Fcfa 937,000) the milling component was one of the lowest and constituted only 38% of total revenues. The leftover (reliquat) flour during the milling process is kept by the mill operator; that is, it is a mill revenue if the mill is operated by a family member otherwise a payment in-kind when the mill is operated by an hired operator. Since the leftover flour is of poor quality and there is no active market for flour in Mali, the leftover flour was valued at the grain price. The total value of leftover flour at the mill can be up to Fcfa 32,000 per year. Consuming flour obtained from other than your own grains is not socially accepted. This indicates the difficulty for poor households to pay milling fees in-kind. This also explains why none of the urban or rural mill operators in our sample area have added flour business to their mills.

8.9 Estimates of Grain Processing Demand

8.9.1 Regional Cities and Towns

As mentioned above, almost a complete census of grain processing mills was undertaken in Bougouni city of about 25,500 people and M'pessoba secondary town of 7,089 people. There were a total of 35 grain processing machines; 29 flour mills and 6 hullers in Bougouni. About 4 to 5 owners have 2 to 3 mills each located in different parts of the city. Only few had both a flour mill and a huller. Only 6 mills were run with an electric motor while the rest were diesel powered. M'pessoba town has 9 diesel powered flour mills. 23 diesel powered flour mills in Bougouni and 9 mills in M'pessoba were visited to gain insight into the overall grain milling demand. In Bougouni, one of the mills had just been installed, another was processing solely karite nuts. The estimated total throughput in Bougouni city and M'pessoba town are summarised in Appendix P.

In Bougouni city, about 730 tons of grains (and Karite, in the case of a few mills) were milled in a year by the 21 mills at an average rate of 34.8 tons per mill. Accounting for the remaining 6 electric mills, the total milling throughput is estimated to be about 939 tons per year. To assess what proportion of the total coarse grains consumption is milled mechanically, we need to estimate the total consumption. This is accomplished by using the average annual consumption of 121 kilograms of millet, sorghum and maize by an adult in cities (Appendix Q). Children consume 75% (or 90.75 kilograms) the rate of an adult. In the Sikasso region, 51% of the population is under 15 years. Thus the total consumption of coarse grains for the adult population of 12,495 and child population of 13,005 in Bougouni city is 2692 tons. This means that roughly 35% of all coarse grains consumed in Bougouni city are presently milled mechanically. In other words, 27 mills are being sustained by meeting the full grain processing demand of about 1457 households (or 35%) of a total of 4180 households in the city. Since the grain processing demand is highly seasonal, the percentage of mill users may vary between 25% to 65% of all households.

Similarly for M'pessoba secondary town, the total milling throughput is estimated to be 274 tons per year. Assuming the consumption of millet, sorghum, and maize in a secondary town to be between the consumption rates of urban and rural areas, the average annual consumption per person comes to be 136 kg for a child and 182 kg for an adult (Appendix Q). On this basis, the total annual consumption of coarse grains is about 1123 tons in M'pessoba. This implies that about 24% of the annual coarse grains consumption of M'pessoba town is presently being milled mechanically.

In Bougouni city and M'pessoba's secondary town, there are significant differences in milling fees private mill owners are charging the users (Table 15). The milling fee varies from 8.3 to 18.5 Fcfa per kilogram in Bougouni and from 11.5 to 16.7 Fcfa per kilogram in M'pessoba. There is some competition among mills to attract users from the surrounding communities. Table 15 shows the throughput increasing with a decrease in milling fee and the price elasticity of demand for milling

services is high. A drop of one Franc in milling fee leads to an increase of 1.7 tons per year throughput for a mill in Bougouni city.

Elasticity of demand for milling services is calculated by using the formula:

$$e=\frac{2T}{2F}x\frac{F}{T}$$

where: $\frac{2T}{2F}$ = coefficient on price from regression equation;

F = mean milling fee;
T = mean throughput;

for cities:

$$=(-3.75)\left(\frac{16.1}{34.8}\right)$$
$$=-1.7$$

for villages:

$$=-1.62\left(\frac{15.9}{32.5}\right)$$

Table 15

Throughput in Relation to Milling Fee*

Location Numbers	Milling Fee Fcfa/Kg	# of Mills	Throughput in tons/yr/mill
Bougouni			
City	8.3	1	78.1
1	12.3	5	46.8
2	17.9	15	27.9
3	16.1	21	34.8
Overall			
M'pessoba			
Town	12.9	5	42.4
1	16.7	2	20.8
2	14.0	7	36.2
Overall			
Villages			
1	8.2	4	44.8
2	13.1	9	36.5
3	18.9	11	27.9
4	23.4	3	20.7
Overall	15.9	27	32.5

* Quantitative relationship denoted by simple regression equation is as follows:

a) Bougouni; $T = 95.25 - 3.75\ F$; $R2 = 0.51$
(8.01) (4.46)

b) Villages; $T = 58.24 - 1.62\ F$; $R2 = 0.40$
(5.39) (3.76)

where "T" is throughput in tons per year, and "F" is milling fee in Fcfa per kilogram. Figures in parentheses are t-statistics for the intercept and the regression coefficient. The sample size is smaller than normally used in regression analysis, but all the coefficients are still statistically significant at the 99% confidence level.

Source: Based on data collected in field survey.

8.9.2 Sample Villages

An analysis of potential grain milling demand and quantities actually milled in 16 sample villages/arrondissements is given in Table 16. Overall, only 14% of all coarse grains consumed in sample villages is milled mechanically, and therefore an overwhelming quantity of grains continue to be processed manually. There are significant differences in the percentage of total consumption milled among villages. It varies from as low as 4% to as high as about 31%. A higher proportion of grains consumed are milled in villages with more than one mill, where competition among mills has lead to a decrease in milling fees. For example, in Bramba, M'pessoba, Sirakele in the Koutiala area and Madina and Keleya in the Bougouni area where higher milling percentages occur, more than one private mill exists.

In the case of the NGO mills, relationships between milling fees and percentage of grains processed are even more striking because of the wider range in milling fees at the lower end. In Zamblala village, for a milling fee of Fcfa 15/Kg the corresponding milling percentage is 10; in Dissan a milling fee of Fcfa 9.4/Kg increases the milling percentage to 18, and in Kologo village a fee of Fcfa 6.3/Kg presents a significant increase in the milling percentage to 31. This indicates a high price elasticity of demand for milling services.

For the pooled sample of 27 private, CMDT, and NGO mills in rural areas, a quantitative relationship between milling fee and throughput were estimated (Table 15). The regression estimators, which are statistically significant, indicate that a one Franc decrease in the milling fee results in an increase of more than one and one-half tons of throughput for a mill in a year. Thus, due to the elastic nature of milling demand, there may be some incentives for the mill owners to increase their profit by lowering milling custom charges. However, as expected, the demand for milling service is more elastic in cities and towns than in villages. Women in cities generally have a higher disposable cash income than those in villages.

Table 16

Estimated Annual Demand for Milling Coarse Grains in Sample Villages/Arrondissements

Village	Population 1992	Consumption (Tons)*	Qty. Milled (Tons)	% Milled
Koutiala area:				
Baramba	2,342	494.5	110.2	22.3
Niessouma	1,328	280.4	14.2	5.1
Nigountjina	1,624	342.9	30.1	8.8
Sinsina	4,079	861.3	32.5	3.8
Sirakele	2,532	534.6	63.1	11.8
M'pessoba	7,089	1,123.0	274.1	24.4
Zamblala*	795	167.9	17.1	10.2
Zanzoni	2,289	483.3	48.3	10.0
Sub-total	22,078	4,287.9	589.6	13.8
Bougouni area:				
Denie	727	153.5	17.6	11.5
Madina	882	186.2	40.1	21.5
Faragouran	2,075	438.2	30.7	7.1
Keleya	1,914	404.2	79.5	19.7
Zantiebougou	1,377	290.8	42.7	14.7
Dissan*	678	143.1	25.7	18.0
Kologo*	967	204.2	63.1	30.9
Sido	1,833	387.1	23.7	6.1
Sub-total	10,453	2,207.3	323.1	14.6
Overall	32,531	6,495.2	912.7	14.1

* Consumption of millet, sorghum and maize are estimated based on: (a) rural consumption rates given in Appendix Q, and (b) 51% of population are children whose consumption equivalence ratio is assumed to be 75% of adults (FAO/WHO).

Source: Based on data collected in field survey.

8.10 Analysis of Milling Cost

Investment, fixed and variable costs for 28 sample mills are given in Appendix L to O, and average costs are summarized in Tables 17 and 18. All mills in the Koutiala area at the time of installation were new and the acquisition costs high. In the Bougouni area, 4 of 9 mills were installed as used mills and their acquisition cost was about half that of new mills. The average investment costs for private mills involving the purchase and mounting of a new diesel engine, mill, water and fuel tanks, belt, and plate mill varied between Fcfa 881,000 to over one million Fcfa. The investment costs for mills in Koutiala villages are higher due to

higher transportation and installation charges. The investment costs for the CMDT financed welding equipment and mills are considerably higher than those of NGO mills, which are somewhat higher than the private mills (Table 17). All mills were found to be installed in buildings which are locked and secured from an unauthorised entry.

Table 17

Average Cost of Mill, Energy and Disk Repair Costs by Type of Mills

Region	Mill Type	Cost of Mill[1]	Cost of Diesel	Cost of Lubricants	Disk Sharpening
			(Thousand Fcfa)		
Koutiala	Rural	1057.4	84.0	35.8	18.3
Koutiala	Urban	881.3	106.0	36.5	18.3
Bougouni	New	905.1	110.3	36.6	19.6
Bougouni	Used	442.4	104.6	44.1	18.4
Both	NGO	1109.4	103.2	37.5	27.3
Both	CMDT	2375.0	144.3*	56.7*	16.9

[1] Includes the cost of engine, mill, transportation, and technician fee for the installation.

* Diesel and lubricants costs for CMDT mills are for both milling and welding of tools and equipment. Information was lacking to divide the cost between these operations.

Source: Based on data collected in field survey.

The cost of mill buildings varies whether the mill is a private, NGO, or a CMDT mill. The building cost for the CMDT mills is very high as the mill building consists of three rooms for the separate installation of a generator, a mill, and welding equipment, and masons are hired for construction. For the two CMDT mills, the building costs were reported to be Fcfa 200,000 and Fcfa 250,000. In the case of a private mill or an NGO/village association mill both the engine and the mill are installed in a single room. The NGO mill building is constructed jointly by the community and the cash cost on the building was around Fcfa 25,000 for each of the three sampled mills. Since the whole village community contributed construction labour, the opportunity cost for labour is not included in estimating the cost of building for NGO mills.

The private mills were found to be installed both in rented and family owned buildings. Out of 23 private mills, 8 were installed in rented building. 6 out of 9 mills in Bougouni area were in rented buildings, compared to two out of 14 in the Koutiala area. Thus, the building cost for the Bougouni area refers to the recurring monthly rent and is a fixed cost for the Koutiala area. An average rent paid for a single room building was Fcfa 14,100 per year, and for the commercial analysis a round figure of Fcfa 15,000 is used (see Appendix L to O).

For the remaining 15 private mills, the building was constructed by the owner hiring village masons and buying corrugated iron sheets for roofing and wood for making doors. All unskilled labour and construction material came from owner's family. The cash cost for self-constructed mill buildings varies from as low as Fcfa 25,000 to as high as 125,000 with an average of Fcfa 47,800. The opportunity cost of 45 man-days of family labour is assumed to be Fcfa 6,075. Thus for the financial evaluation of grain processing mills we have used the building cost of Fcfa 55,000 for rural mills and Fcfa 75,000 for urban mills.

The variable costs on energy/lubricants and disk repairs are summarized in Table 17. Cost of energy and lubricants refers to the diesel and engine oil and does not include the cost of transportation to the petrol pump and other incidental charges for the private mills. Mill operators purchase diesel after every 7 to 21 days and change engine oil once or twice a month. Some operators buy extra engine oil while others employ the used engine oil as lubricant. When diesel is available in villages, the price is 10% to 15% higher than in cities.

Fuel consumption efficiency varies among mills according to the age of mill engines, engine horse power, and frequency of start-ups and shut-downs during the milling period. The estimated throughput per litre of diesel fuel comes to an average of 71 to 79 kilograms. This fuel use efficiency reflects the prevailing mill use pattern of users bringing small quantities of grains (1 to 5 Kg) and turning up in small numbers. Even under this use pattern, significant positive relationships were observed between the level of throughput and fuel use efficiency. When a daily milling throughput is 100 kilograms, the fuel efficiency comes to 70

kilograms grains per litre of fuel and increases to over 100 kilograms per litre for a daily throughput of 300 kilograms. Fuel efficiency increases at the rate of 0.16 kilogram per litre for every additional kilogram of grains milled per day (Kg/litre = 55.3 + 0.16 Kg/day). Thus mill owners can realise a fuel economy by locating mills in bigger communities and attracting more grains. This explains why mills in the Bougouni area are installed in rented buildings by non-resident entrepreneurs.

Another regularly occurring variable cost is disk sharpening, which is done one to two times a month. A technician fee for disk sharpening varies between 1250 to 1500 for a pair. Both Koutiala and Bougouni cities have trained technicians who provide repair and mill installation services. Currently, municipal and local taxes on mills are levied only in Koutiala (a large city) and not in Bougouni (a medium size city), arrondissements, and villages. In Koutiala the tax rate is Fcfa 1,000 per month.

In the financial analysis the cost of labour for mill operation is estimated using the opportunity cost for such a labour in the area. Among the 23 private mills, 7 mills had hired operators who were paid a cash salary of Fcfa 4,000 per month in villages and Fcfa 5,000 per month in cities, in addition to the leftover flour. The value of leftover flour varies between Fcfa 13,000 to Fcfa 37,000 per year, depending upon the volume of throughput. Thus using the average value of Fcfa 25,800 for leftover flour and the above cash salary, the opportunity cost of the mill operator is Fcfa 85,800 per year for urban mills and Fcfa 73,800 per year for rural private mills. The operators at the NGO mills are paid a cash salary and travel allowances of Fcfa 24,300 per year in addition to leftover flour and free community labour for their farms. The operator cost for NGO mills is assumed to be Fcfa 52,800. The CMDT mill operators are relatively more skilled and their opportunity cost is assessed similar to the urban operator.

The last category of variable costs refers to repairs and replacements (other than disks) of engines and other equipment. This information was difficult to obtain, especially for those private mills where there is a turnover in hired operators, and because most mills are not old enough to provide cost information over the life of equipment.

In the Koutiala area, the oldest private mills were found to be 10 to 12 years old and, in two cases, engines were replaced after 9 and 10 years. In the Bougouni area some of the used mills were 5 years old. Based on the above information and owner/operators' opinion about the remaining life of mill engines, a life span of 10 years is considered for the 7 to 8.5 HP engine, and 5.5 years for mills fitted with used engines. Some of the CMDT mills (fitted 12 to 16HP engines) were 12 years old and owners expected them to last another 3 years. A life span of 15 years is assumed for the CMDT mills. One of the sample CMDT mill engines was 4 years old and had experienced no repair costs over the 4 year period.

Information for all private and NGO mills was pooled to develop average costs on repairs and parts replacement. For the Bougouni area,

costs were separated out for new and used mills. Repair and replacement costs include both costs on parts and fees paid to the technicians. CMDT-based mills are repaired by the CMDT and records are kept by its engineering department. Repair information was obtained for only one mill. Thus, it is assumed that the repair of the engine and mill will be similar to that of the private mills. The cost for repairing welding equipment has been added. The opinions obtained from mill operators and agricultural engineers were used to extend the repair costs to cover the full life of CMDT mills (Table 18).

Table 18

Average Cost for Repair and Replacement of Mill Equipment for New and Used Mills*

Year	New Mills	Used Mills	CMDT Mills
1	2,100	38,300	3,200
2	13,500	16,700	20,300
3	18,900	25,000	28,400
4	26,400	17,500	39,500
5	25,600	62,300	38,400
6	53,400	62,700	80,100
7	20,300		30,400
8	10,600		15,900
9	62,300		93,500
10	62,700		94,100
11			37,500
12			317,300
13			67,500
14			67,500
15			90,000
Total	295,800	222,500	1,023,600

* The life span of private new and used mills is assumed to be 10 and 5½ years respectively, and that of CMDT mill is assumed 15 years.

Source: Based on data collected in field survey.

These costs seem low and about half of the costs engineers would expect. These costs are closer to conditions in developing countries where owners tend to make repairs themselves and replace parts only when they are broken. In the majority of our sample cases, mill owners repaired the mill engines themselves and regularly changed the engine oil once or twice a month to reduce the wear and tear on the engine. However, to allow the increased costs on repairs, the issue has been dealt with through sensitivity analysis by increasing the reported repair and replacement costs by 50% to 100%.

On a per kilogram throughput basis, the total cost of owning, managing and operating a grain processing mill is at least 10 and more than 13 Fcfa (Table 19). Lowest variable costs are obtained for the NGO mills because of higher throughput and lower labour costs. The major source of cost economy to the mill owners is mainly from the level of throughput, that is, by more efficient use of the mill's fixed capacity and, to some extent, by improving the efficiency of energy use. These average costs show that the potential for reducing the milling custom charges below 10 to 12 Fcfa/Kg may not be feasible with the existing milling technology.

Table 19

Average Fixed, Variable, and Total Costs per Kilogram of Throughput by Type of Mill

Region	Mill Type	Fixed Cost	Variable Cost	Total Cost
			(Fcfa/Kg)	
Koutiala	Rural	4.60	8.68	13.28
Koutiala	Urban	3.14	7.98	11.12
Bougouni	New	2.84	7.68	10.52
Bougouni	Used	2.64	8.58	11.22
Both	NGO	3.39	6.47	9.87

Source: Based on data collected in field survey.

9.0 FINANCIAL ANALYSIS

Financial viability of grain processing mills is assessed using the standard net present value and the internal rates of return analysis (Holtzman, 1989). Appendices R to W contain the basic structure of analytical models used for the different categories of mills. The financial analysis does not include the opportunity cost of family's investment capital. Thus an IRR below the current interest rate, say 12%, would indicate a loss to the enterprise. The net present value of milling revenues is calculated at 12%, 15%, and 20% discount rates to show the sensitivity of returns to varying rates. Similarly sensitivity analysis of net present value and IRR is performed for four important parameter changes in the level of milling throughput, milling fee, repairs and replacement costs, and changes in the cost of fossil fuel.

The milling throughput is varied between 25 tons and 60 tons per year to reflect a modest increase in grain processing demand due to increases in production and rises in household income. This is not to imply that Mali's agriculture is not prone to drops in crop productions caused by occasional droughts. The milling fee is varied on the lower side between 10 and 15 Fcfa per kilogram to reflect increased competition among mills in the future. The repairs and replacement costs as mentioned appeared low. Thus, these costs are increased from 50% to 100% to reflect this and to take into consideration higher maintenance costs facing mills located away from the towns. Similarly the cost of diesel and lubricants is increased from 10% to 50% to reflect the scarcity of foreign exchange to import fossil fuel into a land locked country.

Most private mills are financially viable. The net present value at 12% discount rate varies between Fcfa 246,000 and 582,000 and financial IRR is above 20% (Table 20). The used mills are relatively more profitable than new mills due to low investment costs. A majority of the private mills are owner-operated and tend to be better managed, have a higher throughput, lower operating costs, and higher financial returns than mills with hired operators. Owner-operated mills are generally better maintained and replacement costs are less than mills managed by the hired operator. Owner-operators tend to pick up skills over time and make many of the repairs themselves, while mills with hired operators are repaired by the technicians.

Table 20

Net Present Value and IRR for Grain Processing Mills

Region	Mill Type	Throughput (Tons/Yr)	Mill. Fee (Fcfa/Kg)	NPV (000 Fcfa)	IRR %	Period of Years
Koutiala	Rural	28.2	19.2	582	28	10
Koutiala	Urban	36.4	14.0	348	23	10
Bougouni	New	37.6	13.0	263	21	10
Bougouni	Used	34.8	13.5	246	37	5½
Both	NGO	39.0	8.5	-527	-6	10
Both	CMDT*	16.4	20.8	625	18	15

* For CMDT mills, NPV and IRR refer to both welding and milling operations.

Source: Based on data collected in field survey.

Every one of the three NGO mills surveyed is incurring losses. The two mills charging 6.25 Fcfa/kg milling fee with throughputs of 63 tons and 26 tons have a NPV of Fcfa -212,000 and Fcfa -1,376,000 respectively. The third NGO mill charged 15 Fcfa/kg milling fee and had only 17 tons throughput which resulted in NPV of Fcfa -896,000.

The reason for the two NGO mills being unprofitable is the low milling fee, while for the third mill it is the low level of throughput. It is likely that the third NGO mill could have become financially viable had it been installed in a larger village. Thus, locating the NGO mills in smaller villages with less than 1000 people is a poor economic decision on the part of donor agencies. Small villages have all the disadvantages of fewer users, less milling revenues, and the low cost-sharing community base for the repairs and repayment of loans. In terms of social benefits to the society, the milling subsidy program also remains limited to wealthier families.

Based on the sample of two CMDT mills, the combined operation of welding and milling are marginally profitable. The milling operation, which has low level of throughput, is unsuccessful and has losses. Detailed information was unavailable to divide the fixed investment cost into welding and milling components and run a separate analysis in support of this argument. However, both mill owners expressed their satisfaction with the welding work and, conversely, their disappointment with the milling work. Why these mill owners have not considered lowering their milling fees to attract more users is not clear. CMDT had initially fixed the milling fees, which have been maintained in spite of competition from the private mills. It seems CMDT had justified the mills at a higher milling fee, not considering its negative impact on user demand.

A break-even analysis with IRR of 12% indicates that at the current level of throughput mill owners cannot afford to reduce the milling fee below 11 to 12 Fcfa/kg. Any further reduction in milling custom charges can come from increasing the level of throughput and by adding multiple uses to mill engines to spread larger processed volumes over the large fixed cost. Within the existing use pattern the scope for reducing costs by improving the energy use efficiency is quite limited. However, family-operated private mills are better suited to provide more efficient milling service than are the NGO and CMDT subsidy programs.

The sensitivity of the financial IRR and NPV to parameter changes indicates that they are highly sensitive to changes in the level of throughput and milling fee, moderately sensitive to increases in energy cost, and much less sensitive to increases in repair costs (Tables 21 and 22). Most private mills operating at a throughput of 25 metric tons, or for a milling fee of 10 Fcfa/Kg, have a negative IRR and NPV. They become significantly positive as throughput is increased to 60 tons or milling fee is increased to 15 Fcfa/Kg. As discussed before, there is an inverse relationship between the throughput level and the milling fee. In a given community the mill owners do not notice a big change in their profits with a change in milling price. Thus, they prefer to increase the throughput level by installing or shifting the mills to larger communities, rather than by lowering the milling fee.

Table 21

Sensitivity of the Net Present Value
to Selected Parameter Changes (in Thousand Fcfa)

Parameter	Koutiala		Bougouni			
	Urban mills	Rural mills	New mills	Old mills	NGO mills	CMDT 1/ mills
1. Throughput						
25 MT	-446	272	-549	-207	-1120	*
35 MT	250	1228	98	257	-696	*
45 MT	948	2183	745	722	-273	*
60 MT	1992	3618	1720	1418	362	*
2. Milling fee (Fcfa/kg)						
10.0	-377	-711	-298	-172	-235	-459
12.5	76	-360	169	125	153	-208
15.0	531	-8	637	423	736	424
4. Fuel cost						
Base	348	582	263	246	-527	625
25% increased	170	433	80	118	-702	316
50% increased	-7	284	-103	-10	-878	7
3. Repair/replacement cost						
50% increased	232	464	144	143	-661	399
100% increased	116	345	25	39	-795	173
5. Discount rate						
12%	348	582	263	246	-527	625
15%	266	418	155	199	-557	247
20%	73	210	19	135	-589	-195

1/ Analysis based on both welding and milling operations.

* Unrealistic high values due to high milling fee which cannot sustain the throughput level are assumed in this analysis. The current throughput for the CMDT is below 15 tons.

Source: Based on data collected in field survey

Table 22

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

Parameter	Koutiala Urban mills	Koutiala Rural mills	Bougouni New mills	Bougouni Old mills	NGO mills	CMDT 1/ mills
1. Throughput						
25 MT	-6	20	-14	-15	Negative	*
35 MT	20	44	15	39	-14	*
45 MT	41	68	36	84	4	*
60 MT	72	107	65	162	22	*
2. Milling fee (Fcfa/kg)						
10.0	-3	-16	0	-9	5	8
12.5	15	0	18	25	16	10
15.0	29	12	33	55	31	12
4. Fuel cost						
Base	23	28	21	37	-6	18
25% increased	18	24	15	25	-14	15
50% increased	12	20	8	11	-34	12
3. Repair/replacement cost						
50% increased	20	25	17	27	-13	16
100% increased	16	22	13	16	-35	14

1/ Analysis based on both welding and milling operations.

* Unrealistic high values due to high milling fee which cannot sustain the throughput level are assumed in this analysis. The current throughput for the CMDT is below 15 tons.

Source: Based on data collected in field survey

The moderate level of sensitivity of the financial viability of private mills to price changes in fossil fuel indicates the vulnerability of the mechanised grain processing mills to the availability of imported energy. Thus the growth of this agro-industry is not only linked to the effective grain milling demand by Malian women; it is also linked to the foreign exchange availability for the import of fossil fuel and mill equipment.

10.0 CONCLUSIONS

In large cities and towns of the Sikasso region, motorized grain processing mills installed by the private sector are very common. Only a few large villages, within 40 to 50 kilometres from the town, have access to fossil fuel and repair facilities. Rural populations living in remote areas lack access to grain mills. Although CMDT and NGOs have milling subsidy programs in Mali, most of the village mills in the Sikasso region are privately installed without any financial and technical assistance from the government. Most village mills owners are from farming families and have used their savings from the sale of cotton to buy mills. Some businessmen from Bamako and other large cities have hired operators to run village mills.

NGO mills managed by the village association are running at a loss due to their remote locations in small villages and low milling fees. In addition utilization is sporadic due to the seasonal nature of milling. The CMDT financed welding and milling units lack the dynamism of private mills and their milling operations are not financially viable. However, the CMDT units indicate that an effort to make multiple use of diesel engines could contribute to improving the financial returns on investments.

Most private mills are better managed and are operating on narrow financial margins (after considering the opportunity cost of family capital) due to the limited number of mill users and seasonality of milling demand. Mills are currently under-utilized because milling fees are high relative to women's ability to pay. Demand for coarse grains milling is significantly higher in cities and towns than in villages. Similarly, potential for increasing the milling throughput by lowering milling fees is greater in cities and towns than in villages. However, with the existing motorized milling technology it is not economically feasible to lower the grain milling fee below 10 to 12 Francs per kilogram. Thus the existing milling technology only reaches the richer sections of the rural population -- those who can afford to pay the existing milling fees.

The public sector and NGO support in the form of mill credit subsidies seems to have very limited impact on grain processing in Mali. These programs imported mills from Europe which are more expensive than the Indian manufactured mills installed by the private sector. These interventions are financially unsustainable and they discourage private investment in village mills and the development of domestic milling service. Any effort by the public sector and international organizations to develop cheaper grain processing technology and/or increase the income generating capacity of rural women would alleviate the grain processing constraint in Mali.

REFERENCES

1. Direction Nationale de la Statistique et de l'Informatique, Enquête Agricole de Conjoncture 1985-86, Ministère du Plan, République du Mali, 1988.

2. Direction Nationale de la Statistique et de l'Informatique, Enquête Agricole de Conjoncture 1986-87, Ministère du Plan, République du Mali, 1988.

3. Direction Nationale de la Statistique et de l'Informatique, Enquête Agricole de Conjoncture 1987-88, Ministère du Plan, République du Mali, 1988.

4. Direction Nationale de la Statistique et de l'Informatique, Enquête Agricole de Conjoncture 1988-89, Ministère du Plan, République du Mali, 1989.

5. Direction Nationale de la Statistique et de l'Informatique, Enquête Budget Consommation (1988-89), Ministère du Plan, République du Mali, 1991.

6. Direction Nationale de la Statistique et de l'Informatique, Enquête Agricole de Conjoncture 1989-90, Ministère du Plan, République du Mali, 1990.

7. Direction Nationale de la Statistique et de l'Informatique, Enquête Agricole de Conjoncture 1990-91, Ministère du Plan, République du Mali, 1991.

8. Direction Nationale de la Statistique et de l'Informatique, Recensement Général de la Population et de L'Habitat, Volume 3, Sikasso, Ministère du Plan, République du Mali, 1987.

9. Direction Nationale de la Statistique et de l'Informatique, Recensement Général de la Population et de L'Habitat, Ensemble du Pays, Ministère du Plan, République du Mali, 1987.

10. FAO/WHO, Energy and protein requirements, Report of a joint FAO/WHO/UNU consultation, Technical report series 724, WHO, Geneva, 1985.

11. Holtzman, J.S. et. al. 1991. Expanding coarse grain utilization in Mali: Current situation, constraints, opportunities and program options, Washington D.C.: USAID.

12. Holtzman, J.S. 1989. Coarse Grain Processing in Senegal: Issues, Constraints, and Policy and Program Options. AID project # 936-5477. Washington D.C.: USAID.

13. UNIFEM, Cereal Processing, Food Cycle Technology Source Book # 3, Intermediate Technology Development Group, U.K., 1988.

14. U.S. Agency for International Development, Microenterprise Strategy paper, (Washington D.C.: USAID, 1991) Bamako, Mali.

APPENDIX X

LIST OF PERSONS CONTACTED

1. Mr. Sino Konate
   Ministère de l'agriculture
   Division de la Statistique, Bamako

2. Mr. Sekouba Diarra
   Division nationale de la statistique et de l'informatique (OPAM), Bamako

3. Mr. Zoumana Camara
   Division nationale de la statistique et de l'informatique (OPAM), Bamako

4. Mr. Cheick Oumar Diakite
   Directeur chef de publication/vetre des livres
   Division nationale de la statistique et de l'informatique (OPAM), Bamako

5. Mr. Francis Keita, tel 22 36 02
   Système d'information sur les marchés céréaliers (SIM)
   Bamako

6. Mr. V.Duarte, Economist
   USAID, Bamako
   tel 22 36 02

7. Mr. Serge Coelo
   Consi eller ministeriel
   Ministère des finances
   Restructuration des marchés céréaliers
   B.P. 1626, Bamako, Mali

8. Mr. Michel Arrion
   Conseiller économique
   FED, Délégation da la Commission des Communautés Européenes,
   B.P 115
   Bamako, Mali

9. Mr. Marcel Monette
   Conseiller Technique

10. Cooperation Canada - Mali
    PROGRAMME D'APPUI AU PRMC
    B.P. 198, Bamako, mali
    Tel: 22-45-83

APPENDIX A

SURVEY OF COARSE GRAINS PROCESSING MILLS IN SOUTHERN MALI

Date:----------

1. Location:----------Region:----------

2. Name of owner(s):----------Male/Female----------

3. Ownership: Association/Individual/Govt----------

4. Name of operator:----------

5. No. of mills owned:----------

6. How many other mills in this town/village?----------

7. Has any mill you know gone out of business?----------

   If so, who?----------

8. Present condition (Good/Fair/Poor) of your:

   Mill----------
   Engine----------

9. Expected remaining life in years of:

   Engine----------
   Mill----------

10. Specification of Mill and year when installed:

	Make	Type	HP/KWH RMP	Yr inst	New/ used
Mill	-----	-----	xxxxxx	-------	-----
Diesel engine	-----	-----	------	-------	-----
Other equipment	-----	-----	------	-------	-----

(Engine cooling system: Air----------water---------)

11. Did you use any other type of machines in the past? Yes--No--

    If yes, what machines?----------

49

FINANCIAL MECHANISM USED TO BUY THE MILL:

* Total cost: FCFA----------
1. Family saving/funds: FCFA----------
2. Association saving: FCFA----------
3. PVO grant/gift: FCFA----------
4. Government grant/gift: FCFA----------

5. Loan: FCFA----------Date:-------Source:----------
   a. Interest rate:----------
   b. Payment period:----------
6. Other sources:----------
7. Loan amount paid back: Yr1---------Yr2--------Yr3--------
   Yr4---------Outstanding loan balance:----------

RECORDS OF EXPENSES/INCOME AND MANAGEMENT OF MILL

1. Do you maintain a record book? Yes/No----------
   If yes, who keeps record: Operator?--------Owner?----------
   Coop President, etc.?----------

2. What records are kept:

   a. Daily receipts----------
   b. Fuel/electric expenses----------
   c. Engine oil change data------- Expenses----------
   d. Type of repairs----------and cost----------

3. Which of the following uses do you make of the income you earn from the mill:

   a. Pay back loans----------
   b. Deposit in a bank/other saving scheme----------
   c. Divide up among members----------
   d. Invest in business run by women----------
   e. Invest in business run by man----------
   f. Given loans to coop members----------
   g. Purchase fertilizer----------
   h. Purchase livestock----------
   i. Hire farm labor----------
   j. Keep cash home----------
   k. Meet family daily living expenses----------
   l. Invest in durable goods----------
   m. Other----------

50

4. VILLAGE MILL COOPERATIVE

a. How many members in your cooperative? Women-----Men------
b. How often coop meets and discusses mill matters?---------
c. Who works at the mill?----------
d. What major problems are experienced?----------

5. Since you installed mill what changes have you (if coop mill by the members) experienced in your:

a. Farm size: increased/decreased/same; how much?----------
b. No of animals: increase/decrease/same; how much?---------
c. Hiring of labor?----------
d. Family women busy: more/less/same----------
e. Family men busy:more/less/same----------
f. Other?----------

6. What other businesses you/coop own?

a. ----------
b. ----------
c. ----------

7. Why did you buy the processing mill and not invest in another business?

a. To reduce grain processing work load of your women-------
b. To increase income----------
c. Other----------

8. What other business possibilities are in this area:

a. Taxi Car----------
b. Livestock----------
c. Trading----------
d. Building/construction------
e. Other----------

9. What major problems have you experienced in running the mill?

INFORMATION ABOUT MILL USERS:

1. Which of the following bring their grains to your mill:

a. Neighbor----------
b. Distant families--------
c. Nearby villagers--------
d. Coop members----------
e. Restraunt owners----------
f. Food retailers----------
g. Others----------

51

2. What is the most common quantity of grains people bring for milling?----------

3. What is the total quantity of grains do you mill in a day:
   a. during the busy season----------
   b. during low season----------

4. Do the users prefer milling: wet grains?-----dry grains-----

   Why?----------

5. What is the longest distance people travel to come to your mill?----------

6. Do you prefer milling: wet grains?------ Dry Grains?-------

FIXED/INVESTMENT COSTS

		No.	Cost	Where purchased
1.	Land (area)	-----	----------	----------
2.	Building/shed	-----	----------	----------
3.	Rent paid		----------	
4.	Machinery:			
	a. Engine	-----	----------	----------
	b. Mill	-----	----------	----------
5.	Belts	-----	----------	----------
6.	Installation:			
	a.Foundation	-----	----------	----------
	b. Water tank/hoses	-----	----------	----------
7.	Fuel containers	-----	----------	----------
8.	Technician fee	-----	----------	----------
9.	Transportation	-----	----------	----------
10.	Other	-----	----------	----------

11. MILLING WORK LOAD BY MONTH:

Month	Hrs/day	Receipts/day		
January	----------	----------	----------	____
February	----------	----------	----------	____
March	----------	----------	----------	____
April	----------	----------	----------	____
May	----------	----------	----------	____
June	----------	----------	----------	____
July	----------	----------	----------	____
August	----------	----------	----------	____
September	----------	----------	----------	____
October	----------	----------	----------	____
November	----------	----------	----------	____
December	----------	----------	----------	____

52

12. Since you installed the mill, has the work load increased?---- ---- decreased?--------

13. What were the milling costs/cup when you first started the mill and what are the costs now:

Grain	Beginning	Now in 1991
Sorghum	----------	----------
Millet	----------	----------
Corn	----------	----------
Beans	----------	----------
Groundnut	----------	----------

OPERATIONAL COSTS

		High Season	Medium Season	Low Season
1.	Diesel(Lit/day)	----------	----------	_____
	Cost/lit	----------	----------	_____
	Qty.purchased each time	----------	----------	_____
	Purchase interval (days)	----------	----------	_____
2.	Engine Oil:			
	Days/change	----------	----------	_____
	Lit/change	----------	----------	_____
	Price/lit	----------	----------	_____
*	Location oils purchase	----------	----------	_____
*	Travel distance	----------	----------	_____
*	Means of transport	----------	----------	_____
3.	Transport cost	----------	----------	_____
4.	Operator cost			
	a. Salary	----------	----------	_____
	b. Room/board	----------	----------	_____
	c. Reliquat (cups)	----------	----------	_____
	d. Value of reliquat/day	----------	----------	_____

5. Repairs

	#/Yr.	Cost/Repair	On-site/ off-site
a. Sharpening of disks	-----	----------	_____
b. Belt	-----	----------	_____
c. Tightening bolts	-----	----------	_____
d. Injectors	-----	----------	_____
e. Welding	-----	----------	_____
f. Others:	-----	----------	_____
g. Transport cost for repair	-----	----------	_____
h. Technician cost	-----	----------	_____

6. Replacement Costs (since the purchase of the mill):

Item	Yr.replaced	Cost of parts	Labor cost	On-site/ off-site
a. Belt	----------	--------	--------	_____
b. Valves	----------	--------	--------	_____
c. Disks	----------	--------	--------	_____
d. Oil filter	----------	--------	--------	_____
e. Air filter	----------	--------	--------	_____
f. Injector	----------	--------	--------	_____
g. Bearings	----------	--------	--------	_____
h. Bushings	----------	--------	--------	_____
i. Fuel pump	----------	--------	--------	_____
j. Piston rings	----------	--------	--------	_____
k. Piston	----------	--------	--------	_____
l. Cylinder head	----------	--------	--------	_____
m. Cylinder lining	----------	--------	--------	_____
n. Connecting rods	----------	--------	--------	_____
o. Technician cost	----------	--------	--------	_____
p. Transport costs for replacements	----------	--------	--------	_____

Major Breakdowns Experienced:

1. No. of breakdowns in the past year:----------

2. Total No. of days mill remained closed:----------

3. Reasons for extended close downs:----------

54

Availability of Parts:

1. Most needed parts:----------

2. Availability in your town: Imported------- Locally made-----

3. Quality of parts:----------

MILLING THROUGHPUT/REVENUE

		High Season	Medium Season	Low Season
a.	No of hrs/day	-------	-------	-------
b.	Qty.milled(cups/day)	-------	-------	-------
c.	Cost/cup: Sorgum	-------	-------	-------
	Millet	-------	-------	-------
	Corn	-------	-------	-------
	Fonio	-------	-------	-------
	Beans	-------	-------	-------
	Groundnut	-------	-------	-------
d.	Milling revenue/day	-------	-------	-------
e.	Qty. of reliquat/day	-------	-------	-------
f.	Value of reliquat/day	-------	-------	-------
g.	Reliquat retained by: Operator?---------- Owner?---------			
h.	Which grains do you mill the most?	-------	-------	-------
i.	Weight of cup: for	Sorgum----------	Millet----------	
		Corn----------	Beans----------	
		Fonio----------	Groundnut---------	

4. Why don't you charge in-king payment?----------

5. Which of the following mills would you like to buy and replace your present mill:

   a. Smaller mill which cost less and is slower than your mill?----------
   b. Animal driven mill which will have no fuel costs?--------
   c. Mobile mill which can be carried from one place to another?----------
   d. Other

6. Other costs and fees paid:

   a. Mill licence fee?----------
   b. Mill registration fee?----------
   c. Electric meter fee/month?----------
   d. Sales tax/duties on the purchase of mill?--------
   e. Taxes paid on mill revenue?----------

f. Mill manager costs?----------

7. During the past year did you purchase grains to mill and sell flour to others? Yes------ No-------.

   If yes, give quantity of grains purchased, price paid and price received for flour:

Grain type	Qty. Purchased	Price Paid	Price Received
Sorghum	----------	----------	----------
Millets	----------	----------	----------
Maize	----------	----------	----------
Groundnut	----------	----------	----------

Total amount earned?----------

APPENDIX B

MILLET PRODUCTION (TONS) IN MALI BY REGION AND BY YEAR

Year	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
1985/86	21,255	142,441	165,931	386,504	134,739	20,286	156	871,312
1986/87	8,494	115,292	143,520	394,869	125,157	18,431	0	805,763
1987/88	32,790	110,897	101,580	200,751	235,922	11,586	0	693,526
1988/89	11,333	163,015	155,827	323,434	315,609	30,610	73	999,901
1989/90	21,113	116,176	147,344	386,093	132,159	38,909	0	841,794
1990/91	4,630	76,964	134,831	322,102	183,882	13,404	1,204	737,007
Average	16,601	120,798	141,506	335,626	187,911	22,204	239	824,884
%	2	15	17	41	23	3	0	100

Source: Based on data collected in field survey

APPENDIX C

SORGHUM PRODUCTION (TONS) IN MALI BY REGION AND BY YEAR

Year	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
1985/86	87,655	135,429	196,984	44,533	11,959	243	305	477,108
1986/87	42,828	141,938	165,808	83,201	20,062	9,529	1,199	464,565
1987/88	132,138	110,638	170,874	64,058	18,816	1,824	14,828	513,176
1988/89	131,562	172,014	150,514	157,591	25,358	33,851	1,539	672,429
1989/90	115,910	225,123	204,049	105,391	11,648	67,966	779	730,866
1990/91	42,691	131,398	185,802	149,034	16,081	4,799	1,578	531,433
Average	92,131	152,757	179,005	100,643	17,321	19,702	3,371	564,930
%	16	27	32	18	3	3	1	100

Source: Based on data collected in field survey

APPENDIX D

RICE PRODUCTION (TONS) IN MALI BY REGION AND BY YEAR

Year	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
1985/86	16	180	7,325	987	29,102	9,766	28,349	75,725
1986/87	96	383	8,186	4,031	47,985	18,687	8,685	88,053
1987/88	193	1,159	14,732	11,100	65,471	2,997	15,927	111,579
1988/89	0	46	8,639	13,438	70,578	15,683	25,273	133,657
1989/90	0	527	24,539	16,009	77,539	16,766	32,172	167,552
1990/91	531	8,301	13,225	153,534	56,272	38,592	11,911	282,366
Average	139	1,766	12,774	33,183	57,825	17,082	20,386	143,155
%	0	1	9	23	40	12	14	100

Source: Based on data collected in field survey

APPENDIX E

MAIZE PRODUCTION (TONS) IN MALI BY REGION AND BY YEAR

Year	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
1985/86	8,197	21,538	105,788	4,523	0	0	0	140,066
1986/87	11,778	30,628	150,409	20,597	11	0	0	213,423
1987/88	39,443	26,194	101,117	11,307	548	0	0	178,609
1988/89	36,867	42,959	112,575	22,118	0	0	0	214,519
1989/90	23,896	28,872	154,416	17,362	848	0	0	225,394
1990/91	16,011	31,660	136,607	11,475	826	0	0	196,579
Average	22,699	30,312	126,819	14,564	372	0	0	194,765
%	12	16	65	7	0	0	0	100

Source: Based on data collected in field survey

APPENDIX F

FONIO PRODUCTION (TONS) IN MALI BY REGION AND BY YEAR

Year	Kayes	Koulikoro	Sikasso	Ségou	Mopti	Tombouctou	Gao	Total
1985/86	0	650	8,116	7,633	4,089	0	0	20,488
1986/87	112	0	6,491	10,628	11	0	0	17,242
1987/88	1,750	0	5,378	8,461	0	0	0	15,589
1988/89	3,655	2,111	3,457	10,961	0	0	0	20,184
1989/90	3,651	379	5,355	6,767	2,777	0	0	18,929
1990/91	24	0	5,517	12,572	3,655	0	0	21,768
Average	1,532	523	5,719	9,504	1,755	0	0	19,033
%	8	3	30	50	9	0	0	100

Source: Based on data collected in field survey

APPENDIX G

MILLET PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

Year	Sikasso	Bougouni	Kadiolo	Kolondieba	Koutiala	Yonfolila	Yorosso	Total
1985/86	28,446	21,844	8,355	5,982	63,603	302	37,399	165,931
1986/87	27,107	13,050	12,925	3,324	55,741	45	31,328	143,520
1987/88	19,758	15,830	10,160	5,660	33,013	0	17,168	101,589
1988/89	12,689	15,903	16,128	3,178	68,722	487	38,720	155,827
1989/90	13,940	13,772	13,291	5,177	70,244	900	38,019	147,343
1990/91	20,212	10,334	9,672	1,793	61,742	2,445	25,633	134,831
Average	20,359	14,289	11,755	4,166	58,844	697	31,378	141,507
%	14	10	8	3	42	0	22	100

Source: Based on data collected in field survey

APPENDIX H

SORGHUM PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

Year	Sikasso	Bougouni	Kadiolo	Kolondieba	Koutiala	Yonfolila	Yorosso	Total
1985/86	49,102	17,576	11,236	8,485	66,382	2,627	41,576	196,984
1986/87	49,064	23,428	7,663	4,648	60,612	2,761	17,632	165,808
1987/88	53,252	21,355	9,337	6,715	49,995	3,451	26,769	170,874
1988/89	24,343	24,142	6,751	12,034	56,290	7,494	19,460	150,514
1989/90	27,678	42,852	9,902	9,387	76,754	8,213	29,262	204,048
1990/91	37,639	37,449	8,464	10,257	56,198	8,038	27,755	185,800
Average	40,180	27,800	8,892	8,588	61,039	5,431	27,076	179,005
%	22	16	5	5	34	3	15	100

Source: Based on data collected in field survey

APPENDIX I

RICE PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

Year	Sikasso	Bougouni	Kadiolo	Kolondieba	Koutiala	Yonfolila	Yorosso	Total
1985/86	3,887	2,157	249	98	0	934	0	7,325
1986/87	4,159	669	917	230	360	1,853	0	8,188
1987/88	11,325	655	0	254	0	2,498	0	14,732
1988/89	3,834	1,818	1,475	0	0	1,512	0	8,639
1989/90	13,342	4,764	5,690	92	0	651	0	24,539
1990/91	1,236	2,148	3,435	63	0	4,244	0	11,126
Average	6,297	2,035	1,961	123	60	1,949	0	12,425
%	51	16	16	1	0	16	0	100

Source: Based on data collected in field survey

APPENDIX J

MAIZE PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

Year	Sikasso	Bougouni	Kadiolo	Kolondieba	Koutiala	Yonfolila	Yorosso	Total
1985/86	27,740	16,186	8,126	707	32,630	15,638	4,760	105,787
1986/87	48,947	14,868	16,465	12,284	22,418	30,083	5,343	150,408
1987/88	30,762	8,042	16,084	9,312	14,491	18,982	3,444	101,117
1988/89	15,435	34,891	12,819	9,248	20,306	17,360	2,515	112,574
1989/90	34,498	28,285	28,146	6,877	35,377	13,157	8,075	154,415
1990/91	35,719	11,992	13,915	7,574	42,704	17,910	6,793	136,607
Average	32,184	19,044	15,926	7,667	27,988	18,855	5,155	126,818
%	25	15	13	6	22	15	4	100

Source: Based on data collected in field survey

APPENDIX K

FONIO PRODUCTION (TONS) IN SIKASSO REGION BY CIRCLE AND YEAR

Year	Sikasso	Bougouni	Kadiolo	Kolondieba	Koutiala	Yonfolila	Yorosso	Total
1985/86	0	5,268	1,457	1,223	0	131	37	8,116
1986/87	190	2,223	2,601	1,065	0	413	0	6,492
1987/88	0	3,540	0	1,343	0	495	0	5,378
1988/89	146	1,518	142	436	0	1,216	0	3,458
1989/90	0	3,133	398	1,265	0	494	64	5,354
1990/91	417	2,679	496	864	0	909	153	5,518
Average	128	3,060	649	1,033	0	610	42	5,719
%	2	54	15	18	0	11	1	100

Source: Based on data collected in field survey

Appendix L: Summary of throughputs, revenues and costs for the private rural and urban mills in Koutiala region

ITEM	Rural mills M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	Average	Urban Mills M 1	M 2	M 3	M 4	M 5	Average
Throughput(Kg/yr)	34,969	18,530	30,126	36,575	32,493	14,198	24,469	38,584	24,267	28,246	44,235	58,225	38,250	22,756	18,536	36,400
Revenue(FCFA/yr):																
Milling	699,375	463,250	664,550	731,500	649,850	295,600	489,375	482,300	404,450	542,272	737,250	582,250	510,000	406,350	308,925	508,955
Leftover floor	32,340	16,030	33,097	29,540	23,253	12,789	18,690	25,931	29,155	24,536	32,550	37,100	30,450	27,269	16,328	28,739
Total	731,715	479,280	697,647	761,040	673,103	308,589	508,065	508,231	433,603	566,808	769,800	619,350	540,450	433,619	325,253	537,694
Variable costs(FCFA):1/																
Diesel	113,650	67,421	93,371	105,100	78,850	46,180	74,954	94,850	81,550	83,992	124,000	151,763	114,750	77,278	62,200	105,998
Lubricants	45,000	39,000	36,000	36,000	36,000	36,000	30,000	28,800	35,580	35,820	39,600	39,000	39,000	28,800	36,000	36,480
Disk sharp	18,000	18,000	24,000	21,000	18,000	13,500	16,500	18,000	18,000	18,333	10,500	15,000	22,500	24,000	15,000	17,400
Fixed Costs (FCFA):																
Operator salary2/									48,000	48,000			60,000	60,000	60,000	60,000
Building rent									12,000	12,000	18,000					18,000
Municipal taxes	0	0	0	0	0	0	0	0	0	0	12,000	12,000	12,000	12,000	12,000	12,000
Investment costs(FCFA):																
Engine & mill	1,600,000	950,000	850,000	1,150,000	1,000,000	950,000	850,000	800,000	763,375	990375	950,000	375,000	875,000	1,000,000	800,000	800,000
Disk	0	20,000	40,000	0	20,000	20,000	20,000	40,000	0	17778	20,000	40,000	0	0	0	12,000
Mounting	24,400	58,500	47,000	32,500	15,000	30,000	20,000	14,250	123,900	40617	70,000	10,000	15,000	47,000	130,000	54,400
Transportation	3,000	5,000	0	0	25,000	5,000	15,000	10,000	15,000	8667	0	10,000	12,000	30,000	22,500	14,900
Total	1,627,400	1,033,500	937,000	1,182,500	1,060,000	1,005,000	905,000	864,250	902,275	1057436	1,040,000	435,000	902,000	1,077,000	952,500	881,300
Building3/	32,900	25,000	35,000	30,000	50,000	45,000	40,000	25,000		35,363		45,000	35,000	35,000	125,000	60,000

1/ Repairs and replacement costs for other than plate disk are summarized in the text Table 18.
2/ Refers only to cash wages of hired operator. See Part 8.10 for total payments to mill operator.
3/ Does not include the cost of labor, see text Part 8.10 for details.

Source: Based on data collected in field survey

6

Appendix M: Summary of throughputs, revenues and costs of new and used private mills in Bougouni region

ITEM	New mills M 1	M 2	M 3	M 4	M 5	Average	Used Mills M 1	M 2	M 3	M 4	Average
Throughput(Kg/yr):	57,020	42,665	28,014	35,914	24,153	37,553	30,713	29,063	32,256	47,002	34,758
Revenue(FCFA/yr):											
Milling	712,750	556,500	400,200	513,050	284,150	493,330	614,250	484,375	230,400	542,325	467,838
Leftover [illegible]oor	16,050	24,105	20,780	22,520	19,420	20,575	22,640	22,710	21,940	20,070	21,840
Total	728,800	580,605	420,980	535,570	303,570	513,905	636,890	507,085	252,340	562,395	489,678
Variable costs(FCFA):1/											
Diesel	156,975	124,560	76,356	117,480	76,050	110,284	94,920	103,510	99,291	120,600	104,580
Lubricants	32,400	33,600	49,500	30,000	37,500	36,600	37,800	81,000	38,400	19,200	44,100
Disk sharpening	18,000	28,000	18,000	16,000	18,000	19,600	22,500	18,000	18,000	15,000	18,375
Fixed costs(FCFA):2/											
Operator salary				60,000	36,000	48,000				39,000	39,000
Building rent	18,000	24,000	12,000	7,500	12,000	14,700	12,000	12,000	12,000	9,000	11,250
Investment costs:											
Engine & mill	800,000	750,000	800,000	750,000	850,000	790,000	350,000	350,000	500,000	367,000	391,750
Disk	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Belt	5,000	5,000	5,000	5,000	5,000	5,000	6,000	6,000	6,000	5,000	5,750
Mounting	23,000	45,000	140,000	40,000	129,750	75,550	9,000	20,500	26,000	0	13,875
Transport	5,000	20,000	20,000	20,000	7,500	14,500	20,000	2,000	20,000	2,000	11,000
Total	853,000	840,000	985,000	835,000	1,012,250	905,050	405,000	398,500	572,000	394,000	442,375

1/ Repair and replacement costs for other than disk plate are summarized in text Table 18.
2/ There are no municipal taxes levied on mills in Bougouni city.

Source: Based on data collected in field survey

62.

ppendix N: Summary of throughputs, revenues and costs for the NGO mills

EM	M 1	M 2	M 3	Avg
roughput(Kg/yr)	17,093	63,110	25,687	39,001
evenue(FCFA/yr):				
Milling	256,400	394,440	240,815	332,652
eftover floor	25,170	26,625	12,300	24,122
otal	281,570	421,065	253,115	356,773
riable costs(FCFA):1/				
iesel	59,212	145,320	73,773	103,197
ubricants	25,600	36,400	36,300	37,500
isk sharpening	13,500	31,500	27,500	27,333
xed costs(FCFA):				
perator salary	12,820	31,900	24,600	23,784
perator allowances	1,800	8,700	2,200	4,667
vestment costs(FCFA):				
Building	25,000	25,000	25,000	25,000
Engine,mill	1,488,080	850,000	770,000	1,036,027
Disk	20,000	20,000	20,000	20,000
Mounting	30,000	Free	130,000	53,333
Transport	Free	Free	Free	0
Total	1,563,080	895,000	945,000	1,134,360

Repair and replacement costs for other than the disk plate are summarized in ext Table 18.

urce: Based on data collected in field survey

Appendix O: Summary of throughputs, revenues and costs for the CMDT mills

ITEM	M 1	M 2	Avg
Throughput(Kg/Yr)	13,360	19,340	16,350
Revenue(FCFA/Yr):			
Milling	308,300	371,925	340,113
Welding	672,500	487,250	579,875
Leftover flour	19,140	15,625	17,383
Total	999,940	874,800	937,371
Variable costs(FCFA):1/			
Diesel cost	159,120	129,514	144,317
Lubricant cost	63,000	50,400	56,700
Disk sharp cost	15,750	18,000	16,875
Iron	95,000	75,000	85,000
Investment costs(FCFA):2/			
Building	200,000	250,000	225,000
Engine,mill,& welding eqipment	2000000	2750000	2375000

1/ See text table 18 for repair and replacement costs. Also refer to section 8.10 for mill operator cost.

2/ Mounting and transportation of equipment was provided by CMDT and not charged separately.

Source: Based on data collected in field survey

APPENDIX P

MILLING FEE AND ESTIMATED MILLING THROUGHPUT IN BOUGOUNI CITY AND M'PESSOBA TOWN

Bougouni city

Mill #	Mill.fee (Fcfa/kg)	Throughput Tons/Yr
1	8.3	78.1
2	11.1	58.5
3	11.9	42.4
4	11.9	28.5
5	12.8	71.2
6	13.9	33.5
7	15.1	30.1
8	16.7	39.6
9	16.7	23.6
10	16.7	12.3
11	18.5	41.7
12	18.5	37.2
13	18.5	33.4
14	18.5	32.6
15	18.5	30.2
16	18.5	27.4
17	18.5	26.5
18	18.5	23.6
19	18.5	23.5
20	18.5	19.8
21	18.5	16.8
22–27	estimated*	208.7 *
Total		939.2

* Estimated based on average of 21 mills in Bougouni.

M'Pessoba town

Mill #	Mill.fee (Fcfa/kg)	Throughput Tons/Yr
1	11.5	58.2
2	13.3	44.0
3	13.3	38.3
4	13.3	32.5
5	13.3	26.3 a/
6	16.7	15.2 a/
7	16.7	16.6
8	estimated	33.0
9	estimated	10.1 b/
Total		274.1

a/ Mills established in 1991, throughput for 6 months.
b/ Mill gone out of business during 1991.

Source: Based on data collected in field survey

APPENDIX Q

CEREAL CONSUMPTION PER PERSON IN THE SIKASSO REGION

Cereal	Rural	Urban	Overall
	(kg / year)		
Millet	102.9	39.4	93.4
Sorghum	62.3	38.4	58.7
Maize	76.7	43.2	71.7
Fonio	8.7	5.0	8.2
Rice	14.3	31.1	16.8
Wheat	0.4	0.5	0.4
All	265.3	157.6	249.2

Source: Direction Nationale de la Statistique et de l'Informatique, Enquête Budget Consommation (1988–89), Ministère du Plan, Mali, 1991.

APPENDIX R: FINANCIAL NET PRESENT VALUE AND IRR FOR RURAL MILLS IN KOUTIALA REGION

Year	1	2	3	4	5	6	7	8	9	10	Total
a) Investment costs:											
Engine,mill etc	1,039,658										1,039,658
Disk	17,778		20,000		20,000		20,000		20,000		97,778
Building	55,000										55,000
sub-total	1,112,436		20,000		20,000		20,000		20,000		1,192,436
b) Other fixed/variable costs:											
Operator wages	18,450	73,800	73,800	73,800	73,800	73,800	73,800	73,800	73,800	73,800	682,650
Building repair					5,000					5,000	10,000
Diesel	21,169	83,992	83,992	83,992	83,992	83,992	83,992	83,992	83,992	83,992	777,097
Lubricants	8,954	35,820	35,820	35,820	35,820	35,820	35,820	35,820	35,820	35,820	331,334
Repair/replacements	6,715	31,863	38,609	46,017	45,246	73,084	39,919	30,267	81,992	82,367	476,079
sub-total	55,288	225,475	232,221	239,629	243,858	266,696	233,531	223,879	275,604	280,979	2,277,160
Total costs	1,167,724	225,475	252,221	239,629	263,858	266,696	253,531	223,879	295,604	280,979	3,469,596
c) Revenues											
Quantity milled(Kg)	7,062	28,246	28,246	28,246	28,246	28,246	28,246	28,246	28,246	28,246	261,276
Milling cost(F/Kg)	19	19	19	19	19	19	19	19	19	19	
Milling revenue(FCFA)	135,590	542,323	542,323	542,323	542,323	542,323	542,323	542,323	542,323	542,323	5,016,497
Qty of reliquat(Kg)	175	701	701	701	701	701	701	701	701	701	6,484
Price (FCFA/Kg)	35	35	35	35	35	35	35	35	35	35	
Value (FCFA)	6,134	24,535	24,535	24,535	24,535	24,535	24,535	24,535	24,535	24,535	226,949
Total revenues	141,724	566,858	566,858	566,858	566,858	566,858	566,858	566,858	566,858	566,858	5,243,446
Net Revenues	(1,026,000)	341,383	314,637	327,229	303,000	300,162	313,327	342,979	271,254	285,879	1,773,850
Discounted values:		Discount rate=		12%							
Total costs	1,042,611	179,747	179,526	152,289	149,720	135,116	114,685	90,421	106,598	90,468	2,241,180
Total revenues	126,539	451,896	403,478	360,249	321,650	287,188	256,418	228,944	204,415	182,513	2,823,290
Net revenues	(916,071)	272,148	223,952	207,960	171,930	152,071	141,733	138,523	97,817	92,045	582,110

Source: Based on data collected in field survey

NPV= 582,110
IRR %= 28

APPENDIX S: FINANCIAL NET PRESENT VALUE AND IRR FOR URBAN MILLS IN KOUTIALA REGION

Year	1	2	3	4	5	6	7	8	9	10	Total
a) Investment costs:											
Engine,mill,etc	869,300										869,300
Disk	12,000		20,000		20,000		20,000		20,000		92,000
Building	75,000										75,000
sub-total	956,300		20,000		20,000		20,000		20,000		1,036,300
b) Other fixed/variable costs:											
Municipal taxes	3,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	111,000
Operator wages	21,450	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	793,650
Building repair					10,000					10,000	20,000
Diesel	26,500	105,998	105,998	105,998	105,998	105,998	105,998	105,998	105,998	105,998	980,482
Lubricants	9,120	36,480	36,480	36,480	36,480	36,480	36,480	36,480	36,480	36,480	337,440
Repair/replacements	6,707	31,830	37,242	44,650	43,879	71,717	38,550	28,900	80,625	81,000	465,100
sub-total	66,777	272,108	277,520	284,928	294,157	311,995	278,828	269,178	320,903	331,278	2,707,672
Total costs	1,023,077	272,108	297,520	284,928	314,157	311,995	298,828	269,178	340,903	331,278	3,743,972
c) Revenues											
Quantity milled(Kg)	9,100	36,400	36,400	36,400	36,400	36,400	36,400	36,400	36,400	36,400	336,700
Milling cost(F/Kg)	14	14	14	14	14	14	14	14	14	14	
Milling revenue(FCFA)	127,400	509,600	509,600	509,600	509,600	509,600	509,600	509,600	509,600	509,600	4,713,800
Qty of reliquat(Kg)	205	821	821	821	821	821	821	821	821	821	7,594
Price (FCFA/Kg)	35	35	35	35	35	35	35	35	35	35	
Value (FCFA)	7,184	28,735	28,735	28,735	28,735	28,735	28,735	28,735	28,735	28,735	265,799
Total revenues	134,584	538,335	538,335	538,335	538,335	538,335	538,335	538,335	538,335	538,335	4,979,599
Net Revenues	(888,493)	266,227	240,815	253,407	224,178	226,340	239,507	269,157	197,432	207,057	1,235,627
Discounted value:		Discount rate=		12%							
Total costs	913,462	216,923	211,769	181,077	178,261	158,066	135,175	108,716	122,933	106,663	2,333,044
Total revenues	120,164	429,157	383,176	342,122	305,466	272,737	243,515	217,424	194,129	173,329	2,681,221
Net revenues	(793,298)	212,235	171,407	161,045	127,205	114,671	108,341	108,708	71,196	66,667	348,176

Source: Based on data collected in field survey

NPV = 348,176
IRR %= 23

APPENDIX T: FINANCIAL NET PRESENT VALUE AND IRR FOR THE FAMILY OPERATED NEW MILLS IN BOUGOUNI REGION

Year	1	2	3	4	5	6	7	8	9	10	Total
a) Investment costs											
Engine,mill,etc	885,050										885,050
Disks	20,000		20,000		20,000		20,000		20,000		100,000
Sub-total	905,050		20,000		20,000		20,000		20,000		985,050
b) Other fixed/variable costs											
Building rent	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	150,000
Operator wages	18,450	73,800	73,800	73,800	73,800	73,800	73,800	73,800	73,800	73,800	682,650
Diesel	27,571	110,284	110,284	110,284	110,284	110,284	110,284	110,284	110,284	110,284	1,020,127
Lubricants	9,150	36,600	36,600	36,600	36,600	36,600	36,600	36,600	36,600	36,600	338,550
Repair/replacements	7,032	33,130	38,542	45,950	45,179	73,017	39,850	30,200	81,925	82,300	477,124
Sub-total	77,203	268,814	274,226	281,634	280,863	308,701	275,534	265,884	317,609	317,984	2,668,451
Total costs	982,253	268,814	294,226	281,634	300,863	308,701	295,534	265,884	337,609	317,984	3,653,501
c) Revenues											
Qty milled (Kg/yr)	9,388	37,553	37,553	37,553	37,553	37,553	37,553	37,553	37,553	37,553	347,365
Milling cost(F/Kg)	13	13	13	13	13	13	13	13	13	13	
Milling revenue	122,047	488,189	488,189	488,189	488,189	488,189	488,189	488,189	488,189	488,189	4,515,748
Qty. of reliquat(Kg)	200	799	799	799	799	799	799	799	799	799	7,391
Price (F/Kg)	26	26	26	26	26	26	26	26	26	26	
Value(FCFA)	5,194	20,774	20,774	20,774	20,774	20,774	20,774	20,774	20,774	20,774	192,160
Total revenue	127,241	508,963	508,963	508,963	508,963	508,963	508,963	508,963	508,963	508,963	4,707,908
Net revenue	(855,012)	240,149	214,737	227,329	208,100	200,262	213,429	243,079	171,354	190,979	1,054,407
Discounted value:		Discount rate=		12%							
Total costs	877,011	214,297	209,424	178,984	170,718	156,398	133,685	107,386	121,745	102,382	2,272,029
Total revenue	113,608	405,742	362,270	323,455	288,799	257,856	230,229	205,562	183,537	163,872	2,534,931
Net revenue	(763,404)	191,446	152,846	144,471	118,082	101,459	96,544	98,176	61,792	61,490	262,902
NPV(FCFA):	262,902										
IRR % =	21										

APPENDIX U: FINANCIAL NET PRESENT VALUE AND IRR FOR THE USED MILLS IN BOUGOUNI REGION

Year	1	2	3	4	5	6	Total
a) Investment costs							
Machines	422,375						422,375
Disks	20,000		20,000		20,000		60,000
Sub–total	442,375		20,000	0	20,000	0	482,375
b) Other fixed/variable costs							
Building rent	3,750	15,000	15,000	15,000	15,000	15,000	78,750
Operator wages	18,450	73,800	73,800	73,800	73,800	73,800	387,450
Diesel	26,145	104,580	104,580	104,580	104,580	104,580	549,045
Lubricants	11,025	44,100	44,100	44,100	44,100	44,100	231,525
Repair/replacements	42,844	35,042	43,375	35,875	80,700	81,075	318,910
Sub–total	102,214	272,522	280,855	273,355	318,180	318,555	1,565,680
Total costs	544,589	272,522	300,855	273,355	338,180	318,555	2,048,055
c) Revenues							
Qty milled (Kg/yr)	8,690	34,758	34,758	34,758	34,758	34,758	182,480
Milling cost(F/Kg)	14	14	14	14	14	14	
Milling revenue	117,308	469,233	469,233	469,233	469,233	469,233	2,463,473
Qty. of reliquat(Kg)	189	757	757	757	757	757	3,974
Price (F/Kg)	29	29	29	29	29	29	
Value (FCFA)	5,488	21,953	21,953	21,953	21,953	21,953	115,253
Total revenue	122,797	491,186	491,186	491,186	491,186	491,186	2,578,727
Net revenue	(421,792)	218,664	190,331	217,831	153,006	172,631	530,671
Discounted value:		Discount rate=		12%			
Total costs	486,240	217,253	214,143	173,722	191,892	161,390	1,444,640
Total revenue	109,640	391,570	349,616	312,158	278,712	248,850	1,690,547
Net revenue	(376,600)	174,318	135,474	138,436	86,820	87,460	245,907
NPV(FCFA):	245,907						
IRR % =	37						

Source: Based on data collected in field survey

APPENDIX V: FINANCIAL NET PRESENT VALUE AND IRR FOR THE VILLAGE ASSOCIATION MILLS

Year	1	2	3	4	5	6	7	8	9	10	Total
a) Investment costs											
Engine & mill,etc	1,089,360										1,089,360
Building	25,000										25,000
Disks	20,000		20,000		20,000		20,000		20,000		100,000
sub-total	1,134,360		20,000		20,000		20,000		20,000		1,214,360
b) Other fixed/variable costs											
Operator wages	13,575	54,300	54,300	54,300	54,300	54,300	54,300	54,300	54,300	54,300	502,275
Building repair					5,000					5,000	10,000
Diesel	25,799	103,197	103,197	103,197	103,197	103,197	103,197	103,197	103,197	103,197	954,570
Lubricants	9,375	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	346,875
Repairs/Replacements	8,965	40,863	44,109	51,517	50,746	78,584	45,417	35,767	87,492	87,867	531,325
sub-total	57,715	235,860	239,105	246,513	250,742	273,580	240,413	230,763	282,488	287,863	2,345,045
Total costs	1,192,075	235,860	259,105	246,513	270,742	273,580	260,413	230,763	302,488	287,863	3,559,405
c) Revenues											
Qty milled (Kg)	9,750	39,001	39,001	39,001	39,001	39,001	39,001	39,001	39,001	39,001	360,761
Milling price(F/Kg)	9	9	9	9	9	9	9	9	9	9	
Milling revenue	82,878	331,510	331,510	331,510	331,510	331,510	331,510	331,510	331,510	331,510	3,066,471
Qty of reliquat(Kg)	196	785	785	785	785	785	785	785	785	785	7,262
Price(F/Kg)	31	31	31	31	31	31	31	31	31	31	
Value of reliquat	6,030	24,122	24,122	24,122	24,122	24,122	24,122	24,122	24,122	24,122	223,125
Total revenues	88,908	355,632	355,632	355,632	355,632	355,632	355,632	355,632	355,632	355,632	3,289,597
Net revenue	(1,103,167)	119,772	96,527	109,119	84,890	82,052	95,219	124,869	53,144	67,769	(269,809)
Discounted values:		Discount rate=		12%							
Total costs	1,064,352	188,026	184,426	156,664	153,627	138,604	117,798	93,201	109,080	92,684	2,298,463
Total revenues	79,382	283,508	253,132	226,011	201,795	180,174	160,870	143,634	128,244	114,504	1,771,254
Net revenues	(984,970)	95,481	68,706	69,347	48,169	41,570	43,072	50,432	19,164	21,820	(527,209)

NPV(FCFA): (527,209)
IRR % = -6

Source: Based on data collected in field survey

APPENDIX W: FINANCIAL NET PRESENT VALUE AND IRR FOR THE CMDT/BLACKSMITH MILLS

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
a) Investment costs																
Generator,mill,etc	2,375,000															2,375,000
Disks	20,000		20,000			20,000			20,000				20,000			100,000
Building	225,000					25,000					25,000					275,000
sub-total	2,620,000		20,000			45,000			20,000		25,000		20,000			2,750,000
b) Other fixed/variable costs																
Operator wages	21,450	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	1,222,650
Iron	21,250	85,000	85,000	85,000	85,000	85,000	85,000	85,000	85,000	85,000	85,000	85,000	85,000	85,000	85,000	1,211,250
Diesel	36,079	144,317	144,317	144,317	144,317	144,317	144,317	144,317	144,317	144,317	144,317	144,317	144,317	144,317	144,317	2,056,517
Lubricants	14,175	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	56,700	807,975
Repairs/replacements	7,417	37,170	45,288	56,400	55,244	97,001	47,250	32,775	110,363	110,925	54,375	334,178	84,375	84,375	106,875	1,264,009
sub-total	100,371	408,987	417,105	428,217	427,061	468,818	419,067	404,592	482,180	482,742	426,192	705,995	456,192	456,192	478,692	6,562,401
Total costs	2,720,371	408,987	437,105	428,217	427,061	513,818	419,067	404,592	502,180	482,742	451,192	705,995	476,192	456,192	478,692	9,312,401
c) Revenues																
Qty milled(Kg)	4,088	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	16,350	232,988
Milling priceF/Kg	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	
Milling revenue	85,020	340,080	340,080	340,080	340,080	340,080	340,080	340,080	340,080	340,080	340,080	340,080	340,080	340,080	340,080	4,846,140
Qty of reliquat-Kg	111	442	442	442	442	442	442	442	442	442	442	442	442	442	442	6,299
Price(F/Kg)	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	
Value of reliquat	4,343	17,371	17,371	17,371	17,371	17,371	17,371	17,371	17,371	17,371	17,371	17,371	17,371	17,371	17,371	247,531
Welding revenue	144,969	579,875	579,875	579,875	579,875	579,875	579,875	579,875	579,875	579,875	579,875	579,875	579,875	579,875	579,875	8,263,219
Total revenue	234,331	937,326	937,326	937,326	937,326	937,326	937,326	937,326	937,326	937,326	937,326	937,326	937,326	937,326	937,326	13,356,890
Net revenue	(2,486,040)	528,339	500,221	509,109	510,265	423,508	518,259	532,734	435,146	454,584	486,134	231,331	461,134	481,134	458,634	4,044,489
Discounted values:			Discount rate=		12%											
Total costs	2,428,903	326,042	311,123	272,140	242,326	260,316	189,565	163,408	181,091	155,430	129,707	181,211	109,131	93,346	87,455	5,131,192
Total revenues	209,224	747,230	667,170	595,687	531,864	474,878	423,998	378,570	338,009	301,794	269,459	240,588	214,811	191,795	171,246	5,756,324
Net revenues	(2,219,678)	421,188	356,047	323,548	289,538	214,562	234,434	215,162	156,918	146,364	139,752	59,377	105,680	98,449	83,791	625,132
NPV(FCFA):	625,132															
IRR % =	18															

Source: Based on data collected in field survey

APPENDIX X

LIST OF PERSONS CONTACTED

1. Mr. Sine Konate
   Ministère de l'agriculture
   Division de la Statistique, Bamako

2. Mr. Sekouba Diarra
   Division nationale de la statistique et de l'informatique (OPAM), Bamako

3. Mr. Zoumana Camara
   Division nationale de la statistique et de l'informatique (OPAM), Bamako

4. Mr. Cheick Oumar Diakite
   Directeur chef de publication/vetre des livres
   Division nationale de la statistique et de l'informatique (OPAM), Bamako

5. Mr. Francis Keita, tel 22 36 02
   Système d'information sur les marchés céréaliers (SIM)
   Bamako

6. Mr. V.Duarte, Economist
   USAID, Bamako
   tel 22 36 02

7. Mr. Serge Coelo
   Consi eller ministeriel
   Ministère des finances
   Restructuration des marchés céréaliers
   B.P. 1626, Bamako, Mali

8. Mr. Michel Arrion
   Conseiller économique
   FED, Délégation da la Commission des Communautés Europésnes,
   B.P 115
   Bamako, Mali

9. Mr. Marcel Monette
   Conseiller Technique

10. Cooperation Canada - Mali
    PROGRAMME D'APPUI AU PRMC
    B.P. 198, Bamako, mali
    Tel: 22-45-83