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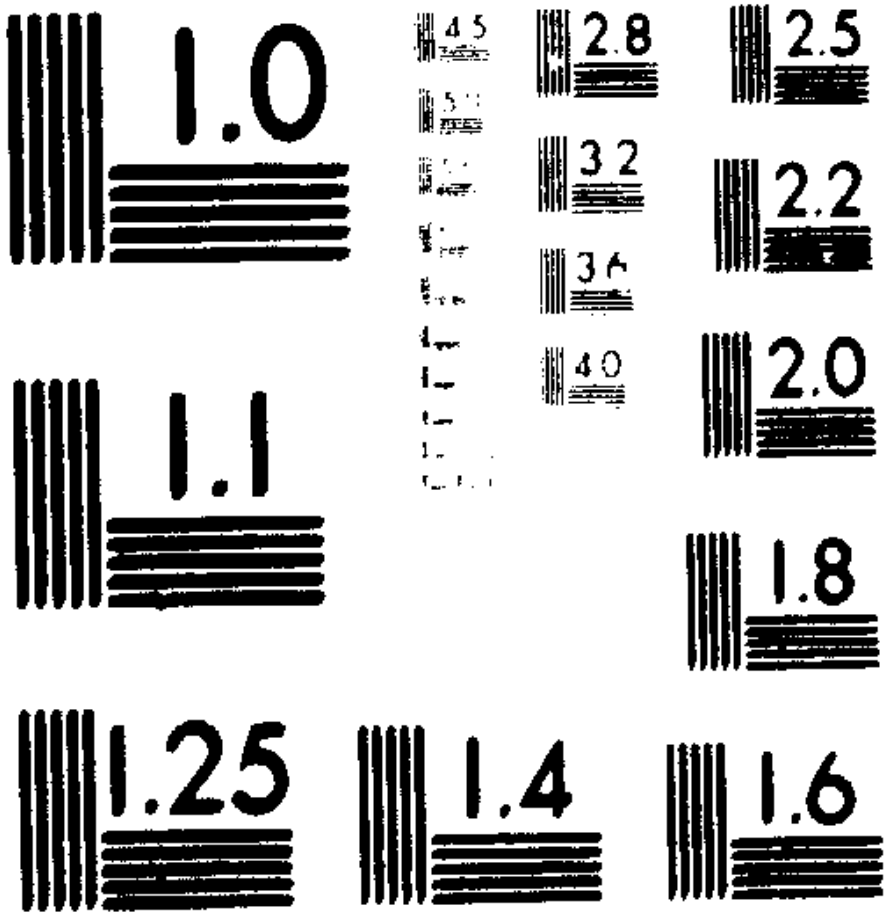

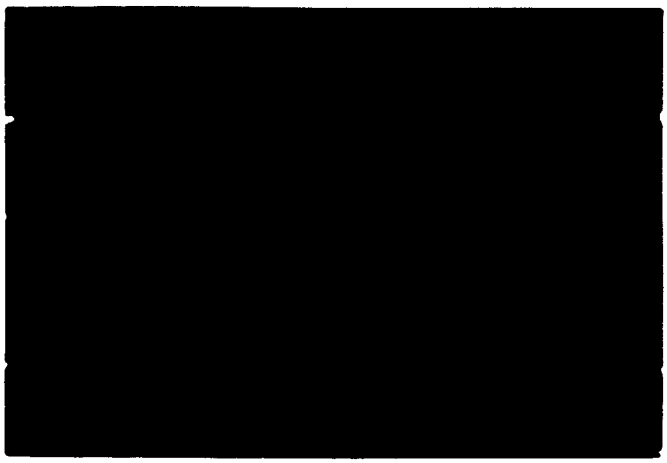

MTI

MARPLAN-TÖPFER-INSTITUT

FÜR MARKETING UND WIRTSCHAFTSFÖRDERUNG

MARPLAN-TÖPFER-INSTITUT
FÜR MARKETING UND WIRTSCHAFTSFÖRDERUNG

GESCHÄFTSBEREICH INTERNATIONALE ENTWICKLUNG

09699

(R) PRE - FEASIBILITY SURVEY

FLOUR MILLING IN NIGER

SI/RAF/77 801

By MARPLAN - TOEPFER - INSTITUT

For UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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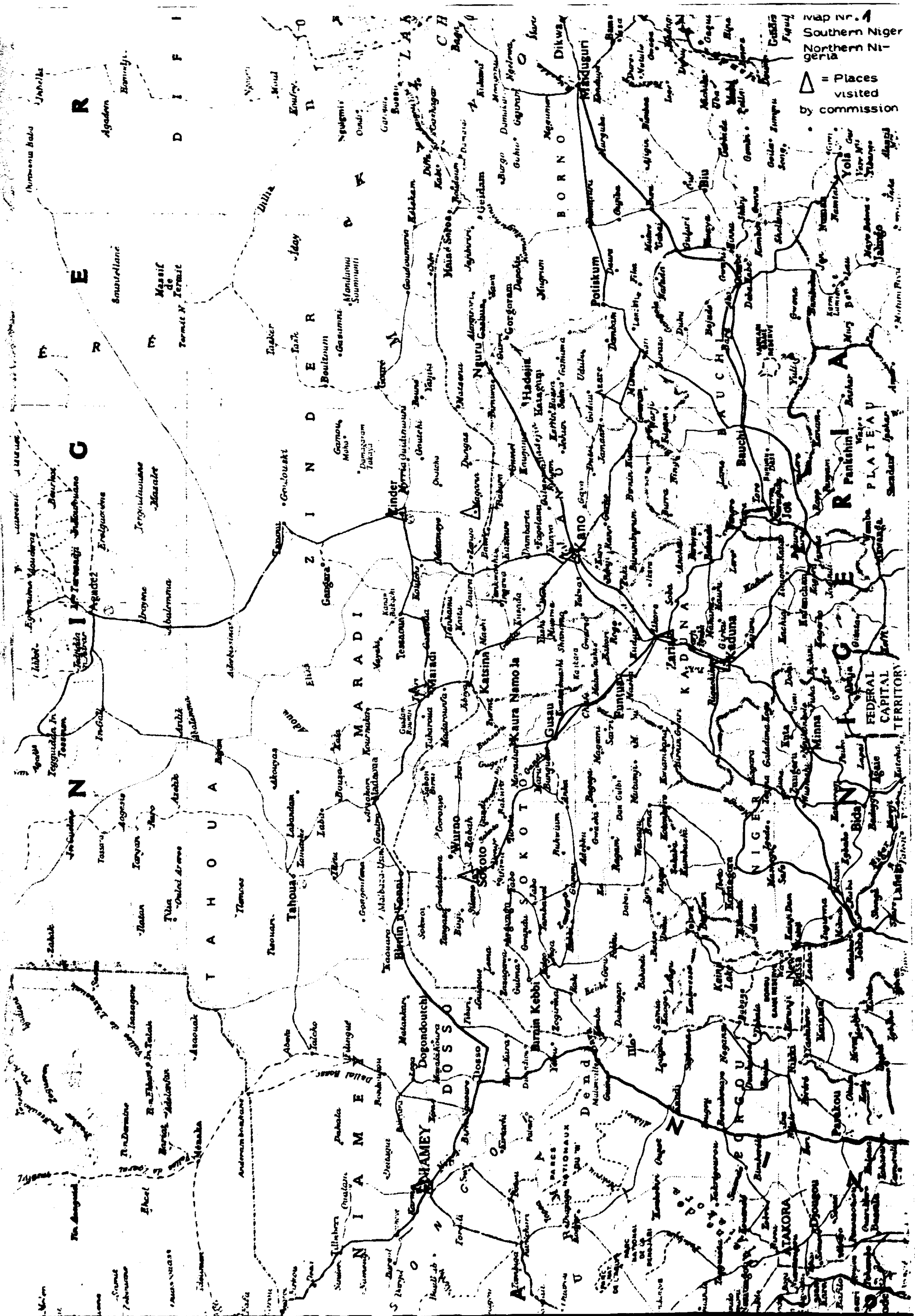
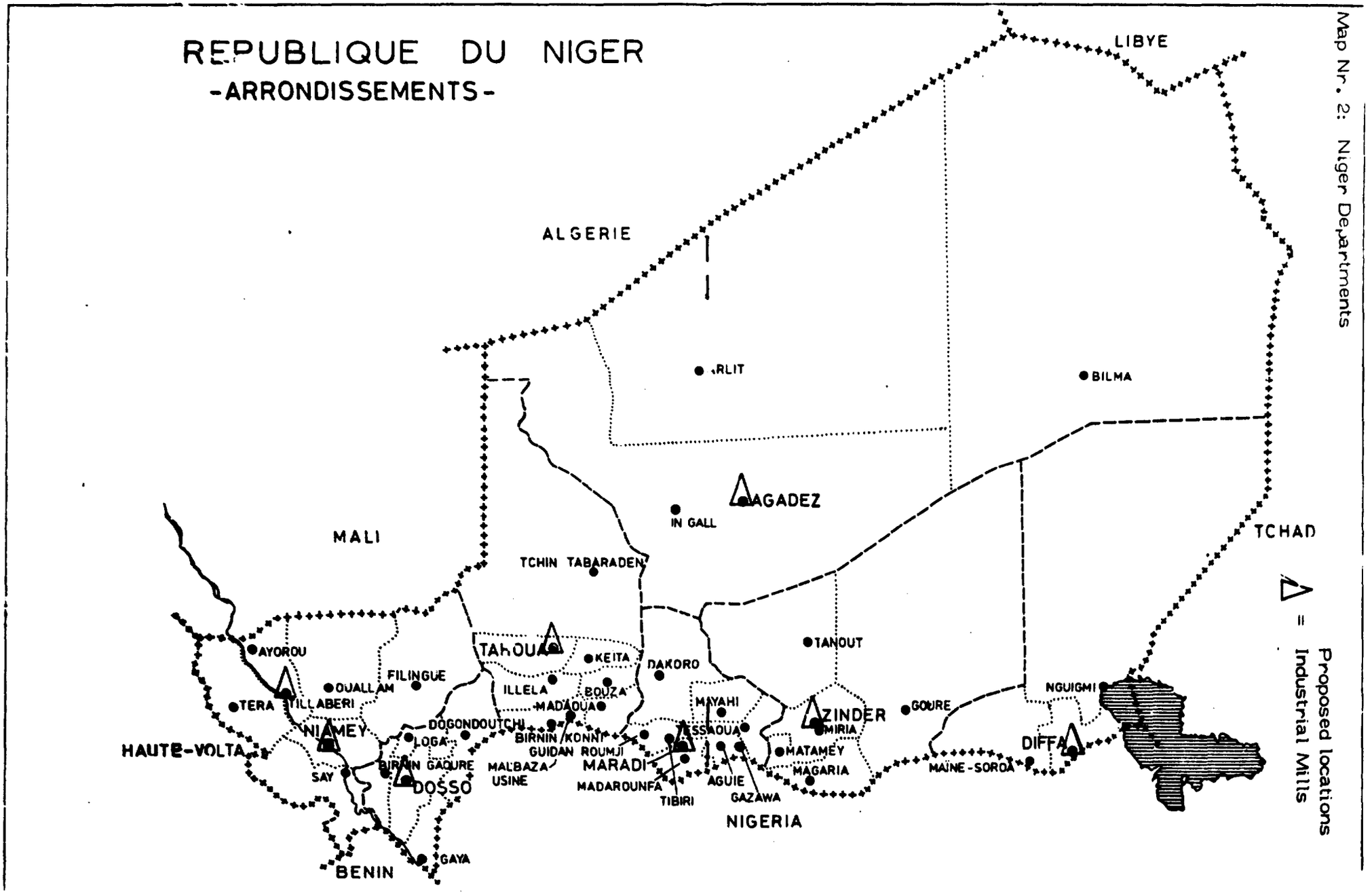

Map Nr. 1
Southern Niger
Northern Nigeria
△ = Places visited by commission



Map Nr. 2: Niger Departments

A. Summary

1. Objectives and background of the study

MARPLAN - TOEPFER - INSTITUT was commissioned by UNIDO to carry out a Pre-feasibility survey in Niger to evaluate the viability of creating mills for the industrial production of sorghum and millet flour, based on the markets of Niger and Northern Nigeria.
The field study was conducted between the 13 th and 27 th of January 1980.

Niger and Nigeria have established a Joint Commission For Economic Cooperation. The main objective of this commission is to ensure a well balanced economic development in the two countries especially in Southern Niger and Northern Nigeria where on both sides of the border the Hausa population has very strong family links and a high degree of cultural, linguistic and religious integration.

Both Niger and Nigeria have established in their National Development Plans objectives and priorities which show the importance of the subject delt with in this study: Selfsufficiency in human food and development of an agro-based industry supported by an increased agricultural production are the priority sectors closely linked with the establisment of a milling industry for sorghum and millet.

2. Millet and sorghum in the national economic context

Sorghum and millet are by far the dominant crops in Niger and Northern Nigeria. The production in the two countries had the following volume in 1977/78 (1000 t):

	Sorghum	Millet
Niger	1.123	364
Nortnern Nigeria	3.280	2.579

3. The consumption and supply situation

The estimated annual per capita consumption of sorghum/millet is approximately 220 kg in Niger and 150 kg in Northern Nigeria (national Nigerian average approximately 70 kg).

Sorghum and millet are mainly autoconsumed by the producers and the percentage of commercialization depends upon the annual production volume but it will rarely be higher than 15 % in both countries.

Niger has almost reached self-sufficiency during the agricultural year 1978/79 but a minor UN-aid was still necessary. In Northern Nigeria there is still a gap of at least 800.000 t compared with consumption habits and considerable gaps are projected for the coming years.

In Nigeria wheat consumption based on imports plays a major role (807.227 t / 1977) while in Niger wheat consumption is still low (imports 1978/79 approximately 10.000 t donated by WFP) [1].

This shows that the basic conditions for a sorghum/millet flour programme are different in both countries.

Niger:

Both consumer habits and availablity of raw material are actually favourable. There is a good chance to avoid an increased wheat import if a sorghum/millet flour of good quality can be produced at a lower price than wheat flour.

Nothern Nigeria:

Conditions are less favourable because there still is a considerable shortage of sorghum/millet for traditional consumption purposes. On the other hand the consumption of wheat flour based on imported wheat is by far more common than in Niger.

1) For abreviations see app. 2

Conclusions:

Niger:

The existing favourable consumption habits should be preserved and strengthened by

- avoiding an increase in wheat imports: The existing wheat milling capacities in Zinder and the planned project in Niamey are sufficient for the existing demand, no further expansion should be allowed.
- promoting the milling of a high quality sorghum/millet flour and the diversification of use and consumption: e.g. composite flour for industrial use (up to 30 % substitution of wheat flour in bread baking) and propagation of new dishes.

Northern Nigeria: [1)]

Cautious measures should be taken in order to increase the use of industrial sorghum/millet flour by users and consumers of wheat flour. This could be started by substituting about 5 % of the locally milled wheat flour by sorghum/millet flour (composite flour programme).

In both countries the future availability of sorghum and millet for industrial milling will depend upon the possibilities to increase the yield per ha. The promotion programmes for crop production started by AFP. (Nigeria) and IRAN (Niger) should also be geared to the industrial demand and coordinate their efforts.

Because of the more favourable conditions in Niger an industrial sorghum/millet flour programme should be started in a major scale from the beginning on. In Nigeria however in the first stage the programme should be started in a minor scale in order to gain the necessary own experiences, benefit from the experiences in Niger and secure the raw material provision before the necessary major investments for a comprehensive programme are made.

1) see app. 23

4. The processing conditions

Up to now industrial production of sorghum flour in Niger (Sotramil) and Northern Nigeria (Kaduna and Maiduguri pilot plants) has not been very successful. Low quality (bitter taste) and relatively high production costs were the major obstacles.

In Niger bakeries refuse to use the sorghum flour for bread. The traditional preparation of sorghum/millet flour by fermenting and pounding still prevails but there is a growing tendency to replace the pounding by semi-industrial milling in a small grinder (capacity 20 kg /hour). Before passing it through the small grinder the sorghum/millet is still fermented in the traditional way. The fermentation causes the special sour taste which is highly appreciated by the consumers.

The lack of this special flavour in the industrial sorghum/millet flour has been an important reason of their negative attitude. These negative aspects of industrially produced sorghum and millet flour are due to the development gap in special milling equipment for those crops. But recently a major progress has been achieved. In Sudan there has already been installed and tested a sorghum/millet mill (UNPP/FAO/Schule-system) which gave completely, satisfactory results regarding quality and production costs of flour. Several other African countries are also starting projects for the industrial milling of sorghum/millet at the moment: Senegal, Upper Volta, Mali, Botswana and Tanzania.

5. The marketing conditions

In Niger and Northern Nigeria the influence of the private marketing system is strong. In Niger growing intervention measures are executed by OPVN and UNCC: Official prices, assembling monopoly, regional public storage and sales to consumers at low prices tend to control price fluctuations and provision over the year.

In Northern Nigeria NGB and NGPC have similar functions but their influence has been even weaker than public interventions in Niger.

Observers agree that prices and margins are not excessively high when considered as average values over some period. They also agree that temporary price fluctuationsand price peaks only to a limited extent are caused by exploitery practices of the private merchants. In addition experiences -also in other developing countries- have proven that the private distribution system tends to be more effecient and flexible than the public system. Therefore we strongly recommend to include the private marketing sector in the marketing measures for sorghum/millet flour. The spatial and temporal fluctuations which characterize the price behaviour are often due to lack of transport and communication facilities. Therefore the improving of market transparency is of special importance in order to avoid major price fluctuations.

A special problem is caused by the unofficial exchange rate for the Nigerian Naira (official exchange rate 1 N = about 380 FCFA, unofficial exchange rate 1 N = more or less 200 FCFA, Jan. 1980).

This results in much lower prices for sorghum and millet and wheat flour brought from Northern Nigeria to Niger.

At the moment the only industrial sorghum flour in Niger (Sotramil) is sold at the same ex-factory price as wheat flour (84 FCFA/kg). Based on the unofficial exchange rate Nigerian wheat flour leaves a higher margin to the merchants. As the successful introduction of sorghum/millet flour for industrial use will depend upon the price, the unofficial wheat flour imports from Niger present a serious problem.

Conclusions:

Industrial sorghum/millet flour production should be consumer and user oriented from the very beginning on:

- consumer acceptance tests with regard to coulour and taste
- baking and other processing tests for the industrial use of the flour

should be used to find out the most suitable crop varieties and processes for the milling. Sorghum/millet flour should be sold at a lower price than wheat flour especially for introduction purposes. The UNDP/Schule- System operates at production costs whiche are considerably lower than all other milling systems compared with in this study. The actual Sotramil selling price for sorghum flour is 84 FCFA/kg. The UNDP/Schule - system would allow selling prices of

70 FCFA/kg for sorghum flour

80 FCFA/kg for millet flour.

This price policy should be accompanied by on promotion campaign: advertising, information in mass media, nutritional education etca. Based on price, quality and information measures the setting-up of a distribution system with a net of agencies selling at recommended price even if the private sector will be more effective.

7. Conclusions and proposals

7.1. Industrial milling in Niger

Conclusions:

There is a demand for industrially milled sorghum/millet-flour in Niger and Northern Nigeria. In order to satisfy this demand the sorghum/millet-flour should have a lower price than wheat flour and correspond to the quality standards (taste, baking usability, shelf live etca.) of consumers and users. The technical equipment which meets both the price and the quality conditions is available. Therefore following project is proposed:

Milling project:

Installation of 8 plants of the UNDP/FAO/Schule-system (capacity 1,75 t/hour) in the following urban centers in Niger : Niamey, Maradi, Zinder, Dosso, Tahoua, Diffa, Agadez, Tillabéri .

These locations are recommended because of the existing warehouse facilities which could be used for the milling programme. The total capacity of these mills would amount to 46.368 t/year. About 30 % of this capacity could be used for the milling necessities of the WFP (PAM) and the Food For Work Programme. The rest should be mainly used to promote the industrial use of sorghum/millet flour (bakeries, pastry industry) and to establish a positive image for further market expansion.

Economic and financial aspects total investment:

- 1 mill: US $ 0,714 million (DM 1,249 million)
- 8 mills: US $ 5,712 million (DM 9,992 million)

Pay-back-estimate of total investment based on

- full capacity years: 2,8 years
- 2/3 capacity years: 5,1 years

Simple rate of return based on

- full capacity: 31,9 %
- 2/3 capacity: 15,1 %

Break-even point (BEP) based on

- sorghum milling: 2.609 t/year/mill (45 % of total capacity)
- millet milling: 3.277 t/year/mill (57 % of total capacity)
- sorghum (50 %) millet (50 %) milling 2.943 t/year/mill (51 % of total capacity).

These prices according to the BEP-Analysis could be even reduced as soon as the mills are operating at full capacity. A sorghum/millet flour of good quality would allow a substitution of 10- 30 % wheat flour in bakeries. Based on the COPRO-import figures for 1978/79 this would result in net foreign exchange savings of 117.745 million FCFA p.a.

Promotion project.

In order to overcome the actual bad image of industrial sorghum flour in Niger and to create a good image for the new industrial sorghum/millet flour a project for market and product development is proposed:

- Control laboratory for quality assurance of sorghum/millet flour and extension of quality certificates for industrial flour. Compilation of test results of other research institutes and promotion of application of test results in Niger's flour-based industry. Assistance in the development of new products and problem solving in private industry.

- Flour promotion campaign

  Advertising and information campaign (consumer and user-oriented) to establish a favourable image of sorghum/millet flour.

  Marketing assistance to industrial sorghum/millet mills: Creation of a common brand, licencing system for marketing chain, grading, packaging, logistic etc.

  Estimated programme costs:

Laboratory	US $	105.000 (DM 185.000)
Product and market developm.	US $	171.000 (DM 300.000)

The industrial milling project together with the product and market development should be executed by OPEN and BDRB.

7.2. Small grinder programme

Conclusions:

There is a strong demand both in urban and rural areas for small grinders. In order to determine the most urgent demand and the optimal local conditions for an expansion of these capacities further investigation is necessary. The operating costs of the grinders are high compared with the industrial milling, but the special advantage exists in the replacement of the time-consuming and toilsome pounding (average family 5 hour/day). A promotion programme for small grinders should therefore include women-oriented measures and integrated village development aspects.

In order to analyse the more detailed economic and social implications and conditions of such a programme a comprehensive study has to be conducted.

Only some indicative figures can be given here:

Investment costs for grinder. :

- with diesel engine FCFA 620.000 (incl. tax)
- with electric engine FCFA 820.000 (incl. tax)

Milling costs: 13,30 FCFA/kg.

Number and location of small grinders aswell as the costs of a mobile maintenance and repair service should be established in the above mentioned special study.

The small grinder programme should be executed by UNCC and UNCA in close cooperation with OPEN and its industrial milling project.

Bilateral and/or multilateral assistance in capital and personnel will be needed for the implementation of this project. The most important aspects hereof are given in this study but more detailed data have to be established in definitive feasibility studies.

7.3. Pilot programme in Northern Nigeria [1)]

Kano:

Installation of 1 UNDP/FAO/Schule-mill (1,75 t/hour) as part of the NNFM plant.

Purposes:

- to gain first experiences in composite flour
- to train personnel of other sorghum/mills
- to gain the planning data for a comprehensive programme of sorghum/millet milling
- to cover local flour demand

Zaria:

Installation of 1 UNDP/Schule-mill (1,75 t/hour capacity) as part of the NAFFP.

Main purposes of this installation:

- to permit the selection of sorghum/millet varieties especially suitable for milling purposes
- to carry out consumer and user tests
- to cover local flour demand .

Investment costs per mill aproximately US $ 588.000 (without working capital).

1) see app. 23

C. LIST OF TABLES AND DIAGRAMS

C. LIST OF APPENDICES

List of maps:

Map Nr. 1 = Southern Niger and Northern Nigeria, Places visited by commission

Map Nr. 2 = Niger Departments, Proposed locations of Industrial Mills

Map Nr. 3 = Map of Hausaland

D. Study Report

1. Introduction

1.1. Objectives and procedures of the study

MARPLAN - TOEPFER - INSTITUT (MTI) was commissioned by UNIDO to carry out a Pre-feasibility Survey of flour milling in Niger. The main purpose of the study is the evaluation of the viability of creating mills for the industrial processing of sorghum and millet in Niger, based on the markets of Niger and Northern Nigeria. The following specific tasks were stipulated:

1) Conduct of a market survey for millet, sorghum and flour mills products (distribution channels, prices).
2) Survey of existing flour mills in Niger and Northern Nigeria in order to decide
   - if these units should be expanded
   - or entirely new mills should be established.
3) Determine the optimum solution including
   - proposals as to the capacity, location and plant machinery and equipment
   - calculation of costs of investment and production
   - assess the financial and economic viability of the project
4) Make further recommendations on technical assistance that may be required for investment follow-up, construction and start-up, supporting measures and further investigation.

The study team sent by MTI was composed of
Dr. rer. nat. Edward MOHR, Study leader and Industrial Milling Expert
Dipl.-Kfm. Gerhard ARNOLD, Marketing Economist
Dipl.-Volksw. Peter TOEPFER, Industrial Economist

The team conducted the survey in Niger and Northern Nigeria between 13th and 27th of January 1980. While Mr. Toepfer concentrated on the research in Niamey, Dr. Mohr and Mr. Arnold visited the most important centers of the project area in Niger and Northern Nigeria.
A detailed account of contacts and routes travelled is given in app. 1 and map Nr. 1

As explained in our report both in Niger and Northern Nigeria during the last years different projects in the field of milling and commercializing of sorghum and millet flour were started. The results up to now have not been very encouraging. The study team therefore gave special priority to the analysis of the underlying causes of these difficulties. Dr. Mohr and Mr. Arnold travelled more than 3500 km through Southern Niger and Northern Nigeria in order to analyse in personal interviews the technical and marketing espects of the existing projects and the prerequistes for an improved new project. We considered this to be the main objective of a survey in the actual stage of sorghum and millet processing.

Due to the limited financial buoget which also resulted in a very short field mission there was not time enough left to carry out a deeper economic ano financial analysis of the proposed projects. Although the most important economic and financial aspects are shown as can be expected in a pre-feasibility survey, there still remains the necessity to carry out a more comprehensive economic and financial analysis as part of a future feasibility study for the proposed projects.

During its visit the team was permanently and most efficiently supported by Mr. Guy LAMBERT-DAYNAC, UNIDO/FAO-adviser to the Nigeria-Niger Joint Commission, who also participated in the visit to the project area. Special assistance was granted to the study team by Mr. Gabriel S. AKUNWAFOR, Secretary General of the Joint Commission and Mr. Boureima MAGAGI, Assistant Secretary General of the Joint Commission who arranged the necessary contacts and gave valuable advice.

The study team would like to thank the above mentioned persons expressing at the same time their gratitude towards all the other national and expatriate members of the ministries and organizations visited and indicated in app. 1 for their friendly cooperation.

1.2. Background of the study

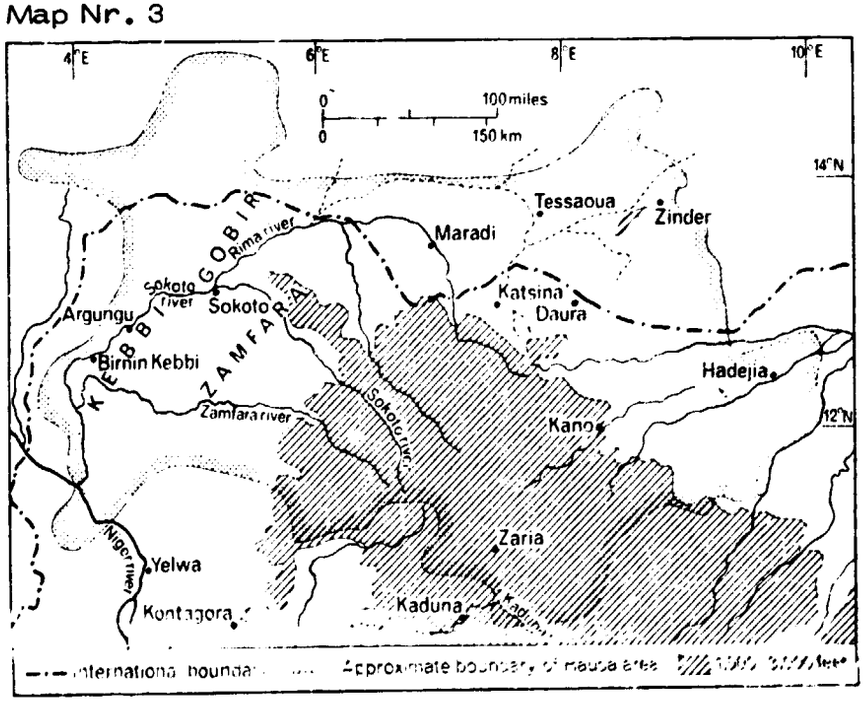
1.2.1. The Nigeria - Niger Joint Commission

Niger and Nigeria have established a Joint Commission For Economic Cooperation between the two countries. The creation of this Commission in 1971 was to enable the two states to formalize the economic cooperation which had existed between them over the years.

The close links between the two countries are most of all due to the Hausa language which is spoken in Northern Nigeria and in the Niger Republic mainly in the southern region. Hausa is a language which is also spoken by many other people which ethnically do not belong to the Hausa.

The Hausa enjoy a high degree of cultural, linguistic and religious integration especially in the original Hausa land. The boundaries of this region are shown in the following map.

Map Nr. 3



Map of Hausaland (after Morgan and Pugh, 1969)

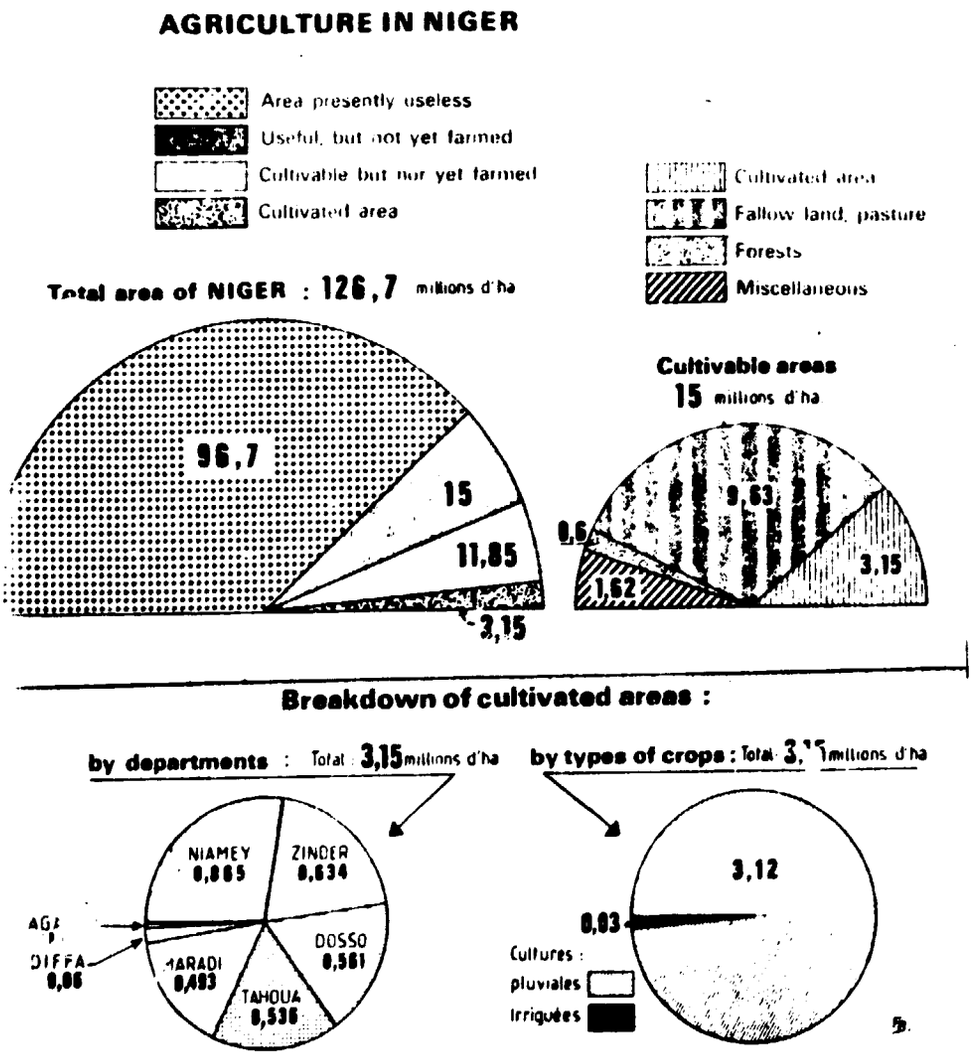
Traditionally Hausa are farmers and traders. The famliy and commercial links between the Hausa in Niger and Nigeria have not been hindered by the creation of the two states. It therefore is one of the most important objectives of the Joint Commission, to ensure a coordinated and well balanced economic development of the Hausa region thus contributing to the welfare and harmony among its people.

1.2.2 The economic situation of the two countries

Niger is a land-locked country in the center of West-Africa. According to the census in 1977 it had a population of 5.098 million growing at about 2,7 % per year. About 75 % of the total population can be considered as agricultural and sedentary and about 15 % of the total population are nomads. With more than 90 % of its population belonging to the primary sector, the country has suffered severely from the droughts in 1969, 1971 and 1973. But since 1975 Niger's economy has developed favourably at a growth rate of about 9 %. This was most of all due to the growing uranium production which accounted for 13 % of theGDP and about 70 % of export revenues in 1978. But also the primary sector has developed at a growth rate of more than 9 % contributing about 45 % to theGDP in 1978. The industrial processing sector had results of very different nature. Problems in the agro-based industrial sector were mainly caused by a shortage of local raw material.

The conditions of Niger's agriculture are characterized by the following diagram [1]:

Table Nr. 1



1) Source: Marchés tropicaux - June 1st, 1979:
The present situation of Niger's Economy, p. 49

In short, it can be said, that Niger cultivates 2,5 % of the nation's territory (3,15 million ha). But only 31.000 ha are irrigated, leaving 3.119 completely dependent on rainfall. In former years peanuts were Niger's main cash crop with sales raising up to 191 thousand tons in 1967. But since the situation began to deteriorate in 1973 because of the catastrophic drought, sales have gone down drastically to 15 thousand tons in 1978. On the other hand there has been a constant growth of Niébé beans production resulting in a harvest of 245 thousand tons in 1978. Niébé has also become an export product during the last years.

The National Development Plan 1979 - 83 (Plan Quinquenial) establishes the following long term objectives in the field of agriculture and industry which show the priority of the project evaluated in this study:

1) Improve agricultural production in order to attain selfsufficiency in human food

2) Develop an industry based mainly on the utilization of local raw material in order to substitute import and promote the creation of small and middle scale enterprises.

Nigeria is the most populous African country with an estimated population of about 70 million. Its territory covers more than 923 thousand sqkm. Its GDP per capita amounts to 420 US $ (1977) beeing essentially higher than Niger's GDP (160 US $ in 1977). Inspite of beeing one of the major Oil-producing-countries about 65 % of the total employment is located in the primary sector. On the other hand the agricultural sector only contributes about 26 % (1975) to the GDP. Especially the share of agricultural products has decreased in export during the last years. Agricultural conditions in Niger are more favourable in Nigeria than in Niger, almost 50 % of the total area can be used for agriculture and 25 % of the total area offers favourable conditions for plant production.

The industrial sector contributes 44 % (1975) of the GDP. There are numerous small firms and relatively few bigger industrial firms. Among small scale industrial bakeries and flour mills play an important role.

Like Niger's development strategy Nigeria also aims at the promotion of its agricultural production in the Third National Development Plan (1975-1980). Contrary to the former export orientation the focus is now on ensuring domestic selfsufficiency. At the same time an agro-based industry shall be promoted to make use of on expanded crop production in the future. The National Accelerated Food Production Programme (NAFPP) is one of the most important instruments of this strategy. In the northern states special effort is made to develop water resources for irrigation (River Basin Projects) to permit double cropping and to promote wheat production.
A comparison of the main development indicators of Niger and Nigeria and other African countries is given in appendix 3.

1.2.3. Technical aspects

Up to now there is no industrial millet mill in Niger/Nigeria. All the millet flour is home made or produced semi industrially in small grinders (differential mill) of home fermented and hulled millet.

The pilot plants of the sorghum mills in Niger and Nigeria cannot be recommended because of their high milling costs, which result in a very high flour price. The quality of the flour is not satisfactory and is not accepted by the population. In our opinion the introduction of the FAO developed and recommended milling system for sorghum and millet (Schule System) is the only technical answer, because these mills have already been tested and installed with good results in Sudan and other countries of the Sahel Zone.

The acceptance of the flour product by the population is however the most important question.

Meanwhile new experience has been gained and there are new milling systems known which fulfill favourably the quality requirements for flour.

In order to demonstrate the importance of sorghum and millet we refer to the following table. Although there are world wide industrial milling systems for wheat, rice, maize and oats up to now we are only at the beginning of industrial milling systems for millet and sorghum.

Table 2

World Production	Mio t/year 1978 [1)]
Wheat	441
Rice	376
Maize	363
Millet and Sorghum	107

1) FAO Production Yearbook 1978, Vol. 32

The lack of proper industrial milling systems for millet and sorghum has been the main reason why so far no bread industry based on sorghum and millet has developed. Today about 60 % of the world population are bread eaters and wheat is still the main raw material for this product.

There is a world wide experience that growing income automatically induces consumers to turn to bread consumption or increase bread consumption. In many Developing Countries local conditions and agricultural production techniques are more in favour of other cereals than wheat.
With regard to the utilization of traditional crops and substitution of importations of wheat the development of milling systems for traditional crops and a flour suitable for bread making has become a central problem.

2. The production and consumption of sorghum and millet

2.1. The comparative importance of millet and sorghum production

2.1.1. Niger

The total area of cultivable land approximates 15 million ha, but only 2,25 million to 3 million ha are cultivated each year [1]. About 95 % of the total area cultivated each year is used for millet and sorghum. The following table gives an impression of the relative importance of the different crops in 1978 [2]:

Table 3

Crops \ Indicators	Area + (1000 ha)	Production (1000 tons)	Yield (kg/ha)
Millet	2.746,7	1.122,6	409
Sorghum	795,9	363,5	461
Niébé beans	959,4	277,5	284
Groundnuts	210,2	96,8	461
Voanzou	14,6	8,1	557
Cassava	26,1	204,9	7.850
Cotton	9,2	4,4	480
Rice	25,4	31,6	1.245
Gombo (Hibiscus)	0,8	0,4	532
Maize	12,1	8,7	722
Wheat	0,9	2,1	2.300

+ The addition of different areas does not correspond with the total cultivated area indicated above as there is an interplanting of crops.

1) CILSS: Commercialisation, p.4
2) SOURCE: Ministry of Rural Development
2) A complete survey of crop production during the years 1969 - 1978 is given in appendix 4

There is no doubt that millet and sorghum are by far the most important crops in Niger.

The comparative importance of the different regions in millet and sorghum production in 1979 is shown in the following table [1]:

Table 4

Crops / Region (Departments)	Millet 1000 t	Sorghum 1000 t
Niamey	328,4	46,3
Dosso	200,5	19,2
Tahoua	149,1	90,6
Maradi	244,2	83,6
Zinder	292,7	74,7
Diffa	12,6	19,9
Agadez	0	0
Total	1.227,5	334,3

These figures show a concentration of sorghum and millet production in the south of the country, especially in the regions bordering Nigeria.

In Niger the cultivation of millet is by far more important than the cultivation of sorghum; only in the Department of Diffa sorghum productions tends to be higher than millet prodcution.

1) Source Ministry of Rural Development

1) see map Nr. 2 for location of departments

2.1.2. Nigeria

The production of major crops during the last agricultural years is shown in appendix 5. The shares of the most important crops in relation to the whole production are the following [1]:

Table Nr. 5

crops / years	Millet	Sorghum	Yam	Maize	Cassava
1977/78	14,8 %	19,1 %	38,2 %	4,4 %	10,9 %
1976/77	16,2 %	16,5 %	37,3 %	6,0 %	10,5 %
1975/76	12,1 %	14,7 %	35,4 %	5,9 %	19 %

Sorghum and millet constitute about 30 % of the major crop production in Nigeria. Within the national agricultural production yam and cassava have been of higher importance than sorghum and millet. The regional importance of sorghum and millet production is characterized by a strong concentration of the production of this crops in the northern regions of Nigeria as can be learned from the following table.

1) SOURCE: Federal Office of Statistics, Lagos: Rural Economic Survey 1977/78

Shares of the Northern Nigerian States in millet and sorghum production 1977/78 (1000 Tons) [1]:

Table Nr. 6

Crops / States	Millet 1000 t	Sorghum 1000 t	Total 1000 t
Bauchi	207	353	560
Benue	28	91	119
Bornu	333	137	470
Gongola	19	335	354
Kaduna	435	450	885
Kano	495	506	1001
Kwara	37	100	137
Niger	33	203	236
Plateau	71	255	326
Sokoto	921	850	1771
Total	2.579	3.280	5.859
Share of National Production	100 %	96,8 %	99,[illegible] %

1) See map Nr. 1 for location of States

Shares of Nigerian States bordering Niger in millet and sorghum production 1977/78 (1000 Tons)

Table Nr. 7

Crops / States	Millet 1000 t	Sorghum 1000 t	Total 1000 t
Bauchi	207	353	560
Sokoto	921	850	1.771
Kaduna	435	450	885
Kano	495	506	1.001
Bornu	333	137	470
Total Border States	2.391	2.296	4.687
Share of National Production	93 %	69 %	79 %

2.1.3. Comparative analysis of crop production in Niger and Northern Nigeria

The analysis of the crop production figures in Niger and Northern Nigeria proves that the same production preferences prevail in Niger and Northern Nigeria. It can be stated, that sorghum and millet are the dominant crops in both areas. In the Nigerian States of Sokoto and Borno millet production is more important. The remaining Northern States of Nigeria give either almost equal importance to both crops or show even a tendency to prefer sorghum production (e.g. Gongola, Benue, Niger, Kwara, Plateau). There are different reasons influencing the preference for sorghum or millet in a region and often an interdependence between different factors can be supposed. When asking peasants why one of the crops is preferred, often consumption habits, especially taste and use for certain dishes, are mentioned as decisive criteria. But there is also an influence of soil and climate on the alternative choice of the crops and it can be assumed that at first these conditions favour the cultivation of certain crops in a region and that the consumption habits developed on that base.

2.1.4. Cultivation characteristics of millet and sorghum

Sorghum (daiwa) is considered to be less drought resistant than millet. But there are numerous different varieties and types with different cultivation characteristics. Often Farmers grow both crops (may be interplanted) in order to avoid the effects of drought, which according to date may effect one grain more than the other.

Millet, especially early millet (gero), is said to be particularly drought resistant. FAO [1] regards gero as a crop of the "marginal lands", where it is a question not of economics but of survival.

---

1) Food and Agricultural Organization (FAO): Agricultural Development in Niger , 1965 - 1980; Rome 1966, p. 178

Late millet (maiwa), is often planted on unmanured bushland, while gero is grown on manured land. In the official statistics early and late millet are not distinguished and appear under the general heading "millet".

The agricultural cultivation calender for sorghum and millet depends on the rainy and the dry reason. The rainy season starts in May and ends in October. But a two-month variation in the date of planting rains is possible. In the north the rainy season is shorter than in the south.
Early and later millet are planted at the beginning of early rains. Sorghum generally is planted after rains are well established and immediately after a good rain. Thus the planting dates will vary depending on the area and the beginning and the distribution of rain falls during the rainy season.

The maturing times for these crops are generally:

Early millet:	3 months
Late millet:	4 1/2 - 6 months
Sorghum:	4 - 5 1/2 months

Where there is no marshland, nearly all the farming operations apart from manuring and clearing are carried out during the rainy season and in the following weeks, when usually late millet and sorghum are harvested.

2.2. The consumption of sorghum and millet

2.2.1. The general consumption pattern

There is a considerable range in the per capita consumption figures published by different sources. The following table shows some of the commonly used estimates for Niger [1]:

Table Nr. 8

Population Group	% Population	Consumption Estimates		
		1.	2.	3.
Agricultural	75	212.8	250	-
Nomadic	20,7	120	-	
Urban	4,3	140	-	220
Weighed Avarage		190,5	229	220

Sources: 1. SEDES, Les Produits Vivriers du Niger, Paris, 1963
2. John Becker, An Analysis and Forecast of Cereals Availability in the Sahelian Entente States of West Africa
3. Republic of Niger, Ministry of Agriculture

A per capita consumption of 190 kg is considered a reasonable estimate by the CILSS - Study for Niger. This would mean a daily calorie intake of 1850 per capita in the case of millet and a little less (1800 calories) in the case of sorghum. These calorie intakes seem realistic also in relation to other African countries with similar conditions. [2]

1) CILSS: Commercialisation, p. 112
2) See appendix 3

In Northern Nigeria an annual per capita consumption of 150 kg is estimated, but there are considerable variations with different ethnic and income groups [1].

In Niger and also in many parts of Northern Nigeria millet and sorghum are preferably consumed by the producers themselves.

It is very difficult to estimate the exact percentage of sorghum and millet consumed by the producers themselves. Marchés Tropicaux (The present situation of Nigers Economy, Jan. 1979) gives the following figures for 1976/77:

Total Harvest of sorghum and millet:	1.466.360	(100 %)
Local millet and sorghum purchase:	45.987	(3,14 %)
Autoconsumption of producers:	1.420.373	(96,86 %)

It must however be considered that the available data about purchases are mainly based on the informations given by the governmental marketing chains (UNCC, OPVN). The share of sorghum and millet marketed through private channels is not known exactly.

It is estimated [2] that the percentage of marketed sorghum and millet in Niger might be between 10 or 15 %.

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1) Hays, H.M,. The Marketing Storage of Foodgrains in Northern Nigeria, University Ahmadou Bello, Zaira, Nigeria 1975

2) CILSS-Study: Commercialization, p. 6/7

Also for Northern Nigeria the data available vary considerably [1]. The percentages of total farm production entering commercial markets according to different sources are:

Table Nr. 9

Sorghum	Millet	Source
2,7	5,3 - 5,4	Norman(in Zaria)
8,9	9,4	Goddard(in Sokoto)
16,9	22,8	Hays (in Zaria)
10 - 15	5 - 10	Gilbert(in Kano)

Other observers state,that the quantities sold by the producers do not react much to price changes, because only the surplus production is marketed.

A comparison of production and consumption of sorghum and millet in Niger and Nigeria shows that the quantities produced in this area are almost exclusively used for the human consumption in the same area. In Nigeria very little sorghum and millet is consumed in the south.

1) Food and Grain Processing in Nigeria, p. 76

2.2.2. The nutrional consumption requirements

Minimum requirements for the per capita consumption are 2,191 Kcal and 53,8 g of crude protein according to FAO standards. The actual consumption is shown in the following estimates [1]:

	Kcal.	Protein (g)
Niger	1,872	62
Nigeria	2,084	46

The nutritional values of the two crops are:

	Kcal.	Protein (g)
Millet (1kg)	3,500	90
Sorghum (1kg)	3,400	70- 160

In other words: In order to fulfill the FAO standard of 2,191 Kcal/per day the following quantities of the two crops would be necessary:

	kg/ per day	kg/ per year
Millet	0,286	225
Sorghum	0,644	232

The quantities indicated above would also cover the total protein demand according to FAO standard.

1) Source appendix 3

2.2.3. The supply situation

2.2.3.1. Niger

The general actual supply situation according to latest data available is shown in table 11 (next page).

The calculation is based on a consumption of 220 kg/ YR/ PC which would provide more than 2100 Kcal/per day and would be sufficient according to FAO standard if one assumes that the small remaining demand is covered by other food.

The following table shows the projections for 1981 - 1983 alternatively based on a minimum consumption of 190/kg/YR/PC and maximum consumption of 250 kg/YR/PC.

Table Nr. 10

Niger Supply Projections				
Indicators \ Years		1981	1982	1983
Production[1] (1000 tons)		1.658	1.694	1.731
Population[2] (growth rate 2,9)		5.715	5.881	6.052
Waste, seed 15 %		0.249	0.254	0.260
Human Consumption	190 kg	1.085	1.117	1.150
	250 kg	1.429	1.470	1.513
Surplus/ Deficit	Minimum Consumpt.	+ 324	+ 323	+ 321
	Maximum Consumpt.	- 20	- 30	- 42

If consumption habits remain unchanged during the next years and the production projections prove correct, only in the case of a per capita consumption of 250 kg a small deficit can be expected. There will be however influences from the higher growth rate (8 %) of the urban centers which may result in a shortage in rural labour and new consumption habits of the new urban population.

1) Source: Ministere du Plan
2) Calculation based on "Recensement General de la Population, 1977"

Table 11

Niger 1978 Regional Consumption and Production of Millet and Sorghum						
	Population [1] (1000)	Consumption 220 kg/PC/YR (1000 t)	Production [2] (1000 t)	Losses [3] 11,5 % (1000 t)	Seedreserve 3,5 % (1000 t)	Surplus Deficit (1000 t)
Agadez	124,7	27,4				./. 27,4
Diffa	166,7	36,7	14,5	1,7	0,5	./. 24,4
Dosso	692,8	152,4	381,1	43,8	13,3	171,6
Maradi	944,3	207,7	271,6	31,2	9,5	23,2
Niamey	1171,7	257,8	276,2	31,8	9,7	./. 23,1
Tahoua	994,5	218,8	221,6	25,5	7,8	./. 30,5
Zinder	1003,7	220,8	337,8	38,8	11,8	66,4
Total	5098,4	1121,6	1502,8	172,8	52,6	+ 261,2 ./. 105,4 + 155,8

1) Ministère du Plan: Recensement Général de la Population, 1977
2) Source: Ministry of Rural Development
3) Calculation based on: Yves Gazzo, Perspectives Alimentaires du Sahel 1985, Niamey 1973, p. 43

2.2.3.2. Nigeria

For Northern Nigeria no reliable consumption figures for the states and the whole region are available. In 1971 Reuben [1] identified the following food deficit areas in Northern Nigeria.

City of Sokoto area: Predominant food crops: millet, sorghum, rice and maize. Deficit because of higher population density and shortage of land.

Kano area: Predominant food crops: millet and sorghum. Deficit because of migrant workers who require traditional food and over-population.

Jos and Pankshin area: Predominant food crops: Yam and sorghum. Deficit because of migrant mine workers who demand traditional food.

The general supply situation can also be characterized by the following considerations:

FAO calorie standard per capita/day [2]:	2.191 Kcal
Calorie intake from cereals 42 % [3]:	920 Kcal
Calorie intake from sorghum and millet, 80 % of total intake from cereals [3]:	736 Kcal
Annual calorie intake per capita from sorghum and millet	264.960 Kcal
Annual kg/per capita consumption of sorghum and millet necessary, to cover nutrional requirements	77 kg

1) Reuben, Udo K.: Food Deficit Areas of Nigeria, The Geographical Review, 61 (3), pp. 415 - 430

2) German Federal Office of Statistics: Nigeria 1979

3) O.L. Oke: The potential of millet and sorghum as food in Nigeria

Based on a population estimate [1] of 68.724 million and an average consumption of 77 kg/ YN/PC the Nigerian total consumption of millet and sorghum would amount to approximately 5.292 million tons of sorghum and millet.
The provisional production figures for 1977/78 show a total of 5.906 million tons.
Deducting 14 % [2] for animal food, seeds and waste would leave 5.079 million tons of the annual production for human consumption.
These would mear an actual sorghum and millet deficit of about 800 thousand tons in relation to FAO nutrition standards and the above mentioned consumer habits.
In Nigeria the National Accelerated Food Production Programme (NAFPP) assumes a growth rate of demand of 4,7 % p.a. [1]. Based on this rate the following future demand is estimated:

Table Nr. 12

Crops / Years	Millet		Sorghum	
	Demand	Gap	Demand	Gap
1981	3.140	-640	4.864	1.086
1982	3.258	-352	5.057	- 678

A comparison of the NAFPP projection for the years 1976 to 1978 with the actual production figures published by FAO show a higher actual production than expected. This would be in line with our supply estimate for the present time.

1) see appendix

2) Information given by Northern Nigeria Flour Milling

2.2.4. The import situation

2.2.4.1. The wheat import

It is a declared objective of the second National Development Plan of Nigeria to become independent from imported food crops (p. 65). Especially the substitution of wheat imports could additionally influence demand and production of sorghum and millet. So far domestic production of wheat has not been encouraging. Yield and qualities are still low and flour made from domestic wheats results in prices which are up to 100 % higher than flour from imported wheat [1].

In Niger and Nigeria during the last year the following quantities of wheat (including flour) have been imported [2]:

Table 13

	Niger	Nigeria
1975	5.782	407.626
1976	9.440	735.497
1977	17.390	807.227
1978/79	10.000 +)	

+)Information COPRO 16.1.1980

For Nigeria an increase of wheat requirement of 300 % from 1977 till 1985 is predicted [3] while in Niger no dramatic change in wheat demand can be expected.

1) Information given by Northern Nigeria Flour Mills
2) FAO Production Yearbook 1978 Vol. 32
3) Source FIIRO

2.2.4.2. The possibilities of import substitution and general conclusions

In order to assess the necessities and chances of industrial milling capacities a very important question will be, whether wheat flour could be substituted by millet or sorghum flour. The answer to this question will depend upon the following factors :

(1) Increase of sorghum and millet production:
Is it possible to increase production to obtain sufficient quantities for industrial processing without reducing the direct consumption of sorghum and millet of the population ?

(2) Marketing:
What marketing requirements are necessary and are they available in order to commercialize millet and sorghum flour and the products made thereof.

(3) Acceptibility of millet and sorghum flour:
Will consumers accept bread , alimentary paste or other products partly made from sorghum and millet flour ?

(4) New products
Is it possible to develop new products with sorghum and millet flour as main ingredients in order to substitute similar wheat flour products ?

The questions 1.), 2.) and 3.) will be analyzed later in this study. In relation to the production aspects the following conclusion can be made:

Production could be increased by increasing the farmed area or by increasing the yield / ha.

The yield situation is characterized by FAO [1] giving the following yield/kg/ha figures:

Table Nr. 14

Region / year	NIGER		NIGERIA		AFRICA		WORLD	
	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet	Sorghum	Millet
1976	465	403	620	597	709	607	1255	682
1977	467	414	617	600	702	591	1320	648
1978	451	404	633	620	736	636	1331	685

Also from figures published by other authors and sources [2] it can be learned that the yield/ha in Niger both for Sorghum and millet is one of the lowest in the whole world.

Unfavourable factors during the last years have been the shortening of the fallow period in the south because of losses of land in the north during the drought and use of inferior soils while richer soils were used for cash crop production.

In the case of Nigeria O.L. Oke [3] estimates that in 1969/70 the yield/ha of 323 - 651 kg millet and 457 kg sorghum presented only 16 - 32 % (millet) and 21 - 31 % (sorghum) of the potential yield.

In Niger and Northern Nigeria the possibility of using or creating additional farmed land for millet and sorghum production are limited. Much will depend on the success of high yielding varieties.

---

1) FAO Production Yearbook 1978, Vol. 32

2) e.g. GAZZOY.: Perspectives .....
FAURE, J.: L'industrie de la mouture et de la transformation des farnies...

3) OKE, O.L.: The potential of millet and sorghum

Both the NAFPP in Nigeria and INRA (Institute National de Recherche Agronomique du Niger) have presented encouraging results for sorghum and millet in experimental productions. But it still remains unknown how long it will take to improve the production techniques and means of the farmers to meet the requirements of the new varieties. Furthermore the following years will show whether the new varieties are suitable for local growing conditions. The problems caused by high yielding groundnut varieties in Niger during the last years show that solutions cannot be expected in the short run.

For a joint economic development of Niger and Northern Nigeria permanent and close cooperation between NAFPP and INRA is strongly recommended. If Nigeria -because of better resource conditions- would improve its yield/ha faster and on a larger scale than Niger, negative effects on Niger's agriculture can be forseen. As we will discuss later there are no efficient and advisable measures to close or control the border between the two countries. Therefore a price reduction because of more econimical production in Niger would most probably lead to an increased offer of millet and sorghum on the Niger market. This would endanger Niger's producers if they are not able to reduce their production costs at the same time.

3. Marketing sector

3.1. Market structure

3.1.1. The public sector

3.1.1.1. Niger

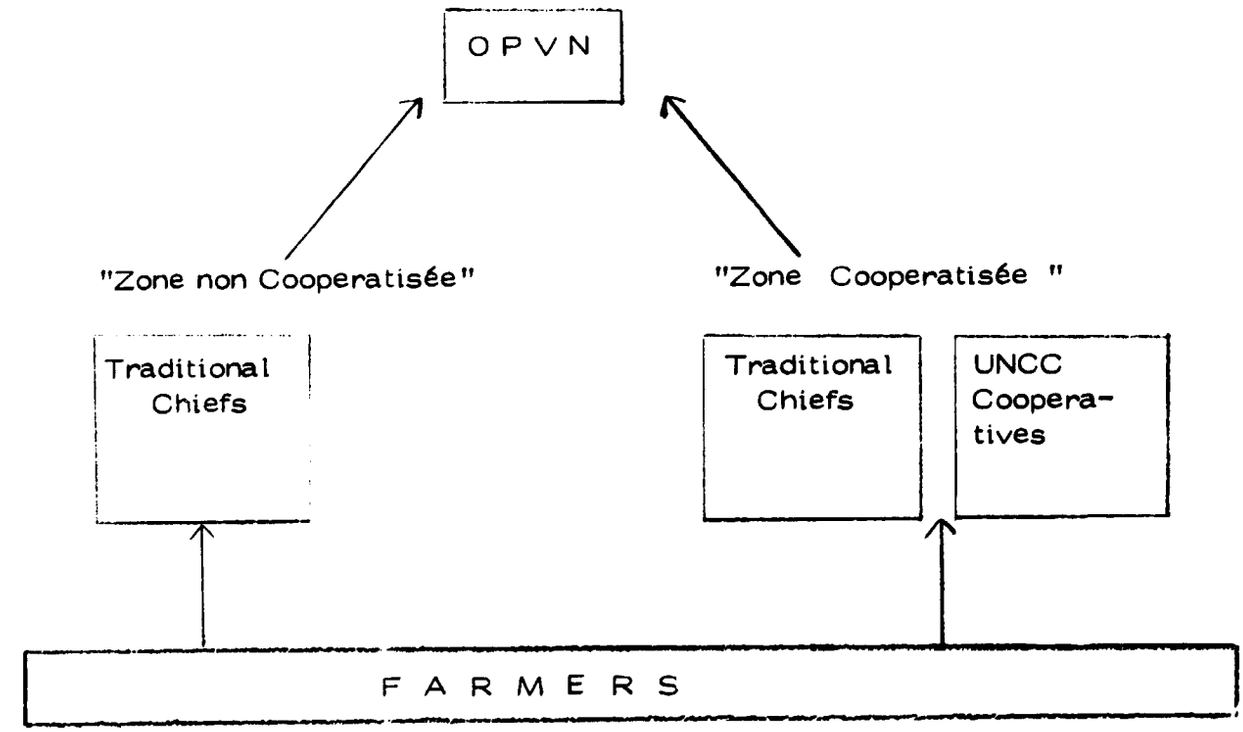
Within the public marketing system for sorghum and millet the "Office des Produits des Vivriers du Niger (OPVN) holds a central position. According to decree Nr. 36/SEP/AE/CI/PCI of Sept. 24th, 1975, the marketing of sorghum and millet is the exclusive domain of OPVN [1].

However during the last years the assembling system has been changed several times, especially with regard to the participation of private licenced assemblers, the Union Nigerienne de Crédit et de Cooperation (UNCC) and the traditional chiefs.

The following graph shows the actual organization of the rural assembling of millet and sorghum as stipulated in "Arrêté Nr. 13/MAECI/DCI/MDR/M du 19. Oct. 1979 ."

Table Nr. 15

Assembling System 1979/80



1) Other products belonging to the domain of OPVN:
Paddy, Niébé-beans and products of the food aid programme

Contrary to the regulation of the agricultural year 1978/79 private licenced assemblers are no longer admitted. On the other hand there is a very strong participation of the traditional chiefs which are the only authorized assemblers in non-cooperative zones and which are also participating in the cooperative activities. UNCC-cooperatives and traditional chiefs are obliged to sell exclusively to OPVN. Transport for the local assembling and the transfer to the regional OPVN warehouses is provided mainly by OPVN; but also military and private vehicles are used.

Besides buying the crops at a fixed price and storing them, OPVN has still a range of other important functions [1].

- Safeguard the provision of the urban centers with basic food
- Supply Agadez and other remote regions
- Guarantee to the producers a higher price than they will receive from the private merchants
- Guarantee to the consumers a lower price than they would have to pay to private retailers.

It is obvious that these tasks are very difficult to combine and to fulfill.

The following table gives an impression of the extent to which OPVN and UNCC were able to cope with these goals:

1) See CILSS: Commercialization, p. 20

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The following table gives an impression of the extent to which OPVN and UNCC were able to cope with these goals:

1) See CILSS: Commercialization, p. 20

Table Nr. 16

Production and Commercialization of sorghum and millet [1]					
Years / Shares	a) 1974/75	a) 1975/76	a) 1976/77	a) 1977/78	b) 1978/79
Total Production	1.101.5	835.1	1.305.7	1.472.3	1.486.1
Local purchase by OPVN	a) 64.1	a) 21.7	a) 46.0	a) 13.8	b) 58.1
OPVN percentage of total product.	5,8%	2,6%	3,5%	0,9%	3,9%
Purchase by UNCC	b) 15,7	b) 10,8	c) 10.6	c) 5.0	c) 7.5
UNCC percentage of total product.	1,4%	1,3%	0,8%	0,3%	0,5%

1) Sources: OPVN (a), Ministère de l'Agriculture (b), UNCC (c)

As we have already indicated above (p.18) in Niger a share of 10 % - 15 % of the total production is estimated to be marketed. This proves that during the last year neither OPVN nor UNCC have been able to reduce the private marketing sector on a major scale. It is also visible that the quantities purchased by the public marketing sector only, could allow a limited intervention in to the consumer market in order to safeguard low retail prices. OPVN has increased its storage capacities considerably during the last years. Especially within the "stock de reserve" programme additional storage capacities were provided. This improves OPVN's chances for future efficient market interventions. The figures available for the current campain indicate that OPVN's and UNCC's share in commercialization will encrease for the first time considerably (UNCC: 23.194 tons till 31st of Dec. 1979). There are however plausible reasons [1] why the private marketing sector will maintain its strong role in the commercialization of sorghum and millet. It therefore is advisable to consider also the effects of the private marketing sector, when analyzing the crop supply and flour marketing conditions of sorghum and millet.

The official importation and commercialization of wheat flour and wheat are carried out by the Société Nationale de Commerce et de Production du Niger (COPRO) [2] . COPRO sells the imported products through a chain of official agencies (1 in each Department) and a number of licenced whole_salers.

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1) CILSS-Study : Commercialization...., p. 66

2) Other products of the COPRO domain: Salt, sugar, milk, cigarettes, tea, tomato concentrate.

3.1.1.2. Nigeria

The public marketing system is composed of:

- the cooperative movement
- the Nigerian Grains Board (NGB)
- the National Grains Production Company (NGPL)
- various state government storage facilities.

The influence of this system is still very weak. In fact the whole grain marketing system depends on the private sector. Even the cooperatives mainly sell to private traders which buy from members and non-members alike. The State Co-operative Division decides what commodities should be bought by the area office and how to dispose of them. The area office provides transport and sale of produce. Purchase advance is also provided for the buyer's use by the area office of the Co-operative Division.

The NGB was formally established in 1977 abolishing the old system of state operated marketing boards. Instead of the export and cash crop orientation of the old system NGB is expected to encourage grains production and to organize the marketing of grains for the local supply. So far the interventions of NGB have been very limited and mainly concentrated on the storage sector.

The NGPC was founded in 1975 as a governmental commercial company in order " to boost foodgrain production and ensure reasonable prices for to customers " [1]. So far the main activities have dealt with constructing storage facilities and making them available to NGB, Further more a pilot mill for maize and sorghum has been set up in Kaduna. The experiences gained with this project will be discussed later.

In conclusion it can be stated that so far no major influence on the national marketing system of sorghum and millet has been effected by NGPC.

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1) More detailed information on NGPC see app. 7

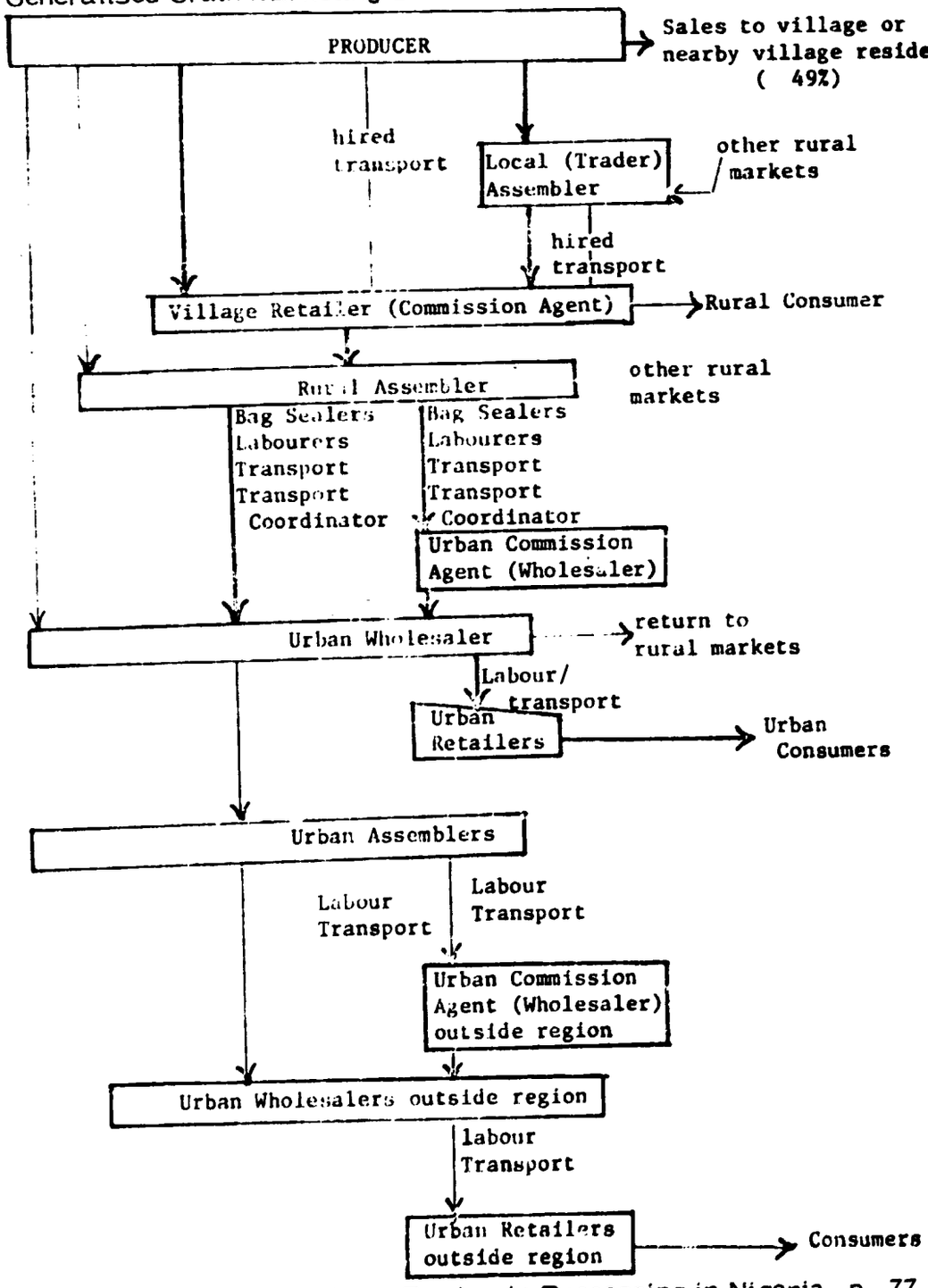
3.1.2. The private marketing

3.1.2.1. Marketing of sorghum and millet

The private sector both in Niger and Northern Nigeria presents very similar structures. The following shematic of the private grain marketing in Nigeria can also be applied to the Niger conditions [1]:

Table Nr. 17

Generalised Grain Marketing Shematic



1) From Feasibility Study on Foodgrain Processing in Nigeria, p. 77

The main characteristics of grain marketing in both countries are:

(1) A very high percentage of sales effected by the producers either directly to consumers in the neigbourhood (49 % of total sales in Nigeria) or directly by producers on periodical rural markets (75 % - 80 % in Niger).

(2) A great number of local assemblers which are often part-time traders (farmer-traders) and who at the same time will provide the farmers and the local communities with consumer goods (tea, sugar).
They are often assisted by a local intermediary (Rabatteur).

(3) Wholesalers who may be lorry - owners at the same time. Many wholesalers use local agents who are often members of their family. Especially the trade between Niger and Northern Nigeria is based on family links on both sides of the border.

(4) The retailers buy either directly from the producers or from the wholesalers. They generally rent a stand onthe urban markets. They have to compete with the farmers and their wives who usually sell their produce in the neighbouring streets of the official market, where they have to pay no market fees.

(5) The importance of retail trade conducted by women either as house-trade (especially in the case of strict muslim seclusion) or as street trade by children and younger women. In Northern Nigeria it was estimated that 40 % [1] of the women were involved in preparing food for immediate sale. The processed food often has millet and sorghum as ingredients (fura, marmari, tuwo).
These women are also important buyers of grains, each purchasing an average quantity of 3 - 8 kg [1] grain per day.

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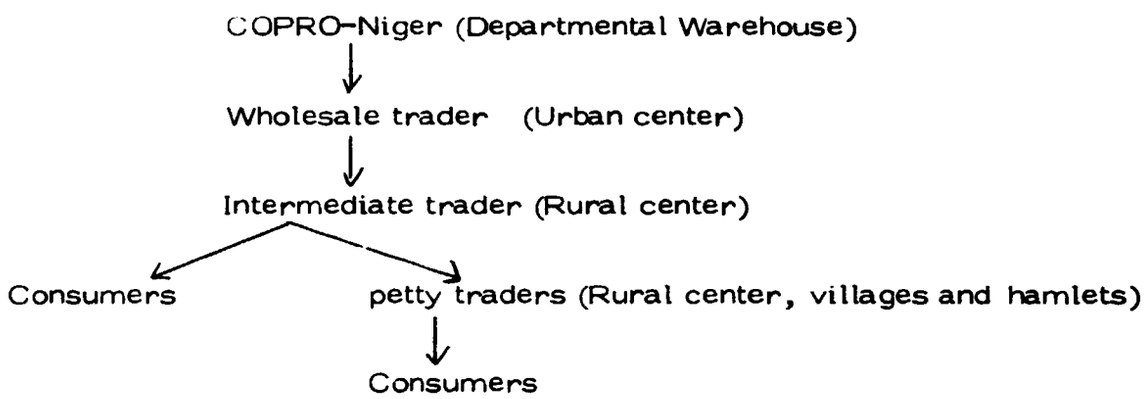
1) Feasibility study on Foodgrain processing in Nigeria, p. 77

3.1.2.2. The marketing of flour

In Niger the flour produced by Sotramil is sold either directly to private merchants and bakeries or through OPVN and COPRO which often function as whole sale agents. A typical path of distribution is shown in the following diagram [1]:

Table Nr. 18



These chains also correspond with the distribution system for flour imported by COPRO. Besides there is a considerable private trade in wheat flour from Kano (Northern Nigeria Flour Mills) brought into Niger by private importers and sold through the private channels.

Actually no official importation of wheat flour from Niger exists. Northern Nigeria Flour Mills declared that the contracts which had been signed with licenced importers from Niger gave no satisfactory results.

In Northern Nigeria 50 % of the local flour production is sold directly to bakeries (70 % to industrial bakeries and the rest to traditional bakeries). The rest of the total production is sold through the private marketing system. The perfomance and problems of the existing flour mills in Niger and Nigeria will be analyzed later (see chapter 4).

1) From Spittler, G.: Traders in Rural Hausaland, p. 371

3.2. Market performance

3.2.1. Analysis of prices and margins

3.2.1.1. Prices and margins of the public sector

The producer prices for sorghum and millet as well as for cowpeas and rice are officially fixed each year in Niger.

Development of Official producer prices during the last years (FCFA/kg):

	1971-73	1973-78	1978-80
Millet	12.5	25	40
Sorghum	10	20	35 (red sorghum) 40 (white sorghum)

The margins of the official assembling system are also fixed by the government (FCFA/Kg).

Producer price (millet)		40
Cooperatives zones		
- margin of the cooperative	1	
- margin of the traditional chiefs	1	2
- "chefs de villages"	0,5	
- "chefs de cantons"	0,5	
Non-cooperatives zones		
- margin of the "chefs de village"	1,5	
- margin of the "chefs de cantons"	0,5	(2)
Price granted by OPVN at local assembling point		42
Transport margin to next OPVN warehouse		2
Price granted by OPVN at regional warehouse		44

The following selling prices (per 100 kg bag) were given by OPVN [1]:

millet	50 FCFA/kg
white sorghum	50 FCFA/kg
red sorghum	40 FCFA/kg

This would result in gross margins of 8 FCFA/kg (including transport to a regional warehouse) or 6 FCFA/kg without transport to regional warehouse. In 1976-77 the official OPVN calculation indicated costs of 8.25 FCFA/kg (including a UNCC-commission of 1.50 FCFA and transportation costs of 2 FCFA). Even at that time OPVN officials estimated effective costs of 16.50 FCFA/kg [2].

This clearly demonstrates that the OPVN prices strongly depend on state subsidies. The aim of OPVN's marketing policy is the protection of both consumers and producers from speculative price behaviour. An analysis of the private sector will help to judge if a state monopoly in the cereal market is justified and advisable.

In Nigeria only minor state interventions in the millet and sorghum market are known (e.g.: storaging, semi-fixed retail-wholesale margin for sorghum).

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1) Information by OPVN on 17th Jan.1980

2) CILSS-Study: Commercialisation p.19

3.2.1.2. Analysis of price variations

Temporal price behaviour

Seasonal price fluctuations are clearly related to harvest-dates. The price peaks are usually between May and July while prices go down usually in November - January [1].

But there are also many short-term price fluctuations from one week to the next. This is mainly due to the high dispersion of markets with difficult transport and communication conditions.

In Niger the average range of price fluctuations between November - January (low-prices) and May - July (price-peaks) is shown in the following table [2]:

Table Nr. 19

Years	Average Maximum/Average Minimum Prices +++
1961 - 1968 +	1.27
1970 - 1976 ++	1.22

+ before OPVN intervention +++ Average Minimum Pri e = 1

++ after OPVN intervention

Also for Nigeria researchers report no exessive average seasonal price-fluctuations especially for sorghum and millet price increases compare favourably with storage costs [3].

1) Price fluctuation of millet in the Department of Zinder: see appendix 8
2) Source: CILSS-Study: p. 97/98
3) Feasibility Study on Foodgrain Processing in Nigeria, p. 13

Spacial price differences

Both in Niger and Nigeria inter market price differences are commonplace. In Niger a relatively high integration [1] of markets were found to follow a common trend in their price behavior (see also appendix 8). On the other hand it was found that OPVN was able to reduce price differences between different markets, especially by selling cereals in the urban centers at a reduced price. Spatial price differences are especially due to a great number of variables found in transportation costs in Niger and Nigeria. This includes distances, consignee's responsibilities, capacity of lorries, part or full load, etc.
Only the price spread between different markets which is greater than costs of transportation (plus costs of selling and risk) would indicate that traders are benefiting from exploitery practices.

3.2.1.3. Analysis of margins

Annual averages of marketing margins in the private sector in Nigeria are provided by Hays[2]:
Marketing margins as per cent of final retail price using one sack of millet and sorghum:

Table Nr. 20

	Millet	Sorghum
Producer	68.2	69.8
Local Assembler	9.1	9.5
Local Transporter	2.6	2.2
Rural Market Community Agent	2.0	2.2
Rural Assembler	5.0	4.1
Lorry Transporter	3.9	3.2
Wholesale Communtiy Agent (urban)	2.6	2.2
Retailer	6.6	6.8

1) CILSS-study: Commercialisation, p.53

2) Source: Food Grain Processing in Nigeria, p. 94

In January 1980 we have found the following average prices and margins for millet in different markets (FCFA/kg) in Niger:

Table Nr. 21

	Producer Price	Wholesale Price	Retail Price
Price	40	55 - 60	85
Margin	47 %	17 - 23 %	30 - 36 %

It must however be considered that private merchants will not always pay the official producer price. Lower prices in remote areas and higher prices during the seasonal price peaks are possible. In some regions price rises up to 12.000 FCFA/sack of 100 kg may occur during the year. But it is not justified to suppose that this is only due to exploitery behaviour of private merchants, as these price rises often start at the producer level. In short, it can be stated, that many researchers [1] have found -in comparing private trade margins and costs in Niger and Nigeria- that it is highly unlikely, that traders are benefiting from exess profits within the normal trade operations in their countries.

3.2.2. Analysis of price differences between Niger and Nigeria

3.2.2.1. The problem of the exchange rate

The difficulties in exchanging the Nigerian Naira at the official exchange rate have led to an unofficial exchange rate. In relation to FCFA the official rate in January 1980 was 1 Naira = 380 FCFA while unofficially the Naira could be bought at 180 - 210 FCFA. A number of Nigerian merchants are especially interested in selling their goods in Niger or at least against FCFA in order to get a currency with free external convertibility. This has caused special conditions for the exchange of consumer goods between the two countries. Therefore a comparison of prices between the two countries has to be especially aware of the cross rate.

1) Sources: see CILSS-Study, p. 62
Food grain Processing in Nigeria, p.13

3.3.2.2. Sorghum and millet

During December 1979 the following average retailprices were reported from 5 Kano municipal markets [1]:

Table Nr. 22

	Kobo/kg	FCFA/kg +	FCFA/kg ++
Sorghum	23	87	46
Millet	25	95	50
Assuming an average trade margin of 32 % (see p. 40) this would lead to the following producer prices in FCFA:			
Sorghum		59	31
Millet		65	34

\+ Exchange rate 1 N = 380 FCFA
++ Exchange rate 1 N = 200 FCFA

In January 1980 retail prices in Niamey, Zinder and Maradi were between 80 - 90 FCFA/kg for sorghum and millet. Wholesale prices were between 48 - 60 FCFA/kg (sorghum) and 55 - 65 FCFA (millet).

The comparison shows that the price level on the retail markets of Kano and the mayor urban centers in the south of Niger is almost equal if one applies the official exchange rate. But the aspect changes completely when applying the unofficial rate. In the latter case it would result very profitable to buy millet and sorghum in Northern Nigeria and sell it in Niger. Some of the wholesale traders asked by us on the Maradi market admitted quite openly that their sorghum and millet originated from Northern Nigeria. Therefore there are strong reasons to believe that actually considerable amounts of sorghum and millet are unofficially imported from Northern Nigeria to Niger.

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1) Source: Kano State, Statistics Unit, Ministry of Finance and Economic Development

3.2.2.3. Comparis on of wheat flour prices

As mentioned before there is also a considerable quantity of Nigerian wheat flour offered on all Niger markets. A comparison of prices in Zinder (Sotramil) and Kano (Northern Nigeria Flour Mills) under cross rate aspects gives the following results:

Table Nr. 23

	/t	FCFA/t +	FCFA/t ++
NNFM selling price	254.20	96.596	50.840
Sotramil selling price		84.000	
COPRO selling price		107.660	

\+ Exchange rate 1 = 380 FCFA
++ Exchange rate 1 = 200 FCFA

In the flour market the same price situation as in the sorghum and millet market is visible. Based on the unofficial exchange rate the NNFM selling price is only 62 % of the sotramil and 47 % of the COPRO price.
In order to estimate the size of a profit margin, transportation costs have to be considered. Appendix 20, shows realistic calculations for Niger in 1978. Applying these rates to the transport of one ton of flour from Kano to Maradi would result in a cost price (NNFM selling price + transportation costs) at Maradi of approximately 60.000 FCFA/t (part load) or 55.500 FCFA/t (full load)). Even if one considers the remaining costs of a merchant bringing wheat flour from Nigeria, it is obvious that a very profitable net margin will be left.

3.2.2.4. Comparison of sorghum flour prices

The sorghum flour milled by Sotramil aims at the substitution of wheat flour in bread and pastry. Apart from the problems of quality also the price relationship to wheat flour has to be considered.
Sorghum flour is sold by Sotramil at the same price as wheat flour (84 FCFA/kg). Considering the price relationship to unofficially imported Nigerian wheat flour (60 FCFA/kg) it is obvious that price competition is very hard at the moment for sorghum flour.
But also under normal conditions it can not be expected that bakeries and other users will be inclined to substitute wheat flour by sorghum flour without a price incentive, i.e. a sorghum flour price which is lower than the wheat flour price.

3.3. Conclusions:

In Niger and even more in Nigeria the distribution system for crops and flour strongly depend on the private sector. In Niger there are hopes that the public intervention system will become more efficient especially what concerns assembling and storage. An industrial milling system should therefore look for close cooperation with the already existing warehouses in Niger.

With regard to the distribution of sorghum and millet flour both the public and the private distribution system should be used. Sufficient storage posibilities, decentralized milling capacities and means of price control in the private sector are necessary for a satisfactory distribution system of sorghum and wheat flour.

Besides the quality aspect, the flour price plays a decisive role in the acceptance of the new product by users and consumers. The Sotramil sorghum flour does not fulfill these conditions. Even if the quality could be improved, one has to be doubtful whether the price can be reduced, as the actual price is not yet covering the production costs.

The unofficial exchange rate presents a serious problem in the flour marketing. In order to compensate the price advantage of unofficially imported wheat flour an effective marketing concept for millet and sorghum flour is necessary. This would include high quality, new utilization purpose, a good image and last but not least an attractive price which should be lower than the wheat flour prices of Sotramil and COPRO as a minimum condition.

In our opinion the possibilities to control the unofficial import of wheat flour from Nigeria are very limited. Free border traffic between the Hausa population on both sides of the border should be considered as a prerequisite for harmony and social satisfaction. Rigorous control measures could have undesirable political effects among the Hausa population and are very difficult to carry out because of the considerable extension of the border.

4. The milling of millet, sorghum, rice, maize and wheat

4.1. The different varieties of millet and sorghum grain and grain quality

In botanic literature there is a distinction between different species of sorghum and millet which are subdivided into varieties:

Sorghum (andropagon sorghum) = yellow-brown has the following varieties:

Sorghum Guineensia (Guine Corn)

Sorghum bicolaria (Brown Sorghum)

Sorghum caffra (Kafir Corn, read Sorghum)

Sorghum nervosa (Sorghum Koaliang)

Sorghum durra and its subvarieties red durra, yellow durra

Sorghum drummondii (Chicken Corn).

A survey of some subspecies of sorghum is given in app. 9. Besides there are existing in Niger 137 - 162 local strains.

The most recommended strains of sorghum guineensia are called for instance Ex-Bauchi HP 3, RZ1, FFBL, SU 5912, L 187.

Sorghum grain kernels have an average composition of 4 - 8 % pericarp, 10 % germ and 82 - 88 % endosperm.

Millet has the varieties:

Pennisetum typhoides (African Millet)

Panicum miliaceum (Hog Millet)

Setaria Hulica (Italian Millet)

From "Italian Millet" the subvarieties "Sano" (slightly grey) or souna (brownish) are known. In Northern Nigeria the strains of Pennisetum typhoides are cultivated: Gero (early millet), Maiwa (late millet) and Dauro (transplanted). Gero is interplanted with sorghum.

The grain quality can be classified by 3 characteristics:
The milling characteristic, the characteristic based on appearance and cooking quality in food preparations and the characteristic based on nutritional value.
The latter characteristic may help the livestock feeder, but nobody usually buys food just because it is nutritional value. This nutritional view point is only important for the food planners and to assess the nutritional situation of a population.
With regard to the characteristic based on appearance and cooking quality in food preparations little is known in literature. The only argument we could confirm is that millet has a fuller taste than sorghum. Sorghum needs more aromatisation [1]. On the other hand in our opinion red sorghum has no real future, due to its high bitter taste caused by the poly phenolic substances.

The epicarp of pearl millet is thicker and more dense than that of sorghum.
The relative proportion of germ to endosperm is higher for pearl millet.
The endosperm cells of millet contain greater quantities of protein than sorghum. -This may be the reason for a fuller taste of millet flour- .
The protein bodies of pearl millet are smaller and more uniform in size than those of sorghum. Starch granules are smaller than those of sorghum.
They appear accordingly to Sullins and Rooney more resistant to hydrolysis by amylases compared to sorghum starch granules.
The milling characteristics of sorghum are based on sound grains, endosperm texture, average kernel weight, low content of stones, sand and foreign matters.
Kapasi-Kakana has given a useful survey of sorghum [1] in this respect.

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1) International Association for Cereal Chemistry, Symposium 1976
Sorghum and millets for human food, Vienna, Tropical Products Institute, London ISBN 085 954 0677

The milling characteristics of millet depend upon their size. The grains of millet have a granulation of 2,5 mm, 2 mm, 1,5 mm and 1 mm. Those below 1 mm can not be used in milling industry. 2 % of millet are below 1 mm and 50 % of the millet grains are bigger than 2 mm. The experts of FAO propose to differentiate millet into 3 classes [1].

Class 1: Sound grains, no insects, less than 10 % of foreign matters and grains smaller than 1,5 mm. Not more than 2,5 % sand and stones.

Class 2: Sound grains, no insects, less than 16 % of foreign matters and grains smaller than 1,5 mm. Not more than 2,5 % sand and stones.

Class 3: (bad quality) All qualities which are worse than class 1 and 2.

We acknowledge the value of this classification as an important prerequisite for successful milling.

4.2. Milling of millet, sorghum and maize in households in Niger and Nigeria in the traditional manner

The process of making flour from millet, sorghum and maize is in Niger the same as in Nigeria. While in Niger about 90 % of the households use the traditional procedure, in Nigeria the share is only 30 %.

The traditional method of processing millet-, sorghum and maize with a wooden mortar is as follows:

The grain is soaked overnight in water of about 30 °C. The natural microbes (lactobasillus fermentli and candida kruse): of the grains are growing and producing acids. By this fermentation process all pathogene microbes are killed.

1) FAO-Report, DP/FAO, AGS/NER/71/521, Etude du Procede de Fermentation des Mils Utilisé par la Sotramil à Zinder et Possibilite d' Industrialisation, Rome, 1974

2) Grain milling and utilization (Nigeria), an evaluation IDRC-Report, February 1978

The starch of the grain takes up water and is swelling [1]. By this swelling the grains are loosing their hull. The damp grain is pounded manually in a mortar to take off the hull then dried in the sun and winnowed to remove the hull particles. The hulled grain is returned to the mortar and pounded into a coarse flour. The yield is only 60 - 65 % of the original grain. The flour is then sifted. The capacity of one person is 1 kg/1,5 hours of wet flour (30 - 40 % water). Because the flour remains damp, its shelf life is limited to a few days. Therefore the housewives sometimes dry flour in the sun. The water content of the different flours is shown in table 24.

If the time or facilities for hulling are not available, the raw intact sorghum may be passed through the grinder. The resultant flour is not very popular, because of this high fibre content and its dark hull flocks in the flour.

1) FAO-Report AG/DP/NER/71/521

Table 24

Water content of different, processed sorghum and millet flour and grain

	Water	Acid content $\frac{n}{10}$ $NaO\overset{+}{H}$ of 10 g flour
Sorghum flour, home made, damp hulled (Niamey), +fermented	29,4 %	3,2
Millet flour, home made, hulled dried (Maradi), fermented	10,0 %	5,0
Sorghum flour, industrial, Kaduna+	7,6 %	1,3
Sorghum flour, industrial, Zinder+	8,7 %	1,8
Sorghum flour, industrial, decorticated, Zinder	12,8 %	1,4
Sorghum flour, industrial, Sudan	6,0 %	1,4
Sorghum corn, Zinder, red durra	4,5 %	-
Millet corn, grand marché, Niamey, yellow-green	4,1 %	-
Millet corn, grand marché, Niamey, brown	5,3 %	-

+) The porridge had a sandy texture due to the fact that the fineness was not good enough. In Zinder and Kaduna a differential mill is used.

In many cases it is assumed that the taste of "industrially milled" millet or sorghum flour is not as good as "home-made" - sorghum or millet flour. It is said that this is due to the fermentation process of "home-made" flour which results in a higher acid content of the flour.

Table Nr. 24 shows the acid content of different millet and sorghum flours. The fermented flours have about three times more acids than the industrially made flours. We object to the normal argumentation that the good taste quality of sorghum or millet flour is due to this acid content, because we have tested industrial unfermented sorghum flour made in Sudan, which has a clean good taste and a low acid content (table Nr. 24).

We think that the quality of sorghum and millet on one side and a good and proper decortication on the other side are the most important factors. Therefore a good quality control with testing of the decortication is of great importance in every mill.

In addition we recommend to spray lactic acid solution or to add citric acid powder enriched with natural bitter aroma to the flour cautiously after milling. According to the results of table Nr. 24 we had to spray either 15 g of lactic acid (30 %) and to add 3 - 5 g citric per kg sorghum flour.

The aromatisation could be completed by cream or bitter aroma. The spraying process could be done with the same installation as used for the aromatisation of instant coffee.

4.3. Semi-industrial grinders of millet, sorghum and maize

The following description of the semi-industrial process can be given:
Only home fermented and hulled millet, sorghum or maize are used.
The fermentation process takes place as discribed under chapter 4.1.
The wet (30 - 40 % H_2O) fermented, hulled millet, sorghum or maize are brought by the house wives in 2,5 kg wooden containers (called tiya) to the private grinder station.
The grinder station consists of a small scale grinder (Differential Mill) with dieselengine [1]. The capacity of the grinder is about 10 - 20 kg of wet product/hour = 50 t/year.
The price for grinding 1 kg is 7 - 15 FCFA in Niger or 7 Kobo in Nigeria.
In Nigeria there are about 25.000 small scale grinders with a theoretical total capacity of 25.000 x 50t/year = 1,25 million tons flour production [2].
In urban districts we have about 1 grinder for 1.700 people and in the whole country 1 grinder for 3.000 people. The grinders working at full capacity could grind 0,08 kg/person/day. Assuming a consumption rate of 200 - 400 g flour person day, only 20 - 40 % of the flour demand could be ground by semi industrial grinders.
The housewives dry the wet ground flour at home on large mats.
Table Nr. 25 shows the grinders in the Kano and Kaduna regions.

1) We Found Grinders From India, Type 1 A, Muhluck, grinding type 4446
2) Feasibility Study on Foodgrain Processing in Nigeria, IDRC, 1978

Table 25			
Grinder Survey Northern Nigeria [1]			
	Grinders reported	Population $\times 10^3$	Individual Grinder Capacity to/year
Kaduna	558	217	228
Kano	163	600	191

In Niger there are less of these semi industrial grinders. They are usually found in towns like Niamey, Maradi, Zinder, Agadez. In Niamey it was estimated that about 100 grinders are working; that would mean a daily capacity of 9 - 6 to flour. Based on a population of 150.000 in Niamey and a 200 - 400 g consumption of flour per day/person these grinders could cover 16 - 30 % of the demand. In other districts or towns in Niger the percentages is in any case lower, so that we may say that about 10 - 15 % of the flour demand in urban centers is covered by semi-industrial grinders.

The advantages of these semi-industrial grinders are:

- Good taste according to consumers opinion
- Relatively low prodcution costs
- No infestation
- No transport costs

The disadvantages are:

- Low keeping quality (some days only)
- Low yield of flour from the grains (65%), and therefore waste of nutrients
- High labour costs
- Not suitable for industrial use of flour
- No export of flour possible
- Grinding not fine enough

1) Feasibility Study on Food Grain Processing in Niger, IDRC, 1978

4.4. Present industrial milling of millet, sorghum, maize rice and wheat in Niger and Northern Nigeria

4.4.1. Niger

4.4.1.1. Millet mills

There is no industrial millet flour production in Zinder (Sotramil). In 1974/75 FAO published excellent reports [1) 2)] how to produce fermented millet flour in an industrial scale. According to this report about 1,7 % of substances are wasted by water treatment, the production costs are 80 % higher than for milling sorghum flour and the lipophylic enzym activities are much higher than for non fermented flour. This results in a product which has a good taste when it is fresh, but which has a high price and which is very bitter when it is consumed. We know that a fermentation process kills the pathogenic microbes. But on the other hand any fermentation process increases the lipophylic enzyme activity and reduces the good keeping quality of the millet flour [3)]

For hulling purposes the fermentation process is no longer necessary, as high standard hulling equipment for industrial use has been developped. For the taste aspects of fermentation see chapter 7. As in Zinder (Sotramil) there is a properly equiped laboratory, this equipment could be used later on by the official control laboratory (see Chapter 6.4.) for sorghum and millet flour.

4.4.1.2. Sorghum mills

There are: one sorghum mill in Zinder
one sorghum mill in Miria, Village Djeda
two sorghum mills in Magaria, Village Koya
one sorghum mill in Madamey, Village Bannama

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1) FAO-Report, DP/FAO, AGS/NER/71/521 .....

2) PNUD , Rome AG/DP/NER/71/521 .....

3) International Association of Cereal Chemistry, Symposium 1976 (Abdoul Aziz Thiam).

The sorghum mill at Zinder began to operate in 1968 and has a capacity of 1,5 t/hour. The construction is of French origin and was set up with the technical assistance of UNDP/FAO. The installation consists of destoner, cleaner, conditioner, huller, rollmill, dryer, sifter and packaging machine. Compared with the new technologies it is a very complicated and labour intensive installation. The machinery comes from different industries (Gebr. Glöckner). Baldesch & Sandrea (Italy), Bühler (Swiss), Ultrfina, Soccam, Rohr (France). The staff consists of 55 persons. The theoretical capacity is 4000 - 5000 t/year, but in 1979 the actual production was only 2000 t/year, because of lacking demand for Sotramil flour. These 2000 t flour consists of 878 t wheat flour, 561 t sorghum flour and 464 t bran. We were told that the wheat flour of Zinder can not be used in bakeries. This is said to be due to the poor wheat grain quality Sotramil had to use as raw material.

The sorghum flour produced by Sotramil is strongly criticized by consumers and users, because it becomes bitter when kept for a time. It is essential to solve these quality problems of sorghum flour. A lot of research work has been done in Dakar [1] and the results could be applied in Zinder.

The technical process in Sotramil is as follows: The grain is first washed and graded. Then is heated up to 70 °C in order to dry the grain and kill the Lipase. After this the grains are passing a hulling machine (Bavaria) with horizontal stones. The grindling operation is carried out by an "Ultrafina" apparatus. The flour is sifted on revolving bolting mills, which separate it from the semolina. The yield is 65 - 70 % flour.

The keeping quality of this Sotramil sorghum flour is not good, because of the oxidation of the fat of sorghum flour. This oxidation results in a bitter taste of the flour. This is due to the enzymatic oxidation of the lipids.

Abdoul Aziz Thiam [1] did not find any confirmation of lipoxigenatic activity but this is due to the fact that he used an unsufficient method (ultraviolet spectrophotometry).

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1) International Association for Cereal Chemistry, Symposium 1976

The lipoxygenase is activated by the washing and drying process and the high water content of the sorghum flour (7 - 12 % H_2O). So the technical concept of Sotramil is not according to the chemical need.
On the other hand it was found that there is a lot of microbiological deterioration of sorghum or millet flour, if the water content is higher than 6 % [1].
Sotramil products are mainly sold to the army.
The mills of the villages of Djeda, Koya and Bannama are grinders for the milling of home fermented millet. They are of the same type as the semi industrial mills (french type) and were installed 1967.
Three mills of USAID are planned in Sirimi, Mameley and Balgara. The capacity and the type of the mills were unknown.

4.4.1.3. Wheat mills

There is no other wheat mill in Niger. In Niamey a private wheat is planned. It will have a capacity of 15.000 t/year which corresponds to the PAM-Programm = 15.000 t wheat flour/year. Thus the wheat flour import could be replaced by wheat grain.In this context we advise to make weaning food from the wheat germs, which increases the rentablility of the mills.

4.4.1.4. Rice mills

There are rice mills in Niamey and Tillabéri.
The theoretical capacity of Niamey is about 300.000 t/year and of Tillabéri 100.000 t/year. The actual capacity is about 60 % of the theoretical capacity in Niamey and 30 % in Tillabéri . The products have a fair quality, which also depends on the quality of the imported rice. We were told that the local rice is difficult to process. The paddy is first cleaned in a destoner and than passes through a conditioner and a huller and is polished thereafter. Then the broken rice is seperated from the high quality polished rice by sifting.
The bran of the rice is up to know used for cattle feeding. Because of his excellent nutritional value it could be very useful as an important component for a locally producted weaning food in order to substitute the imports of weaning foods.

1) International Association for Cereal Chemistry, Symposium 1976

4.4.2. Nigeria

4.4.2.1. Millet mills in Northern Nigeria

There is no millet flour production in Nigeria. Several attempts have been made in Maiduguri to hull and grind the available varieties of millet by the dry process. The hulling was successful unfortunately the flour developed an unpleasant green colour when beeing cooked.

4.4.2.2. Rice mills in Northern Nigeria

About 500.000 tons of rice are consumed annually in Nigeria. 95 % of the rice is processed in 2.000 Engleberg-type hull polishers. The larger rice mills make a better product (Ilorin, Jos, Abakaliki, Ada-rice, Awka) but thea are note located in the northern part of Nigeria. The local rice is too expensive to be processed and cannot compete with imported rice. Therefore there is a need to improve the quality of the domestic rice.

4.4.2.3. Wheat mills in Northern Nigeria

98 % of Nigeria's wheat grain consumption is imported. In Northern Nigeria there are private wheat mills in Sokoto (150 t/day) in Maiduguri (300 t/day) and in Kano (800 t/day). In Kano an expansion from 800 t - 1.300 t/day is under construction. The Kalaba mill (180 t) is now managed by the Northern Nigeria Flour Mills. According to Northern Nigeria Flour Mills there is actually a demand of about double the quantity (2500 t/day). The wheat mills are all well organized, dispose of skilled personnel and give a satisfactory profit. The experimental bakery in Kano "Northern Nigeria Wheat Mills" made successful experiments in replacing 20 % of wheat by sorghum flour in bread. So a potential market of 1300 t/day x 20 % = 260 t sorghum flour/day, (72.000 t/year) could be estimated. Preferably "Hard Winter Wheat" with 13 % protein is used for flour production. As mentioned before the local wheat can hardly be used for commercial milling as it is lower in quality and much higher in price than the imported wheat.

Up to now the wheat germs are used for cattle food. It would be worth while to look for a use for human consumption, because the germs have a low price.

50 % of the wheat flour is bought by bakeries, 15 % by the trade and 35 % by private consumers.

4.4.2.4. Sorghum and Maize Mills in Northern Nigeria

Pilot plant mills for sorghum are exsisting in Maiduguri and Kaduna.
Both pilot plants are sponsored by the Borno and Kano State and IDRC,Canada.
The mills (Hammermill) process about 400 kg grain sorghum ormaize per hour. The yield is about 320 kg flour/hour, 2,5 t/day = 700 t/year. The mills produce about 60 % of their capacity, because they cannot sell more (1,7 t/day).
Compared with other products of the market and the home made flour, the flour from Kaduna has a low quality in respect to taste, colour and fineness (see chapter 4.5.), and an extremely high price.
The water content of the sorghum flour is too high (7,6 %). It should be lower than 6 % in order to prevent the enzyme activity of lipoxygenase, which causes the bitter taste of sorghum or millet flour by oxydation of the fat. We have already stated in schapter 4.1. that the water content of sorghum or millet corn with a good keeping quality, should be below 6 %.
The taste of cooked sorghum flour (Kaduna) is not satisfactory. We found a taste of old grain which is due to bad hulling. The fineness of the flour was not good enough compared with the home made products.
In our opinion over-staffing is the main reason for the high production costs. In order to reduce costs a reduction of personnel and a reorganization of the marketing activities are advisable..
The installation consists of: Huller (Bay State, Canada), Hammermill (AG Buder Jakobson Masha Works Inc.), air transportation sieves, semi-automatized packaging, weigher , 2 Dieselengines.
The staff consists of 11 persons,

The fineness of the flour is of great importance. Actually the fineness in Maiduguri mill is only 4/64 mash while in Kaduna the fineness is 1/64 to 1/60 mash. The fineness of Maiduguri was not acepted by the consumer. Other complaints about the Maiduguri sorghum flour concerned the lack of the sour taste appreciated so much by the local consumer and a grey colour which resulted after cooking the flour.
In our opinion there is no doubt that this grey colour is due to bad hulling.

4.4.3. Summary of 4.4.

All the existing mills are lacking the consumer and market orientation. The quality is lower than the quality standards which could be reached with their installation.
Therefore the most important activity should be to build up a quality assurance combined with special certificates. This task should be entrusted to a small independent governmental laboratory, which in addition could provide regular training in quality assurance to the technical staff.

4.5. Nutritional and chemical composition, taste, viscosity of millet and sorghum compared with maize, rice and wheat

The knowledge of the composition is very important in respect to nutritional and milling aspects and for the devlopment of new products based on sorghum and millet.

4.5.1. Nutritional and chemical composition of cereals

The composition of millet, sorghum, maize, rice and wheat is listed in table 26.
The protein content of the grains is very important for the "Sahel-Zone".
The minimum protein content of the food should be 12 %. Therefore the sorghum has a very good protein value and is preferable to maize, rice and wheat.
The fat content is very high in millet as well as in sorghum and maize.
This is another argument for sorghum and millet. Compared with rice and wheat, the fibre content is very low. That is the reason why milling losses are lower.
The calorie values for millet, maize and sorghum are higher than those of rice and wheat.

Table 26

The composition of millet, sorghum, maize, rice and wheat in % dry matter [1,2,3),4),5)]

	Italian millet	Sorghum	Maize	Rice	Wheat France
Water	10 - 8	11 - 8	10	-	15 - 13
Protein	9	7 - 16,2	10,6	7,8 - 11,5	13 - 9
Carbohydrates	84	64 - 76,2	82,5	64 - 73,5	68 - 75,0
Fat	4,9 - 5,7	3,2 - 4,5	4,1	1,6 - 1,9	1,9 - 2,0
Ash	1,1	2,6	3,1	5 - 4,4	1,6 - 1,7
Fibers	1,3 - 0,6	1,3 - 2,9	1,3	9,0	1,8 - 9,0
Calories/g/ dry matter	416	392,8	409	357	366

1) Ed. Wyss, The Processing of Millet and Sorghum, Bühler Brothers Ltd. Swiss

2) Annual Report of Accelerated Food Grain Processing, Kaduna 1978

3) Etude de viabilité sur la transformation industrielle des Mils (Phase II), Niger, FAO, Rome 1973

4) Ullmanns enzyklopädie, Bd. 8, p. 14

5) Handbuch für Lebensmittelchemie, Springer-Verlag, Berlin

In table 27 we summarize the differences in protein fraction of the most important grains in Niger/Nigeria [1]. The knowledge of the proteinfraction is important in respect to the problem of composite flour and their technological characteristics (the proteinfractions of millet are unknown) for the case of replacing wheat flour by compositeflour.

Table 27

Proteinfraction of sorghum, maize, rice and wheat (in %)

	Total Protein	Albumin	Globulin	Prolamin	Glutelin	Pentosan
Sorghum	7 - 16	10 - 11		-	30	3
Maize	7 - 13	-	5 - 6	1 - 5	30 - 45	-
Rice	8 - 10	-	2 - 8	10-15	85 - 90	-
Wheat	9 - 13	3 - 5	6 - 10	40-50	30 - 40	-
Mixture 30% Sorghum, 70% Wheat	-		9 - 13	28-35	30 - 41	1,5

But from the technical view point a certain quantity of wheat flour can be replaced by sorghum flour if we take wheat grain with high protein fractions. About 30 % of wheat can be replaced by sorghum, if we take wheat varieties with a high prolamin content (Canadian wheat). This is realistic especially in the case of making a French type wheat bread. The amin acid composition is important in respect of the nutritional value of the food. Especially the essential amino acids, which cannot be synthetized by the human body, are important. Compared with wheat, sorghum has a lowe value in respect of Leucine (50 % wheat) and Methionine (30 % of wheat).

1) Ullmanns Enzyklopädie, Band 8 uff. Handbuch für Lebensmittelchemie, Springer Verlag, Berlin, 1968

The Lysine content and Cystine content of sorghum are better than in wheat [1].
The Lysine content of millet is comparable to that in high-lysine corn [2].

Table 28

Mineral composition of millet, sorghum, maize, rice and wheat in mg/100g [3]

	Millet	Sorghum	Maize	Rice	Wheat France
Calcium	50	23	6	12	36
Phosphors	358	71	300	290	392
Magnesium	180	230	160	119	170
Potassium	310	370	400	342	480
Sodium	10	20	50	78	100
Iron	9	0,4	2,5	2	3,0
Manganese	14	27	6,8	10	45
Copper	5	7	4,5	3,6	7,9

The mineral composition of millet is very exceptional in respect of the high calcium content, which is nearly 50 % of cow milk (table 28).

Sorghum and millet contain in their shell tannic acid substances. These tannic acids coagulate proteins. Therefore a carefull elimination of the shell by hulling is essential for the nutritional value of sorghum and millet.

The tannic acid content is extremly high in red sorghum. Therefore the flour of red sorghum effects the protein quality and the baking quality of wheat flour.

In Sotramil (Zinder) red sorghum was used for making sorghum flour, because the red sorghum is cheaper than the yellow or brown one. This can not be recommended.

Last but not least should also be given attention to the vitamin content of sorghum (table 29).

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1) Ullmanns Enzyklopädie, Bd. 8,14.
2) International Association for Cereal Chemistry, Symposium 1976
3) Annual Report 1979, AFPP, Zaria

Table 29

Vitamin-content of sorghum compared with wheat 1)

Vitamines	Sorghum full corn mgr/100gr	Sorghum decarticated mgr/100gr	Wheat mgr/1oogr	"Recomended Daily Intake" 2)
B_1 (Thiamine)	250-350	350	250-350	1600 - 1400
B_2 (Ribo flavine)	150-230	180	150-230	2000 - 1800
B_6 (Pyridoxine)	800-900	1000	800-900	1800 - 1600
Niacine	2000-2800	5300	2000-2800	9000 - 15000
Penthotenic acid	-	1300	-	8000
Tocopheroles	-	200	-	12000

Sorghum has a similar vitamine content as wheat. By 500 g sorghum one gets sufficient vitamines except Tocopheroles and Carotinoides. This is a very important conclusion what concerns quality view points if nutrition. In short, sorghum is a very good food which is in some cases better than the traditional grain food (wheat, rice) of Europe.

1) Ullmanns Enzyklopädie, Bd. 8, p. 14

2) Empfehlungen für die Nährstoffzufuhr, Deutsche Gesellschaft für Ernährung, Umschau Verlag, Frankfurt/M., 1975

4.5.2. Taste

Last but not least we try to describe the difference in taste of sorghum and millet. In Diffa (Niger) people prefer sorghum. The same applies to Bornu (Nigeria), while in the other parts of Niger and Northern Nigeria millet is preferred. While cooked sorghum has a texture similar to cooked farina; cooked millet has a smooth texture like pudding.

Sorghum flour of good quality (well hulled) has a neutral taste, while millet has a slight green fresh and slightly sour taste. This taste depends upon the quality of the raw material and the flour milling system (see table 30).
In order to increase the good taste of the flours housewives grind sorghum together with onion, green paprica etc. This aromatizing of sorghum flour can also be done by the industry (see 4.1.).

Table 30

Taste and colour of different flours available on the market

Flour type	Colour of the dry flour	Colour of 15% porridge preparation	Taste of 15% porridge preparation	
Sudan Sorghum flour, Schule Mill	white 1.	white 1.	neutral 1.	good
Zinder Sorghum flour, Sotramil flour, fresh	gray-brown 5.	white 1-2	neutral 1/2	sandy
Kaduna Sorghum flour, Industrial flour	yellow-brown 4	brown 4	taste like old grain 4	inferior quality
Maradi Millet flour, home made	yellow-white 2	white-yellow 3	fresh green smooth texture 3	good
Niamey millet flour, semi industrial grinder	gray-white 3	green 5	fresh green sour smooth texture 4	inferior quality

The fresh Zinder sorghum flour was of good quality, while we often found in the market samples of unsatisfactory quality which had become bitter. This must be due to oxidation of the fat during storage. The bitter taste is caused by the enzyme lipoxigenase which can only react, if the flour has a water content of more than 6 %. We recommend for Zinder flour to dry the flour to a water content of 4 - 5 % in order to increase the keeping quality to 6 - 12 months.

The keeping quality may be influenced by the fat phase and their fatty acid composition. The analytical fat results are shown in table 31[1]. The fatty acid composition of sorghum, millet, maize, wheat and rice are very similar. They have a high quantity of the essential fatty acids and linoleic acid.

Table 31

The Fat and Fatty acid Composition of sorghum, millet, maize, rice and wheat (in %) [2] [3]

	Sorghum	Millet	Maize	Wheat	Rice
Fat content (ether extract)	4,3	5,6	4,5	-	-
Palmiteic acid	10 - 14	18 - 25	12,7	12	11-17
Stearic acid	2,1	2 - 3	2,6	0,8	2,5
Arachidonic acid	0,2	0,5	0,4	-	0,5
Palmitioleic acid	1,0	0,6	0,4	-	-
Oleic acid	28 - 42	20 - 31	26,0	27	41
Linolenic acid	42 - 56	40 - 52	56,3	39	30
Linolenic acid	1 - 5	2 - 5	1,6	9,6	-
Free fat	3,16	-	4,25	-	-
Bound fat	0,19	-	0,14	-	-

1) L.W. Rooney: Cereal Chem. 5.5. (5), 584 - 590, 1979

2) H.P. Kaufmann und G. Thieme:: Neuzeitliche Technologie der Fette und Fettprodukte, Aschendorffsche Verlagsbuchhandlung, Münster/Westfalen, 1956

3) Cereal Chemistry 55 (5), p. 572, 1978

The fatty acid composition of the germs of sorghum and millet corresponds to that of the endosperm. The content of carotionids is very low. The riper the grain the lower the content of the carotionids..

For milling experiments the fat distribution in sorghum may be of interest (see table 32):

Table 32

Fat distribution in the different parts of sorghum [1)]

	% of Kernel	% Total Lipids	% Triglycerides of Total Lipids
Kernel	-	4,3	82,4 .
Germ	10,8	32,5	79,9
Endosperm	82,4	1,0	55,9
Pericarp	6,1	0,2	-
Tipcap	0,7	0,3	-

It may also be of interest that in the shell of sorghum there is a wax which is similar to Carnabauwax which has a great importance in polishing dragee sweets. In the future it could be useful to isolate this wax from the bran for industrial purposes. The composition of this sorghum wax compared with carnabauwax is shown in table 33. .

Table 33 Comparison Sorghum wax and carnabau wax

	Sorghum	Carnabauwax [+)]
Alcohols	46 %	12 %
Esters	49 %	80 %
Paraffines	5 %	1 %
Lactones	-	3 %
Residues	-	4 %

+) extracted with hot benzine for 30 seconds

1) Cereal Chemistry, 55 (5), 572 (1978)

The following informations deal with the colours and enzymes of sorghum and of millet. The amylase of millet has its highest activity at pH 5. This is important with regard to the breakage of millet starch during industrial treatment [1] and results in a higher bread volume of wheat bread by addition of 10 % to wheat flour. It is known that in red sorghum there is a high content of tannic acids which inactivates amylase. Therefore flour of red sorghum is not suitable for mixing with wheat flour [2].

The yellow green pigments of millet are phenolic substances [+] which are in alcaline solution yellow green and sour medium white creamy [3]. Therefore the flours with higher acid content are more creamy white. To achieve this creamy colour also in cooked flour, the addition of acids to sorghum flour can be recommended (3 g of citric acid per kg/flour).

Last but not least we have to determine the viscosity (consistence) of sorghum and millet porridge as a basis for the different nutritional preparations. As indicated in table 34 the sorghum has a higher viscosity (more solid texture) than millet. In its texture millet reminds more of oat porridge and sorghum more of semolina.

The gelatination of sorghum and millet starts at 70 °C. If under certain circumstances one wishes to have a sorghum porridge of the same texture as millet porridge, we propose the addition of enzyme preparations to sorghum flour.

In table 34 we compared the viscosity of maize and wheat porridge. It was demonstrated that the viscosity of sorghum is much higher than that of millet wheat and maize. This has on the one hand great importance with regard to baking experiments with mixtures of wheat and sorghum (higher water absorption at 70 - 100 °C) and on the other hand sorghum may play an important role in all foods, were starch is used because of his gelatination power.

+) Glucosylvitexin (29 mg/kg), Glucosylorientin (11 mg/kg) and Vitexin (4mg/kg)

1) J.S. Kovron und K. Lorenz: Cereal Chemistry 56 (6) 559, (1979)
2) A.V. Bailey, G. Semwell: Cereal Chemistry 56 (4) 295, (1979)
3) R.D. Reickert: Cereal Chemistry 56 (4) 287 - 294 (1979§

The other important advantage of sorghum flour compared with maize and wheat flour is that by long cooking or cooking several times there is no decrease of the gelatinous capacity. This should be studied further in view of to the problems of the "canned food industry". One reason for the high viscosity of sorghum flour is that sorghum contains β-amylase which results in dextrine and millet wheat contains α-amylase which results in Maltose.

Table 34

Viscosity of 15 % sorghum and millet-porridge (measured 6 hours after preparation)

	Viscosity c.p.
Millet Flour Niamey, fermented home made, 15 %	1740
Millet Flour Maradi, fermented home made, 15 %	1920
Sorghum Flour, Zinder, industrial, 15 %.	3000
Sorghum Flour Kaduna, industrial, 15 %	2880
Sorghum Flour Sudan, industrial, Schule, 15 %	3120
Maize Flour, 25 %	588
Wheat Flour, 15 %	240

4.6. Conclusion of 4.0.

Sorghum and millet are very nutrional foods. This was shown by describing the botanical and chemical composition of sorghum and millet.
The technical methods and possibilities to prepare a well tasting flour have been discussed: The "home made " and the "semi industrial methods" a result in sorghum-and millet-flour, which are accepted by the population.
The wheat mills and rice mills however are not suitable for milling of sorghum and millet. The Sotramil-system is not yet recommendable for Niger or Northern Nigeria, because the products are not fully accepted by the population, the keeping quality is unsufficient and the production system is relatively compliated and expensive. All chemical and technical knowledge has been described in this chapter which is relevant in case of technical or quality problems or for new products.

5. Comparison of existing standard milling equipment for millet and sorghum

5.1. Home flour mill

The process of making home flour is described in chapter 4.1.
A housewife needs 1 hour for fermentation and hulling and 1 5 hours for pounding 1 kg of millet flour or sorghum flour. The minimum salary (18.000 FCFA/months) is about 100 FCFA/hour. That means the manpower costs for 1 kg home flour are 250 FCFA (2,50 DM/kg).
The yield of flour is about 60 % for sorghum and 50 % for millet. 1 kg millet grain costs 50 FCFA and 1 kg sorghum grain 47,5 FCFA (official price).
That means the material costs are 79,1 FCFA for sorghum flour and 100 FCFA for millet flour. The whole costs for 1 kg home made millet flour is 375 FCFA (3,75 DM) and for 1 kg sorghum flour 354,1 FCFA (3,54 DM).

5.2. Small grinder / semi industrial milling

The technical details see chapter 4.

The material costs for 1 kg fermented millet flour are 100 FCFA and for 1 kg sorghum 79,1 FCFA.

The manpower costs are as follows: The costs for fermentation and hulling are the same as in 5.1. = 100 FCFA/hour. For grinding customers have to pay about 15 FCFA for 2,5 kg of wet product (30 % H_2O), that means 11,6 FCFA for 1 kg dry flour = 111.6 FCFA (1,12 DM/kg) for the whole handling.

The total cost for 1 kg semi industrial sorghum flour are 200,7 FCFA (DM 2,00) and for millet flour 221,6 FCFA (DM 2,21).

5.3. IDRC-type mill Kaduna and Maiduguri

The technical installation is given in chapter 4. The theoretical capacity of the Kaduna mill was 400 kg flour/hour and 2, 4 t flour/day. The actual capacity is about 1,4 t/day grain(app. 13) and 1,075 kg flour/day. So the operating efficiency results in a production of 134 kg/hour.

These 134 kg flour/hour are produced in 1980 with a shift of 11 persons (6 specialists, 3 assistants, 1 student and 1 driver). According to the report of IDRC (1978) the production costs are 7,22 ₦ /100 kg = 26 DM/100 kg that means 0,26 DM/kg (see app. 13).

5.4. Sotramil - Zinder - Mill

The theoretical capacity of the mill is about 1,750 kg/hour but the operating efficiency up to now was only 750 kg/hour. This out-put is produced in one shift by about 25 persons. The building requirement for the installation of the mill is about 600 m^2 (exclusive a 3.000 t store).

Besides this there is a pastry (350 t) and a biscuits (1oo t) production in separate rooms. The cost calculation for the production of sorghum flour is given

in app. 14, it results in about 0,41 DM/kg sorghum flour.
The yield of wheat flour milling is 70 - 74 % and of sorghum flour milling 70 - 75 %.

5.5. Karma mill, small mill

The technical details available are given in app. 15. This mill is actually in the state of planning and no operating results can be given.
In app. 15 a calculation which was given by ONAHA (Mr. Greppi) is presented. As this milling system corresponds to the Kaduna/Maduguri mill a comparison with the experiences in Nigeria is possible. This would result in a change of the former calculation (see app. 15), mainly because of the following considerations:

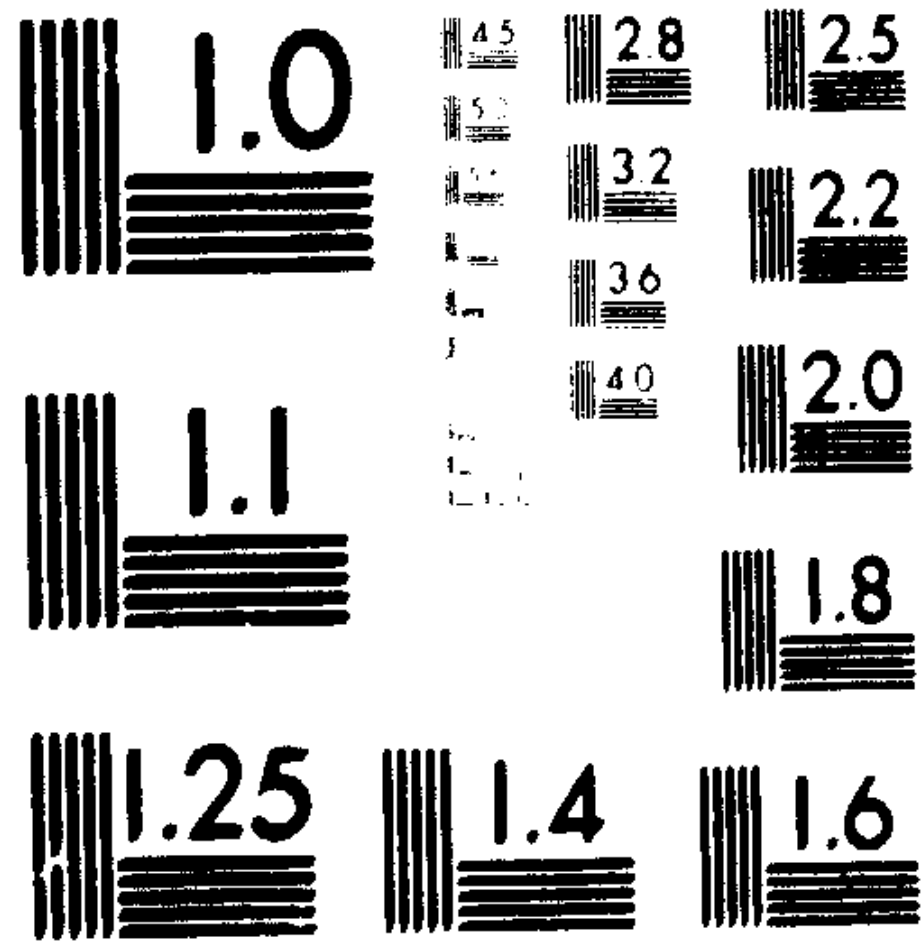
- labour costs are much higher today in Niger,
- only the costs of 1 motorist are calculated, while in Kaduna 11 persons are eomployed. In our opinion an operating staff of about 4 persons is realistic; that would result in the following costs

  DM 445.-- for 1 manager/month
  DM 630.-- for 3 assistants/month
  DM 1075.-- x 12 months = DM 12.900/year.

  Instead of DM 840 per year our calculation results in 12.900 DM/year for labour costs,

- the ONAHA calculation is based on 360 production days while we consider 300 days realistic.

These changes finally result in total production costs of 0,11 DM/kg instead of 0,038 which were calculated by ONAHA. Furthermore the quality of the flour produced in Kaduna is not yet satisfactory regarding taste and consistency.



5.6. Wheat - Mill - Kaduna

The flow sheet of a wheat mill is shown in app. 16. According to Porten a wheat mill is not suitable for making sorghum or millet flour, because the millet and sorghum bran are easily pulverized and are found more in fine flour fractions. This high bran content results in a bad quality of sorghum or millet flour [1]. Contrary to sorghum and millet wheat has a more elastic bran and needs therefore a different technic than millet and sorghum.

By replacing the standard rollers in a wheat mill by special sorghum rollers, sorghum can be ground. But this is a very time-consuming and costly procedure. The third disadvantage is a more expensive building and equipment for the same capacity than the special sorghum millet system of the UNDP/FAO proposal requires.

There is however an argument that one gets a lower fat content in the sorghum flour by using a wheat mill system (see table 35).[2]

Table Nr. 35

Sorghum and millet flour made by two different mills

	Special sorghum mill	Wheat mill system
Sorghum	1,81 % fat	1,15 % fat
Millet	2,40 % fat	2,10 % fat

We think that the differences in fat content are so small that it doesn't influence the keeping quality of the flour.

1) International Association for Cereal Chemistry, Symposium 1976

2) Wyss, Ed. : The precessing of millet and sorghum

In app. 17 a complete comparison of the costs for a standard wheat mill of 1,75 t/hour with the special sorghum mill (UNDP/FAO) is shown. The results are summarized in table 0 of app. 17. The costs for 1 t sorghum flour produced by the wheat flour system is 159,33 DM.

5.7. Rice Mill - Niamey and Tillabéri

Up to know there is no experience in using this rice mill for sorghum or millet flour production although some machines in rice making are similar to the sorghum flour production. We do not recommend to make different products on the same equipment because in those cases the efficiency of the plant and the quality of the product is unfavourably influenced by this combination (see Zinder production).

5.8. Sorghum millet mill (UNDP/FAO/Schule)

The technical details are given in app. 18.
This milling systems has produced the best results known to us up to now.
It is the officially recommended method for milling of sorghum or millet.
The sorghum millet mill can be delivered with a capacity from 1,7 - 4 t/hour.
In general sorghum has a higher flour yield than millet.
In app. 17 the calculation of the special sorghum millet mill compared with a standard wheat mill (1,75 t/hour) is shown. It is obvious that the sorghum millet mill (75,76 DM/t flour) is much cheaper as to investment and operating costs than the standard wheat mill (159,33 DM/t flour).
The special sorghum millet mill causes about 48 % of the costs of a wheat mill. Based on a capacity of 1,75 t/hour investment costs of a wheat mill (1,3 million DM), are three times higher than the costs of a special sorghum millet mill (0,45 million).
The production costs of a mill with a capactiy of 1,75 t/hour are 75,76 DM/t = 0,076 DM/kg operating at full capacity. This is about 57 % of the production costs of sorghum milled by a wheat mill (0,159 DM).

The advantages of the special sorghum millet mill flour compared with "home made" or semi industrially made flour or Sotramil flour are

- higher yield (75 % instead of 66 %)
- better quality and keeping quality (1 year)
- use of the bran for cattle feeding products (25 FCFA/bag)
- lower production costs.

5.9. Conclusions of 5.5.

In table 36 we summarize the production costs of the different milling systems which are existing or planned in Niger/Nigeria compared with the special sorghum millet mill (UNDP/FAO - Schule).

Table Nr. 36

Comparison of the production costs of the different systems in Niger and Nigeria (in DM/kg flour)

	DM/kg flour
Home flour milling	2,5
Semi industrial milling (small grinder)	1,32
IDRC-type mill Kaduna/Maduguri	0,260
Sotramil Zinder	0,413
Karma mill project	0,110
Wheat mill, 1,75 t/hour	0,159
Special sorghum millet mill (Schule system)	0,076

Besides the quality problems discussed above it can be said, that the existing milling systems produce at higher costs than the UNDP/FAO/Schule system. Under favourable conditions, based on the production costs of the UNDP/FAO/Schule system the following selling price of the mill should be possible:

Table Nr. 37

Calculation for 1 kg sorghum		
	FCFA	DM
Cost of raw material (purchase price 47 FCFA, yield 75 %)	62,7	0,63
Production costs (incl. admin. costs)	7,6	0,08
Sales cost + profit	6,7	0,07
./. 0,25 kg bran sold at 25 FCFA/kg	[illegible]	0,07
	70,0	0,71

Calculation for 1 kg millet		
	FCFA	DM
Cost of raw material (purchase price 50 FCFA, yield 65 %)	76,9	0,77
Production costs (incl. admin. costs)	7,6	0,08
Sales cost + profit	4,[illegible]	0,04
./. 0,35 kg bran sold at 25 FCFA/kg	8,7	0,09
	80,0	0,80

The favourable conditions needed for the above calculated production costs consist of:

- a small well trained staff
- optimal location (preferably besides OVPN warehouses)
- decentralized production (low transport costs).

A comparison of different production costs in table 38 shows a clear advantage of the UNDP/FAO/Schule system resulting in selling costs whiche are even lower than the raw material costs in homes production.

Table Nr. 38

Price relation between different milling flour systems in DM/kg				
1 kg grain	costs for raw material home made (see 5.1.)	1 kg flour home made	1 kg semi industrial	1 kg flour UNDP/ FAO/Schule
Sorghum 0,475	0,791	3,54	2,007	0,71
millet 0,500	1,00	3,75	2,216	0,80

6. Improvement and extension of milling capacities in Niger and Nigeria

6.1. Niger

6.1.1. Improvement of existing milling of sorghum in Niger

In order to improve the Zinder mill (Sotramil) we make the following suggestions:

- Installation of a dryer for sorghum flour, in order to achieve a water content of 4 - 5 %. As we have already mentioned there is less enzymatic oxydation and bitter taste development during the storage time, if the water content is reduced below 6 %.
- Installation of the milo production in Zinder in order to diversify sorghum in the market.
- Training of the staff in order to diminish the man power requirements from 55 to 35 persons. This would cause lower prices for the flour.
- Elemination of the conditioner.
- Production of "sorghum rice" that means very well hulled sorghum.

With regard to the already existing small grinders (semi-industrial milling) no suggestions for improvement are necessary as these mills fulfill their functions in a satisfactory manner.

6.1.2. Extension of new milling capacities for sorghum and millet

There is a potential demand of 1,1. - 1,3 million tons sorghum and millet flour in Niger. A special demand for industrially produced flour exists in the urban centers. We suggest locations where there are already OPVN-warehouses, WF (PAM) - Programmes and where building facilities of other projects can be used:

	Location near
Agadez	OVBN Storage
Diffa	OVBN Storage
Zinder	Sotramil
Maradi	OVBN Storage
Tahoua	OVBN Storage
Dosso	OVBN Storage
Tillabéri	Rice Mill
Niamey	Rice Mill

Even though Tillabéri is the smallest town among this urban centers, it is proposed because of the already existing storage and transportation facilities which could also be used by the new mill. Furthermore there is a population of more than 140 thousand inhabitants in the total arrondissement. Therefore also in respect to the demand the location is justified.
These mills should be also used for the milling of the WFP (PAM) - donations (12.000 t sorghum flour/year) and the demand of the Food for Work-Programme (250 t/year).
The total capacity of the 8 mills would correspond to the following calculation:
1,75 t x 12 hours x 23 days/month x 12 months x 8 mills = 46.368 t.
About 30 % of this capacity would be needed for the WFP (PAM) and Food for Work Programme. The rest of this capacity should be used to build up a market for industrially milled sorghum and millet flour. We will later discuss the most important measures for the image improvement of this flour. One of the major objectives of this measures should be the increasing use of sorghum and millet flour by bakeries and in pastry production in order to substitute wheat flour.
Furthermore we recommend the installation of small grinders in the villages. As we have already analyzed the home milling of flour is a very time-consuming and toilsome work. The time necessary for fermenting and pounding 1 kg is about 2,5 hours. In order to produce the daily demand of an average family about 5 - 6 hours of fermenting and pounding are necessary.
To make favourable use of the time saved by the semi-industrial milling additional women-oriented village development measures should be planned (nutrition education, new dishes etc.). The cost calculation in chapter 9 shows that the small grinders have relatively high production costs and that the actual milling fee of 7 - 15 FCFA in many cases may not cover the total costs. On the other hand the advantages have to be considered which result in the improvement of the women's situation. In addition there will be an influence on the quality of nutrition as we were told that some millet based dishes are no longer prepared because women find it too wearisome to produce the millet flour.

As we were told by USAID-Niger, a small grinder is the tream of every village. In Zinder 51 requests for purchase credits for small grinders were made in January 1980 to the CNCA which also indicates the strong interest.
We think however that any official measures or project to cover this demand should be integrated in a community development programme in order to guarantee proper operation and maintenance of the grinder and to make positive use of the time saved.
In this first stage we propose the installation of these grinders in all villages where there are already community development, production promotion projects or active cooperatives.
The programme should also foresee mobile maintenance and repair units and a basic training of the grinder operators.
In order to calculate the exact quantity of grinders and the details of the additional extension measures a special investigation is necessary.

6.1.3. Wheat milling in Niger

In respect of new installations for wheat flour milling we cannot recommend any major expansion. There are many plausible reasons especially what concerns existing consumer habits and foreign exchange savings. Thus Niger should concentrate on the processing of sorghum and millet.
On the other hand the conditions for wheat production are more favourable in Nigeria. Therefore it would be more recommendable to promote the wheat milling industry in Nigeria which also could cover a limited demand of wheat flour in Niger.

6.1.4. Quality assurance for sorghum and millet flour in Niger

The example of the Zinder-Sotramil experiment shows us that the quality of the flour and the keeping quality of the flour is very important. All over Niger there is a common negative attitude towards Sotramil flour, because of its bad quality. This is a most dangerous situation for the future market of such a product. In order to start a successful industrial production of sorghum- or millet- flour it is essential to guarantee or assure the good quality of sorghum- or millet-flour all over the country. As we have already mentioned this control must be done by an official chemist, who controls the colour and smell of the flour, the colour and taste of the cooked flour, the fineness of the flour and carries out an accelerated keeping test of the flour in order to predict the keeping quality of the product.
If the standards of good flour quality are fulfilled, a certificate should be extended. Only the flour which corresponds to the quality standards should be admitted for selling to bakeries or for an export to Northern Nigeria.

These quality measures should be accompanied by joint marketing activities of the industrial mills:

- creation of a common brand for industrially produced sorghum and millet flour.
- Standardized packaging with uniform brand name and symbol.
- Nation-wide advertising campains for the introduction of the new flour quality.
- Introduction of new scientific treating methods for quality assurance (e.g. high frequency treatment of the flour bags).
- Propagation of the experiences of the test bakeries in Kaduna and Dakar in order to encourage local bakeries in the use of sorghum and millet flour.

6.2. Northern Nigeria

6.2.1. Improvement of existing milling capacities for sorghum in Northern Nigeria

The technical installation of the Maiduguri and Kaduna mill does not correspond to latest standards. This is one reason for the high production costs (see chapter 5.9.).

A staff of 11 persons is too much for the production capacity of the mill. In our opinion the production staff could easily be reduced to 4 - 5 persons, if this reduction would be accompanied by practical training of the remaining staff.

The sales method and organization has to be revised in order to avoid exaggerated trade margins. One possible measures could be the creation of a net of licenced retailers who could be supported by an advertising campain. For more concrete measures a thorough analysis is needed.

6.2.2. Creation of new milling capacities for sorghum and millet in Northern Nigeria [1)]

We cannot recommend the creation of major state-owned capacities in Northern Nigeria. All the experience gained up to now show that these mills cannot be expected to operate at a reasonable cost level and will therefore depend on subsidies.

In our opinion the first step necessary, is the production of a high quality sorghum and millet flour in order to create a market for industrially produced flour, which can be used for new food products or for the substitution of certain percentages of wheat flour in existing products.

The measures and installations proposed for Niger will prove if this aim can be reached. In case of favourable results in Niger, the positive experience could be used for similar activities in Nigeria. Therefore we recommend the immediate start of well planned export activities for millet and sorghum flour from Niger to Nigeria as soon as a permanently satisfactory quality standard is attained.

1) Alternative proposal see app. 23

At the same time the experiences of the Niger pilot-mills should be made available for interested entrepreneurs in Northern Nigeria. As soon as the quality problems are solved and prospects of a growing market are visible the interest of private entrepreneurs will increase. The role of the public sector should be limited to the following supporting measures:

- provision of credits and coordination of import of machinery (in order to avoid a diversity of milling equipment),
- official quality control and certificate,
- buisiness consultancy to entrepreneurs as well as technical and administrative training of personnel,
- tax incentives for investment in appropriate areas,
- initiating and coordination research and application of results.

The theoretical demand for industrial sorghum and millet flour in order to substitute wheat flour was indicated in chapter 4.4.2.3. (72.000 t/year). This demand could be covered by installing 8 industrial mills(4 /hour-capacity). With regard to the household consumption there are estimations that about 70 % is covered by small grinders. In our opinion, this figure is too high. In any case before beginning a promotion programme for small grinders regional surveys have to be conducted in order to determine the actual demand. In case of additional demand through credit conditions and import regulations the setting up of a standardized equipment should be ensured.

6.2.3. Extension of wheat milling in Northern Nigeria

The actual capacity of the wheat mills in Northern Nigeria (Kano, Maiduguri and Sokoto) must be doubled according to the market demand in Northern Nigeria. The performance of the existing wheat mills is good and the technical "Know How" is of a high level. There is no need to support these private efforts by official activities. It is only important that the government authorities do not hinder the activities of the private sector as was reported with regard to the installation of the wheat mill in Maiduguri.
In order to cope with the growing wheat milling capacities the volume and quality of the local wheat production has to be promoted. There is a necessity for high yielding varieties which are at the same time suitable for the milling purposes.

6.2.4. Quality assurance for sorghum and millet flour in Northern Nigeria

As mentioned above the composite flour programme has favourable aspects, if the sorghum mills will produce a fair quality with a good keeping capacity. Especially in Nigeria the industrially produced flour should mainly be used for substituting part of the considerable consumption of wheat in bread and other products. A very good quality assurance in respect to grain control, production control and final flour control will be needed in Nigeria. It is therefore necessary to build up bigger production units than in Niger, otherwise the quality assurance could be not organized rationally and will become too expensive. The task of the quality assurance is the control of the fineness of the flour, of the water content, of the colour, of the water absorption and baking control in mixture with wheat flour.
It should be remembered that the sorghum flour must have a low water content (below 6 %) in view of its high fat content and the enzyme activity. In the "composite flour programme" it may be necessary that the wheat flour must also have a low water content of ca. 5 - 6 %. This is very complicated and the easier way in this programme may be that the flours are mixed in the bakeries. In this case the packaging of the sorghum flour should be according to mixing requirements of the bakeries.

2 bags of 50 kg wheat flour
1 bag of 30 kg sorghum flour } sorghum flour share of total mixture = 23 %

In respect of the keeping capacity of the sorghum flour insect infestation can be a severe problem. Therefore an installation of high frequency treatment of the packed flour should be fore seen at least in the major mills. Last but not least we recommend a closer contact of the milling staff to the Food Research Center in Khartoum and to the Fiiro in Nigeria.

6.3. Some additional aspects for improved or expanded milling capacities

The necessity of selling sorghum and millet flour at a lower price than wheat flour has already been discussed (chapter 3.2.2.4.).
Promotion measures will be presented in chapter 7.3.
The industrial milling equipment proposed for the extension of the capacities would allow an ex-mill price of about 70.000 FCFA/t (Sorghum) and 80.000 FCFA (Millet). This price would be lower than the actual Sotramil price for wheat and sorghum flour (84.000 FCFA/t) and the ex-store price of COPRO for wheat flour (107.660 FCFA/t). If at the same time a good quality standard can be achieved two very important marketing prerequisites are fulfilled.
In order to avoid complicate logistic problems the industrial mills should only aim at the regional market in the first stage. Special marketing assistance should be granted as soon as export activities begin.
Joint sales promotion programmes and consumer information will help to strengthen the position of the mills in relation to wholesalers and retailers.
As soon as a common brand with a favourable image is introduced a licencing system for the commerce can be established.
As the promotion measures should be planned and financed by technical aid or by Government funds a certain price control can be established: only those mills and merchants who are willing to regard certain price ranges and margins should be allowed to use the common brand for their flour or will get a licence as official selling agent. This system could be enforced by

regular price information in the advertising campains.
This price information in promotion campains for sorghum and millet flour could also be a first step for a permanent market intelligence service. Improving the market transparency by a regular price information service is often a better means of avoiding exploitery practices than introducing fixed prices.

6.4. Conclusions

Some proposals for improving quality and cost situation of Sotramil were given. One must however see that the Sotramil system does no longer correspond to modern standards and that the dual purpose of the mill always will result in higher production costs for sorghum flour.
For Niger the installation of 8 industrial mills (1,75 t/hour) is recommended. This capacities should cover the most urgent demand of larger scale milling caused by WF (PAM) and Food for Work Programme and urban consumers. At the same time this industrial flour should be used to create a demand in bakeries and pastry production for high quality sorghum and millet flour. An efficient quality control is needed for this purpose.

For Northern Nigeria we recommend the installation of private industrial mills as soon as the experiences in Niger justify the promotion of sorghum and millet flour production. The new mills should be located in centers where there are already wheat mills.[1)]

1) Alternative proposal see app. 23

7. Consumer habits in Niger and Nigeria for sorghum- and millet-flour and future developments

7.1. Consumer habits in Nigeria for sorghum and millet flour

7.1.1. Sorghum

Sorghum is widespread in Northern Nigeria.
Most common is the consumption and the distribution of the home made products like: Fura, dan wake, masa and inwa (see app. 10).
Fura is made of sorghum but also with millet, while dan wake is made of sorghum and cowpeas.
30 % of the household retail the home made fura and 3 - 4 % of the household retail the dan wake and masa. The consumption at home consits of 36 % fura 25 % dan wake and 30 %masa. [1)]

According to our observations there may be a growing demand for milo.
This product consists of hulled sorghum which is conditioned with vapor and than transformed into flakes by using hot rollers.
The flakes are used for the preparation of a porridge by cooking them with milk or water. It may be possible to use the Sotramil conditioner for this purpose after changing the rolls.
Another interesting product may be puff of sorghum. The tests carried out in Germany resulted in a product with a pleasant nutty flavour (Equipment: Chio Popcorn, Peter S.R. Maldus OHG, 8971 Burgberg/Häuser, FRG).

In Nigeria a considerable demand for weaning food can be found.
This would be a favourable base for a local production of infant food.
As main ingredients sorghum flour, wheat germs, groundnut butter etc. could be used.
The most effective way to favour the national economy will be however the promotion of composite flour programmes in Niger and Nigeria. The experiences and results of the test bakery in Kaduna (Composite flour FAO-Programme) and the Institut de Technologic Alimentaire in Dakar should be used for practical application in Niger and Nigeria.

1) Source: Feasibility Study on Foodgrain Processing in Nigeria

7.1.2. Millet

Millet is the second important grain in Northern Nigeria. The millet flour is consumed as fura which may include koko and kumi. Widespread is the consumption of sour millet porridge or sinasin prepared with milk. Contrary to sorghum most of the millet products are autoconsumed by producers and not retailed (3 % only) [1]. Some proposals for millet production are made in 1977 by Desikacha [2].

Consumers in Nigeria who can afford it financially, are inclined to replace millet and sorghum flour products by rice. Today rice is a prestige product in Nigeria.

7.2. Consumer habits in Niger for sorghum and millet flour

7.2.1. Sorghum

While in the Diffa and Tillbéri region sorghum is prefered, in all the other regions of Niger it plays only a minor roll in grain consumption compared with millet. The preparation and consumption is the same as Nigeria: in fura, dan wake, masa and tuwo some sorghum flour is used. For the biscuit production in Zinder (Sotramil) sorghum flour is also used.

With respect to new products we propose puff-sorghum, micro-sorghum, composite flour , weaning food etc. (see chapter 7.1.).

In Niger the aromatisation of sorghum flour according to the taste of people has a very great importance. As we have already mentioned a mixture of food acids and cream aromatic substances is needed for this purpose. With respect to weaning food a Feasibility Study has already been conducted in Niger (1973).

1) Simons, E.B.: The small-scale rural food processing industry in Northern Nigeria p.p. 147 - 161

2) International Association of Cereal Chem., Symposium 1976

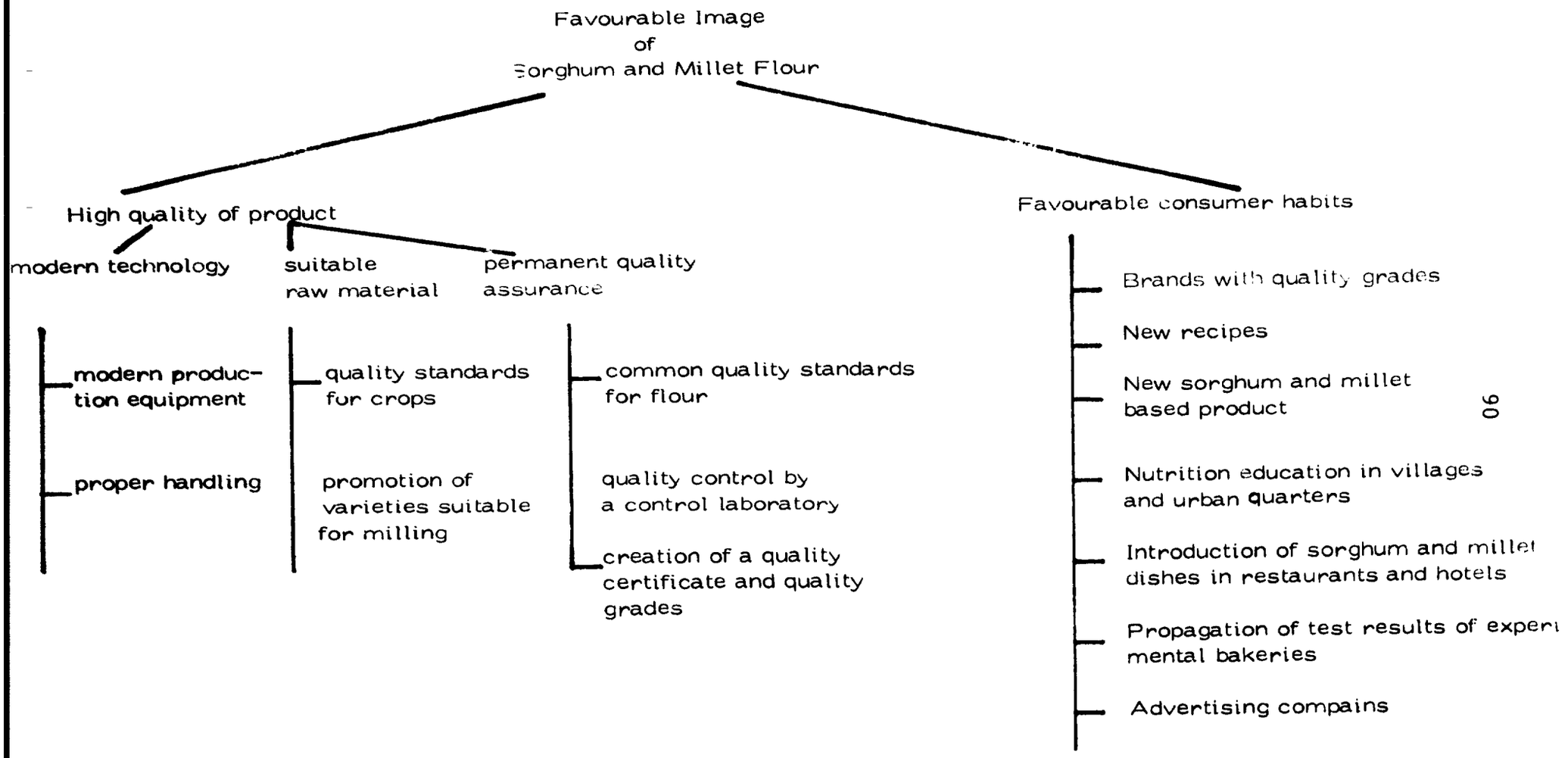
7.2.2. Millet

In Niger consumers usually prefer millet flour to sorghum flour because of its taste. Millet flour has according to our experience a sour creamy fresh green taste, while sorghum flour is very neutral and has an empty taste. It should not be difficult to aromatize the sorghum flour in order to get a similar taste as millet flour. The housewife achieve this effect by adding 5 - 10 % of sliced green paprica or onion to the fermented hulled sorghum before milling with the small grinder.
The main part of millet is eaten as sour porridge with milk at noon. The other part is prepared as fura which is eaten together with special fried fish, meat and cooked vegetables.

7.3. How to develop a good image for sorghum and millet flour

Due to an efficient quality control and a good technic rice and wheat flour have established a favourable image both in Niger and Northern Nigeria. In Niger up to now it has not been possible to create a good image for industrial sorghum flour.
On the other hand the economic situation in Niger and Northern Nigeria will depend considerably upon the acceptance of industrial sorghum and millet flour by users and consumers. If the efforts fail to create a positive image there will be a growing trend to imported products (wheat flour) or products with less nutrional value.
Sorghum and millet should be promoted in this region not only because, they are the traditional crops but also because they have a higher nutritional value than wheat and rice.
A strategy for the creation of a better image is shown in the following graph:

Table Nr. 39 Image Improvement Strategy



Besides the quality assurance measures already mentioned there is a need for compains which directly influence user and consumer attitude. Ore objective should be to change the image of sorghum and millet as only being the food of the poor. High class restaurants and hotels should be encouraged to offer sorghum and millet dishes. As a good examples the Menu Card of the Hilton Hotel, Khartoum is shown in app. 12 . Last but not least we recommend an official certificate for the private mills which states quality grades:

- Export Quality (1st class)
- Standard Quality (2nd class)
- Country Quality (3rd class)

An official control laboratory (1 chemist, 2 assistants) is responsible for the chemical analysis of the samples which should be provided periodically through the "sous prefect" of the district. The quality certificate will be extented by the central laboratory; At the same time the laboratory should maintain contacts with the experimental bakeries in Kaduna and Dakar in order to propagate the results among the bakeries in Niger and encourage and support practical application.

7.4. Food research for sorghum- and millet products

Besides the practical experiments in the test bakeries additional basic research is necessary. This research should also be coordinated by the central laboratory. The laboratory should not execute research by itself but only compile results from existing research institutions, formulate concrete questions for additional research and propagate results for practical application. The following urgent tasks can be listed:

- Summarize the known recipes of Niger and Nigeria for different preparation or meals in a first "cooking book ".
- Systematic research work on the gelantinous power of sorghum or millet products (flour, farina, Rice-type etc.), sorghum flour has a higher gelantinous power than wheat or potato flour. This can be important for the canned food industry.
- Pure sorghum or millet bread (Knäcke-bread).
- Addition of 10 % millet flour to wheat flour to increase the volume of bread.
- Composite flour programme , realization in Niger and Nigeria by replacing 25 % of wheat flour by sorghum flour .
- Sorghum popcorn-production.
- Beverages based on roasted sorghum and millet(coffee drinks) are of high nutrional value and could replace other soft drinks.
- Sorghum grits for beer brewing
- Preparation of tortillas from sorghum. (see app. 16 b)
- Weaning food production.
- Water-Permeability of different packing material for sorghum or millet flour. This is important for a better keeping quality of the flours.

- Production of sorghum starch.
- Glucose production from sorghum.
- Replace 20 % wheat flour by sorghum or millet flour in the PAM
- Aromatizing research on sorghum flour.
- Extraction of tannic substances of red sorghum bran for anti-microbiological purposes in food or aroma mixtures.

This research works increases the value of the sorghum and millet. Therefore it is a recommendable investment for the future of sorghum and millet products.

7.5. Consumer acceptance and nutrition education

In Nigeria at the Ahmadu Bello University, Zaria, consumer acceptance tests for new sorghum and millet varieties have already been carried out. This experience and the "Know how" of these tests should be used for testing the new millet and sorghum flours or testing the aromatized flour in Niger and Nigeria.
On the other hand nutrion education is very important. The instruction by rural extension services, advertising in radio, news papers or in the package material of the flour should give new impulses for diversification of food preparation and improvement of image.

7.6. Conclusions of 7.

Consumer habits have to be influenced systematically in favour of sorghum and millet flour consumption. This also requires additional research in order to find new utilization purposes especially for the industrial use of sorghum and millet and for improving products. For Niger and Nigeria the coordination of the research activities is necessary with special regard to the work already done in Kaduna (experimental bakery), Zaria University and FIIRO. At the same time permanent contacts to the "Institut de Technologie Alimentaire" at Dakar and the sorghum pilot mill at Khartoum are necessary.

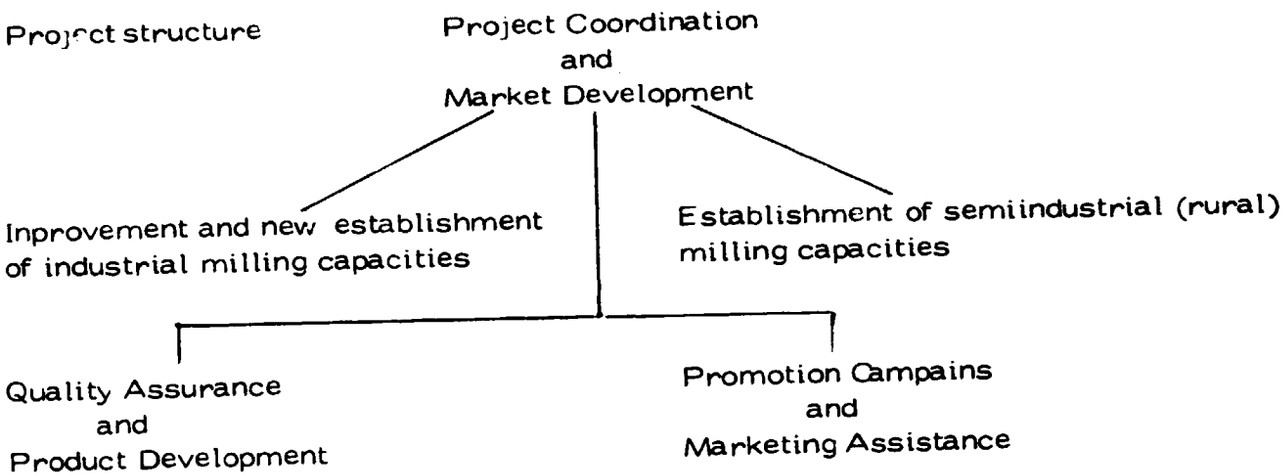
8. The project sheme [1)]

8.1. The project structure

The following project structure is proposed for the promotion of flour milling based on sorghum and millet.

Table Nr. 40

Project structure



8.2. Project coordination and market development

8.2.1. Functions

There is an urgent need for initiating and coordinating systematic measures for a high quality sorghum and millet flour production and the promotion of this product for consumption and further processing. The setting up of the technical and commercial facilities for the flour production and distribution should be carried out by the private sector. The public sector in cooperation with multilateral and/or bilateral assistance should concentrate on coordinating, financing and supporting the private activities.

1) see app. 21 for project idea Nigeria

Promotion Campaigns

The image of sorghum and millet and the flour made thereof has to be improved by the following means:

- The results of the existing research institutes and pilot projects have to be compiled and their application by industrial users has to be promoted through information, instruction and consultancy.
- Recipes for food preparation and attractive dishes have to propagated through advertising and extension campains for consumers.
- Informative material for nutrition education in urban and rural areas has to be prepared.
- Acceptance tests for new dishes, and new varieties have to be organized with consumers and producers.
- Marketing assistance for industrial mills:
  - consultancy in packaging, labeling, handling, pricing, selling conditions and logistic has to be provided,
  - advertising campaigns for high quality products and brands with official quality certificate,
  - price information for consumers.
- Export consultancy and market coordination between Niger and Northern Nigeria.

Quality Assurance and Product Development

An official central laboratory has to be installed with the following responsibilities:

- Permanent control of the industrial flour and the products made thereof.
- Establisning quality grades and extending official quality certificates.
- Maintaining permanent contacts to relevant research institutes and pilot projects in Nigeria and other African countries.
- Assistance to private firms in the development of new products.
- Identification of problems to be analyzied by research institutes.
- Preparation of informative material for consumer - and user-oriented promotion campains.

8.2.2. Personnel Requirements

1 Project leader:

Market economist with profound knowledge of practical food marketing, management and organizing capacity and experience.

1 Chemist:

Assistant project leader and head of laboratory. Practical experience in product research and development and in quality assurance in food industry.

2 Laboratory assistants.

Short-time experts: A special fund should be established to allow the appointment of specialists for short periods in order to solve problems identified by the project leader or his assistant.

8.2.3. Local Project Organization

We propose to integrate the project coordination as well as the laboratory in the OPEN organization.

8.3. Improvement and new establishment of industrial milling capacities

8.3.1. Functions

Project preparation: The details for the installation of the mills have to be studied . Future owners, precise location, credit conditions, implementa tion methods etc.

Financing: The financial means should be provided by bilateral or multilateral capital aid (e.g. Federal Bank for Reconstruction, (FRG), World Bank) and canalized through the BDRN (Banque de Developpement de la République du Niger).

Coordination of purchase: In order to garantee a standardized and homogene equipment the selection and purchase of the material should be done by the project.

Supervision of installation: Proper installation through the supply firms and training of local staff through these firms should be secured by the project.

Technical consultancy: Permanent assistance to mill owners especially during the starting period. Identification and solving of technical problems. Organization of training courses.

8.3.2. Personnel requirements

1 Industrial engineer with practical milling experience and supply management.
1 Assistant: machanical engineer with training experience.

8.3.3. Organizational Integration

These functions should be fulfilled by OPEN in close cooperation with BDRN. The experts should be employed directly by OPEN and report to the project leader.

8.4. Establishment of semi-industrial milling capacities

8.4.1. Functions

Demand analysis: The most urgent demand and the most favourable locations for the small grinder installation have to be analysed.

Financing: A credit programm should be established through the CNCA (Caisse Nationale de Credit Agricole) to finance the purchase of the equipment.

Organizational integration of rural small grinders:

Cooperatives: The perfomance of cooperatives up to now has not always been satisfactory in Niger and Nigeria. Therefore in every case it is necessary to asses the capactiy of the existing cooperative to operate the grinder.

Private owners: As in the case of crop marketing the traditional chiefs or other reliable village members could be entrusted will the mill. A fixed milling margin could be stipulated as a precondition for the credit.

Women's association: As pounding of sorghum and millet is usualy done by women, they have the strongest interest to have a well functioning grinder in their village. We therefore recommend an additional study in order to analyse the chances of women's association for the operation of small grinders. This association could at the same time organize the nutrition education and the propagation of new sorghum and millet dishes in the villages.

Maintenance: Mobile maintenance and repair facilities for the small grinders should be established.

8.4.2. Personnel requirements

1 Mechanical engineer for the training of the maintenance personnel and the supervision of the installation.

The purchase of the equipment could be organized through the same staff as in the case of the industrial mills.

8.4.3. Organizational integration

UNCC should be responsible for the implementation of the programme. The mechanical engineer and the personnel of the maintance facilities should be employed by UNCC. The programme should however be realized in close co-operation and permanent coordination with the OPEN team. Furthermore joint activities in the field of community development should be planned. As women will dispose of additional time after the installation of small grinders an increased home production and home-trade of sorghum- and millet-based products could be promoted.

9. Economic and financial analysis

9.1. Investment

9.1.1. Improvement and new establishment of industrial milling capacities

9.1.1.1. Investment costs

A detailed list of investment guide figures is given in app. 17, tables 0 - 7.

The approximate costs for 1 mill (1,75 t/hour) completely installed in Niger are

	DM (1000) [1]	US $ (1000) [1]
Machinery and equipment	440	251,4
Building	589	336,6
Total investment costs for building and equipment for 1 mill	1,029	588,0
Total investment costs for building and equipment for 8 mills	8,232	4,704

1) Exchange rate 1 DM = 1,75 US $

Working Capital	DM (1000)	US $ (1000)
Financing for first purchase and storage of raw material, working progress and finished products	200	
Emergencies	20	
Total working capital for 1 mill	220	126
Working capital for 8 mills	1,760	1,008

	DM (1000)	US $ (1000)
Total investment costs for 8 mills		
- Machinery, Equipment and Building	8,232	4,704
- Working Capital	1,760	1,008
Total	9,992	5,712

9.1.1.2. Pay-back-considerations and estimate of rate of return

Expected net profit [1] and "profit" (in DM)

	Full capacity [2]	Capacity 2/3 [2]
Production Volume	5.780 t	3.880 t
Sales proceeds	4.681.840	3.138.881
Factory costs		
- fixed costs	334.103	330.903
- variable costs	118.186	79.336
- raw materials	3.897.694	2.616.366
Admin. costs	20.000	15.000
Net profit	311.857	97.276
Interests		
- on fixed assets	71.954	71.954
- on working capital	14.400	11.200
Depreciation	50.997	50.997
" profit "	449.208	231.427

1) Net profit = Net profit before tax. This calculation seems justified as also Northern Nigeria Flour Mills Ltd. have been exempted from tax up to now.

2) Production volume based on 2/3 Sorghum and 1/3 millet milling.

The calculation shows that based on years of full capacity the pay-back-period would be 2,8 years (total investment 1.249.000DM). Based on a capacity p.a. of approximately 67 % (8 hours/working day) the pay-back-period would be 5,1 years (total investment 1.189.000 DM) 1).
Assuming a construction and starting period of 2 years and 2/3 capacity during the following 6 years would allow a pay-back of the total investment after approximately 7 years.
In order to calculate the simple rate of return (R) the above figures can be applied in the following way:

NP = Net profit after interest and depreciation
Calculation of net profit is given on page 102 (pay-back-considerations):

	Full capacity (5780 t)	Capacity 2/3 (3880 t)
Net profit (DM)	311.857	97.276

K = Total investment costs (DM)
Calculation of investment costs is given on page 100 (Investment costs):

	Full capacity	Capacity 2/3
Machinery, equipment and building	1.029	1.029
Working capital	220	160 1)
Total investment costs	1.249	1.189

I = Interests (DM)
Calculation of is given on page 101 (pay-back-considerations)

	Full capacity	Capacity 2/3
Interests on fixed assets	71.954	71.954
Interests on working capital	14.400	11.200 1)
Total interests	86.350	83.154

$$R_O = \frac{311.857 + 86.354 \times 100}{1.249.000} = 31,9\ \%\ \text{(full capacity)}$$

$$R_1 = \frac{97.276 + 82.154 \times 100}{1.189.000} = 15,1\ \%\ (2/3\ \text{capacity})$$

In conclusion it can be said, that the favourable impression of the UNDP/FAO/Schule mill imparted by comparing the production costs of different mills (chapt. 5.9.) continues when regarding pay-back-conditions and simple rate of return. In addition these ratios would even become more favourable, if the building costs could be reduced by installing the equipment in already existing buildings (e.g. warehouses).

1) Working capital requirements reduced because of lower production volume

9.1.2. Extension of small grinder capacities (semi-industrial milling)

The investment costs for 1 grinder (20kg / hour) are:

with Diesel engine FCFA 620.000 (incl. tax)

with electrical engine FCFA 820.000 (incl.)

Costs of one mobile workshop (Mercedes or MAN) completely equipped:

Cif. Niamey = DM 200.000

= US $ 114.300

As it is not possible to estimate the demand without further special investigation, for small grinders no total investment sum can be given.

9.1.3. Quality assurance and product development

Laboratory: An equipment list is given in app. 21. The room necessary for the installation should be foreseen within the Niamey Sorghum/Millet-mill-building.

Cost estimate for laboratory installation

(German Origin) Cif Niamey = DM 185.000

= US $ 105.700

9.1.4. Promotion campaign and marketing assistance

Cost estimate for advertising and information campaign

(material services and media-costs) = DM 300.000

= US $ 171.430

9.2. Break-even analysis

9.2.1. Industrial mills (1,75 t/hour)

The production costs are indicated in app. 17, table 7

Basic data for break-even point calculation:

	DM	FCFA
Fixed costs	319.703	31.970.300
Variable costs per ton (sorghum)	647.45	64.745
- operation costs (app. 17,7)	20.45	2.045
- raw material sorghum (p.76)	627.00	62.700
Variable costs per ton (millet)	789.45	78.945
- operation costs (app. 17,7)	20.45	2.045
- raw material millet (p.76)	769.00	76.900

Sales prices sorghum/millet and bran (see chapt. 5.8. and chapt. 5.9.)

Sorghum: flour = 70.000 FCFA ; bran = 7.000 FCFA/t.; total 77.000 t

Millet: flour = 80.000 FCFA ; bran = 8.700 FCFA /t.; total 88.700 t

Break-even point (BEP) in case of using the mills only for sorghum milling.

$$BEP = \frac{\text{Fixed costs}}{\text{Sales proceeds / t } 77.000 \text{ ./. variable costs per unit}}$$

$$BEP = \frac{31.970.300}{70.000 + 7.000 \text{ ./. } 64.745} = 2.609 \text{ t (45 \% of full capacity)}$$

Break-even point in case of using the mills only for millet milling

$$BEP = \frac{31.970.300}{80.000 + 8.700 \text{ ./. } 78.945} = \frac{31.970.300}{9.755} = 3.277 \text{ t (57 \% of full capacity)}$$

The total production costs would be covered with the following production volumes exclusive sorghum milling = 2.609 t/year (45 % capacity)

exclusive millet milling = 3.277 t/year (57 % capacity)

50 % sorghum and 50 % millet milling = 2.943 t/year. (51 % capacity)

At the full capacity (5,780 t/year) a profit and administration margin of about 31.500 million FCFA/year could be achieved. The calculation is based on 2 shifts at 6 hours or a total of 12 working hours/day.

But even working at a capacity utilization of 67 % (8 hours/day) a sales costs and profit margin of about 10,8 million FCFA /year or 903 thousand FCFA/month could be gained.

This figures also show, that the ex-mill selling prices for industrial sorghum and millet flour could be reduced as soon as the mills are operating normally.

9.2.2. Semi-industrial mill (small grinders)

Capacity about 20 kg/h of wheat sorghum or millet.

Price: with Diesel engine FCFA 620.000 (incl. tax)

with electric engine FCFA 820.000 (incl. tax)

Operation costs for Diesel operated mill:

Daily operation time 8 hours and 7/days/week

1 Operator

	FCFA
Expenses variable	
Fuel, 1 l/hour, Oil, grease x130 x 2.496	324.480
Repair and maintencance 5 % of New (1,25 FCFA/h)	3.120
Operator's Salary, 100 FCFA/h	249.600
	577.200
Expenses overhead	
Depreciation (10 %)	62.000
Interest costs (8 % of average value)	25.600
	87.600

Total expenses/year	FCFA	664.800
variable expenses/hour	FCFA	231
variable expenses/kg	FCFA	11.55
total expenses/hour	FCFA	260
total expenses/kg	FCFA	13.30

As indicated in chapt. 4.3. the price for grinding 1 kg is 7 - 15 FCFA.
The calculation shows that under the above capacity conditions a fee of 13.30 FCFA/kg would cover all the milling costs (about 33 FCFA per tiya).
Often the actual fees especially in urban centers are lower, therefore it can be assumed that

- the operator does not earn the minimum salary and / or
- no depreciation or interests are calculated and / or
- repairs are made by the owner himself and / or
- the actual useful life of the mills is longer than 10 years.

As explained in chapt. 9.3.2. the advantages of the installation of small grinders result most of all in indirect economic and social advantages.
As mentioned in chapt. 6.1.2. (p. 80) there is a growing demand for small grinders especially by small entrepreneurs . This shows that small grinders are considered to be a profitable investment. Our recommendation of a small grinders project aims however at the indirect economic and social advantages, which can be seen by comparing the improvement of the housewife's situation with the small grinder milling costs (see chapt. 9.3.2.).

9.3. National economic and socio-economic effects

9.3.1. Import substitution

As we have already stated about 20 - 30 % of wheat flour could be replaced by sorghum or millet flour. Based on the COPRO-import figures 1978/79 the following savings of foreign exchange for Niger could be calculated (in 1000 FCFA):

25 % of total wheat import = 2500 t

total amount of foreign exchange saved (2.500 t x 88.-- FCFA)

Cif price = 220.000.—

amortization payments p.a. for milling equipment (amortization period 10 years) in foreign exchange = 97.400.—

foreign exchange necessary for import of fuel and lubrication oil for milling equipment [1] = 4.855.—

Net foreign exchange savings 117.745.—

This indicates that the foreign exchange saving even under actual conditions would by far exceed the additionalforeign exchange demand caused by importing the milling equipment and the fuel and lubrication oi' for the whole project. In addition one can expect, that this figures may encrease rapidly as we have mentioned in the case of Nigeria. As soon as he income situation improves a higher bread consumption must be expected. Therefore the chance of higher foreign exchange savings in the future can be improved by the production of a high quality millet/sorghum flour.

In Niger the imports of wheat are actually much higher (807.227 t in 1977). An estimate of substitution possibilities would be very theoretical because there is still a major unsatisfied demand of sorghum and millet for traditional consumption habits. It will depend upon the food production promotion projects wether an additional surplus for substitution purposes can be produced.

1) fuel consumption for milling of 1 t = 7l diesel fuel.
5.780 x 7 l x 100 FCFA (import price) = 4.046.000 FCFA + 20 % for lubrication oil = 4.855.200

9.3.2. Socio-economic effects

In the case of the small grinders there is a considerable chance to improve the situation of the female population especially in rural areas. The average rural family has a daily consumption of 3,5 kg sorghum/millet. This means more than 5 hours of women's work per day only for pounding the grain. By using the small grinder this work could be done in about 10 minutes. Based on a milling fee of 13 FCFA/kg for the small grinder and on the minimum salary for the women's work the following comparison can be made:

Grinder fees for 3,5 kg	45,5 FCFA
Labour cost for pounding 3,5 kg	500,0 FCFA

As women in rural areas seldom have the chance to earn the minimum salary this calculation is theoretical. On the other hand it serves as a trend indicator, if it will be possible to use the time saved for more productive female work . The more the monetary equivalent of this additional work approaches the minimum salary the more realistic the above calculation becomes. Other social and health improvements which are very difficult to quantify can be created by the installation of the small grinders, if the time saved is used for "job-enrichment" measures for the women.

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ABBREVIATIONS

BDRN	Banque du Développement de la Republique du Niger
CILSS	Comité Interministeriel de Lutte Contre la Sécheresse au Sahel
CNCA	Caisse Nationale du . Crédit Agricole
COPRO	Société Nationale de Commerce et de Production du Niger
FAO	Food and Agriculture Organization of the United Nations
FCFA	Franc(s) de la Communauté Financière Africaine
FIIRO	Federal Institute of Industrial Research, Nigeria
GDP (PIB)	Gross Domestic Product
INRAN	Institut National de Recherches Agronomique du Niger
IDRC	International Development Research Center
NAFPP	National Accelerated Food . Production Programme
NNFM	Northern Nigeria Flour Mills Ltd.
NGB	National Grains Board
NGPC	National Grains Production Company
ONAHA	Office National des Aménagement Hydro-Agricole
OPVEN	Office des Produits Vivriers du Niger
OPEN	Office de Promotion de l'Entreprise Nigerienne
SEPANI	Société de l'Exploitation des Produits d'Arachide du Niger
SEDES	Société d'Etudes et de Développement Economique et Social
UNDP (PNUD)	United Nations Development Programme
UNCC	Union Nigerienne de Crédit et de Cooperation
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
WFP (PAM)	World Food Programme

WICHTIGE ENTWICKLUNGSINDIKATOREN NIGERIAS
IM VERGLEICH MIT KENNZAHLEN AUSGEWÄHLTER AFRIKANISCHER LÄNDER*)

Appendix 3

Indikator / Land	Ernährung 1 a) Kalorien-	b) Protein- versorgung 1974 je Einwohner/Tag	Gesundheitswesen 2 a) Lebenserwartung bei Geburt, Durchschnitt der männl. Bevölkerung 1)	b) Einwohner je Planbett im Krankenhaus 2)	Bildungswesen 3 a) Analphabeten an der Bevölkerung (15 Jahre und darüber) 3)	b) eingeschriebenen Schüler der Bev. im Grund- u. Sekundarschulalter	Landwirtschaft 4 a) Landwirtschaft am Bruttoinlandsprodukt	b) landw. Erwerbspers. insges. 1977	Energie 5 Energieverbrauch je Einwohner	Außenhandel 6 Anteil weiterverarbeiteter Produkte an der Gesamtausfuhr 5)	Verkehr 7 Pkw	Informationswesen 8 a) Fernsprechanschlüsse	b) Fernsehempfangsgeräte	Sozialprodukt 9 Bruttosozialprodukt 1977 zu Marktpreisen je Einwohner
	Kalorien	g	Jahre	Anzahl	%				kg SKE 4)	%	Anzahl (je 1 000 Einwohner)			US-$
Ägypten	2 634	[illegible]	[illegible]	469(75)	25(76)	59(75)	10(75)	52	473	9(76)	5(76)	14(75)	17(75)	310
Äquatorialguinea	.	.	42(75)	171(67)	.	55(72)	.	76	94	.	.	.	.	340
Äthiopien	1 912	59	37(75)	3 081(72)	28(65)	14(73)	44(75)	81	27	6(75)	2(76)	3(76)	1(76)	110
Algerien	2 121	57	52(75)	320(70)	26(7?)	56(75)	8(76)	53	729	2(73)	17(75)	15(76)	30(76)	1 110
Angola	2 021	42	37(75)	322(72)	.	44(72)	34(74)	60	166	1(74)	20(72)	5(76)	.	330
Benin (Dahome)	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.	[illegible]
Botsuana	[illegible]	69	42(75)	332(75)	.	62(76)	27(74)	62	.	.	6(76)	12(7?)	.	440
Burundi	2 308	67	40(7?)	436(72)	.	13(73)	59(74)	84	11	.	1(76)	1(76)	.	130
Elfenbeinküste	2 654	65	42(75)	730(7?)	.	53(75)	23(77)	81	382	4(76)	[illegible]	9(76)	5?(76)	710
Gabun	2 301	50	25(6?)	98(69)	12(6?)	115(75) a)	9(75)	79	1 279	1(72)	19(74)	12(73)	16(76)	3 730
Gambia	2 334	59	39(75)	697(66)	.	21(76)	56(74)	79	64	.	6(73)	6(76)	.	200
Ghana	2 317	53	42(75)	534(75)	30(70)	45(76)	51(74)	53	157	0(75)	6(76)	7(76)	1(76)	380
Guinea	1 934	42	39(75)	599(72)	.	22(71)	26(74)	82	93	.	3(72)	2(74)	.	230
Kamerun	2 373	59	39(75)	390(76)	.	69(76)	31(76)	82	58	5(75)	9(76)	4(73)	.	340
Kenia	2 114	60	d49(70)	759(72)	36(70)	69(76)	34(77)	79	152	6(75)	6(76)	10(76)	4(76)	270
Kongo	2 179	33	42(75)	195(75)	16(61)	104(75) a)	16(74)	37	142	11(75)	14(76)	9(76)	2(76)	500
Lesotho	2 288	70	44(75)	402(74)	59(66)	79(76)	38(74)	86	.	.	4(75)	1(74)	.	230
Liberia	2 373	36	46(71)	687(70)	17(74)	61(75)	14(77)	72	474	1(75)	8(76)	3(74)	5(76)	430
Libyen	2 755	70	51(75)	242(75)	21(73)	114(76) a)	2(77)	20	1 598	.	101(75)	28(73)	4(75)	6 680
Madagaskar	2 396	57	38(66)	405(75)	39(66)	47(75)	41(74)	85	66	5(74)	9(74)	4(76)	1(76)	210
Malawi	2 397	68	41(72)	639(70)	24(73)	46(76)	45(73)	86	56	7(74)	2(76)	4(76)	.	140
Mali	1 774	53	37(75)	1 347(76)	2(60)	19(75)	34(74)	88	27	5(74)	3(74)	1(71)	.	110
Marokko	2 614	71	53(75)	748(75)	21(71)	37(75)	24(75)	53	273	7(75)	19(76)	15(7?)	29(76)	570
Mauretanien	1 891	62	37(75)	2 328(75)	11(65)	10(71)	21(74)	84	102	5(72)	4(72)	.	.	270
Mauritius	2 458	56	67(73)	264(75)	55(62)	72(76)	30(75)	30	405	11(75)	24(76)	30(76)	46(76)	760
Mosambik	1 975	37	42(75)	772(72)	12(73)	30(72)	..	67	133	1(72)	10(76)	6(76)	.	150
Niger	1 872	62	37(75)	1 200(74)	11(61)	12(76)	38(74)	90	35	6(75)	2(76)	2(76)	.	160
Nigeria	**2 084**	**46**	**37(66)**	**1 168(75)**	**20(73)**	**35(74)**	**26(75)**	**56**	**94**	**.**	**3(73)**	**2(76)**	**2(76)**	**420**
Obervolta	1 859	59	32(61)	1 474(71)	.	3(76)	42(74)	83	18	2(75)	2(75)	1(75)	1(76)	110
Ruanda	2 086	51	39(75)	583(75)	23(70)	35(76)	59(74)	91	17	0(75)	2(76)	1(76)	.	130
Sambia	2 052	59	43(75)	250(75)	47(70)	65(75)	14(77)	65	545	.	18(74)	11(76)	5(76)	450
Senegal	2 309	67	39(75)	735(75)	25(70)	29(75)	21(74)	76	156	14(75)	10(76)	9(76)	0(76)	420
Sierra Leone	2 224	51	42(75)	927(72)	15(75)	26(75)	38(76)	67	112	.	6(76)	5(76)	3(76)	200
Somalia	1 822	55	39(75)	569(72)	26(63)	30(76)	32(74)	82	47	1(74)	3(72)	2(70)	.	110
Sudan	2 071	61	47(75)	982(75)	20(76)	28(76)	39(74)	79	143	1(75)	2(76)	3(76)	6(75)	300
Swasiland	2 084	56	42(75)	285(75)	.	78(76)	26(74)	75	.	.	16(76)	16(76)	.	580
Tansania	2 002	47	d43(70)	775(70)	61(76)	43(75)	44(77)	83	68	1(75)	2(76)	4(76)	.	200
Togo	2 198	52	32(61)	680(72)	18(61)	65(76)	30(74)	70	85	2(75)	6(74)	3(73)	.	300
Tschad	1 781	60	29(64)	1 140(74)	.	22(76)	41(75)	86	23	2(74)	1(75)	2(75)	.	130
Tunesien	2 440	67	53(75)	427(7?)	55(75)	58(76)	17(76)	43	456	22(76)	17(76)	24(76)	36(76)	860
Uganda	2 094	56	48(75)	636(75)	37(70)	33(76)	53(71)	83	48	.	2(74)	4(76)	6(76)	280
Zaire	1 884	32	42(75)	327(73)	.	53(72)	19(75)	76	62	1(75)	3(74)	2(76)	0(76)	130
Zentralafr. Kaiserreich	2 300	45	33(60)	532(72)	.	45(75)	31(74)	89	41	0(75)	3(70)	2(73)	.	250

*) Die Daten für das Berichtsland sind durch Unterstreichung hervorgehoben. Bei den in Klammern gesetzten Zahlen handelt es sich um Jahresangaben, z.B. (69) = 1969, die entweder das Erhebungs- bzw. Berichtsjahr kennzeichnen oder (im Fall eines mehrjährigen Zeitraums) das Endjahr einer Erhebungs- bzw. Berichtsperiode. Näheres ist aus den Originalquellen zu ersehen. Auf ausführliche Fußnoten-Anmerkungen wurde aus Platzgründen bewußt verzichtet.
1) Für viele Länder liegen nur Schätzwerte der UN Population Division vor. Falls Durchschnittswerte für Männer und Frauen nachgewiesen sind, ist dies durch ein vorangestelltes d gekennzeichnet. - 2) Im allgemeinen Betten in öffentlichen und privaten Krankenhäusern (einsch.. Spezialkliniken usw.), in einigen Ländern nur öffentliche Anstalten. - 3) Lese- und Schreibkundige. - 4) Steinkohleneinheit. - 5) SITC - Pos. 5, 7 und 8.
a) 100 % übersteigende Anteile begründen sich aus der Erfassungsmethode nach Unterrichtsstufen, wobei z.T. Schüler miterfaßt werden, die nicht zur entsprechenden Altersgruppe gehören.

Quellen: FAO Production Yearbook 1977 (Ernährung; Landwirtschaftliche Erwerbspersonen); UN Statistical Yearbook 1977 (Gesundheitswesen; Landwirtschaft/BIP; Energie; Verkehr); UNESCO Statistical Yearbook 1977 (Schüler; Informationswesen); Yearbook of International Trade Statistics 1976 (Außenhandel); World Bank Atlas 1978 (Sozialprodukt); UNRISD Research Data Bank of Development Indicators.

GERMAN FEDERAL OFFICE OF STATISTICS
Comparison of important development indicators of selected African countries

Translation:

1 = Nutrition: a) Calorie and b) Protein supply per capita/day

2 = Health: a) Life expectancy (average of male population)
b) Inhabitants per hospital bed

3 = Education: a) Illiteracy rate of population over 15 years
b) Enrolement ratio

4 = Agriculture: a) Contribution to GDP
b) Employment in agriculture as percentage of local employment

5 = Energy: Consumption per capita

6 = Foreign trade: Processed goods as percentage of total export

7 = Transport: Cars per 1000 inhabitants

8 = Communication: a) Telephone connections per 1000 inhabitants
b) Television sets per 1000 inhabitants

9 = GDP per capita

Source: Minist. de l'Agriculture

Appendix 4

Superficies (S. en 000 ha) Production (P. en 000 tonnes) Rendements (R. en kg/ha)
des cultures de 1969 à 1978

Cultures		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Mil	S	2.271,9	2.309,8	2.356,8	2.165,5	2.007,7	2.200,0	1.698,8	2.326,9	2.732,5	2.746,7
	P	1.095,4	870,8	958,9	918,8	626,9	[illegible]	581,3	1.019,1	1.172,7	1.128,6
	R	482	377	407	425	312	[illegible]	343	438	429	409
Niébé	S	968,1	979,0	998,6	923,6	892,0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	P	83,3	84,3	72,1	144,1	98,2	[illegible]	216,3	246,1	268,8	277,2
	R	86	86	72	156	112	144	260	260	255	284
Sorgho	S	595,0	605,1	579,3	556,8	448,0	[illegible]	790,1	615,3	732,5	795,9
	P	289,3	290,2	266,8	208,4	126,1	218,0	253,8	286,6	342,0	363,5
	R	486	360	461	374	282	404	320	483	472	461
Arachide	S	319,8	357,3	384,2	418,5	363,8	336,0	319,7	164,2	174,3	210,2
	P	206,9	204,6	253,5	260,2	77,1	129,1	41,7	79,2	82,3	96,6
	R	647	572	660	385	212	384	130	483	472	461
Voandzou	S	60,2	56,3	53,3	50,8	24,7	29,2	26,3	11,7	17,7	14,6
	P	43,5	29,4	31,8	21,3	21,3	12,4	12,6	5,8	15,9	8,1
	R	723	522	586	419	869	333	480	496	422	557
Manioc	S	27,5	24,3	24,3	18,5	23,8	31,2	34,9	22,0	30,7	26,1
	P	197,4	181,3	165,8	94,7	155,9	200,6	175,6	197,4	175,6	204,9
	R	716,5	7.400	6.850	5.120	6.530	6.420	5.000	8.960	8.690	7.850
Coton	S	20,2	19,9	20,6	15,9	10,1	15,2	16,4	12,4	10,4	9,2
	P	12,6	10,5	9,0	6,1	3,6	7,9	11,1	7,2	6,4	4,4
	R	526	526	436	382	352	520	676	571	609	480
Riz	S	15,5	16,4	17,1	17,2	17,8	14,8	17,2	21,7	23,0	25,4
	P	38,0	37,1	27,3	31,8	46,3	30,2	29,3	28,7	26,6	31,6
	R	2.521	2.259	1.595	1.407	2.605	2.037	1.820	1.320	1.155	1.245
Gombo	S	2,5	3,0	3,6	2,7	3,0	2,6	2,8	1,7	0,5	0,8
	P	0,9	0,9	1,1	0,7	1,6	1,3	0,9	0,7	0,3	0,4
	R	380	293	300	215	544	500	340	385	562	532
Maïs	S	2,8	2,7	2,9	3,7	5,2	[illegible]	5.3	15,8	7,1	11,1
	P	1,5	1,6	1,9	2,3	2,6	3,7	3,7	11,9	5,6	8,7
	R	542	595	670	627	492	568	460	757	787	726

Appendix 5

STATE	MILLET	G. CORN	G. NUT	BEANS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ANAMBRA	-	-	1	-	80	-	31	28	1	-	-	2	-
BAUCHI	107	353	55	45	-	54	61	8	42	-	-	2	-
BENDEL	-	-	3	...	611	-	78	360	22	12	-	1	-
BENUE	29	91	28	8	1,378	-	40	147	55	38	4	8	2
BORNO	333	137	76	29	-	1	1	1	81	-	-	-	-
CROSS RIVERS	-	-	3	-	129	-	15	199	3	1	-	65	-
GONGOLA	19	205	66	1	1,077	19	49	12	53	...	4	...	-
IMO	-	-	...	1	293	-	38	397	10	11	-	75	-
KADUNA	425	650	89	29	-	30	54	47	65	-	-	48	-
KANO	466	586	115	102	-	9	3	62	8	-	1	-	-
KWARA	37	109	9	4	292	-	25	9	7	19	-	-	-
LAGOS	-	-	-	...	3	-	1	8	-	-	-	-	-
NIGER	33	208	29	3	289	-	3	10	23	31	-	-	-
OGUN	-	-	...	...	96	-	21	89	7	...	-	1	-
ONDO	-	-	1	-	127	-	19	35	3	2	-	15	-
OYO	-	42	1	4	857	-	248	494	17	5	-	...	-
PLATEAU	71	255	30	11	681	3	76	36	14	16	...	30	-
RIVERS	-	-	-	-	203	-	30	198	-	1	-	70	-
SOKOTO	921	660	102	85	-	183	1	-	1	-	-	-	-
TOTAL	2,579	3,527	557	110	6,521	365	752	1,900	408	149	6	368	2
1976/77	2,893	2,650	499	727	6,669	294	1,075	1,878	218	167	14	532	...
1965/66	4,737	3,225	449	888	8,821	314	1,332	4,514	515	271	15	504	6

17.418
17.865
22.661

Source: Federal Office of Statistics Lagos;' Rural Economic Survey 1977/78

TABLE NO. 3.14 Appendix 6

PROJECTIONS OF MILLET SUPPLY (38)

	Current Practice (million tonnes)	NAFPP Target (million tonnes)	NAFPP National gap estimates (thousand tonnes) [1]
1975	1.904	--	-553
1976	1.914	--	-640
1977	1.924	1.933	-724
1978	1.934	1.991	-773
1979	1.943	2.071	-804
1980	1.952	2.237	-766
1981	1.963	2.505	-640
1982	1.974	2.906	-352

[1] Based on an assumed growth rate of demand of 4.7% per annum

TABLE NO. 3.15

PROJECTIONS OF SORGHUM SUPPLY (38)

	Current Practice (million tonnes)	NAFPP Target (million tonnes)	NAFPP National gap estimates (thousand tonnes) [1]
1975	2.816	--	-1,018
1976	2.808	--	-1,180
1977	2.800	2.836	-1,313
1978	2.792	2.921	-1,396
1979	2.784	3.038	-1,453
1980	2.776	3.281	-1,391
1981	2.768	3.778	-1,086
1982	2.760	4.379	- 678

[1] Based on an assumed growth rate of demand of 4.7% per annum

From Feasibility-Study on Foodgrain Processing in Nigeria, (IDRC), p.44

NATIONAL GRAINS PRODUCTION COMPANY LIMITED

N G P C

No. 2, Maska Road, Kaduna,(Nigeria)
Telephone: Kaduna 243407
Telex: 71305 NAGREN NG

OBJECTIVES

The activites of the National Grains Production Company are geared to:

1. expand foodgrain production both for human consumption and livestock production through the establishment of large commercial farms and the use of improved production technology.

2. provide efficient storage and handling facilities for the produce yielded by the farm projects with the main objective of minimizing the losses of produce particularly at the farm level and alleviating the wide seasonal fluctuations in foodgrain prices at the consumer level.

3. develop foodgrain processing designed to promote the commercialization of agro-allied industries in the country.

4. develop an efficient marketing system for its products, both raw and processed, with the main objective of provicing high quality products to the consumer at the lowest possible prices.

ORGANIZATIONAL STRUCTURE

NGPC has four departments and two units:

- Production Department
- Storage and Processing Department (Mr. Ming)
- Administration Department
- Finance Department
- Internal Audit Unit
- Planning/Marketing Unit

The Board of Directors of NGPC is appointed by the Federal Government. The General Manager is the Chief Executive of the Company and is responsible for its day to day management. He is assisted by 2 Assistant General Managers each heading the two Departments of Production and Storage/Processing; the Company Secretary/Legal Adviser who heads the Administration Department and the Chief Accountant, incharge of the Finance Department, responsible for the accounting and financial control of the Company's activities. The Internal Auditor is responsible for the pre-payment and post-payment audit in addition to regular inspection of stocks and inventories.

In line with its ever increasing and diversifying activities, NGPC has, since its inception, felt the need for having a strong Planning/Marketing Unit. This Unit, which has been established with technical assistance from FAO/UNDP has been charged with the onerous responsibilities of assisting with the planning, evaluation and implementation of grain production, storage, processing and marketing functions of NGPC. The Planning/Marketing Unit provides vital support functions to all the Departments of NGPC.

SCOPE OF ACTIVITIES

To meet its objectives, NGPC is pursuing the establishment of large scale mechanized farms, storage and processing facilities together with the provision of all necessary anciliary facilities.

A. ESTABLISHMENT OF JOINT VENTURE FOODGRAIN PRODUCTION PROJECTS:

NGPC is actively promoting the establishment of a large scale mechanized farm of 4,000 hectares (or 10,000 acres) in each of the 19 States of the Federation. Except in Niger State where at Mokwa a large scale mechanized farm is in operation under the direct management of National Grains Production Company, the policy for the implementation of all other farm projects has been conceived as follows:

— Each large scale mechanized farm project will be constituted into a separate commercial company involving NGPC (representing the Federal Government), State Government (including also the Local Government), the Technical Partners (indigenous and/or foreign) and any other interested Nigerian investor;

— Participation in the joint ventures will be strictly on the basis of equity share holding and in accordance with Nigerian Enterprises promotion Decree 1977, the foreign technical partners can hold up to 60% equity;
— The capital base for each project has been fixed at ₦1 million (equivalent to US $1.75 million at Oct. 1979 exchange rates).

Using the above stated implementation strategy, NGPC has already established farm projects in some States and is pursuing necessary action in setting up projects in the remaining States of the Federation.

Prospective technical partners (foreign and/or indigenous) are invited to contact NGPC for further details on the implementation of the farm projects.

B. ESTABLISHMENT OF FOODGRAIN PROCESSING AND STORAGE FACILITIES:

As mentioned earlier one of the main functions of NGPC is to develop foodgrain processing designed to accelerate commercialization of agro-allied industries in the country.

The company has already set up on a pilot basis a flour mill in Kaduna for the milling of sorghum and maize. NGPC maize and sorghum flour has been on the market since August, 1979 and has been readily accepted by the consumer because of its high quality and competitive prices. As the supply of NGPC flour falls much short of the market demand at present, it is now planned to double the production capacity of the flour mill. Plans have also reached an advanced stage for the establishment of rice milling and animal feed milling facilities by NGPC. It is expected that the experience gained from NGPC pilot processing facilities will be of intimate relevance to the integrated functions of large scale mechanized farms where primary and later on secondary processing will constitute an integral part of the farming enterprise.

As part of its storage programme, NGPC have already constructed storage facilities in 9 States of the Federation capable of storing 80,000 tons of grains. These facilities have since been made available to Nigerian Grains Board. Plans are also now underway for a phased programme for the provision of storage facilities at the mechanized foodgrain production projects mentioned under (A) above. These facilities will not only alleviate burden of excessive expenditure on transport facilities particularly in the peak post harvest supply period, but would also help to minimize losses of produce.

C. DEVELOPMENT OF MARKETING FUNCTIONS:

Being a commercially oriented company, NGPC is concentrating attention to the timely provision of inputs at its farm projects and the efficient distribution of the outputs of the farm projects and the products of its processing plants. The emphasis of the company is to provide efficient storage and handling facilities for the produce yielded by the farm projects and the processing plants with the main objective of minimizing losses and alleviating wide seasonal fluctuations in foodgrain and foodgrain product prices at the consumer level.

FURTHER INFORMATION

Inquiries should be directed to:

The General Manager,
National Grains Production Company Limited,
P.M.B. 2182,
No. 2, Maska Road, (Off Dawaki Road),
Kaduna, NIGERIA.

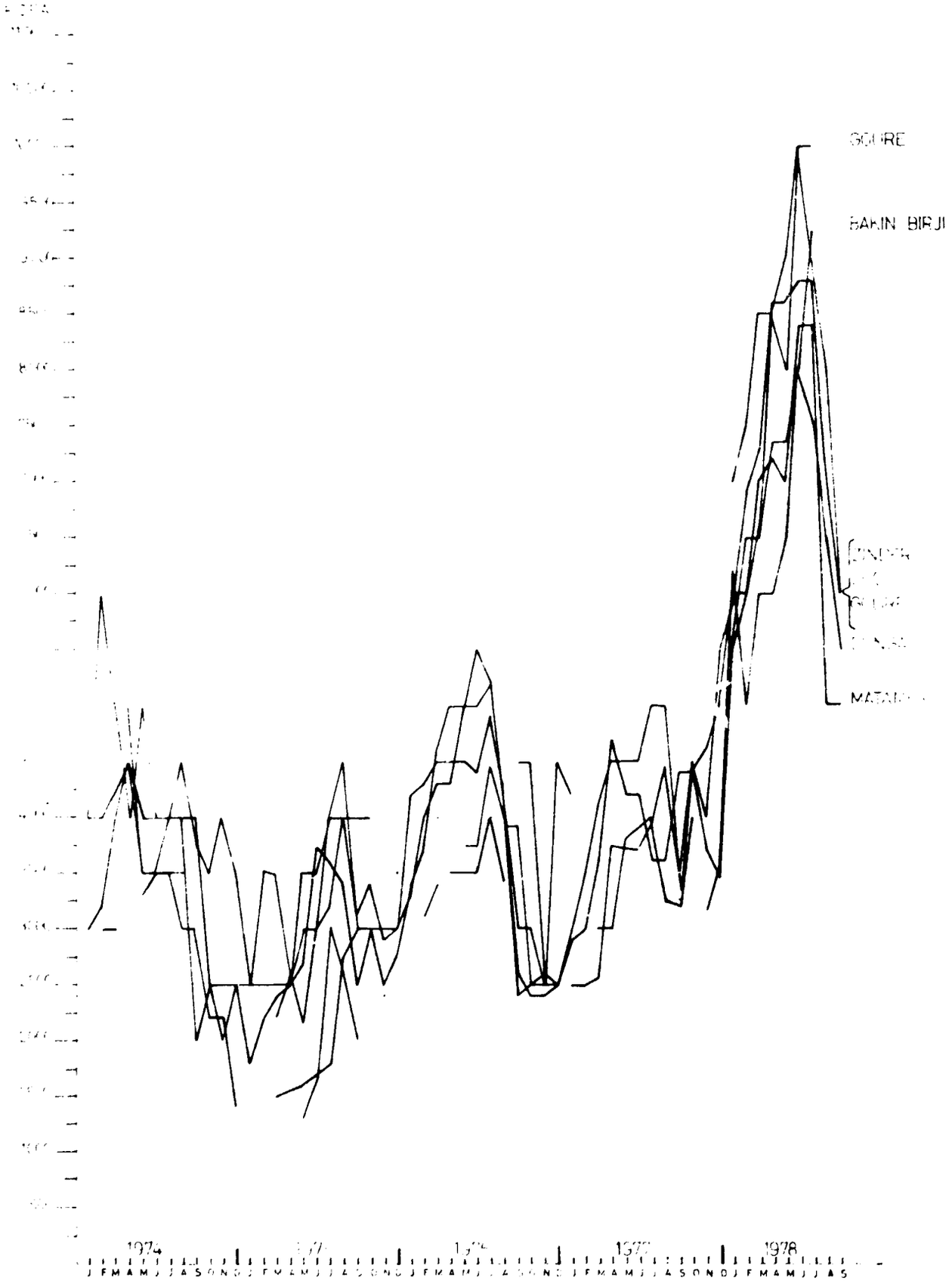
.....

Telephone: Kaduna 243407
Tele: 71305 NAGREN NG

Printed by Sooji Press Ltd., Kaduna.

ZINDER BILAN DEPARTEMENTAL 1977

EVOLUTION DU PRIX DU MIL EN FCFA (sac de 100 kg)



Source : [illegible] Rapport Mensuel sur les Prix [illegible] Octobre 1978.

Annex 9

Subspecies of Sorghum

subseries	aantal subspecies	chief subspecies	nom anglo-saxon	nom français	distribution	uses
(1) Drummondii	3	*S. drummondii* (Steud.) Millsp. & Chase	Chicken corn		Trop. W. Africa	Grain, little economic value
(2) Guineensia	7	*S. guineense* Stapf	Guinea corn		Trop. W. Africa, Sudan and Uganda	Grain; principal sp. in W. Africa
		S. roxburghii Stapf	Shallu		East Africa, India and Burma	Grain and fodder
(3) Nervosa	6	*S. nervosum* Bess. ex. Schult.	Kaoliang	gaolian	China; most easterly sp.	Grain; principal sp. in E. and C. China
(4) Bicoloria	6	*S. dochna* (Forsk.) Snowden	Broom sorghum	houque, sorgho à balai	India and Burma, but widely introduced	Principal broom sorghum; but includes many sweet sorghums
		S. bicolor (L.) Moench	Sugar sorghum	houque sucrée	India, but widely introduced	Includes many sweet sorghums
(5) Caffra	5	*S. caffrorum* Beauv.	Kafir corn	sorgho des Caffres	Africa south of the equator	Grain; principal sp. in S. Africa
		S. nigricans (Ruiz & Pavon) Snowden	Beer sorghum		Equatorial Africa	Grain, mainly for brewing beer
		S. caudatum Stapf	Feterita		E. and W. Africa and Sudan	Grain
(6) Durra	4	*S. durra* (Forsk.) Stapf	Durra	dari, dourra	Sudan, Egypt and India	Grain
		S. cernuum Host	White durra	sorgho penché	Asia Minor to India	Grain and fodder
		S. subglabrescens Schweint. & Aschers	Milo		N.E. Africa, Arabia to India	Grain and fodder

Preparation of Inwa-soup (Northern Nigeria)

To one cup of fermented sorghum flour (sour) add two and a half cup of water and about to 2 g of potash in order to preserve and soften the sorghum. Mix it up and cook it for 3 minutes.

One usually cooks the quantity for one week. Due to the addition of potash this soup has a keeping quality of one week.

Recipe for Tortillas

1.) 6 kg of sorghum grain
12 Ltr. water
0,120 g lime (calcium hydrocycle)

2.) The mixture is stirred cold and than cooked at 94° C until the grains are soft. After cooking the grains are washed with water and wet milled into dough.

3.) From this dough tortillas are made and then dehydrated.

Preparation of wheat bread with 10 % sorghum flour in the "boulangerie a Niamey"

2 x 50 kg	wheat flour (imported)
10 kg	sorghum flour (Sotramil)
30 Ltr	normal water
20 Ltr	warm water (40 - 30°C)
1,6 kg	salt
0,9 kg	yeast (Gistex Brocades, Netherland)

162,5 kg are mixed for ten minutes.

Then thirty minutes stand by,

Then devide the dough to small baquet,

20 Minutes in automized baking oven at 30°C.

Due to the bitterness of sorghum flour of Sotramil more sorghum flour could not be used.

A sorghum flour based menu at Hilton, Khartoum 1979

March 27th. 1979

VEGETABLE SOUP WITH
PEARL DURA

GREPES NANTUA

ROASTED BABY CHICKEN
RISI BISI

MIXED SALAD WITH
WHITE CHEESE

PEARL DURA PUDDING
WITH CRISP SWEETS

FRESH FRUITS

SORGHUM BREAD

COFFEE

LUNCHEON CO-SPONSORED BY THE KHARTOUM HILTON HOTEL.

MAIDUGURI PILOT FLOUR MILL NINE MONTH REVENUES AND EXPENSES SUMMARY
(January 1976 to September 1976)

	PER 100 kg ₦	PER MONTH ₦
REVENUE		
TOTAL VALUE OF PRODUCTION	22.38	7,262
COST OF WHOLE GRAINS USED	14.60	4,736
GROSS MARGIN FOR MILL OPERATION	7.78	2,525
EXPENSES--Variable		
MILLING LABOUR COSTS	1.43	465
FUEL, OIL, GREASE	.22	71
EQUIPMENT & BUILDING REPAIRS (Estimated--3% of New)	.32	104
PACKAGING SUPPLIES	.97	316
TOTAL VARIABLE COSTS	2.94	956
EXPENSES--Overhead		
MILL MANAGEMENT SALARIES (Manager, Mechanic, Miller)	2.58	981
GUARDIAN WAGES	.43	
DEPRECIATION--Equipment (10%)	.52	167
Building (5%)	.38	125
INTEREST COSTS (8% of present value)	.69	222
TOTAL OVERHEAD COSTS	4.60	1,495
TOTAL MILL COSTS	7.22	2,451
NET ABOVE ALL COSTS	.56	75

Averadge production in Maiduguri - Kaduna mill
(IDRC - Report 1978)

MAIDUGURI PILOT FLOUR MILL NINE MONTH PRODUCTION SUMMARY (January 1976 to September 1976)

	TOTAL PRODUCTION kg	DAILY PRODUCTION kg
INPUTS		
SORGHUM AND MAIZE	291,944	1,431
OUTPUTS		
FLOUR	61,400	301
GRITS	123,596	606
MIDDLINGS	34,380	169
TOTAL EDIBLE PRODUCTS	219,376	1,075
DUSA (BRAN)	58,186	285
LOSSES	14,382	71

TEST CAPACITY PER DAY*	2,400 kg
DAYS WORKED IN PERIOD	204 days
GRAIN PROCESSED PER DAY	1,431 kg.
OPERATING EFFICIENCY	60%
EDIBLE PRODUCTS PER DAY	1,075 kg.
EXTRACTION RATE	75%
BRAN PER DAY	285 kg.
LOSSES PER DAY	71 kg.
LOSSES	5%

*Six hours @ 400 kg/hr each eight hour shift.

Estimated costs for sorghum flour in Zinder (Sotramil)

	140 t / months
Total value of production	-
Cost of whole grains used (180 t x 0,40 DM)	72.000 DM
Gross margin for mill operation	-

Expenses variable

Milling labour costs (20 p)	6.000 DM
Fuel, oil, energy	2.000 DM
Equipment, building repairs (estimated 5 % of New value)	4.150 DM
Packaging supplies	1.400 DM
	11.550 DM
	(0,083 DM/kg)

Expenses overhead

Milling management salaries (Manager, two millers)	2.000 DM
Depreciation of equipment (10 %)	16.300 DM
Building (5 %)	8.300 DM
Interest costs (10 % of present value)	2.500 DM
	47.100 DM
	(0,33 DM/kg)

Total Milling Costs per kg Flour 0,413 DM/kg

2-2-2 SOURCE PERMANENTE DE FINANCEMENT CAISSE MUTUELLE

Un facteur de bloquage de l'évolution de la coopérative de KARMA, c'est l'évolution trop lente de la caisse mutuelle. En effet les revenus possibles sont très faibles.

Par exemple le tonnage commercialisé plafonne autour de 150 tonnes par campagne et les ristournes nettes sont guère importantes.

Les revenus de l'exploitation des eucaliptus ne commencent être significatives que dans quelques ans.

La recherche d'une source permanente de financement s'impose.

La recherche de spéculations à intérêt collectif à fait l'objet de plusieurs réunions de C.D. et une bonne idée en est sortie : l'achat et l'exploitation d'un moulin et d'une décortiqueuse à mil, servant à tout le village de KARMA. En effet le décorticage et le moulage constitue à KARMA un véritable problème, aucune machine de ce genre n'existant dans le village.

L'opération est lancée et le but recherché c'est :

- Equiper le village de KARMA d'un centre de décorticage et de moulage.
- Resoudre un problème social, en effet la grosse partie du mil du canton de KARMA est transportée à NIAMEY pour être traité et ramenés à KARMA, avec des frais considerables.

Le montant total de l'Opération c'est :

Un moulin	550.000 FCFA
Une décortiqueuse	870.000 FCFA
Un moteur	520.000 FCFA
TOTAL.	1,940.000 FCFA

9000,- DM

Financement : C N C A et CAISSE MUTUELLE.

PLAN AMMORTISSEMENT

Le plan d'ammortissement, étant un prêt CNCA doit suivre les échéances prévues par la banque.

	Moulin	Décorticage	Moteur	Total
Immobilisation	550.000	870.000	520.000	1.940
Date mise en Service	30-6-79	15-10-79	15-10-79	
Durée ammortissement	42 mois	42 mois	42 mois	4
Dotation mensuelle	13.095	20.714	12.380	
Provision mensuelle réparation (1)	2.292	3.625	4.333	

- Note (1) la provision pour réparations est égale :
- Pour le moteur 10 % de 520.000/ an
- Pour les machines 5 % de 550.000 + 870.000/ an

COMPTE PREVISIONNEL POUR UN AN DE FONCTIONNEMENT

	FCFA
- Motoriste 12 mois x 17.500	210.000
- Carburant (2 l/h x 5 h/jour x 360 jours) ≈ 110	396.000
- Lubrifiant (20 % de 396.000)	79.200
- Ammortissements et provisions 30%	677.268
	1.362.468

DETERMINATION DU COUT DU KG DE PRODUIT DECORTIQUE OU MOLU

- Rendement moulin ou décortiqueur 200 kg/heure
- Heures de fonctionnement journalier : 5 heures
- Frais factionnement horaire(5 heures/jour x350J=1800h/an

$$\frac{1.362.468}{1800} = 760 \text{ FR/heures}$$

- Coût de revient du kg traité :

$$\frac{760 \text{ FR}}{200} = 3{,}8 \text{ F kg}$$

- Yield of Flour 70%

PRIX MINIMUM DE LA PRESTATION/SAC DE 100 KG

Cout de revient	380 FR/Sac
5 % bénéfice	20 FR/Sac
TOTAL	400 FR (1)

Note (1) en aucun cas le prix de la prestation doit être inférieur à ce montant.

BENEFICE EN FIN D'OPERATION

On doit noter que la courte durée de la période d'ammortissement, imposée par les échéances de la CNCA oblige à considerer deux périodes d'exploitation :

- Pendant les premiers trois ans : il y aura un bénéfice de 5 % sur les chiffres d'affaire. Pendant cette période de l'installation travaillera presque uniquement pour se payer.

- A partir de la quatrième année, il n'y aura plus d'obligation en vers la CNCA et les ammortissements devindrons bénéfices nets.

On suppose que l'installation aie une vie d'ou moins 5 ans.

PREMIERE PERIODE

En supposant que le nombre de kg traités par jour soit également à 1000 kg pendant la période seront traités 1.080.000kg.

Le bénéfice cumulé sera : 1.080.000 x 0,2 F/KG = 216.000

DEUXIEME PERICDE : Durée d'ou moins deux ans

- Bénéfice normal

$$\frac{216.000}{36} \times 24 \text{ mois} = 144.000$$

Ammortissement

46.189 x 24 mois 1.108.536

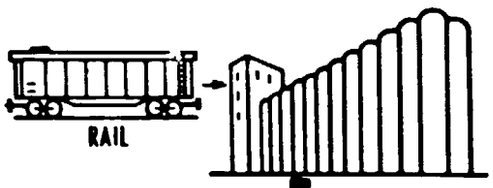
Le bénéfice total en fin d'opération sera

216.000 + 144.000 + 1.108.536 = 1.468.536

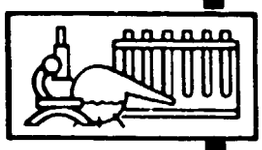
Flour sheet of the Kano Wheat Mill

HOW FLOUR IS MILLED

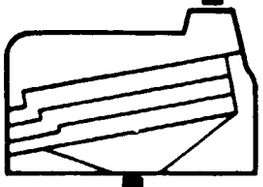
IT STARTS HERE...



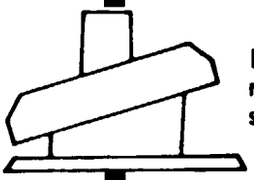
ELEVATOR—storage and care of wheat.



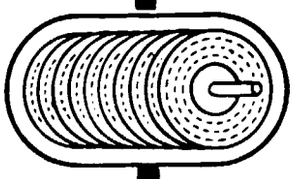
PRODUCT CONTROL—chemists inspect and classify wheat, blending is often done at this point.



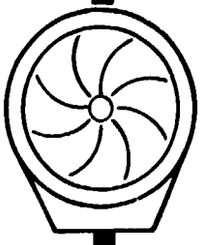
SEPARATOR—reciprocating screens remove stones, sticks and other coarse and fine materials.



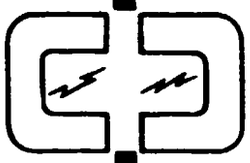
DRY STONER—removes stones



DISC SEPARATOR—Barley, oats, cockle and other foreign materials are removed

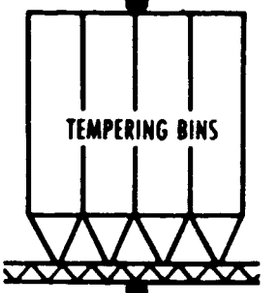


SCOURER—beaters in screen cylinder scour off impurities and roughage.

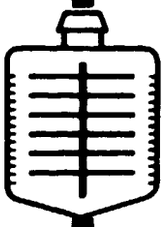


MAGNETIC SEPARATOR—iron or steel articles stay here

TEMPERING—water toughens outer bran coats for easier separation—softens or mellows endosperm.



BLENDING—types of wheat are blended to make specific flours.



ENTOLETER—impact machine breaks and removes unsound wheat.

FIRST BREAK—corrugated rolls break wheat into coarse particles.

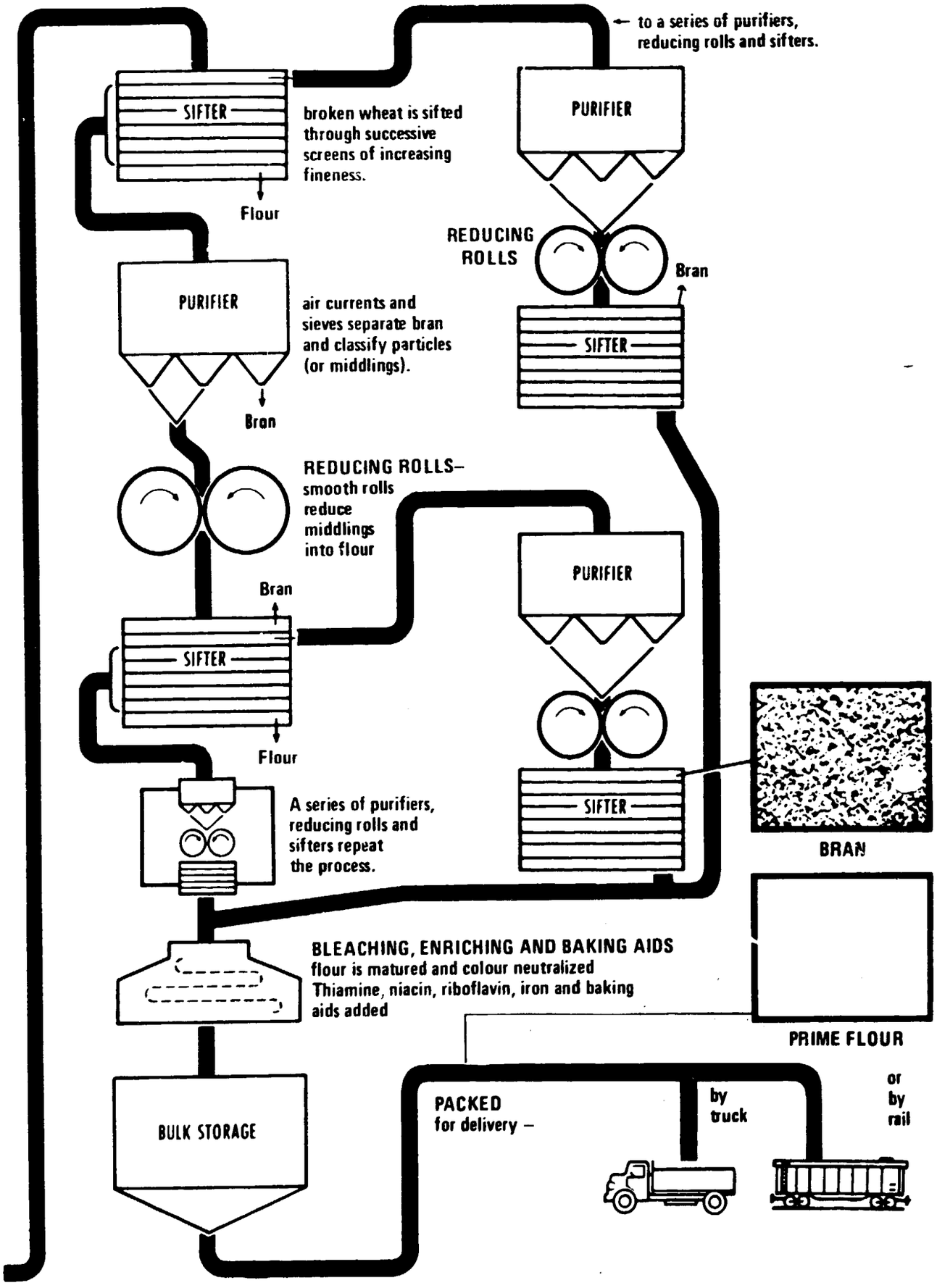

← to a series of purifiers, reducing rolls and sifters.
SIFTER
broken wheat is sifted through successive screens of increasing fineness.
Flour
PURIFIER
REDUCING ROLLS
Bran
PURIFIER
air currents and sieves separate bran and classify particles (or middlings).
Bran
SIFTER
REDUCING ROLLS– smooth rolls reduce middlings into flour
PURIFIER
Bran
SIFTER
Flour
A series of purifiers, reducing rolls and sifters repeat the process.
SIFTER
BRAN
BLEACHING, ENRICHING AND BAKING AIDS
flour is matured and colour neutralized
Thiamine, niacin, riboflavin, iron and baking aids added
PRIME FLOUR
BULK STORAGE
PACKED
for delivery –
by truck
or by rail

Table 1 Appendix 17

Investment for Machinery and Equipment

(guide figures)

UNIDO/IF.

No.	Section	(Wheat) Flour Mill DM	Specific Sorghum Mill DM
1	Cleaning	71,120.--	49,475.--
2	Conditioning	18,285.--	-
3	Hulling	77,230.--	63,608.--
4	Milling (grinding)	516,320.--	103,434.--
5	Conveying Equipment	90,050.--	17,220.--
6	Blending plant	73,550.--	33,510.--
7	Electric Switch Gear	53,870.--	15,200.--
8	Erection Material	35,000.--	27,390.--
9	Total amount FOB Hamburg	935,425.--	309,837.--
10	Plus ocean freight and insurance (10% of FOB value)	93,543.--	30,983.--
11	CIF	1,028,968.--	340,820.--
12	Port handling charges (1 %)	10,290.--	3,408.--
13	Inland transportation (3.5%)	36,015.--	11,390.--
14	Free site of erection	1,075,273.--	356,158.--
15	Erection cost	125,920.--	52,350.--
16	Starting cost	42,320.--	19,600.--
17	Local material	32,800.--	4,500.--
18	Local temporary labour	60,485.--	6,500.--
19	Machinery and equipment ready for operation	1,336,799.--	439,108.--
20	Technical period of depreciation	12 years	12 years
21	Depreciation per annum	83,550.--	27,445.--
22	Specific depreciation (DM per ton of produced product)	9.83	3.23

Table 2 Appendix 17

Cost of Investment for Building

Base of calculation: DM 400.-- per cubic metre (m3)

Section of Production Building	(Wheat) Flour Mill	Sorghum Mill	1 W
Cleaning plant	244,800.--	102,400.--	2
Tempering	94,000.--	-	
Mill	544,000.--	179,200.--	7
Mixing section	28,800.--	-	
Blending bin	28,000.--	-	
Flour store	360,000.--	307,200.--	9
Total	1,299,600.--	588,800.--	

Table 3

Depreciation:		
Duration	25 years	25 years
Value of depreciation per annum	51,984.--	23,552.--
Specific Depreciation (in DM per ton of produced end product)	8.46	3.84

Note:

All prices are given in Deutschmark.

Table 4

Cost of Maintenance and Repairs per annum

No.	Maintenance	(Wheat) Flour Mill DM	Specific Sorghum Mill DM
1.1	Maintenance of Buildings (2 % of building value)	25,992.--	11,776.--
1.2	Maintenance of Machinery and Equipment (3 % of total FOB value.	28,063.--	9,295.--
2.0	Sub-Total	54,055.--	21,071.--
3.0	Wearing Parts (estimated)	15,000.--	12,000.--
4.0	Total of Maintenance Cost per annum	69,055.--	33,071.--

Table 5
Wages and Salaries
- incl. social expenses -
(guide figures)

No.	Salaries	(Wheat) Flour Mill DM	Specific Sorghum Mill DM
1.1	Chief Miller	12,000 --	8000.--
1.2	Electrician	7,000.--	7,000.--
	Sub-Total	19,000 --	15,000.--
	Wages per shift		
2.1	Miller	6000.--	6,000.--
2.2	Foreman	5,000.--	-
2.3	Mechanic	6,000.--	6,000.--
2.4	Temporary labourers	24,000.--	14,400.--
	Sub-Total per shift	41,000.--	26,400.--
3.1	First shift (salaries and wages)	60,000.--	41,400.--
3.2	Second and third shift (salaries and wages)	82,000.--	52,800.--
4.0	Total expenses of wages and salaries per annum	141,000.--	94,200.--

Table 6

Summary of Production Cost per annum

No.	Description	(Wheat) Flour Mill DM	Specific Sorghum Mill DM
1.1	Depreciation on building	51,984.--	23,552.--
1.2	Depreciation on machines	83,550.--	27,445.--
2.0	Sub-Total of depreciation	135,534.--	50,997.--
3.0	Wages and salaries	145,000.--	94,200.--
4.0	Current and water consumption	170,550.--	101,650.--
5.0	Fire insurance	7,224.--	2,816.--
6.0	Calculated interest	184,548.--	71,954.--
7.0	Total of production cost	642,856.--	321,617.--

Table 7

Fixed and Variable Cost of the Mills

No.	Description	(Wheat) Flour Mill DM	Specific Sorghum Mill DM
1.0	Fixed cost		
1.1	Depreciation	135,534.--	50,997.--
1.2	Wages and salaries	209,000.--	83,700.--
1.3	Administrative overheads p.a.	145,000.--	94,200.--
1.4	Proportionate Maintenance Cost[1)]	34,527.--	16,536.--
1.5	Fire Insurance	7,224.--	2,816.--
1.6	Calculated interest	184,548.--	71,954.--
2.0	Sub-Total of fixed cost	715,833.--	319,703.--
3.0	Variable cost		
3.1	Current and water consumption	170,550.--	101,650.--
3.2	Proportionate maintenance cost[1)]	34,527.--	16,536.--
4.0	Sub-Total of variable cost	205,077.--	118,186.--

1) Assumption 50 % due to operation (variable) and 50 % due to time (fixed)

Sorghum Millet Mill
- Schule-system -

- Storage of finished products

ıfacturing complete in-tandard units, a com-two floors, mounted in for low type hangars wheat mills. The basic cortication is the VERTICAL SHELLING MACHINE (see left ill on front cover) and the percus-sion-type ASIMA PROGRESS MILL (see right ill on front cover) for the flour pro-duction. Our laboratory for sorghum and millet can test your raw products and based on those results we will offe you the most suitable plant.

Appendix 18

The raw material, consisting of timely harvested, dry, mill stock is conveyed either mechanically or pneumatically throughout the plant. For the cleaning process the SCHULE Combigran grain cleaner is employed (item 2, ill. 5103), cleaning the material by vibratory sieve with a large sifting surface and separating all offals such as sand, dust and coarse impurities. The incorporated air-flow separator removes light particles by means of vertical air flow, a permanent magnetic separator is adopted for removal of iron particles.

For the separation of earth, lumps, stones, glass and other heavy contaminants the SCHULE Dry Stoner (item 3, ill. 5308) is used. The machine is working according to the air reversing principle.

Both, Combigran cleaner and Dry Stoner are equipped with dust removal systems consisting of fans and dust collectors or filter equipment.

After thorough cleaning, the grain is transported to the decorticating section where the material is decorticated by the Vertical Shelling Machine (item 4). During this process the pericarp and the germ are being removed by means of emery discs of different granulation. A separate aspiration system serves to cool the unit and separates the bran. The bran is pneumatically conveyed into a Centrifugal Separator and then released by a dust lock.

The separated air is cleaned by a filter, in order to keep the plant dust-proof. The last stage of the decorticating section is the Centrifugal Sifting Machine (item 9, ill. 5405) for the separation of the bran into two fractions in order to relaim the coarse grain particles, thus improving the yield of flour.

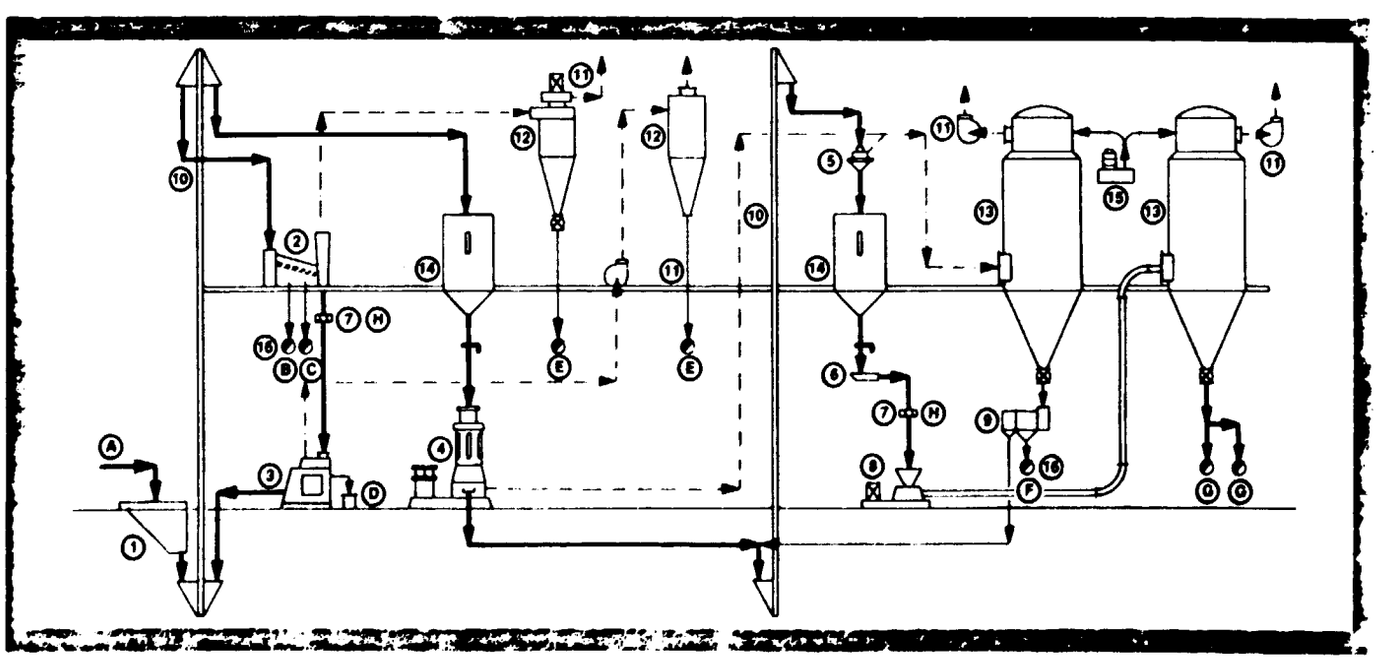
Grinding of the decorticated grain will be carried out in a single pass on the SCHULE ASIMA MILL. (item 8) Mill stock is fed to the unit by means of a Vibratory Feeder and controlled for iron particles by a Magnetic Separator.

This impact grinder is best suited for medium hard products.

The flour is pneumatically conveyed to the Filter Unit (item 13, ill. 5372). Finally the flour is bagged-off and stored.

- Ⓐ Raw Sorghum
- Ⓑ Sand, Seeds
- Ⓒ Coarse Impurities
- Ⓓ Stones, Earth
- Ⓔ Dust
- Ⓕ Iron
- Ⓖ Bran
- Ⓗ Sorghum Flour
- ❶ Intake Hopper
- ❷ COMBIGRAN Cleaner
- ❸ Dry Stoner
- ❹ Vertical Shelling Machine
- ❺ Counter Current Coarse Sifter
- ❻ Vibratory Feeder
- ❼ Magnetic Separator
- ❽ ASIMA Mill
- ❾ Centrifugal Sifting Machine
- ❿ Elevators
- ⓫ Fans
- ⓬ Centrifugal Dust Collectors
- ⓭ Jet Filters
- ⓮ Bins
- ⓯ Air Compressor
- ⓰ Sacking-off Boards

The above described flow of production can be completed with more special equipment for PEARL DURA etc or according to local demands of finished products



List of official salaries in Niger 1980 — Appendix 19

Classifications	Salaires annuels
3ème Catégorie ... Worker	20.927 francs
4ème Catégorie	24.300 "
5ème Catégorie ... Mechanics	28.662 "
6ème Catégorie ... I	33.166 "
7ème Catégorie	37.570 "
Hors Catégorie	41.745 "
8ème Catégorie A ... Simple manager	44.500 "
8ème Catégorie B	47.356 "
8ème Catégorie C ... Technician	51.784 "
9ème Catégorie A ... Managers	57.000 "
9ème Catégorie B	63.440 "
10ème Catégorie A	64.312 "
10ème Catégorie B	70.600 "
10ème Catégorie C	76.193 "
11ème Catégorie	82.771 francs

B/ - Branche professionnelle des Banques

1ère Catégorie B	17.865 francs
2ème Catégorie A	18.428 "
2ème Catégorie B	19.417 "
3ème Catégorie	20.927 "
4ème Catégorie	24.300 "
5ème Catégorie	28.662 "
5ème Catégorie	33.166 "
7ème Catégorie	37.570 "
Hors Catégorie	41.745 "
Classe - I	46.391 "
Classe - II	48.979 "
Classe - III	52.979 francs

.../...

TABLEAU G.13

Appendix 20 a

COUT DES VEHICULES KILOMETRIQUES

Republique du Niger
Ministère des Travaux Publics
des Transports et de l'Urbanisme
- Plan de Transport', 1978 -

Type de véhicule	T Y P E D E C H A U S S E E									
	R.B.		R.T.M.L.		R.T.S.		P.A.		P.N.A.	
	H.T.	T.T.C.	H.T.	T.T.C.	H.T.	T.T.C.	H.T.	T.T.C.	H.T.	T.T.C.
V.P.	51,5	74,9	55,0	80,0	94,3	135,5	132,7	188,5	175,2	247,0
Camionnette	39,3	53,8	41,5	57,0	57,9	79,2	77,0	105,0	90,1	122,5
Car	56,9	77,3	60,4	81,9	76,2	103,5	97,4	132,4	118,7	161,3
Camion léger	73,0	101,7	76,1	106,5	92,1	128,1	104,6	145,1	121,0	167,1
Camion lourd	112,4	153,4	118,1	161,3	146,2	199,7	170,6	232,6	200,8	273,4
Ensemble articulé	170,7	220,8	178,7	230,8	230,9	300,1	279,1	362,9	349,6	455,9

Unité : F CFA/Km

R.B. = Route bitumée
R.T.M.L. = Route en terre moderne
R.T.S. = Route en terre sommaire
P.A. = Piste âmeliorée
P.N.A. = Piste ordinaire (non-améliorée)

TABLEAU C.1.4

COUT DES UNITES KILOMETRIQUES TRANSPORTEES

Appendix 20 b

Type de véhicule	Taux de chargement (1)	TYPE DE CHAUSSEE									
		R.B.		R.T.M.L.		R.T.S.		P.A.		PNA	
		TTC	HT	TTC	HT	TTC	HT	TTC	HT	TTC	HT
Camionnette (voyageurs) - 12 places -	50 %	9,0	6,6	9,5	6,9	13,2	9,7	17,5	12,8	20,4	15,0
	100 %	4,5	3,3	4,8	3,5	6,6	4,8	8,8	6,4	10,2	7,5
Camionnette (commerciale) - 1 T. -	50 %	107,6	78,6	114,0	83,0	158,4	115,8	210,0	154,0	245,0	180,2
	100 %	53,8	39,3	57,0	41,5	79,2	57,9	105,0	77,0	122,5	90,1
Car- 23 places -	50 %	6,7	4,9	7,1	5,3	9,0	6,6	11,5	8,5	14,0	10,3
	100 %	3,4	2,5	3,6	2,6	4,5	3,3	5,8	4,2	7,0	5,2
Camion léger - 4 T. -	50 %	50,9	36,5	53,3	38,1	64,1	46,1	72,6	52,3	83,6	60,5
	100 %	25,4	18,3	26,6	19,0	32,0	23,0	36,3	26,2	41,8	30,3
Camion lourd - 12 T. -	50 %	25,6	18,7	26,9	19,7	33,3	24,4	38,8	28,4	45,6	33,5
	100 %	12,8	9,4	13,4	9,8	16,6	12,2	19,4	14,2	22,8	16,7
Ensemble articulé - 22 T. -	50 %	20,1	15,5	21,0	16,2	27,3	21,0	33,0	25,4	41,4	31,9
	100 %	10,0	7,8	10,5	8,1	13,6	10,5	16,5	12,7	20,7	15,9

unité : F CFA/passager-kilométrique
ou F CFA/tonne-kilométrique

(1) 50 % : aller ou retour à vide

Laboratory Installation

Furniture + exhauster
(15 meter)

Analytical wheighers

Drying ovens (150^{o} 2)

Laboratory backery, oven, 2 mixer

Extensiograph, Farinograph (from Zinder)

Microscope

Microbiological installation

Haake viscosimeter

Protein-Kjeldahl

Fat extraction

Ash oven

Colourimeter

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MTI

Alternative proposal for Northern Nigeria

After the presentation of the draft report the UNIDO/FAO-Adviser to the Joint Commission, Mr. Lambert-Daynac, visited Germany and the situation in Northern Nigeria was discussed again under additional development and planning aspects given by Mr. Lambert-Daynac.

Consequently it was decided to include an alternative expansion proposal for Northern Nigeria in the report which would result in an earlier start of a pilot-programme for sorghum/millet-milling in Kano and Zaria.

As already mentioned in the introduction only a very limited budget for the field work was available. Therefore only short discussions with representatives of NNFM (Kano) and Ahmadou Bello University (Zaria) could be held.

The information given in this conversations is not sufficient for an economic and financial analysis of the following proposals. As price and cost-conditions are comparable (or even better) to Niger the economic viability of this project can be assumed. Details have to be analyzed in a further investigation.

The following project proposal is an alternative to the conclusion given in chapt. 6.2.2.:

Kano:

Installation of 1 UNDP/FAO/Schule-mill (1,75 t/h) as part of the already existing milling plant of NNFM. The mill should be owned and operated by this firm. The production of this mill (13.000 t/y) [1] could be used as a first step for a composite flour programme in Nothern Nigeria. The above mentioned capacity would allow an addition of approximately 5 % (actual wheat flour capactiy) or 3 % (planned wheat flour capacity) of sorghum/millet flour to the wheat flour production.

This sorghum/millet mill could also be used for the training of milling personnel both from Niger and Nigeria- by the experienced staff of NNFM.

1) The NNFM plant works on a 24 hours/daily base . The sorghum/millet mill capacity utilization is calculated on the same base.

In addition detailed planning data for a comprehensive sorghum/millet programme in Northern Nigeria could be gained.

Zaria:

Installation of 1 ! JDP/FAO/Schule-mill (1,75 t/hour) as part of the NAFPP at the Ahmadou Bello University.

This mill should guarantee, that processing aspects from the standpoint of milling and further industrial use of the flour should be duely regarded in the selection and propagation of high yielding sorghum/millet varieties. For this purposes a close cooperation with the already existing experimental bakery in Kaduna is necessary.