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**COWPEA PROCESSING
PROJECT 685-0281**

**END OF PROJECT
OCTOBER 1988 TO JUNE 1989**

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**PREPARED FOR:
U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
SENEGAL**

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BY

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ON

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"Japan is a poor nation without many natural resources. We don't have petroleum; we don't have anything except spirit.

The Japanese people put their spirit into whatever they make".

"Soshitsu Sen"

This project was implemented with the continuous encouragement of Ms. Sara Jane LITTLEFIELD, the USAID Director in Dakar.

The following collaborators contributed to the success of this project.

ITA : Mr. Mouhamadou DIOP, General Director
 Dr. Ababacar NDOYE, Deputy Project Director

PDO : Mr. D. MYERS, Chief PDO
 Mr. William HAMMINK, Project Supervisor
 Mr. Mamadou KAME, Project Officer
 Dr. M. M. HANDY, Technical Advisor.

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SUMMARY AND CONCLUSIONS

Villagers in the northern regions of the Peanut Basin produced millet in 1988 only 50% of their annual need, and were forced to buy 40% from local markets. The carré in these regions on average spent annually 40,000 CFA to buy millet, and 75,000 CFA to buy rice(3).

Rainfall in 1988 was about average so one need not imagine the situation during years of drought as it was the case in 1983/1984. Cowpea crop tolerates drought during maturity period, and delivers satisfactory crops on short rainy seasons (30 - 45 days) which makes it a promising relief to regions who cannot produce enough millet and peanuts for their needs. Cowpeas was proved in 1985 to be a productive crop however the lack in markets and its vulnerability to infestation made it unprofitable to many producers.

The project attacked these problems by setting up studies to find out villagers and urbanites attitudes on cowpea consumption ; to establish strategies that would increase cowpea consumption by the population ; and to transfer the technologies and information to Louga villagers and to potential processors or entrepreneurs in Dakar.

Inquiries in Louga and St.-Louis regions showed that average yearly per capita consumption of cowpeas was 7.5 kg. In comparison of the same in Dakar and suburbs the average per capita intake was 0.86 kg. The majority of rural population prepared cowpea as couscous and Neukheul while in Dakar it was as a snack (Akara) and/or as garnish for meat sauces.

Villagers had better knowledge on the nutritional qualities of cowpeas than urban households in Dakar.

Seventy per cent of the sample (555 carrés) in Louga and St.-Louis expressed the quality of cowpea for good health while only 9% of the sample in Dakar (500 households) confirmed that. On the negative side 91% of the carrés experienced digestive problems after eating cowpea grains and 7% of Dakar sample stated this problem, meanwhile 72% had experienced no ill-effects.

Cowpea consumption did not correlate necessarily with low-income families. 12% of carrés with 10,000 CFA or less monthly income consumed cowpeas, while 15% of carrés with income of 100,000 CFA or more were consumers of cowpeas.

Household in Dakar sample spent monthly an average of 87% of their income on food items. Five out of ten districts had households which spent 105 to 129% of their monthly income on food purchase. These districts were eliminated from the home-test of cowpea products.

Seven out of ten cowpea-product concepts were accepted by the Dakar sample. The following concepts were satisfactory to more than 70% of households, and which were in descending order : flour for gâteau and cakes, canned products, precooked, dry grain, precooked-flour, fermented-flour, pickled grain or pods, and toasted-grits. The four underlined products were developed at ITA, were produced on pilot-scale operations, then were tested in 300 homes and at restaurants/vendors in Dakar districts. All products were highly acceptable to consumers particularly precooked, dry-grain, and fermented-flour. Intention to buy and/or to reorder these products surpassed two-thirds of the sample in each case.

Consumers' ^{reflected} (households) appreciation for the tested products was by their valorization. Suggested market-price for one kilogram of toasted flour or grits was 200 to 250 CFA, and that for precooked, dry grain of fermented-flour was quoted at more than 250 CFA.

Flow-sheets for processing : precooked, dry-grain, toasted flour and grits, and fermented-flour were drawn for artisanal and demi-industrial scales of production. Prototypes of pickled grains, and sandwich-spread were developed on a laboratory-scale.

Polyethylene bags in 4 - 5 mil (100 - 125 μ) were adequate to store the products at room temperature for one year without loss in quality.

Eighteen recipes were elaborated on cowpea products and were inserted in 3-day menus for the villagers and urban households. Economy, simplicity, and adherence to traditional senegalese cookery were added to the traditional one for urban use.

The problem of grain infestation and loss in quality during storage at the small producers was resolved by two approaches. Toasting the grain for autoconsumption or potentially for sale eliminated the need for insecticides or chemicals to control infestation. The second approach was realized by the addition of calcium oxide-ash mixture to grain in plastic bags. No deleterious effects were found on grain quality or viability for seed from this treatment. Other chemicals with equal or better protective action were tested as calcium carbide, and calcium oxide/sulphur mixtures.

Cowpea products were analysed for chemical, functional, and nutritional characteristics. Precooked, dry grain (variety Bambey 21) had the best overall quality and in particular from the nutritional aspect. Cooking improved protein digestibility, and practically eliminated inherent antimetabolites such as phytic acid and trypsin inhibitors. Also it reduced the level of oligosaccharides, particularly stachyose, responsible for flatulence. Toasted products and fermented flour were not

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significantly changed in their contents of the latter elements however when cooked their nutritional quality would be significantly improved.

Finally all outputs that were projected in the work plan were achieved where :

(a) the technology of cowpea processing and grain storage was transferred to villagers in Louga region ;

(b) the technology of cowpea processing on artisanal and semi industrial scales was transferred to potential entrepreneurs for Dakar region ;

(c) products were developed and were proved commercially viable for the consumers' market in Dakar.

(d) villagers and urbanites were stimulated to appreciate the advantages in producing and consuming cowpeas.

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RECOMMENDATIONS FOR TRANSFER OF TECHNOLOGY AND
INFORMATION TO RURAL COMMUNITIES IN SENEGAL

Based on the results of tests on the transfer of technology and information to two villages in Louga region the following recommendations are proposed to extend the methods of cowpea storage and processing throughout the rural communities in Senegal.

1. Prepare a timely plan that coincides with the one on production so that the rural communities can implement when the crop is harvested. The information should be "fresh in the producers' mind" to achieve maximum impact.
2. USAID should assign the task to NGO, and CRS or World Vision who may seek the collaboration of Peace Corps volunteers where possible.
3. Priority should be given to regions in the following order : Louga, St.-Louis (Fleuve), Thies, North Sine-Saloum. Also departments within each region should be prioritized on the bases of cowpea production, and density of population.
4. Identify and designate a cowpea basin or belt where there will be a permanent center to coordinate, train, do all extension services related to pre and post harvest activities. The center will be responsible for gathering information and technologies from R & D institutions in Senegal and foreign centers and "package" them for cowpea producers and processors. It is logical to combine in the same center crop as peanuts and other legumes to spread the cost and enlarge the base for services.
5. Common fund should be the principal sponsor of this task with USAID as the organism in charge of implementation.

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RECOMMENDATIONS FOR TRANSFER OF TECHNOLOGY
AND INFORMATION TO COWPEA PROCESSORS

Results and conclusions realized from tests in Dakar at home and at restaurant/vendors indicate urban consumers' acceptability of processed cowpea products. ITA proceeded on a two-step approach to publicize the outputs of this project, and to communicate with interested entrepreneurs or companies on the potential gains in processing cowpeas for local and export markets. Success on this end will provide the pulling power of demand that is necessary to energize the production side. The General Director of ITA addressed the Press Club in Dakar on cowpea processing which was followed by a cocktail of hors d'oeuvres prepared from cowpea products. Three weeks later the same was prepared to invited entrepreneurs and company representative. The following recommendations may help in increasing cowpea consumption :

1. Search for or establish a venture-capital company that will participate in exploiting the technology of cowpea processing and marketing that was developed by ITA. Such "company" will have financial accumen and managerial skill to guide the entrepreneurs in starting new business suitable for the economic condition in Senegal.

There are two "projects" at USAID that may be interested in this part namely : Private Entreprise of Kaolack, and Financial Management of Sahel Countries (SRFMP).

2. Support through the common fund, studies needed to estimate domestic and foreign market volume and constraints.

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"Work in the twentieth century,
rest in the twenty-first"

Donald E. WALKER.

" Virtue is knowledge"

Socrates.

I. INTRODUCTION

The threat of desertification of the peanut basin in Senegal is forever occupying all concerned on the fate of people and loss in agricultural land, which is rather limited as it is, in this country. Failure of millet and peanut crops in the northern zone of peanut basin which is averaged yearly in the 1980's less than 250 mm of rainfall forced the search for a substitute that can thrive under drought conditions.

Cowpeas and in particular California Black-eye peas (CB-5) variety was recommended in 1985 crop year to the Ministry of Rural Development for its short-growing season (57 days), and good grain quality. Cowpea production increased 22.5% from 1984 to 1985, and 31.8% from 1985 to 1986 to a total of 66,000 tons. Table 1 shows cowpea production and estimated value between 1983 and 1988. Cowpea value in 1985 was approximately 21% of peanut crop value. In 1986 cowpea crop value 16% of peanut. The problems encountered in 1986 and 1987 crop-years discouraged the farmers so that in 1988 crop-year total production dropped to 28,600 tons. These problems were concentrated in two areas : producer's difficulties in selling their crop at the floor price set by the Government at 110 CFA/kg, and in suffering economic loss because of the uncontrollable grain infestation. The latter problem may be resolved by

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treating pods in the fields with insecticides, and by other storage techniques developed by ITA and other voluntary service organizations, however it persists and still unresolved from the small producer's viewpoint.

When M. HAMDY, USAID Resident Advisor at ITA on Project Millet Transformation, became aware of these problems in September 1985, he suggested for ITA to initiate a project proposal to solve these problems. ITA, through the Ministers of Industrial Development, and Planning/Cooperation asked in June 1986 that USAID finance a project on cowpea transformation.

Table 1 : Cowpea production and estimated value for crop years 1983 and 1988^{1/}

Crop year	Production in !000 tons	Value in !FCFA, !million	CFA/ton
1983	12.6	541.8	43,000
1984	12.6	554.7	43,000
1985	15.8	947.52	59,969.6
1986	66.0	8,769.75	(132,875.0) ^{2/}
1987	54.9	6,039.0	110,000 ^{2/}
1988	28.6	3,146.0	110,000 ^{2/}

1/ Source Directorate of Agriculture, Ministry of Rural Development.

2/ Based on producers' floor-price of 110,000 FCFA/ton.

USAID/Dakar approved in October 1986 that ITA implement this project. Delays in administrative procedures forced the prolongation of time nine months from October 1988 to June 1989 to complete the work plan at total funding of \$ 735,000 or 185,625,000 FCFA.

II. BACKGROUND

Cowpea or black-eye peas (Vigna Unguiculata) is a widely grown member of the family leguminaseae. It features the advantages of higher protein content and quality than cereals, and the drawbacks of antimetabolites presence such as trypsin inhibitors (TI), phytates that bind available calcium, zinc, and iron. TI are inactivated during cooking but the other two antimetabolites are not significantly reduced in cooked cowpeas. There are no harmful effects from flatus sugars except gas discomfort to some persons and the reduction in iron-absorption because it is bound with phytic acid or phytate molecules.

In a study published by World Health Organization (WHO) African Regional Bureau in 1976/1977 on daily protein intake per capita in francophone african countries, Senegal had above average intake of protein from animal sources such as meat, fish, milk and eggs. Table 2 shows that animal protein constituted 72% of total daily protein intake relative to an average of 67% for the Sahel countries and 39%, 21%, 35% in Ivory Coast, Nigeria and Zaire, respectively.

Table 2 : Daily intake of protein per person in African Countries^{1/}

Protein source	Senegal gm	Sahel ^{2/} countries gm	Ivory Coast gm	Nigeria gm	Zaire gm	Ave. gm
Meat	7.1	7.1	6.5	2.6	5.0	5.3
Fish	9.8	5.4	5.6	1.4	3.5	5.1
Milk	4.0	6.3	0.4	0.8	6.3	1.4
Egg	0.2	0.25	0.3	0.1	0.1	0.2
Pulses ^{3/}	1.3	0.5	14.8	10.4	9.4	9.0
Other	6.8	8.7	5.0	8.7	6.8	6.8
Total	29.7	28.25	32.6	24.2	25	-
% animal prot. of total	72	67	39	21	35	-

1/ Regional African Bureau, Brazzaville, Vol.2 -Afr./Nutr./77

2/Average of : Senegal, Mauritania, Mali, Niger, Chad and B. Faso

3/Including cowpeas.

Certainly this scenario has changed in 1988 mostly because of the drop in GDP per capita. The readers' attention is focused on protein consumption from pulses, which include cowpea, where Senegal and Sahel countries fall way below the average daily consumption that was estimated at 9.0 grams. This translates into 45 to 50 gms of grain/daily relative to 6.5 - 7.2 gms in Senegal.

The economic advantage for cowpea consumption may be illustrated by comparing the price of equivalent gram protein from several food sources as shown in Table 3. Cowpea protein was the next to cheapest source at 19 CFA/gram. The price would be halved when the market price is 100CFA/kg instead of 200 CFA/kg, as calculated in this table.

The following chapters will cover : the objective of this project, strategies and work plan, analyses of results from the socio-economic and technical studies, and conclusions.

Table 3 : Price per gram protein of food sources rich in protein.

Food source	% protein	Price/kg raw product cfa	Price/gram protein cfa	Factor of equivalent value	Price per gram protein of equivalent value cfa
Beef	18.2	1 000	55	0.9	49.5
Fish, fresh	18.8	800	42.5	0.8	34
" smoked	40.0	750	18.7	0.9	16.9
Chicken	20.5	1 000	48.8	0.9	43.9
Milk powder	26.3	600	23	1.0	21
Peanut	20.5	250	17.2	2.1	25.6
Cowpea	22.5	200	9	2.1	19

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III. OBJECTIVE OF STUDY

Encourage the local consumption of cowpea in the rural and urban zones in order to stimulate production. The imbalance between the supply and demand sides during the past two years, and the inability to export the grains to major consumption markets in sub-Saharan or Western african countries have discouraged the small producer from growing cowpeas on a large scale.

As a sub-objective or secondary output with the success of above objective there will be an improvement in the nutritional status of people at or below the poverty line i.e. those who depend solely on cereals for their diet.

IV. THE WORK PLAN

A. - Strategies

Simply stated, the region of Louga and St.-Louis (Fleuve) were selected because of their adverse elements and for being the front-line for desertification. Cowpea varieties that have short-growth period such as 58/57 and CB-5, and which have more tolerance to drought than peanut or millet are the best bet for producers in these regions. Therefore the people in these regions represent the sample of producers and consumers from whom we are interested to know factual information about their attitudes and problems in producing and/or consuming cowpeas. An important problem that was echoed by the responsible personnel at Sonacos, the company that was assigned by GOS to purchase cowpeas from the producers, was and is the loss in grain quality because of beetle infestation. So the first strategy was designed to develop economical storage methods of cowpeas for the small producers and processors. The output should allow the latter to stock the grain without economical loss and quality or value, that is to say to sell at an equitable price year round.

The second strategy was designed to stimulate demand for cowpeas by introducing a variety of products acceptable to consumers in rural and urban zones. Success of this strategy should provide the drawing force that will absorb the supply.

The third strategy focus on the transfer of technology to store and to process cowpea products to producers/and potential processors. Also the benefits of eating cowpea products will be communicated to a sample of producers in Louga region, and with selected restaurants and vendors in Dakar.

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ITA elected to carry out the studies that are shown in chart n°1. These may be grouped under two headings : socio-economic and technical development studies.

A.1. - Socio-economic studies

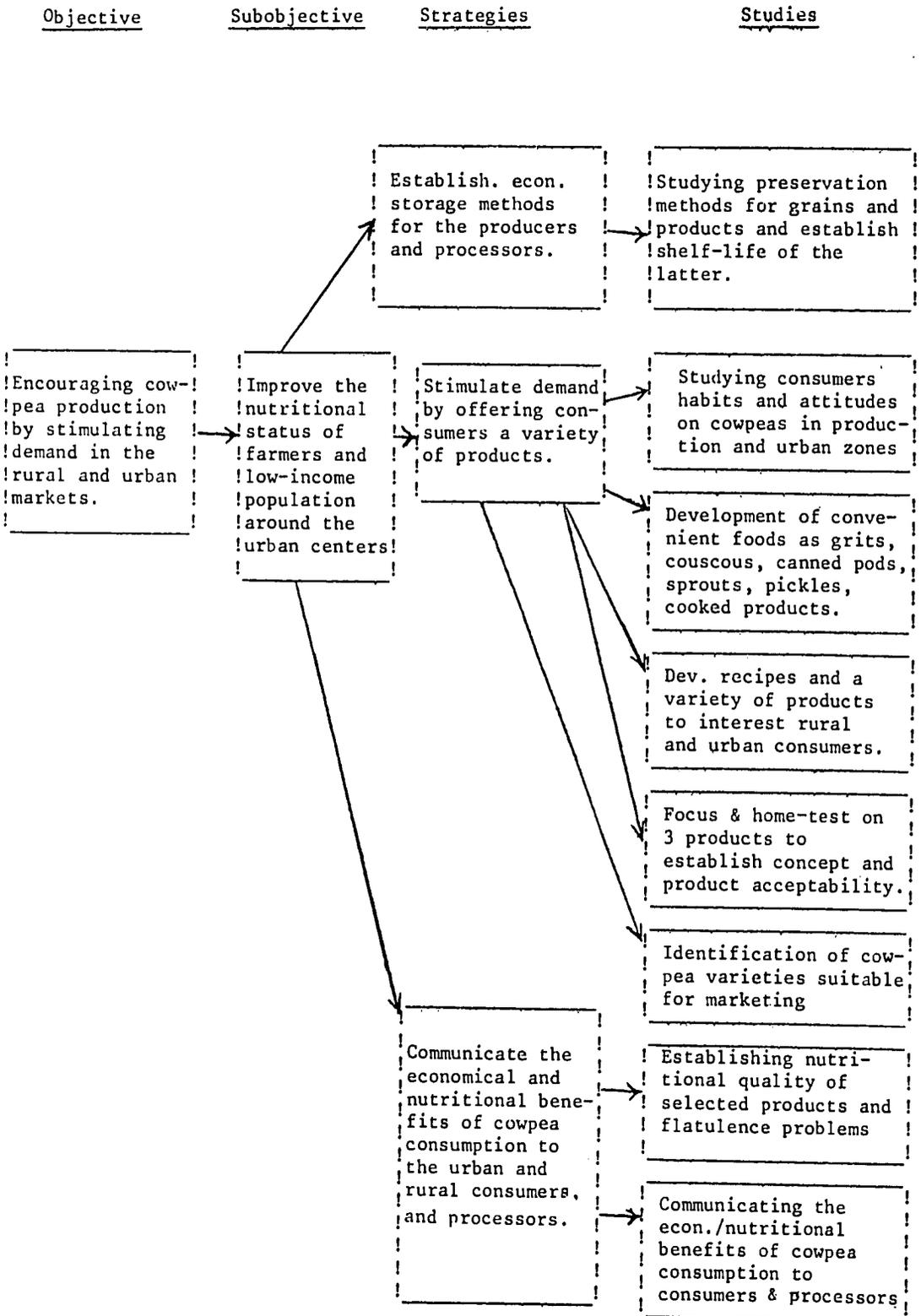
There are five studies under this category as follows :

1. Perceptions and attitudes of villagers in Louga and St.-Louis regions on cowpea production/consumption.
2. Perceptions and attitudes of households in ten districts in and around Dakar concerning cowpea consumption.
3. Consumers' acceptability of cowpea products prepared and served by restaurants and street vendors in Dakar.
4. Home-test on four cowpea products and their acceptability in a population sample from six districts.
5. Evaluation on methods used to transfer techniques and information on cowpea preparations in two villages in Louga region.

A.2. - Technical development studies

1. Selection of cowpea varieties for processing.
2. Methods to control cowpea-beetle infestation in stored grain
3. Extrusion-cooking of cowpeas to make precooked flour.
4. Methods to make cowpea protein-rich flour (concentrate)
5. Development of precooked, dry cowpeas.

Chart n° 1 : Work plan with summary of strategies and studies.



6. Development of toasted grains, grits and flour.
7. Development of fermented flour.
8. Development of pickled grain or pods
9. Development of germinated cowpea-sprouts
10. Technique to can cowpea grain or pods
11. Technique to prepare cowpea -spread for sandwiches.
12. Recipes for cowpeas and precooked products
 - A. - Menu for villagers
 - B. - Menu for urban population.

The menu method is used to introduce cowpea products in rural and urban consumers' diets. This approach illustrates to households or carrés how cowpe recipes may fit into their daily food preparations. The objective is to design a three-day menu for the two categories of consumers which may be cycled or added on with the introduction of other recipes for cowpeas.

Brochures will be prepared in french for a variety of recipes that are fit for use in Lunch or dinner meals. The latters will be based on toasted or precooked-dry grains, toasted grits and flour, and fermented flour. For the tests at resturants and cafeteria of the University of Dakar model recipes for precooked, dry grain will be highlighted for their convenience aspect.

13. Nutritional studies

13.A. - Protein quality and essential amino-acids profile

It is important for those concerned with the nutritional aspects of food to know what changes take place in protein quality and/or quantity as a result of processing. We know that roasting or toasting results in loss of the essential amino acid lysine. Also we know the processes of grain fermentation or cooking will cause reduction of nutrients, but how much ? Only analyses will give the answer to this question.

Two tests will be used to determine the effect of various processing methods on protein quality ;
(1) Protein Efficiency Ratio (PER) bioassay, and Essential Amino Acid (EAA) profile. The former will show the quality of cowpea protein relative to milk protein, and the latter will be compared to the minimum daily requirement of each EAA intake.

13.B. Vitamins

Cowpeas is not an important source of vitamins nevertheless a report by the joint-group from FAO/WHO (1) showed that samples of cowpeas contained important quantities of vitamins B1, B2, and B6. For better understanding of the nutritional quality of the cowpea varieties used in this project, it is necessary to have up-to-date analyses on these varieties. The latter includes : Bambe 21, 58/57, and CB-5. The following vitamins will be determined : A, B1, B2, B6, C, Niacin, and pantothenic acid.

13.C. Macro, and micro-elements (minerals)

Macroelements such as calcium, phosphorus, magnesium, potassium, and sodium are important nutritional part in the diet. It is necessary to establish varietal differences

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and the impact of processing methods such as cooking/drying, toasting, and fermenting cowpea grains. Micro-elements such as iron, zinc, iodine, manganese, copper, boron pay an important role in the metabolic processes, therefore the importance of knowing how they vary in the processed varieties and samples.

Heavy metals such as lead, strontium, and cadmium have dangerous cumulative effect particularly on bone tissues since they compete with calcium metabolism. Usually high level of these elements in grains such as cowpeas is caused by industrial pollution which contaminates soil and water resources.

13.D. Flatulence sugars

Cowpeas as all members of the family leguminosae contain relatively high levels of oligosaccharides that are not digested or metabolised by humans. The two sugars responsible for gas-formation in the large intestines and colon are raffinose and stachyose. These sugars are digested by the microflora that inhabit this part of the intestines and which generate gases as CO_2 and CH_4 .

Individuals vary in their susceptibility to gas problems so that those with low microflora presence normally excrete the indigestible sugars with no ill effects contrary to those who have active microflora present. In the moslem world flatus problems are particularly troublesome because of the necessity to wash for prayers when a person has released gas. So it is important to find out the effect of processing cowpeas and of varietal differences on the levels of flatulence sugars.

13.E. - Antimetabolites: phytic acid and trypsin inhibitors

Antimetabolites are naturally present components that decrease the digestibility or inhibit the metabolic pathway which diminishes the nutritive quality of food. Cowpeas contain phytic acid which binds elements such as calcium, iron, zinc and render them inabsorbable by humans. Also there are protein components that inhibit trypsin from digesting proteins, however they are inactivated to a harmless level by cooking. Levels of trypsin inhibitors vary by variety, local and seasonal conditions, for example Mississippi Silverhull grains contained 12.4 TIU/mg (2) while CB-5 had 9.8 TIU/mg. These levels are low in comparison to soybean flour that contains between 81 to 88 TIU/mg.

13.F. - Fiber content and nutritional value

The role of fiber in diet as a bulk element that regularise intestine movement which moves digested and indigested food through the alimentary system is well established. Total dietary fiber (TDF) also plays a role in absorption of cholesterol that is ingested and/or synthesized by the body. It is therefore important to find the levels of TDF in cowpea varieties and in the processed products in this study.

Total energy or caloric value is calculated from the levels of fat, protein, and metabolizable carbohydrates. Cowpeas in general have low fat content between 1.5 and 2.5%, medium protein levels between 20.0 and 26.0% and the balance in ash and carbohydrates. The latter comprises 10% or less sugars and crude fiber, and 30 - 40% starch.

14. Shelf-life and stability of processed cowpea products

Cowpea products will be tested for stability during storage at ambient laboratory conditions where temperature and humidity ranges normally are 30 - 42°C, and 40 to 80%, respectively. Selected products will be packaged in 80 - 100 μ polyethylene bags, and in 80 μ polyethylene bags plus cartons.

Samples are evaluated every two weeks for physical and organoleptic quality changes in comparison to control samples that are stored in glass jars at 0°C.

Six months of storage stability is deemed as the minimum acceptable shelf-life for the processed products. Susceptability to infestation will be evaluated as a part of the adequacy of polyethylene packaging for packaging cowpea products.

15. Cowpea product specifications

Specifications will be identified for precooked, dry grain, toasted grits and flour ; and fermented-flour.

V. RESULTS AND ANALYSES OF SOCIO-ECONOMIC STUDIES

V.1. - Perceptions and attitudes of villagers in Louga and St.-Louis regions on cowpeas

Before embarking on solving the problem(s) of Louga and St.-Louis villagers relative to cowpea production and consumption, it is important to define the problems as perceived by a representative sample of these regions. Charts n°1 et N°2 show the chosen rural communities which numbered 22 and 13 in Louga and St.-Louis Matam regions, respectively^{1/}. Two villages per rural community were chosen so that there was 44 and 26 villages in two regions. An average of eight carrés was selected randomly in each village to yield a total sample of 560 carrés. Five questionnaire were discarded so that the final sample was 555 : 347 in Louga, and 208 in St.-Louis - Matam.

The questionnaire covered the following aspects of the population sample : a demographic profile, production and storage of cowpeas in 1986 and 1987 seasons, varieties planted by producers, distribution of production, problems experienced by producers in marketing their crop, producer-price in 1986 and 1987, consumption of cowpeas, revenu sources and its distribution.

1/ For details see annex 1 - tables 1 & 2.

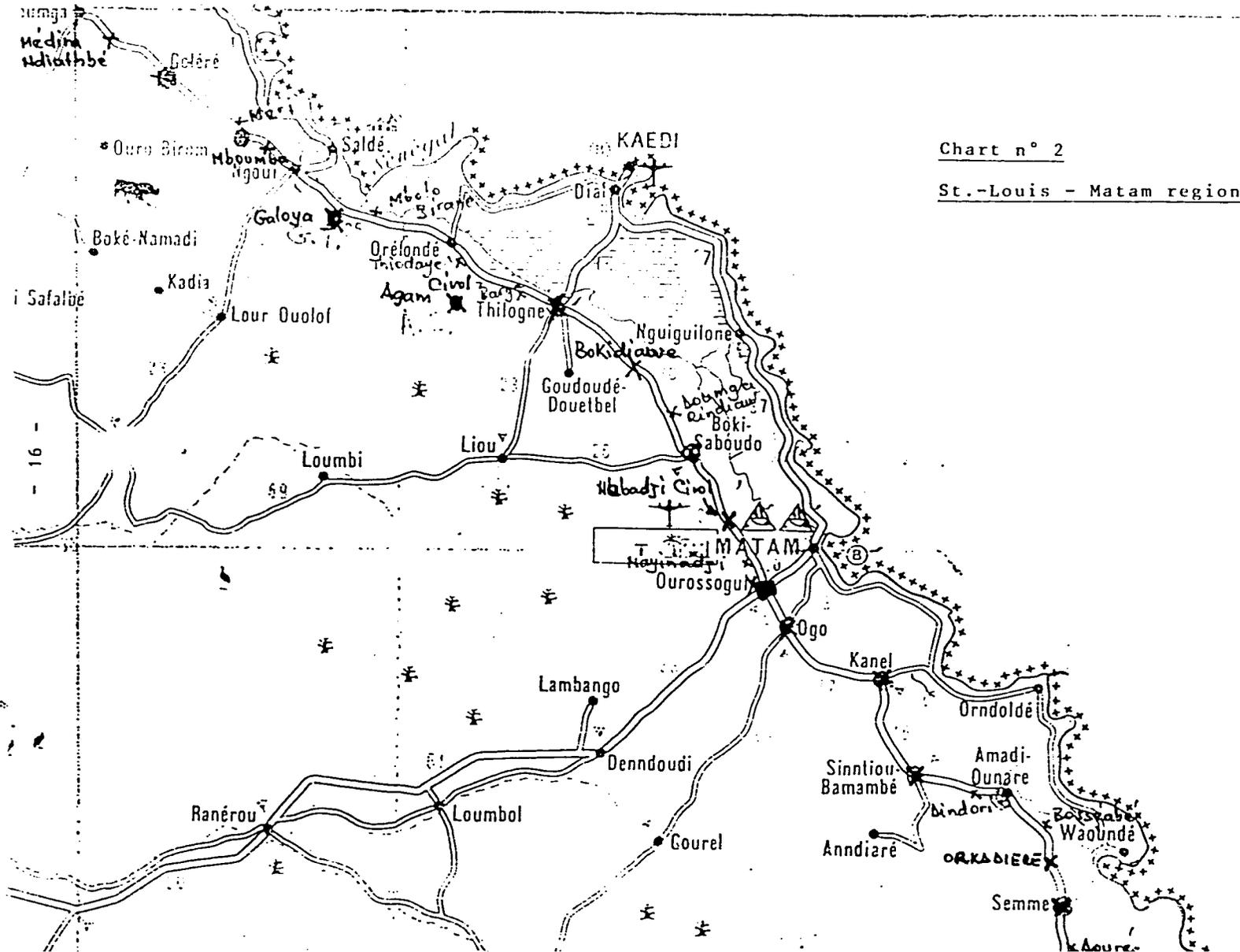


Chart n° 2

St.-Louis - Matam region

Table 4 : Ethnic profile of the population-sample in Louga and St.-Louis Matam Regions.

Ethnie	Number and percentage per region			
	Louga		St.-Louis - Matam	
	N°	%	N°	%
Ouolof	4 725	85.1	445	10.7
Toucouleur	22	0.4	3 288	79.3
Peulh	211	3.8	163	3.9
Maure	177	3.2	6	0.1
Sérère	133	2.4	38	0.9
Sarakollé	16	0.3	177	4.3
Bambara	0.0	0.0	31	0.7
No declared	261	4.7	0.0	0.0
Total	5 548	99.9	4 148	99.9

Table 5 : Distribution of sample by age-brackets and by region

Age bracket \ Region	1 - 5 yr.	6 - 13 yr.	14 - 55 yr.	Over 55 yr.	Total
Louga	1 142	1 350	2 542	514	5 548
St.-Louis-Matam	1 029	984	1 911	114	4 148
Total	2 171	2 334	4 453	738	9 696

V.1.1. - Demographic profile of sample

The population sample numbered 9 696 persons that was partitioned at 57.2% and 42.8% in Louga and St.-Louis Matam regions. Table 4 shows the ethnic profile by region. The distribution of ethnies in each region is normal except the significant proportion of chiefs in Louga region who did not declare their origin. The data show that the average number of persons per carré is 16 and 20 in Louga and St.-Louis, respectively. The ratio of men to women in Louga sample was 55 : 45 while that in St.-Louis Matam was 41 : 59. The latter imbalance between men and women is due to the absence of men who are working in other locations either in Senegal or overseas.

When the sample was classified by age in four groups as shown in table 5 one observes that the percentage of active age (14 - 55 years) brackets is 46% in Louga and St.-Louis Matam regions.

The ratio of sample in the 6 - 13 year bracket is 24% which leaves a balance of 30% for the dependants in the brackets of 1 - 5 years and over 55 years old. Assuming that the adult and active population get some assistance from 6 - 13 yearsold who can do manual chores in the field and in the carré it is found that the population sample is well balanced.

V.1.2. - Production and storage aspects in 1986 and 1987 seasons

Cowpea production in Louga region has gone a full circle between 1983 and 1987 while peanut crop was increased by 176%. Cowpea crop in 1983 was 9,962 tons produced on 27,145 hectares while in 1987 the crop was 11,403 tons on 35,112 hectares. The peak production year

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was 1985 where cowpea harvest reached a record 33,098 tons on planted 55,815 hectares. Table 6 shows cowpea and peanut production in the two regions for 1986 and 1987 crop years. Average production per carré in Louga was halved in 1987, and was less than that in St. Louis-Matam. Peanut on the otherhand more than doubled. These figures reflect problems or situation that hampered the development and growth of cowpea production. So a part of the questionnaire was designed to find out the problems encountered by cowpea producers. Table 7 shows the problems and percentage of carrés who encountered these problems in 1986 and 1987. Infestation in both regions was the first problem in both seasons as expressed by more than two-thirds of the sample in Louga and a little less than half the sample in St.-Louis - Matam. The latter may be explained by the fact that the production was so small at many producers in the sample that the crop did not last more than a couple of months to show important loss^{1/}.

The second important problem was stated as the inability to buy inputs necessary for production. Lack of cash to buy seeds and insecticides was a crucial problem. There was no complaints at large on the lack in manpower, or equipments and tools.

The third problem of shortage of rain was stated by the sample from St.-Louis - Matam for both crop years.

An important proportion of St.-Louis - Matam sample, almost one-third, had other problems which they did not specify.

^{1/} Average production per carré in 1986 & 1987 was 60 and 100 kg respectively (Table 6).

Table 6 : Production of cowpeas and peanuts in Louga and St.-Louis Matam sample for the crop-year 1986 & 1987

Crop year Region	Cowpeas, ton		Peanuts, ton	
	1986	1987	1986	1987
Louga	128.6	56.0	595	1 995
Av. per carré	0.4	0.2	1.7	5.7
St.-Louis - Matam	15.8	9.4	12	15
Av. per carré	0.1	0.04	0.06	0.1

Table 7 : Problem encountered by cowpea producers and their proportion in Louga and St.-Louis - Matam

Problems	% per region/year					
	Louga		St.-Louis - Matam		Ave. of sample	
	1986	1987	1986	1987	1986	1987
Infestation	76.8	69.7	48.6	46.6	68.3	61.1
No money to buy what I needed	36.3	31.4	11.1	12.5	27.0	24.4
Rainfall below 250 mm	4.0	4.9	35.1	36.1	15.5	16.5
Inability to conserve the crop	29.4	26.2	23.6	22.6	27.2	24.1
Lack in manpower	1.7	1.7	2.4	2.9	2.0	2.1
Lack in equipment & tools	2.3	1.7	2.4	2.4	2.3	2.0
Others	15.9	15.6	33.7	34.6	22.5	22.6

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The difficulty of conserving cowpeas was expressed by an average of 27% for the sample for the crop year 1986, and of 25% in 1987. Practically none used the procedure of storing cowpeas in sealed barrels under vacuum which was developed earlier by ITA to store grains. The low proportion of respondents reflect to a great extent the lack in sufficient production that required conservation for an extended period of time.

Approximately twenty-two per cent of St.-Louis - Matam sample confirmed that they did not know how to control infestation during storage, while only 10% of Louga sample had that problem.

V.1.3. cowpea varieties produced in Louga and St.-Louis

It is important to know the supply of cowpea varieties, and whether what the producers cultivated was correspondant to what the consumers preferred. Table 8 lists the varieties and their relative importance. It may be interpreted as the choice or best alternative that the producers in these regions had.

Variety 58/57 which has small grain with black hilum was produced by 50% of the sample. CB-5 which was introduced in 1985 was the second choice, however it was the most preferred in Louga region. The local variety NDiambour^{1/} was cited by 20% of carrés. Mougne was produced by 11% of the respondents while it has been the most in demand in Dakar markets and most expensive of all cowpea varieties. Bambey 21 is a white-hilum, large grain cowpea variety that is under development at CNRA in Bambey. Twenty-two and half per cent of the carrés planted various types of cowpeas that were not clearly identified.

^{1/} a rampant, late maturing variety, that is preferred also for the green pods.

V.1.4. - Distribution of production

Questions were posed to carrés' chiefs to find out how the 1987 production was disposed. Table 9 shows the distribution of crop in that year. It is clear that 60% of carrés autoconsumed the production that year when average crop per carré was 160 kg in Louga, and 40 kg in St.-Louis matam regions. The question on autoconsumption and sale of crop apparently was not clear to the respondents where we find only 30.6% who answered positive. The clear result was that only 2.8% of the producers sold their crop indicate that cowpea was not regarded as a cash crop like peanuts but a tertiary crop to the latter and millet.

When the producers who sold their crop (approximately 33% of carrés) were asked to whom did they sell it the answers were : 54% to Sonacos, 51% in the weekly local market, and 17.3% in the village. Evidently those who had good grain quality were able to sell to Sonacos at the official price of 110 CFA/kg or at best local price, while some sold in the weekly market or in the village.

Less than 5% of the sample indicated that some of their crop was distributed in bartering deals or for donations.

It is clear that 1986 and 1987 small-scale producers did not have particular problems in selling what they wished to sell of their crop. This situation will not be the case if production is increased as it happened in 1985 when the producers were stuck with a relatively large supply of cowpea for sale.

V.1.5. - Problems experienced by producers in marketing their cowpea crops

This part was designed to understand the significance of problems that might have been encountered by the sample in marketing their crop during 1986 & 1987. The results

shown in table 10 should be treated cautiously since they were calculated on the fraction of sample, approximately 183 carrés, that marketed their crop. Also the tendency of the respondents to express their opinions as facts or experience should be taken in consideration.

The first observation is the lower percent of respondents for the year 1987 than in 1986 which coincided with the drop in production (Table 6). Two problems were on the top of all others listed which were : poor marketing conditions to sell when the producers wanted to do so, and the lack in facility to transfer to market(s). Some carrés had carts that could deliver up to 500 kg of grain to the weekly market, but many didn't have such facility which required hiring such service.

Table 8 : Cowpea varieties and their relative importance in Louga and St.-Louis Matam regions

Variety	Producers by carrés	Relative importance
58/57	277	49.9
CB-5	227	40.9
NDiambour	108	19.5
Mougne	61	11
Bambey 21	9	1.6
Others	125	22.5

Table 9 : Distribution of 1987 cowpea crop by the population sample from Louga and St.-Louis Matam

Disposition	% respondents
Autoconsumption	60.2
" and sold	30.6
Barter	4.6
Donation	3.7
Sold	2.8
Others	9.3

Table 10 : Problems encountered by producers of cowpeas in Louga and St.-Louis - Matam regions during crop years 1986 and 1987.

Problem	% of respondents			
	Louga		St.-Louis - Matam	
	1986	1987	1986	1987
. Very few buyers in the market	23.3	11.5	4.3	3.4
. Sonacos did'nt buy the quantities estimated the authorities	21.0	13.5	13.5	7.7
. The price in local market was below 100 CFA/kg	6.1	4.0	2.4	1.4
. The variety and quality of grain was not satisfactory for the buyers	7.8	3.2	0.5	0.0
. Lack in facility to transfer the grain to market	27.7	9.5	7.2	2.9
. No surplus in production to sell	17.0	7.5	0.0	0.0
. Others	14.1	4.6	0.5	0.0
. None	16.7	4.0	7.7	3.4

Table 11 : Producer-price of cowpeas in Louga and St.-Louis regions for the crop years 1986 et 1987

Price per kg - CFA.	% producers who marketed cowpeas			
	1986		1987	
	Oct. to Jan. 1986	Feb. to Sept. 1986	Oct. to Jan 1987	Feb. to Sept. 1987
10 - 40	1.6	1.0	1.5	0.5
41 - 80	12.1	2.2	6.3	2.4
81 - 120	13.5	2.9	4.5	3.2
121 - 160	3.5	1.5	2.2	1.5
161 - 200	2.0	1.3	1.1	0.7
More than 200	1.3	0.7	0.4	0.2
Total	34.0	9.2	16.0	8.5

V.1.6. - Producer-price of cowpeas in crop-years
1986 and 1987

Producer-price in both regions followed a normal distribution pattern in both seasons and years as shown in table 11. The majority of sellers (67 to 75%) sold the grain between 41 and 120 CFA/kg either during the season from October to January or from February to September with no particular advantage to the producers who stored their grain more than four months. It is reasonable to assume that most of cowpea crop was sold during October-January season before the damage in quality caused by infestation completely destroys its economic value. The same trend is observed in 1987 season however the percentage is lower which corroborate the low crop available for sale that year.

V.1.7. - Cowpea consumption in Louga and St.-Louis
regions

It was necessary to know first hand, on a quantitative basis, the consumption of cowpeas by the villagers in Louga and St.-Louis regions. The data in table 12 show the number of carrés who did not consume cowpeas, and those who consume it and in what quantity. The results apply to both 1986 and 1987 crop years with no variations. The majority of sample, 68% and 89% in Louga and St.-Louis, respectively, did not consume cowpeas. Those who consumed it, 32% and 11% in the same order, did so for more than 2 years which indicated that they were used to eat cowpeas.

An inverted-curve of normal distribution was obtained from the quantity of cowpea consumed and the proportion of sample analysed. The largest proportions of the sample were in the brackets of below 5 kg/month and more than 20 kg/month. For an average monthly consumption per person, we arrived at 0.63 and 0.66kg. Considering that

the season from October to January is the most important for cowpea consumption, it is possible to assume that per capita, annual consumption was 2.4 to 2.6 kg. The margin of error in these estimation is rather high, more than 5%, due to the small sample size (111 and 22 carrés in Louga and St.-Louis, respectively).

When the villagers were questioned to determine their knowledge and appreciation for eating cowpeas, we got the results shown in table 13. Generally speaking, the majority of sample know that cowpeas are good for their health and growth of body. Slightly more than 50% believe that cowpea caused their digestion problems and gas discomfort. What is interesting is that 74% did not think that their knowledge influenced them to consume or not cowpeas. If we accept this observation at face value, we should try to relate or correlate low consumption to other factors.

It was desirable to update the information available on protein intake by the villagers and the latter's sources. Table 14 lists these sources and the percentage of sample who did and who didn't eat from each source.

Consumption in Louga sample was mostly from these sources in descending order : legumes, fish, milk, poultry and pulses (cowpeas), meat and last and least was from eggs. St.-Louis sample had a slightly different order so that fish was followed by legumes, milk, pulses, meat, poultry, and far back was eggs. It is concluded that the sample from St.-Louis - Matam consumed far more legumes and pulses than that from Louga. Also high percentage of the sample consumed animal-protein than it was the case in Louga sample.

In order to know the frequency of these protein sources in the diet of the sample the question was asked

of the latter to recall the last four meals prepared and consumed. Table 15 shows the preparations for lunch and dinner and the percentage of sample in both regions.

Table 12: Cowpea consumption in Louga and St.-Louis regions sample for 1986 et 1987 crop years.

Consumption aspects	N° and % of carrés			
	Louga		St.-Louis	
	N°	%	N°	%
. Zero consumption	236	68	186	89
. Consumption 2 years or more	111	32	22	11
Consuming carrés :				
. Less than 5 kg/month	18	16	17	77
. 5 to 10 kg/month	20	18	3	14
. 10 to 20 kg/month	0	0	0	0
. More than 20 kg/month	53	48	2	9
Monthly per capita consumption, kg	0.66		0.63	

Table 13 : Villagers knowledge and appreciation on health aspects of cowpeas.

Health aspect	% sample response	
	Yes	No
. Good for health	70.1	27.4
. Good for body growth	57.1	33.9
. Cause digestion problems and discomfort	51.7	43.1
. Flatus and gas forming	39.6	51.8
. Impact of knowledge on consumption	22.2	74.2

Table 14 : Sources of protein in the diet of sample from Louga and St.-Louis regions

Source of protein	% of carrés*			
	Louga		St.-Louis	
	Consuming	Non consuming	Consuming	Non consuming
Meat	28.2	23.9	50.0	42.8
Fish	47.5	4.9	95.7	2.9
Poultry	36.6	35.1	13.5	83.6
Legumes	75.8	0.9	89.4	2.4
Pulses	36.9	10.2	75.5	1.0
Eggs	25.1	48.1	2.4	96.1
Milk	39.2	7.2	85.6	7.2

* the balance of 100% was in the proportion of carrés who did not respond to the question

Rice with fish and couscous were the two main meals that were prepared alternately for lunch and dinner. The dependence on imported rice for food preparation was more pronounced in all departments of Louga region than it was the case in St.-Louis - Matam region. The latter also consumed a preparation based on a mixture of millet, cowpeas, and fish which confirmed the higher cowpea consumption observation. The fact that average monthly per capita consumption was less than that in Louga sample may be explained by the small quantity of cowpea available for autoconsumption which was estimated at 100 and 40 kg per carré in 1986 and 1987, respectively. It is therefore reasonable to assume that with the availability of cowpeas in St.-Louis - Matam region consumption should be increased.

Table 15 : Memory-recall of the last four main meals prepared in the sample (March - April 1988).

Meal	Main dish	% of sample	
		Louga	St.-Louis
		%	%
1. Last dinner or lunch	R	64.8	63.0
	C	11.5	-
	L	15.2	-
	A	8.3	3.4
2. Dinner or lunch before	MNP	-	32.2
	C	76.9	88.9
	R	15.0	-
	A	8.1	6.7
3. Dinner or lunch before	MNP	-	4.3
	R	57.3	48.1
	C	13.8	-
	L	20.1	-
	A	8.6	8.6
4. Dinner or lunch before	MNP	-	43.3
	R	13.5	-
	C	74.0	91.3
	D	5.2	-
	L	5.2	-
	A	2.0	4.8
	MNP	-	3.8

R = Rice with fish

C = Couscous

L = Lakh

D = Daxiin

A = Other

MNP = Millet, cowpea, fish.

Information was needed to document the recipe or dishes mostly prepared by each region. We found that 60% and 50% of the the sample in Louga and St.-Louis, respectively prepared couscous from cowpeas. Daxin^{1/} was the second highest preference in Louga at 28% of sample while in St.-Louis region it was prepared by only 6% of the sample. That region had several preparations^{2/} that was chosen by 16% of the sample which reflected the familiarity with cowpea food preparations. Akara, a deep-fat fried snack made of fermented ground grains, was prepared by 2.4 and 3.5% of the samples in St.-Louis and Louga, respectively. This is logical because the concept of snack is not widely spread in rural areas, furthermore, the demand for costly oil to fry the batter is discouraging.

V.1.8. - Revenue sources and its distribution

Questions on revenue and expenditure are usually sensitive and in most cases arouse the suspicion of the chief who is questioned. It was however necessary to know the financial status of the population sample and their resources. Table 16 shows the percentage of carrés who received part of their revenue from agricultural and non-agricultural activities. The main source of income in Louga region was from the sale of agricultural crop. Sales of animals and financial assistance were secondary sources while these comprised the principal source for St.-Louis sample and sale of agricultural crops as secondary.

1/ A plate prepared from broken rice or grits with excess water and normally served with fish.

2/ Thioké, Codé Niébé, Gniry bouna, Maffé, Bouillie, Louga region also prepares Thiébou Kétiakh, Niar, Thiopor and Neukheul.

Table 16 : Table of income in 1987 and the percentage of carrés per region

Source of income	% sample		
	Louga	St.-Louis	Total
. Sale of crops (peanut, millet, cowpeas, etc...)	87	59	76
. Sale of animals	26	13	21
. Sale of services	16	11	14
. Sale of manufactured articles	6	4	5
. Financial assistance	25	63	40

Why and how this situation evolved is beyond the scope of this study, nevertheless, the emigration of manpower from St.-Louis region to gain their living in big cities contributed partly to these results. Also the proximity of Kebemer and Louga departments to the main route of Dakar - St.-Louis present a great advantage to these zones comparatively to the remoteness of Matam and Podor.

The population-sample was classified in income brackets as shown in table 17. More than half of Louga sample had in 1987 more than 100,000 CFA per month while only 25% were in that bracket for St.-Louis region. At the lower end, 42% of the respondents from St.-Louis had less than 5,000 CFA in comparison to 14% for Louga. Apparently there was some overlapping between the brackets that the field workers did not pay careful attention in recording the data. It is reasonable to conclude that 47% of Louga sample were below 50,000 CFA mark, and in St.-Louis the ratio was 74. Taking into account that the average number of persons per carré in Louga sample was 16 who might consumed 4-5 kg rice daily at a cost of 540 to 675 CFA, or 16,200 - 20,250 monthly, or 40% of income for the group under 50,000 CFA at minimum one can see the financial advantage to villagers in reducing rice

consumption by half when cowpeas replace it in the daily meals. These figures did not include other savings such as reducing animal protein intake.

Table 17 : Distribution of income among the sample from Louga and St.-Louis regions.

Income group, CFA	% of respondents	
	Louga	St.-Louis
. Less than 5,000	14	42
. 5,000 - 10,000	18	30
. 10,001 - 50,000	15	2
. 50,001 - 100,000	1	0.5
. Over 100,000	51	25

CONCLUSIONS

The following conclusions are drawn from our discussions with the authorities and from the preceding analyses on data collected in Louga and St.-Louis - Matam regions.

1. - Crop infestation and inability to conserve it for long periods without substantial loss in quality and value discourages villagers from producing cowpeas.

2. - Varieties 58/57 and CB-5 are the most preferred by producers because of their early maturity and market-acceptance.

3. - Sixty per cent of the sample auto-consumed their cowpea production in 1986 and 1987 which averaged 60 and 100 kg per carré, respectively. Only 2.8% of the producers sold part of their crop. The concept of planting cowpea as a cash crop replacing peanut in these regions will require

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good planning and guarantees to bring back the producers to this crop.

4. - Two major problems for cowpea producers who had excess crop to sell, as it was the case in Louga in 1986, were : the lack in facility to transfer the crop to where buyers, and that the latter were very few. It appears also that several small producers could not meet the grain standards that Sonacos required in order to buy from them at the official price of 110 CFA/kg. That resulted in accepting lower price offers from the traders in weekly markets.

5. - The majority of villagers consume cowpeas that the average per capita monthly range was 0.63 to 0.66 kg. Also consumption was greatly limited to the season from October to February or 4 months from the harvest of each crop.

6. - More than half the sample stated that cowpea is good for their health, for body development, and can cause digestive problems and gas incomfort. Modesty and politeness are trademarks of senegalese villagers who in some aspects did not reveal their reason why they did not like to eat cowpeas. No doubt that fear of embarrassing situations with gas problems is the main reason.

7. - Villagers eat a variety of protein-rich food with fish and peanuts on the top of the list. Pulses including cowpeas, are consumed by more villagers in St.-Louis region than in Louga region.

8. - Rice is the daily cereal alternately with millet. St.-Louis and Louga samples each had locally known recipes for cowpeas. Fried snack as Akara is unimportant in these regions' diet.

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9. - Louga villagers depended on the sale of agricultural crops for income more than St.-Louis sample who received more financial assistance. Rice consumption in these regions was estimated to deplete at least 40% of monthly income in each carré. Replacing 50% of rice with cowpeas may save between 10,000 to 13,000 CFA/carré/month.

V.2. - Enquiry on urban-consumers' socio-economic conditions and psycho-cultural attitudes on cowpea consumption

This survey was designed to know urban attitudes and habits on cowpea consumption, and particularly to confirm or infirm prior perceptions or opinions on cowpeas. Dakar and Thiaroye were chosen for the population-sample that numbered 500 households. The questionnaire covered the following aspects : a socio-demographic profile per household, preference for varieties, monthly consumption, frequency of cowpea preparations, forms of preparations, sources of cowpea, perception and appreciation, market-price of cowpeas, acceptability of product concepts, revenue and expenditures on food.

V.2.1. - Choice of population-sample

Seven districts were selected in Dakar : Medina, Gueule Tappée and Fass that represented the old, densely-populated zone, Castor, Derklé, Dieppeul, and Gibraltar which are newer districts. The latter four districts are within 2 kilometers from Castor or Tilène markets, while the first three in close proximity to Tilène market. Three districts in the suburb of Thiaroye were chosen : Yeumbeul, Thiaroye Guinaw Rail, and Thiaroye Gare which are close to the important Thiaroye market. Fifty households were selected randomly in each district to yield the 500 sample.

V.2.2. - The socio-demographic profile of population-sample

Table 18 shows the distribution of sample in each district relative to age-bracket and the average of persons per household. The sample totaled 6976 persons with district partition that ranged from 8.2 to 15.3%. Yeumbel, which is a far suburb where households in many features resembles village-carrés, had the highest population density and an average 21 persons per household. Castor, Derklé, and Thiaroye G. Rail had an average of 12 persons.

Castor, Yeumbeul, Thiaroye Gare, and Thiaroye G. Rail had more than 50% of persons under age 14 and from 4 to 9% of their households in retirement age, i.e. over 55 years old. Dieppeul and Fass had the highest proportions of pensioners in the sample where the latters accounted for 17% and 12% in these districts. The significance of these distributions will be discussed later in the part on revenue/expenditures of households.

V.2.3. - Aspects of cowpea consumption

A. - Perception

The majority of respondents (61.6%) were completely familiar with cowpeas while 38.8% knew a little about it. Less than one per cent of the sample did not know much about cowpea and thouht it is not good. Only 0.4% were not familiar with cowpeas.

B. - Consumption & frequency

Table 19 shows the frequency of consumption of cowpeas and the most important "snack" Akara. Slightly more than one fifth of the sample either prepared and/or bought akara the day before the inquiry.

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Table 18 : Population-sample distribution by district, and by age bracket.

District	% sample per age bracket				Total		Ave. number per household
	1-6 yr.	6-14 yr.	15-55 yr.	Over 55 yr.	N°	%	
Castor	28.3	31.4	32.5	7.8	579	8.3	11.58
Derklé	12.1	25.3	58.4	4.0	575	8.2	11.50
Dieppeul	11.2	18.7	52.6	17.2	655	9.4	13.10
Fass	17.5	23.7	46.2	12.4	854	12.2	17.08
Gibraltar	13.5	20.7	62.6	3.0	613	8.8	12.26
Gueule Tapée	13.4	21.1	53.6	8.7	684	9.8	13.68
Medina	14.7	25.5	52.1	7.5	704	10.1	14.08
Thiaroye Gare	26.1	23.1	45.4	5.2	665	9.5	13.30
Thiaroyr G. R.	15.0	26.4	43.7	4.1	578	8.3	11.56
Yeumbeul	26.1	25.6	39.0	9.1	1,069	15.3	21.38
Total %	19.1	14.4	48.1	8.2	6,976	100	13.95
Ave. number per household	2.67	3.41	6.71	1.15	13.94	-	-

Table 19 : Frequency of cowpea preparation and consumption in Dakar and suburb.

Frequency	% sample	
	Last time prepared cowpeas	Last time bought Akara
. Yesterday	21.4	22.2
. This week	39.0	19.0
. Last week	19.2	9.2
. Last month	10.8	8.8
. Do not remember	9.6	35.6
. Did not buy	-	5.2
Total	100.0	100.0

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If we compare the figures from last month and last week (10.8% and 19.2%) one may have the impression that cowpea preparations was on the increase. The impression is strongly enforced when last week and this week percentages are studied (19.2% - 39.0%). When the data on the last time the households bought Akara is analysed one can observe the significant increase in those who bought this week versus who bought last week (19.0% and 9.2%). No practical difference however was registered in the percentages of those who bought last week and last month (9.2% and 8.8%). Almost 42% of the sample either did not remember when they last bought Akara or did not buy at all. Answers to whether the households consumed or did not consume Akara showed that 44% only eat the snack versus, 56% who did not. The reader must be careful in accepting results on memory recall without double checking them with data as we will do next.

V.2.4. - Estimates on monthly cowpea consumption

Table 20 shows estimates on cowpea monthly consumption per household. Nineteen per cent of households did not consume cowpeas, and 66,6% consumed less than 1 kg monthly. When we add these figures we conclude that 86% of the sample consumed 0 to 1 kg. Considering that numbers per household averaged 14 one can see that the data in table 19 is not reliable to draw conclusions. Yeumbeul district which had the highest in cowpea consumption. Castor, Fass, Gibraltar, Thiaroye Gare, and Thiaroye Guinaw Rail districts had between 10 - 14% of households who did not consume cowpea at all. Gueule Tapée which has old established traditions showed 44% of the households as non consumers.

Average yearly consumption per household and per capita was calculated based on the number of households in each category multiplied by the median of the latter i.e. there were 333 households who consumed zero to 1 kg, so

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the monthly consumption of this category was $333 \times 0.5 = 1,66.5$ kg and so forth. The average monthly consumption per household was 1.4 kg which was consumed by an average of 14 persons which yields 100 gram/per persons/month or 1.2 yearly. When one compare the per capita yearly consumption in Louga - St.-Louis regions with that from Dakar, 7.2 versus 1.2 kg, respectively, it is clear that the ready availability of grain to the consumer plays an important part in this difference. Apprehension of flatulence was more pronounced in the rural regions of enquiry than in Dakar and suburb, so it could not be the reason for the low per capita consumption. Another important reason was the market price where in Louga region the price ranged from 70 to 80 CFA/kg, during November - December 1988 where as it was 150 to 175 CFA in Dakar markets.

Table 20 : Estimates on monthly cowpea consumption in kg per household.

District	% households, kg				
	0	< 10	1-5	6-20	21-50
Castor	10	76	12	0	2
Derklé	32	68	0	0	0
Dieppeul	32	62	6	0	0
Fass	10	84	4	2	0
Gibraltar	12	84	2	2	0
Gueule Tapée	44	46	10	0	0
Medina	26	58	16	0	0
Thiaroye Gare	14	72	10	2	2
Guinaw Rail	14	78	6	2	0
Yeumbeul	0	38	48	12	2
Average & total	19.4	66.6	11.4	2.0	0.6

V.2.5. - Sources of cowpeas

Households obtained cowpeas either from gifts, Castor market, and/or Thiaroye market. Tilène market was a close second and other markets in the districts were in third place. Only 4% of households bought the grain from vendors in the street.

V.2.6. - Cowpea variety preference

Table 21 shows the proportions of sample and their preference for cowpea varieties. Households familiarity with variety Mougne was evident in their choice as 46.6% of the sample preferred it. CB-5 and 58/57 varieties were preferred by 33.2% of the sample therefore these came second. Variety Bambey-21 was chosen by almost 11% which was surprising because the grains do not have black hilum. Brown-red cowpeas was last in preference as only 9% of the sample chose it. More than half of households liked large grain over small grain.

V.2.7. - Household utilization of cowpeas

A series of questions were asked to know household choice and type of preparations from cowpeas. Table 22 shows preference by category and by well-known traditional dishes. The largest group of households used cowpeas as garnish or condiment in food preparation which was also confirmed in the data of traditional dishes. This preparation does not require more than a handful of grain which usually is from Mougne variety. Couscous and Daxin preparations are considered as side-dishes or compliments to cereals as rice and/or millet/corn. Main-dish preparations as stew were also prepared by 9 to 11% of the sample. Regionally-known dishes as NDambe, Lakhou Thiakhane, Thialal, or other preparations were reported by 5% or less of the sample.

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Table 21 : Consumer preference for cowpea varieties

Grain characteristics (variety)	% of households
Gray-black grain with white hilum (Mougne)	46.6
Cream color with black hilum (CB-5 or 58/57)	33.2
Cream color	10.8
Brown-red with white hilum (local variety)	0.9
Other	0.4
Total	100.0
Large grain as white beans	54.9
Small grain	43.1
Other	2.0
Total	100.0

Table 22 : Household preference by categories preparation and by known traditional dishes

Category and traditional dish	% of sample
<u>CATEGORY</u>	
Condiment or garnish	35.2
Side-dish as compliment to cereals	27.4
Extender to vegetables and meat	17.1
Main-dish for a meal as casserole or ragout	10.7
Snack	8.7
Other	0.9
Total	100.0
<u>TRADITIONAL DISHES</u>	
Rice with cowpeas	24.1
Couscous	22.6
Daxin	21.4
Akara	11.4
Ragout (stew)	9.1
NDambé	3.3
Lakhou Thiakhane	1.4
Tnialal	1.4
Other	5.3
Total	100.0

These results explain why cowpea consumption is low and the task of education, and influencing the urban population to change their habits requires good planning and implementation.

V.2.8. - Household expressions of most and least desirable aspects of cowpea consumption

We needed to determine if there was consensus among the households on the desirable and undesirable aspects of cowpea consumption. The results are arranged in table 23. Households expressed desirable versus undesirable aspects in the ratio of 85 : 15. Twenty-six per cent of the sample did not have problems with cowpea consumption while 3.9% indicated gastric or gas-problems. Twelve per cent liked the taste of cowpea versus 2.5% who did not care for the taste. Only three per cent mentioned the nutritional advantage of cowpea. Ten per cent of households experienced fast satiety when they eat cowpeas which is a plus in feeding large families.

Table 23 : Household expressions in the desirable and undesirable aspects of cowpea consumption

% households			
Most desirable aspects		Undesirable aspects	
1. Easy to prepare	33.1	1. Long time to prepare	5.7
2. No problems	26.6	2. Gastric problems	3.9
3. Good taste	12.1	3. Taste	2.5
4. Fast satiety	10.2	4. Gas problems	2.4
5. Nourishing	3.3		
Total	85.3		14.5

V.2.9. - Market or consumer price of cowpeas

We divided the year in two seasons : when the new crop arrives to the markets between October and January of the following year, and from February to September.

Table 24 shows the distribution of price brackets and the recall of households on how much they paid for cowpeas in the market close-by them. Practically all the sample bought cowpeas during the season of October to January, and only one per cent who bought during the other season. Forty-one per cent of households paid more than 220 CFA/kg, and 53% paid from 181 to 220 CFA/kg. Price during the rainy season, August-September, have reached 400 CFA/kg in Dakar markets. The question arises why the big differences in cowpea producer-price and market-price which is estimated between 100 to 300 CFA/kg ?

The following discussion may explain in a brief way some of the reasons of this situation.

a. Cowpeas does not have an efficient, organized market in an economic sense. The offer and demand sides meet in a limited way when a retailer in Dakar runs out of stock so he searches in the production zones to buy some grain to replace his stock. There are no wholesale merchants who deal in cowpeas.

b. SEPFA, a subsidiary of Sonacos, tried to establish a circuit of distribution as mandated by GOS in 1985. After two crop-years it gave up the task because of the difficulties it confronted in selling cowpeas even for the export markets.

c. Merchants over compensate for the economic loss incurred by them during storage of cowpeas. Most of the loss, up to 2/3 in weight, occurs in a period of 2-3 months after harvest if the grain is not periodically fumigated to kill the cowpea-beetle.

d. Market volume and share of cowpeas among legumes (peanuts, etc...) and cereals (rice, millet, corn etc..) is so small that merchants do not care to bother about. So those who like to nibble make a killing on the low volume they are able to sell.

This point is critical in limiting demand for cowpeas when sale-price is double that of imported rice, and as expensive as peanut. The consumer prefer to buy rice and peanuts rather than cowpeas

Table 24 : Market-price of cowpeas in Dakar

Price range, CFA/kg	% of sample	
	Oct.-Jan period	Feb.-Sept. period
101 - 120	0.1	0
121 - 140	0.4	0
141 - 160	2.3	0.1
161 - 180	3.7	0
181 - 200	24.4	0.2
201 - 220	28.2	0.4
Over 220	40.8	0.6
Total	99.9	1.3

V.2.10. - Monthly-income per household, and per capita in Dakar and suburb

It is important to estimate revenue per household and per capita to know the purchasing power of the population sample. Table 25 shows income distribution by bracket and by district. Almost 50% of the sample had monthly income in the range of 25 to 100,000 CFA. Slightly more than 34% were in the 101 to 200,000 CFA bracket. Four per cent had monthly income less than 25,000 CFA, and only 3.2% earned more than 301,000 CFA per month.

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Castor, Gibraltar, Derklé, Dieuppeul and Médina in descending order, above average monthly and per capita income. On the other end of the scale Yeumbeul, Fass, Thiaroye G. Rail, Thiaroye Gare, and Gueule Tapée were the poorest with below average incomes.

V.2.11. - Estimates on maximal daily expenditures on food items per households

In order to get more accurate results on daily expenditures for food, we divided the latter in two parts : expenditures on food staples for preparation at home such as fish, rice, vegetables, etc..., and those prepared and ready-to-eat such as bread, biscuits, drinks, etc...

Tables 26 & 27 show expenditures per districts, per household, and per capita in Dakar and suburbs. The data confirms earlier observations on household monthly income where we find districts Castor, Gibraltar, Dieppeul, and Derklé had above average per capita expenditure also. The other six districts were below average and Yeumbeul was the lowest in the sample at 177 CFA per capita. Thiaroye G. Rail households spent daily the least for food at 2,690 CFA while Castor households spent the most at 3,940 CFA. Average expenditure per household was 3,300 CFA for fourteen persons or 236 CFA per person per day.

V.2.12. - Comparison of revenue and expenditures, and evaluation of purchasing power in the sample

Aside from the need to estimate per capita share of revenue and how much each spent on food items daily, it was important to assess the ratio of expenditures on food to revenue and consequently evaluate the capacity to spend or purchasing power in each district. Table 28 sums the data per capita expenditure/revenue ratio in the ten districts.

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Table 25 : Monthly income per household and per capita in Dakar and suburbs, in 1,000 CFA

District	% of households							Income per capita
	Less than 25	25-100	101-200	201-300	301-400	More than 400	Average income	
Castor	0	4	64	24	8	0	187	16.15
Derklé	2	32	60	2	8	2	122.8	10.68
Dieppeul	0	40	46	14	0	0	129.3	9.87
Fass*	0	64	30	4	2	0	102.2	5.74
Gibraltar	0	30	36	20	14	0	172.1	13.99
Gueule Tapée*	2	68	28	2	0	0	89.9	6.57
Médina	12	40	18	5	2	0	112.7	8.0
Thiaroye Gare*	4	18	12	6	0	0	82.3	6.19
Thiaroye G. Rail*	4	86	10	0	0	0	69.3	5.97
Yeumbeul*	16	54	22	6	2	0	90.9	4.25
Total	4.0	49.6	34.4	8.8	3.0	0.2	115.85	8.74

* Income per capita is below average.

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Table 26 : Distribution of maximal daily expenditures on food items per households in CFA

District	Staples for home preparation				Items ready-to-eat					
	Expenditure, CFA	0-500	501-1000	1001-2000	2001-3000	1001-2000	2001-3000	3001-4000	4001-5000	More than 5000
% sample	%	%	%	%	%	%	%	%	%	%
Castor	28	68	4	-	-	2	62	18	12	
Derklé	48	50	0	2	12	62	18	2	6	
Dieppeul	40	42	18	-	4	64	20	10	2	
Fass	50	34	14	2	12	36	18	16	12	
Gibraltar	40	44	12	4	2	4	42	18	12	
Gueule Tapée	66	32	2	-	18	36	20	4	-	
Médina	74	20	6	-	22	44	22	10	6	
Thiaroye Gare	38	54	8	-	20	58	14	6	2	
Thiaroye G. Rail	76	24	0	-	24	70	6	-	-	
Yeumbeul	38	48	14	-	2	48	29	14	-	
Average	49.8	41.6	7.8	0.8	11.6	46.4	26.4	10.4	5.2	

Table 27 : Estimates on maximal daily expenditures on food items per household, in CFA.

District	Ready-to-eat items	Staples for home preparation	Total expenditures	Per capita expenditure
Castor	3,300	640	3,940	340
Derklé	2,450	545	2,995	260
Dieppeul	2,810	685	3,495	267
Fass*	2,640	640	3,280	193
Gibraltar	2,960	710	3,670	299
Gueule Tapée*	2,600	435	3,035	222
Médina	2,550	425	2,975	211
Thiaroye Gare*	2,510	620	3,130	235
Thiaroye G. Rail*	2,320	370	2,690	233
Yeumbeul*	3,120	665	3,785	177
Average	2,726	573,5	3,299.5	236

* Per capita is below average.

Households on average spent 83.5% of their income on food purchase and the range was from 63.2% to 124.6%. The three suburbs of Thiaroye Gare, Thiaroye G. Rail and Yeumbeul were showing deficit if we accept their figures on revenue and expenditures. Fass and Gueule Tapée were on the borderline where the E/R were 100.5 and 101.4%, respectively.

These five districts were considered too risky to proceed with the home-test, therefore they were dropped from the sample. Castor district, as all the data presented so far, showed the most prosperous in the sample followed by Gibraltar, Derklé, Médina, and last was Dieppeul.

Table 28 : Daily per capita expenditures on food and revenue and their ratio in Dakar and suburbs

District	FCFA/day		E/R %
	Expenditures (E)	Revenue (R)	
Castor	340	338	63.2
Derklé	260	356	73.0
Dieppeul	267	329	81.1
Fass*	192	191	(100.5)
Gibraltar	299	466	64.2)
Gueule Tapée*	222	219	(101.4)
Médina	211	267	79.0
Thiaroye Gare*	235	206	(114.1)
Thiaroye G. Rail*	233	199	(117.1)
Yeumbeul*	177	142	(124.6)
Average	243	291	83.5

* Districts where households had negative balance.

V.2.13. - Sample acceptance of concepts on cowpea products

Part of this inquiry was designed to know which product-concepts were the most acceptable to the population sample, and therefore use the results to guide product development at ITA. Home-test was planned to evaluate acceptance of three products and verify whether the product quality was as good as its concept. Table 29 presents the summary of results.

Concepts of products that the consumers were familiar with scored the highest acceptability such as flour for cake,

and canned goods. Concepts of convenience as in precooked grain or flour were well liked as the scores show in concepts three, four, and five. Concepts of pickled grain or pods, and grits were acceptable by 70% of the sample and disliked by less than 10%. Product concepts as flour for sauces, for spreads, and grain-sprouts were not well perceived so that a relatively high ratio of the sample (26-32%) did not state their their choice. Ninety-six per cent of the sample showed willingness to test new concepts.

Table 29 : Population-sample acceptance of product-concept.

Concept	% respondents		
	Like	Dislike	Don't know
1. Flour for cake and sweet goods	82.0	4.4	13.6
2. Canned grains or pods	78.0	1.8	20.2
3. Precooked, dry beans that cook less than 30 minutes	75.6	9.6	14.8
4. Precooked flour of good taste and nutrition for preparation of bouillie	75.4	7.6	17.0
5. Fermented-flour for couscous and Akara preparations	74.4	6.4	19.2
6. Pickled and/or fermented grain for salads	70.2	6.4	23.4
7. Grits that may be cooked as millet	70.0	9.4	20.6
8. Flour that substitute peanut in making sauces as maffé	53.2	20.4	26.4
9. Cowpea-sprouts for cooking and salads	52.0	19.2	28.8
10. Good-tasting spread as chocolate-peanut butter "chocoleca"	51.8	16.0	32.2
11. Other concepts	96.0	0.4	3.6

When the data was analysed by district it was observed that Fass and Yeumbeul had the highest ratios of "no-opinion" in the sample. This situation might have resulted from the inability of the field-workers to communicate these concepts effectively in Ouoloff.

If we discard the results of these two districts, therefore reducing the size of sample to 400, we find that the percentage of households who liked each concept was increased by 10% in average. For example, concept of chocolate spread had an acceptability of 61.8% instead of 51.8%. Reduction of sample size from 500 to 400 households results in an increase in error as shown in table 30.

Table 30 : Percentage in Error on estimates of concept-acceptability by population-samples of 500 and 400 households.

Concept	% Error in Estimate	
	Sample size, households	
	400	500
Precooked, dry grain	3.01	2.30
Toasted grits	2.91	2.22
Fermented flour	3.03	2.30

Errors at 95% confidence level did not exceed 3% in the 400 and 500 sample analyses. Statistical analyses of other data confirmed the same conclusion.

When the respondents were asked for their willingness to try products based on the concepts they liked there was 100% agreement on doing so.

V.2.14 - Conclusion

The objective of this study was to know the socio-economic and demographic aspects for a representative population-sample from Dakar and suburbs which should guide us in the home test preparation. The following conclusions may be drawn from the data presented :

1. The majority of households were familiar with cowpea and preparations. Two-thirds of the sample consumed monthly less than one kilogram cowpeas, and 19% did not eat it at all. Yearly consumption per capita was estimated at 1.2 kg. This is less than one-fifth of consumption in the regions of Louga and St.-Louis - Matam.
2. Households preferred cowpea varieties that were most known to them such as Mougne and CB-5 or 58/57. They also preferred by a small margin large to small grain which is promising for the new variety Bambey 21.
3. The most popular forms of cowpea preparations are as condiment or garnish in sauces, and as a complement to cereal dishes particularly rice. The snack "Akara" is not the predominant form of consumption as was the impression before the study.
4. Households expressed their satisfaction with cowpeas from aspects such as preparation, taste, satiety, and nutrition. Less than 5% of the population-sample felt that cowpeas created the undesirable problems as gas-formation, taste, and/or long time for preparation.
5. Households bought cowpeas in large part during the "season" which lasted from October to January of the following year. Only 1.3% of the sample stated that they bought cowpeas during the period from January to September.

Market-price of cowpea relative to other staples as peanuts, rice, millet etc... may be the major reason for such contracted sales-period. During the "season" cowpea market price ranged from 120-150 CFA while peanuts sold for 100-120 CFA, corn for 100 FCFA, processed rice (imported) for 130 FCFA, processed millet for 150 FCFA. The difference between cowpea and the other staples is extraordinary to the consumers as it is the case during the other season "February to September". In the latter cowpea price accelerates to reach 410 FCFA/kg while rice is always 130 CFA, peanut reaches 250 FCFA, millet 175 CFA. Rational consumer will always prefer the least costly staple to feed himself and family regardless of nutritional advantages or drawbacks.

A secondary reason for the lack in demand for cowpeas during the other season is the poor quality because of infestation. Merchants of cowpeas are mostly retailers who do not pay attention to infestation or find the cost of fumigation onerous so during the summer period the grain in most cases is badly infested that dissuades consumers from buying it in quantities that exceeds 100 gms.

6. Per capita monthly income ranged from 4,250 to 16,150 CFA with an average of 8,740 cfa for the sample. Monthly expenditures on food per capita ranged from 5,310 to 10,200 CFA with an average of 7,080 CFA. Households in five districts namely : Fass, Gueule Tapée, Thiaroye Gare, Thiaroye G. Rail, and Yeumbeul spent on food purchase more than they earned monthly. Population under such stressful conditions will not change their eating habits and buy processed cowpea products which will be more expensive than rice. Home-test will be therefore carried out in the other five districts where chances for success are better and more meaningful.

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7. Among the ten concepts for processed, cowpea products households appreciated highly those that presented convenience in preparation such as precooked products, and that were in forms suitable for preparation of couscous, sauces, and cakes. New product concepts as sprouts was not well perceived, while pickled/fermented grain for salads was well accepted. Precooked, dry grain, toasted grain and flour, and fermented-flour were chosen for testing in homes and in restaurants for determining product acceptability.

8. Reduction of population-sample from 500 to 400 did not affect error margins at 95% confidence, meanwhile it increased sample homogeneity.

V.3. - Consumers' acceptability of cowpea products
as prepared and served at Dakar restaurants
and vendors.

The purpose of testing the developed cowpea products in Dakar restaurants and at market-vendors was to determine consumers' acceptability in the "food service" sector, and to find out how the restaurants/vendors rated the products from the preparation and convenience standpoints.

Sixteen restaurants and eleven vendors were contacted in Dakar to carry out the test. The former were presented by high and low class category as presented in table 31. The latter were composed of the cafeteria at the University of Dakar, and by vendors in the bus terminal of Colobane and near-by Port. Problems such as reluctance to put the products to test, as it was the case in the cafeteria of University of Dakar, or the lack in clientele forced us to drop these institutions from the test and the population-sample was drawn from seven restaurants and ten vendors.

A questionnaire composed of seven questions was prepared to collect the data. Two field-workers were assigned to accumulate at least sixty responses on each product tested. The margin of error in this sample was estimated to be high because of the distribution among multiple choice.

Table 31 shows clientele frequency at each restaurant or vendors. Two-thirds of the sample buy and/or eat daily while approximately 24% eat at the restaurant/vendor from time-to-time. Only 9% stated that they frequented the restaurant/vendor on a weekly basis. If we divide the sample between the restaurant and vendors clients one observes that 78% were daily customers at the vendors while the balance was for the restaurant-clients. The sample was

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split evenly between restaurant and vendors customers who frequented them from time-to-time. The ratio between restaurants' and vendors' clients who ate weekly was 1 : 2.

Table 31 : List of restaurants and vendors where the data were collected, and the clientele frequency at each.

Restaurant/vendor	N° of response per frequency of visit							
	Daily		Weekly		Time-to time		Total	
	N°	%	N°	%	N°	%	N°	%
<u>RESTAURANTS</u>								
1. La Marmite	0	0	3	43	0	0	3	4.5
2. Loutcha	15	75	1	5	4	20	20	03
3. Diarama	3	30	0	0	7	70	10	15
4. Khadim Rassoul	6	86	1	14	0	0	7	10
5. Baye MBarrick FALL	2	28	1	14	4	57	7	10
6. Rest. du Peuple	8	40	1	5	11	55	20	30
7. Massata SAMB	0	0	0	0	0	0	0	0
Sub-total	34	51	7	10	26	39	67	100
<u>VENDORS</u>								
8. Aïssatou SENE	8	89	1	11	0	0	9	55
9. Maguette FALL	12	75	2	12.5	2	12.5	16	10
10. Awa THIAM	17	61	3	11	8	28	28	17
11. NDeye HANN	13	72	3	17	2	11	18	11
12. Fatou CISSE	12	75	3	19	2	6	17	10
13. Marième NIANG	13	76	2	12	2	12	17	10
14. Mariam DIOP	10	100	0	-	0	0	10	6
15. NDeye AIDARA	12	80	0	0	3	20	15	9
16. Cécile HETSELI	15	83	0	0	3	17	18	11
17. Rokhaya SARR	8	53	0	0	7	47	15	9
Sub-total	120	74	14	8	29	18	163	100
Total	154	67	21	9	55	24	230	100

These results show the importance of vendors as an outlet and center for "food service " where senegalese workers eat daily their breakfast, lunch and to a lesser extent their dinner.

The population sample was comprised mostly of residents in Dakar and its suburbs. Table 32 shows 80% of clients at the restaurants were from Dakar and suburbs while 19% were foreigners. More than 50% of the clients who ate at the vendors lived in the suburbs which explain their daily frequency in eating close-by their work place.

Table 32 : Composition of the population-sample by regional affiliation residence.

Region	% of sample	
	Restaurant	Vendors
Dakar	46	39
Dakar suburbs	34	56
Senegal regions	2	5
Foreign countries	18	0
	100	100

V.3.1. - Consumers' knowledge on cowpea products

Four products were tested at the restaurants-vendors sample namely : precooked grain, toasted grits and flour, and fermented flour. The latter was exclusively prepared into "Akara" by vendors whose specialty was to sell this snack. Restaurants prepared the precooked grain in salad or ragout (casserole) with sauce recipes. Toasted grits was cooked in a well-known recipe called Neleng that resembles senegalese couscous, and usually served with tomato and peanut-butter sauce. Toasted flour was served

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in the form of agglomerated granules called "thiakry" with sweetened butter-milk, or couscous, or as a thickener in sauces. Customers were asked, after eating their meal, about their familiarity with the plate they consumed, and if they knew the base product from which it was prepared.

Tables 33 and 34 present the data on customer's familiarity with the plates they consumed. Customers familiarity with the plates ranged from 70% to 100% which testified to their competence in judging and appreciating the quality of base product and cuisine. Precooked grain was evaluated by 118 customers relative to the other products which each was consumed by 60 - 66 persons.

Table 33 : Number and percentage of consumers' familiarity with the dish or plate they ate.

Base product	Customer familiar		Customer not familiar		Total	
	N°	%	N°	%	N°	%
Precooked grain	83	70.0	35	30.0	118	100
Toasted grits	54	82.0	12	18.0	66	100
Toasted flour	47	73	17	27	64	100
Fermented flour	60	100	0	0	60	100
Total	244	79	64	21	308	100

Table 34 : Number and percentage of consumers who knew the base product of the plate consumed.

Base product	Customers who knew		Customers did'nt know		Total	
	N°	%	N°	%	N°	%
Precooked grain	53	45	65	55	118	100
Toasted grits	0	0	66	100	66	100
Toasted flour	1	2	63	98	64	100
Fermented flour	60	100	0	0	60	100
Total	114	37	194	63	308	100

Only forty-five per cent of the sample of 118 knew that the plate was prepared from cowpea grain while 55% did'nt recognize it. Practically all customers who ate dishes based on toasted grits or flour did not know the base material. All the clients knew that "Akara" was prepared from cowpeas but naturally did'nt differentiate between Akara prepared from raw grain and that prepared from fermented flour.

Changing the appearance and form, as it was the case in toasted grits and flour met consumers acceptance, after initial reaction in disbelief, as will be known next under "consumers' appreciation".

V.3.2. - Consumers' appreciation for cowpea products

Consumers of dishes prepared from cowpea products were asked whether they liked what they ate or not. Table 35 shows the results on precooked grain, toasted grits, and flour, and fermented flour.

Ninety-six per cent of restaurant customers liked the precooked grain when it was prepared as salad or casserole and the balance did not like it.

Table 35 : Consumers' appreciation of cowpea products

Restaurant (R)	Appreciation in per cent							
	Precooked grain		Toasted grits		Toasted flour		Fermented flour	
	Like	Dislike	Like	Dislike	Like	Dislike	Like	Dislike
La Marmite (R)	-	-	-	-	33	67	-	-
Loutcha (R)	94	6.0	-	-	-	-	-	-
Diarama (R)	100	0	-	-	-	-	-	-
Khadim Rassoul (R)	100	0	90	10	100	0	-	-
Baye MBarrick (R)	100	0	-	-	-	-	-	-
Restaurant du Peuple (R)	-	-	-	-	90	10	-	-
Massata SAMB (R)	85	15	17	83	-	-	-	-
Sub-Total	56	100	17	75	52	67	0	0
Aïssata SENE (V)	100	0	100	0	-	-	-	-
Maguette FALL (V)	100	0	100	0	-	-	-	-
Awa THIAM (V)	100	0	100	0	80	20	-	-
NDeye THIAM (V)	100	0	90	10	-	-	-	-
Fatou CISSE (V)	100	0	90	10	-	-	-	-
Marième NIANG (V)	-	-	100	0	100	0	-	-
Mariam DIOP (V)	-	-	-	-	100	0	-	-
NDeye AIDARA (V)	-	-	-	-	-	-	100	0
Cécile HETSELI (V)	-	-	-	-	-	-	80	20
Rokhaya SARR (V)	-	-	-	-	-	-	90	10
Sub-total	44	0	83	25	48	33	100	100
Total	100	100.0	100	100	100	100	100	100

In the vendors' sector the precooked grain was satisfactory to all customers. The latter accounted for 44% of the total sample and 56% was the proportion from restaurant-goers.

Toasted grits prepared as couscous or Neleng was not liked by foreigners at Massata SAMB Hotel. The other restaurant, Khadim El Rassoul, showed the opposite results where 90% of the customers liked the product. Vendors were better experienced in preparing toasted grits than cooks in restaurants so that the final results showed 96% of their customers liked the dish while only 4% did'nt care for it. The population sample was partitioned between restaurants and vendors at the ratio of 17 : 83.

Toasted flour was served in the form of sauce in three restaurants and was liked by 74% of the customers. At the vendors this product was prepared as "thiakry" and/or couscous which were appreciated by 93% of the sample. The latter represented 48% versus 52% at the restaurants.

Fermented flour prepared in the form of "Akara" was served solely by specialized vendors. Ninety per cent of customers liked the "Akara" purchased from three vendors and only 10% did'nt care for it.

Th preceding analyses show that all products were acceptable as they were presented by the restaurateurs and vendors. It was necessary also to verify consumers satisfaction by posing the question on their intention to reorder the dish he/she consumed.

Table 36 shows the results as percentage of customers who will or will not reorder or may reorder the product

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in question. Fermented flour was on the top with 73% of the sample expressing their intention to reorder while 1.5% who didn't intend to buy again. Toasted grits, precooked grain, and toasted flour followed in this order with 64%, 62% and 61% of consumers' satisfaction.

Table 36 : Consumers' expression of intention to order dishes prepared from cowpea products

Product	% Respondents		
	Will reorder!	Will not reorder	May be Will reorder
Precooked grain	62	1	37
Toasted grits	64	1.5	34.5
Toasted flour	61	0	39
Fermented flour	73	1.5	25.5

These results are encouraging considering the "newness" of these products to both the preparers and consumers.

The following conclusions are drawn from the experience and results discussed above :

1. - Vendors and small restaurateurs are viable points to sell cowpea products in urban centers as Dakar and suburbs.

2. - Introduction of new products as toasted grits, flour, or fermented flour required intensive demonstration of methods to prepare these products in a variety of senegalese dishes.

V.4. - Home-test of cowpea products in Dakar

Four products namely : precooked, dry cowpea grain, toasted grits and flour, and fermented flour were placed

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in 300 homes selected randomly in six Dakar districts. Within a month field-workers visited each home and filled-in a questionnaire that covered aspects such as : preference among the products, forms of preparation, degree of likeness, further interest in preparing chosen products, type of packaging preferred, marketing-price the households were willing to pay for each, and suggestions on improving product quality.

Each household received one-kilogram of each product with a booklet of recipes and recommendations to serve one meal prepared from cowpea product in a 3-day menu. A copy of the latter is shown in table 37. Precooked grain was suggested for casseroles as NDambé or Thialal, and salad or fish extender (croquettes). Toasted grain was presented in grits which were steam-cooked (Neleng), or for gâteau (cake). Toasted flour was recommended for preparation of couscous and thiakry, or for sauces as Naffé, and Maffé. Precooked fermented flour was suggested to prepare the snack "Akara", for batter in frying shrimp or meat, for couscous and for potato casserole.

V.4.1. - Population-sample distribution

The size of population-sample per district was weighted relative to size and population density. Table 38 shows the number of households per district and its proportion in the overall sample. Medina and Castor districts were represented by 25% and 23.3%, respectively while Hann-village and Gibraltar comprised 10% and 8.3% of the total. Derklé and Dieppeul each constituted 16.7%.

Table 37 : Three-day menu for urban Households as presented for the home-test.

Meal	Day		
	1	2	3
Breakfast	Hot drinks (coffee-milk, kinkelibah etc... Bread-cakes or baked goods.		
Lunch	Rice-cowpea grain (toasted), and fish (<u>Tiébou kétiakh</u> or meat with tomato sauce thickened with toasted cowpea flour (<u>Naffé</u>))	Rice with fish (<u>Tiébou Djeun</u>)* or Corn grits with fish	Okra with palm oil (<u>Soupe Kandia</u>)
Snacks	Deep-fat fried fermented cowpea balls (<u>Akara</u>)	Cowpea cooked granules in sweetened butter milk (<u>Thiakry</u>)	Cowpea gâteau or cake from toasted grits and flour
Dinner	<u>Couscous</u> of millet with meat sauce	Cowpea casserole with peanut sauce (<u>Thialal</u>) or Precooked cowpea casserole with tomato sauce (<u>NDambé</u>)	Cowpea salad of precooked grain and steam-cooked toasted grits (<u>Neleng</u>) with sauce

* National plate consumed daily at lunch.

Table 38 : Sample distribution among Dakar districts

Districts	N° of households	% of sample
1. Castor	70	23.3
2. Derklé	50	16.7
3. Dieppeul	50	16.7
4. Gibraltar	25	8.3
5. Hann-village	30	10.0
6. Medina	75	25.0
Total	300	100
Average	50	-

V.4.2. - Product preference

As mentioned earlier the field-workers placed the four cowpea products at the same time, when the data was analyzed to determine if there was preference, and in what order did the households prepared the products we found the following preference : precooked grain, fermented flour, toasted flour, and last toasted grits. Table 39 shows the number of households per district and the order in which each product was prepared. Fifty-two per cent of the households prepared precooked grain first, while only 25% prepared fermented flour first. Toasted grits was last where only 10% of the households prepared it first. These results were logical in a sense that the precooked grain was attractive in appearance, and presented maximum convenience in time of preparation. Fermented flour was somehow interesting but since the most important recipe was for a snack "Akara" it was no surprise to see it a far second. Toasted grits and flour were the most novel to the households to accept off-hand particularly that they were recommended as substitutes

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for millet and/or for wheat flour for sauces.

V.4.3. - At which meal (snack) was each product served ?

Table 40 presents the number of households and the meals when each product was served. Precooked grain and toasted grits were served for dinner meals by 64% and 53% of the total sample, respectively. Toasted grits was served also as a snack by 35% of the sample particularly in districts of Castor, Derklé, and Hann where the number of households serving it as snack surpassed that who served it for dinner. Toasted flour was served evenly between lunch and dinner meals (37% and 39%) while 24% of households prepared it for snacks (probably Thiakry). Fermented flour was prepared by 86% of the samples as snacks (mostly Akara) while 13% also used it for dinner meals. Totals exceeded 300 because each product was prepared probably for more than one meal, i.e. lunch and/or dinner.

V.4.4. - The place of cowpea in meals served

The question was asked to find out what other plates particularly cereals, were served with the cowpea product. Bread was included as wheat in the list of cereals with rice, millet, and corn. Table 41 shows the number of households who served each product with or without cereals. The percentage of households who served niebe with corn and/or bread did not exceed 1% while those who served rice and millet as accompanying dish to precooked grain were 66% and 16%, respectively. This may be explained by the fact that the recipe of Thiébou Kériakh (rice with niebe and smoked fish) was recommended in the menu for lunch which is more important than dinner meals in which niebe was suggested with millet.

Table 39 : Households preference in preparing cowpea products

District	Precooked grain				Toasted grits				Toasted flour				Fermented flour			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Castor	30	2	16	3	11	11	16	32	13	15	18	24	15	24	21	10
Derkle	23	13	6	8	3	12	19	16	11	8	17	14	14	17	7	12
Dieppeul	25	9	12	4	6	15	10	19	10	14	13	13	9	14	13	14
Gibraltar	14	4	5	2	1	7	9	8	1	7	6	11	9	7	5	4
H. Village	13	13	4	1	2	5	7	16	3	3	15	9	12	9	3	6
Medina	50	14	5	6	6	21	22	26	5	15	15	30	16	25	22	12
Total	155	73	48	24	29	71	83	117	43	62	94	101	75	96	71	58
Pourcentage	51.7	24.3	16	8	9.7	23.7	27.6	39	14.3	20.7	31.3	3.7	25	32	23.7	19.3
Average	26	12	8	4	5	12	12	14	19	7	10	16	12	16	12	10

1. Prepared first 2. Prepared second 3. Prepared third Prepared fourth.

Table 40 : Number of households per district who prepared cowpea products in daily meals^{1/}

District	Precooked grain				Toasted grits				Toasted flour				Fermented flour			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Castor (70)*	0	27	8	58	1	6	35	29	0	36	17	30	1	0	69	2
Derkle (50)*	2	20	1	48	4	12	27	25	0	36	15	41	0	0	49	7
Dieppeul (50)*	0	31	2	49	5	7	24	35	1	28	23	36	0	2	50	10
Gibraltar (25)*	0	9	0	25	0	0	3	23	0	7	13	12	0	0	23	6
H. Village (30)*	0	9	6	25	0	2	17	13	0	21	8	11	0	0	30	1
Medina (75)*	1	37	1	69	0	4	17	61	0	0	33	27	38	0	66	18
(300)* Total	3	133	18	274	10	31	123	186	1	161	103	168	1	2	287	44
%	0.8	31	4.2	64	2.9	8.9	35.1	53.1	0.2	37.2	23.8	38.8	0.3	0.6	85.9	13.2
Average	0	22	3	46	2	5	20	31	0	27	17	28	0	0	48	7

* N° of households

^{1/} Breakfast (1), lunch (2), Snack (3), Dinner (4)

Totals represent the number of meals prepared and not the n° of households.

Table 41 : Number of households who served cowpea products without and with cereals

Cereal	Precooked grain		Toasted grits		Toasted flour		Fermented flour	
	0	1	0	1	0	1	0	1
Rice	102	198	300	0	91	209	299	1
Millet	252	48	225	75	109	191	191	9
Corn	299	1	300	0	299	1	300	0
Wheat (bread)	299	1	300	295	5	297	297	3

0 = Without cereals

1 = With cereals.

When toasted grits were prepared they were served without rice by all the sample, but 25% of the latter served it with millet probably as an extender to the meal. Toasted flour was used with rice by 70% of the sample and by 25% with the millet. Fermented flour was served as a snack without cereals by the majority of households, and only 3% served it with millet probably in the form of couscous.

These results show the possibility of substituting toasted grits for rice and millet in the meals. Also the potential of reducing rice and millet consumption by adding precooked cowpea grain, or toasted grain.

V.4.5. - Preparations of meals based on cowpea products

Housewives were asked to recall the name of dishes prepared from each cowpea product. This information reveals the ethnic background of each household, and their "creativity" in making a variety of meals from each product. Table 42 summarizes the results where we found housewives used precooked grain in preparing twenty-five recipes however the most important were : NDambe, Ragout (casserole), Thiébou Kétiakh, Bassé Salté, Thiébou Yap, Thiébou Guedj (dried fish), and cowpea salad. Daxin was prepared by 6.7% of households and other plates of less importance were mentioned by housewives such as MBaxal, Thioké, Nak etc...

Toasted grits were prepared by 53% of housewives in Lakhou Bissap dish. Neleng recipe was prepared by 27% of households followed by Lakhou Sow at 18%, and Lakhou Neuteri at 17.7%. Other recipe included couscous, NGalakh, Fondé etc...

Toasted flour was prepared in Maffé sauce by 22% of households, while 17% of households used it in Thiakry or couscous. Seven per cent used the toasted flour in gateau, and 6% in making Fondé. Other preparations were the "lakhou"

dishes and in batter for frying meat or chicken

Fermented flour was used by 91% of households in making the snack akara and negligible percentage of households made couscous or batter for frying meat.

V.4.6. - Number of persons who consumed cowpea products

Each household was asked to numerate the persons who consumed the cowpea product per meal. Tables 43 and 44 show the data which included the total number of persons per district and and per product and per meal.

The number of persons decreased in each product category from the first to the fourth meal as the raw material was depleted. The largest number of persons (6,927) consumed the precooked grain and was followed by the ~~toasted~~ flour at 6,817. Toasted grits was consumed by the least number at 4,780 persons. Fermented flour was consumed by 5,824 in practically three preparations.

It is possible to estimate average amount of each product consumed per person by dividing the quantity of product delivered at each household by the total number of persons who consumed it. The latter were not identified as the same persons or different for each meal and included in many cases invited guests. Based on that approach it is estimated that each person ate on average 35 gms of precooked grain, 63 gms. of toasted grits, 48 GMS. of toasted flour, and 53 gms. of fermented flour. Rice consumption per meal averages 275 gms as a point of reference which shows the lower point of saturation or satiety when a person eats cowpeas. The reader should observe that cooked weights of each product is approximately three times that of dry weights.

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Table 42 : Number of households per district in relation to the recipes prepared from each Cowpea product ^{1/}.

District	Precooked grain																Toasted grits						Toasted flour										Fermented flour			
	ND	RG	TK	BS	TY	TG	SDN	DX	TN	TL	OTH.	LB	NL	LS	LN	INGB	OTHER	MF	T	DMD	CC	GT	FD	NF	B	OTH.	AK	VP	CC	OTH.						
Castor	26	39	16	18	11	0	7	7	12	1	7	32	17	14	12	0	10	39	13	18	28	5	9	2	4	8	99	0	1	0						
Derkle	11	34	8	7	6	14	7	0	0	3	7	54	11	12	3	4	3	21	27	36	8	9	10	1	2	5	76	2	5	6						
Dieppeul	19	24	17	7	11	15	5	5	0	4	9	38	10	13	11	6	10	15	24	28	11	12	6	0	6	13	66	3	5	5						
Gibraltar	22	1	4	4	5	2	3	0	1	0	2	7	9	4	4	0	8	6	8	0	8	5	2	3	3	4	27	3	0	1						
Hann-village	11	13	8	7	2	0	4	5	4	0	5	16	4	6	8	0	0	23	1	12	7	0	3	0	0	4	41	0	0	2						
Medina	60	0	29	4	9	8	11	3	0	2	5	12	31	5	15	0	20	18	22	0	25	7	6	22	8	1	80	5	0	1						
Total	149	11	82	47	44	39	37	20	17	10	35	159	82	54	53	10	51	122	95	94	87	38	36	28	23	35	381	13	11	15						
% of households	49.7	3.7	27	15.7	14.7	13	12	6.7	5.7	3	11.7	53	27	18	17.7	3	17	22	17	17	16.6	7	6	5	4	6	91	3	2.6	3.6						

1/ See page 73 for legend.

LEGEND FOR TABLE 42

PRECOOKED GRAIN

BS : Bassé Salté
DX : Daxiin
ND : NDambé
RG : Ragout
SDN : Salad of cowpea
TL : Thialal
TG : Tiébou Guedj
TK : Tiébou Kétiakh
TN : Tiébou Neuteri
TY : Tiébou Yap
Other : MBaxal, Thioké,
purée, fish-balls,
Nak, and Couscous.

TOASTED GRITS

LB : Lakhou Bissap
LN : Lakhou Neuteri
LS : Lakhou SOW
NGB : NGourbane
NL : Neleng
Other: Lakhou Tiakhane, couscous,
Codé Niébé, Daxiin, NGalakh,
Fondé.

TOASTED FLOUR

B : Beignets
CC : Couscous
DMD : Domoda
FD : Fondé
GT : Gateaux
MF : Maffé sauce
NF : Naffé sauce
T : Thiakry
Other : Lakhou Gar, Poulet panée
Lakhou Neuteri, Lakhou Sow,
Purée.

FERMENTED FLOUR

AK : Akara (snack)
CC : Couscous
VP : Viande panée
Other: Fondé, Poulet panée
beignets.

Table 43 : Number of persons per district who consumed cowpea products

District	Precooked grain				Toasted grits				Toasted flour				Fermented flour			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Castor (70)*	958	610	284	15	905	169	20	8	923	525	126	13	083	396	11	10
Derklé (50)*	632	411	112	10	587	302	29	5	640	574	264	54	687	385	43	6
Dieppeul (50)*	542	443	205	60	509	346	10	0	578	495	208	51	639	302	24	0
Gibraltar (25)*	298	155	30	0	306	31	0	0	187	138	0	0	335	68	0	0
H. Village (30)*	378	239	76	40	359	65	0	0	364	212	71	11	430	143	28	0
Medina (75)*	893	476	52	8	966	145	18	0	980	390	22	0	090	155	0	0
Total	3 701	2 334	759	133	3 632	1 058	77	13	3 672	2 334	691	120	4 264	1 408	135	16
Average	617	389	126	22	605	176	13	2	612	389	115	20	711	234	23	3

* Number of households

1. First meal 2. Second meal 3. Third meal 4. Fourth meal.

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Table 44 : Consumption of cowpea products per district, per product, and per person during the home-test.

District	Precooked grain			Toasted grits			Toasted flour			Fermented flour		
	Weight, kg	N° of persons	Consumption gm.	Weight, kg	N° of pers.	Consumption gm.	Weight, kg	N° of pers.	Consumption gm.	Weight, kg.	N° of pers.	Consumption gm.
Castor	56	1 867	30	70	1 102	63	70	1 587	44	70	1 530	46
Derklé	40	1 165	34	50	923	54	50	1 523	33	50	1 121	45
Dieppeul	40	1 250	32	50	865	58	50	1 332	37	50	965	52
Gibraltar	20	483	41	25	337	74	25	325	77	25	403	62
H. Village	24	733	33	30	424	71	30	658	45	30	600	50
Medina	60	1 429	42	75	1 129	66	75	1 392	54	75	1 205	62
Total	240	6 927	212	300	4 780	386	300	6 817	290	300	5 824	317
Ave/district	40	1 154	35	50	797	63	50	1 136	48	50	971	53

The preceding assumption on cowpea consumption was valid because in a separate question on the quantity of each product that was unused when the field worker filled in the questionnaire it was found that 89 to 97% of households had completely used all products in the first preparation and only in the situation on toasted grits that 11% of the sample did not use all the product deposited.

Districts of Gibraltar and Medina recorded the highest per capita consumption of each product, while Castor, Derklé, and Dieppeul registered among the lowest. These data guide in estimating average consumption per person per meal per product and not as indicators of product acceptance.

V.4.7. - Product acceptance and evaluation

The results presented in table 45 sum up the opinions of housewives who responded to the field workers' questions. It is logical to accept their judgement as representative of the sentiment of the members of their households and those who ate the cowpea products. All products except toasted grits registered above 90% of household acceptance as very good. Toasted grits was considered very good by 83% of households and 5% rated it as bad. Considering the novelty of toasted grits as a substitute for millet grits the results are very encouraging.

The best indicator on food acceptability is the expression of consumers' intention to prepare a product more times. Table 46 shows the results of households interest to continue on preparing cowpea products. Fermented flour scored the best response where 9.6% of the sample expressed to prepare it daily* .

* Mostly as the snack "Akara", or couscous, or batter.

Table 45 : Household's appreciation of cowpea products.

District	Precooked grain			Toasted grits				Toasted flour				Fermented flour			
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4
Castor	70	0	0	52	7	7	4	62	4	3	1	63	5	1	1
Derklé	50	0	0	50	0	0	0	49	1	0	0	50	0	0	0
Dieppeul	50	0	0	49	1	0	0	49	1	0	0	47	3	0	0
Gibraltar	25	0	0	19	3	0	3	23	1	1	0	23	1	1	0
H. Village	29	1	0	14	8	3	5	25	5	0	0	27	3	0	0
Medina	73	1	1	66	4	2	3	68	3	2	2	70	4	1	0
Total	297	2	1	250	23	12	15	276	15	6	3	280	16	3	1
%	99	0.7	0.3	83.3	7.7	4	5	92	5	2	1	93.3	5.4	1	0.3
Average	50	0	0	42	4	2	2	46	2	1	0	4	3	0	0

1. Very good 2. Good 3. Not bad 4. Bad

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Table 46 : Households intention to prepare cowpea meals from products as those sampled.

District	Precooked grain, %					Toasted grits, %					Toasted flour, %					Fermented flour, %				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Castor	5	45	16	3	1	1	20	34	4	7	8	38	19	0	5	6	25	33	4	2
Derkle	0	44	6	0	0	0	28	22	0	0	1	43	6	0	0	1	16	33	0	0
Dieppeul	0	44	6	0	0	0	26	23	1	0	2	38	10	0	0	3	21	25	1	0
Gibraltar	0	17	8	0	0	0	10	12	0	3	0	10	14	1	0	3	16	5	1	0
Hann-village	2	14	12	2	0	0	6	12	3	9	1	10	15	2	2	2	8	14	6	0
Medina	5	47	22	0	0	2	28	38	1	3	1	32	38	0	2	13	44	18	0	0
Total	12	211	70	5	1	3	118	141	9	22	13	171	102	3	9	28	130	128	12	2
% *	4	70.4	23.3	1.7	0.3	1	40	47	3	7	4.3	57	34	1	3	9.3	43.3	42.7	4	0.7
Average	2	35	12	1	0	0	20	23	1	4	2	28	17	0	1	5	22	21	2	0

* the balance of 100 was undecided

1. Everyday 2. 2 - 3 times weekly 3. Once weekly
 4. Once monthly 5. No intention to prepare.

Precooked grain and toasted flour were rated as second at 4% of the sample who would prepare either on daily basis. Toasted grits was chosen by 1% of the sample.

Precooked grain was well liked that 70% of households said they will prepare it 2 - 3 times weekly. Toasted flour was second in this category at 57% of households. Both fermented flour and toasted grits registered 43% and 40%, respectively of sample for readiness to prepare each 2 - 3 times per week.

The percentages of households who stated that they were ready to prepare cowpea products once-a-week were : 47% for toasted grits, 43% for fermented flour, 34% for toasted flour, and 23% of precooked grain. The group who chose to prepare the products once-a-month or not-at-all did not exceed 5% except for the toasted grits where 10% indicated so.

V.4.8. - Households' estimations on price of cowpea products

Housewives were asked to estimate the price at which they were willing to buy one kilogram of each product. Table 47 lists the price-brackets based on the data accumulated from 300 homes. The highest bracket was 250 FCFA or more per kilogram and on the lowest was 50 FCFA and under per kilogram. Sixty-six per cent and fifty-five per cent of the sample indicated that one kilogram of fermented flour and precooked grain should sell at 250 FCFA or more, respectively. For toasted grits and flour the percentages were 46% and 44%, respectively. Less than 10% of the sample valued the products at less than 100 FCFA/ kilogram. Between 22 to 25% of households said that all products except fermented flour should be sold at 200 - 250 FCFA per kilogram.

Table 47 : Distribution of households per district by price brackets for each product

District	Precooked grain					Toasted grits					Toasted flour					Fermented flour						
	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	2	3	4	5	6
Castor (70)	0	2	7	14	46	0	1	4	12	11	33	0	1	1	12	13	38	1	1	9	10	47
Derkle (50)	0	3	3	9	35	0	0	0	6	10	34	0	0	2	2	17	29	0	1	5	10	34
Dieppeul (50)	0	5	7	22	16	0	1	6	4	20	19	0	0	5	6	21	18	1	4	3	16	26
Gibraltar (30)	0	2	6	2	15	1	3	2	6	4	9	0	1	5	6	4	9	0	1	0	3	21
Hagn-village (25)	0	0	0	9	21	0	0	0	1	9	11	0	0	0	3	9	16	0	0	1	5	24
Medina (75)	3	9	16	17	30	2	7	16	16	9	25	1	10	14	20	10	20	1	8	12	9	45
Total (300)	3	21	39	73	163	3	12	28	45	63	131	1	12	27	49	74	130	3	15	30	53	193
Average	0	3	6	12	27	0	2	5	7	10	22	0	2	4	8	12	22	0	2	5	9	33

Suggested sale price : 1 = less than 50 F. 2 = 50 to 99 F. 3 = 100 to 149 F. 4 = 150 to 199 F.

5 = 200 to 249 F. 6 = 250 or more.

If we add up the latter group with the highest bracket the results will show :

77% to 91% of the sample estimated precooked grain and fermented flour should sell at 200 FCFA and over ; 66% to 71% of the sample thought that toasted grits and flour would sell at 200 FCFA and over.

The above results reveal a strong sense of households' appreciation for the products and their quality characteristics. What is encouraging further is that at market price of 200 FCFA there will be profit margins for the processor large enough to consider producing cowpea products. Further financial analyses is needed to calculate detailed costs of production, distribution, and other questions.

V.4.9. - Household intention to buy cowpea products

What people do does not always confirm what they say, however for the sake of emphasizing households' intention to buy cowpea products, after they stated their price estimations, they were asked whether they will buy or not buy. Table 48 shows the results for each product. Ninety-nine per cent of the sample expressed their intention to buy the precooked grain and/or fermented flour. Ninety-nine per cent would buy toasted flour, and 89% would buy toasted grits. These results confirm and correlate with those in table 45 on households' appreciation for the products. Among the districts one observes that Castor had the only or the largest number of households who expressed their negative response to buy the products. This is particularly obvious in the results of toasted grits, and to a lesser extent in toasted flour. The novelty of the latter products and their use as substitutes for established ingredients as millet is not easily accepted by conservative, tradition-respecting housewives.

V.4.10. - Household choice of packaging for cowpea products.

Housewives were asked on their preference for packaging cowpea products. They chose plastic bags over carton by 94 - 98% to 1%. Plastic bags are widely used in packaging food and drinks in Senegal because of their availability and relatively low cost.

V.4.11. - Households suggestions on product improvement

Table 49 lists the options given to households to chose from, and the number who suggested to improve on the quality characteristics of each product. The majority, over 90% of the sample, did not suggest any improvements on the quality of precooked grain, fermented flour, or toasted flour. Ten per cent of the sample recommend to improve the taste or flavor of toasted grits, but only 5% suggested the same for toasted flour.

Two districts, Castor and Hann, presented over two-thirds of households who recommended to improve on the taste of toasted grits more than flour. T h e r e is reason to believe that a major part of objection by households in these two districts was the inability of households to read the french-written recipes and/or to follow the directions of preparation for these two products. It is however prudent to take note that good quality control is a must to assure the uniform quality of toasted grits and flour.

Table 48 : Distribution of households per district on intention to buy cowpea products.

District	Precooked grain			Toasted grits			Toasted flour			Fermented flour		
	1	2	3	1	2	3	1	2	3	1	2	3
Castor	69	1	0	60	9	1	64	5	1	68	2	0
Derkle	50	0	0	49	0	1	50	0	0	50	0	0
Dieppeul	50	0	0	50	0	0	50	0	0	50	0	0
Gibraltar	25	0	0	21	9	0	28	2	0	30	0	0
H. Village	30	0	0	21	9	0	28	2	0	30	0	0
Médina	73	0	2	67	1	69	3	3	74	0	0	1
Total	297	1	2	268	21	11	285	10	5	296	2	2
%	99	0.3	0.7	89.3	7	3.7	95	3.3	1.7	98.6	0.7	0.7
Average	49	0	0	45	3	2	47	2	1	49	0	0

1. Intent to to buy

2. Will not buy

3. May be will buy.

.../...

Table 49 : Household suggestions on improvement of quality characteristics

District	Precooked grain						Toasted grits						Toasted flour						Fermented flour					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Castor	1	0	0	0	0	69	11	0	0	0	4	55	7	0	0	2	0	61	1	2	0	0	0	67
Derklé	0	0	0	0	0	50	0	0	0	0	0	50	0	0	0	0	0	50	0	0	0	0	0	50
Dieppeul	0	0	0	0	0	50	2	0	0	0	0	48	3	0	0	0	0	47	1	0	0	0	0	49
Gibraltar	0	0	0	1	0	24	4	1	0	0	1	19	0	0	0	1	0	24	0	1	0	1	0	23
Hann-village	0	0	0	1	0	29	10	0	0	0	3	17	2	0	0	0	0	28	0	0	0	0	0	30
Medina	0	0	0	1	0	74	3	0	0	0	1	71	4	0	0	1	2	68	0	3	0	1	0	71
Total	1	0	0	3	0	296	30	1	0	0	9	260	16	0	0	4	2	278	2	6	0	2	0	290
%	0.3	0	0	1	0	98.7	10	0.3	0	0	3	86.6	5.3	0	0	1.3	0.7	92.7	0.7	2	0	0.7	0	96.6
Average	0	0	0	0	0	49	5	0	0	0	1	43	3	0	0	0	0	46	0	1	0	0	0	48

1. Taste 2. Texture 3. Time of preparation 4. Overall quality 5. Other. 6. None.

V.4.12. - Conclusions

The results presented above confirm households' acceptability of the products : precooked grain, fermented flour, toasted grits and flour as presented and as recommended in the 3-day-menu. Households in Dakar and suburbs liked the concepts of these products by a range from 53% for toasted flour to 75% for precooked grain. The home-test showed that over 90% of the households liked the products and were willing to buy them. Precooked, Bambe 21 grain and fermented flour are two products ready for the market as is, while toasted grits and flour require market-testing with planned campaign for product-promotion and advertising. Cowpea products are well accepted by urban consumers when presented in convenient forms and at competitive price.

V.5. - Transfer of techniques and information on toasting, storage, and utilization

The final phase or step of this project was to transfer the techniques on cowpea conservation and transformation to samples of rural population. This output is a cornerstone for achieving the objective of encouraging local consumption of cowpeas yearound in rural zones.

V.5.1. - Choice of villages for testing the method of diffusion

Two villages in Louga region were chosen to test the methods of grain-storage and of toasting/processing cowpeas. Mayaye II village in the department of Kebemer represented the zone which had the highest production/consumption per capita. Gnandioul village in the department of Linguere represented the opposite where the production/consumption

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was very low. Each village had a peace-corps volunteer who assisted in the preparations in their respective village.

Gnandioul was replaced by Thiamene in the department of Louga when we found out that cowpeas crop in 1988 was a complete failure in the department of Linguere.

After an introduction visit to each village technical teams from ITA proceeded with the activities as summarized in table 50.

ITA team emphasized their awareness of the problems the villagers had in storing and in consuming cowpeas. The purpose of their visits was clearly explained to introduce simple practical methods of storage, and of traditional food preparations based on cowpeas that may be easily adopted in their daily diet.

Table 50 : Summary of activities at villages in Louga region to transfer technology on storage and processing cowpeas.

Activity	Date of visit	
	Mayaye II	Thiamene
1. Demonstrate storage with a mixture of CaO + ash at 5 producers	Oct. 11, 1988	Oct. 27, 1988
2. Demonstrate toasting cowpeas in hot sand	Oct. 11, 1988	Oct. 27, 1988
3. Demonstrate recipes preparation and distribute brochures on traditional recipes	Nov. 16, 1988	Nov. 29, 1988
4. Evaluate diffusion methods, take samples of stored grain for laboratory analyses	Dec. 20, 1988	Dec. 21, 1988
5. Supervise the responsible home-economist in toasting cowpea then preparing it in a rice-recipe	Dec. 20, 1988	Dec. 21, 1988

V.5.2. - Storage of cowpeas in calcium oxide-ash mixture

Results from the laboratory showed that the mixture of calcium oxide and ash was the most effective and practical way to protect cowpea grains from infestation. The method was simplified by changing the percentage by weight of all additives to equivalents in volume so that for ten kilograms of grain a mixture of one kilogram ash plus 0.4 kg of calcium oxide was added and tightly closed in 180 μ thick polyethylene bag. The same proportions might be achieved by using a 15-litre pail which when full will weigh approximately 12 kg of grain. The latter will be treated with a mixture of 1/2 litre of calcium oxide and one litre of ash. The results of the storage test at Mayaye II and Thiamene are shown in table 51.

Samples from Mayaye II had 10.0% moisture in average while those from Thiamene contained 7.7% at the initiation of test. Control samples (untreated) averaged 10.7% after storing for 9 weeks, and treated samples had 7.5%. Average moisture in control and treated stored samples from Thiamene after 7 weeks were 8.0% and 7.3%, respectively. These results show increase in moisture in untreated samples after storage, and the opposite in those treated with calcium oxide/ash mixture. The latter is a drying agent which has the key role in controlling infestation either by competing with insects for moisture or by dehydrating them and drying their egg-patches.

Judging from the data in Mayaye II and Thiamene it is postulated that grain in humidity range of 7.5% to 8.0% will have the least level of infestation, while seeds with moisture higher than 8.0% are vulnerable to beetle attack.

Table 51 : Per cent humidity, and infestation in cowpea samples that were stored with and without CaO mixture for 7 - 9 weeks.

Producer N°	Mayaye II				Thiamène			
	% H ₂ O		% Infestation		% H ₂ O		% Infestation	
	Start	End	Start	End	Start	End	Sart	End
I. Control	9.0	9.4	1.0	6.0	8.2	7.6	8.0	29.5
Treated	9.0	8.0	1.0	1.0	8.2	7.4	8.0	8.0
II. Control	9.0	13.0	0.5	11.0	8.0	9.2	12.0	26.5
Treated	9.0	7.2	0.5	0.5	8.0	6.6	12.0	12.0
III. Control	10.4	12.2	1.5	39.5	7.8	7.7	4.0	10.5
Treated	10.4	7.4	1.5	1.5	7.8	7.2	4.0	4.0
IV. Control	11.4	10.2	1.5	81.5	7.0	8.0	5.5	25.0
Treated	11.4	7.7	1.5	1.5	7.0	7.9	5.5	5.5
V. Control	10.0	9.0	1.5	42.0	-	-	-	-
Treated	10.0	7.5	1.5	1.5	-	-	-	-
Average	9.96	-	1.2	-	7.75	-	7.4	-

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This postulation is confirmed by studying the per cent infestation in treated and untreated grain from the two villages. Treated samples from Mayaye II had total infestation in the range of 0.5 to 1.5% depending on the initial level of infestation after harvesting the crop. Untreated samples meanwhile showed 6.0 to 81.5% infestation. Results from Thiamene were higher in the treated samples, in the range of 4.0 to 12.0%, while the untreated samples had 10.5 to 29.5% infestation. The lower moisture level in Thiamene sample, 7.7%, had an important role in the relatively low level of infestation in the untreated samples in spite of the fact they were more severely attacked than those from Mayaye II, 7.4% vis-a-vis 1.2%, respectively.

V.5.3. - Storage of roasted cowpeas

Calcium oxide and calcium carbide action as desiccants in lowering humidity level in stored cowpea grain led us to conclude that roasted grain which on average contained 2.5% moisture might be stored safely without the loss caused by infestation. This conclusion was confirmed by a laboratory test where roasted grain were artificially infested with adult male and female beetles. The latter deposited egg-patches on the grain, as normal, and after two months the grain was examined for infestation. No larvae or growing insects were found in the grain because they could not penetrate the latter to continue their growth cycle.

This method of storage was recommended to the villagers who wish to keep the grain for autoconsumption or for gift. The little producers were advised to roast the grain directly after harvesting as they roast peanuts with a difference in degree of toasting. It was suggested that a person can roast in a day-work between 10 - 15 kg of grain by heating one-kilogram batches in sand for 9 - 10 minutes.

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For larger quantities a roaster is recommended as described under the technical development studies VI.5.

V.5.4. - Preparation of roasted grain into grits and flour

The purpose of the second visit to Mayaye II and Thiamene village was to demonstrate the preparation of toasted cowpea grits into Neleng, a dish normally prepared from millet grits, and the use of toasted cowpea flour in sauce preparation "Maffé" as a partial substitute for peanut butter. A three-day menu was proposed to the villagers which included one meal per day based on cowpeas.

Women from each village observed and assisted ITA home-economists in the preparation of the meal for the "party". The cowpea products were prepared at the pilot-scale production line of ITA. For the artisanal scale at each village the following method was described to make grits and flour.

Humidify cowpea grain by adding gradually one-tenth-cupfull of water to one kilogram grain. The purpose of this step is to facilitate the separation of seed coat from the cotyledons after toasting. The latter is done as in the procedure for roasting peanuts with the precaution of proportionating the amount of sand to seed at 2 : 1 to avoid burning the latter.

When toasting is done, approximately ten minutes, the grain is transferred to a large mortar where the grain is rubbed in circular motion with a pestle until the coats are separated from the cotyledons. On a large sieve the latter is separated by blowing air and with tossing gently the grain on the sieve.

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Grinding is done in the village mill equipped with 1.0 to 1.5 mm opening sieve depending on the fineness of grits desired. The alternative is to use the mortar-pestle method to break the cotyledons which are normally hardened by the toasting operation.

Separation of grits from flour is done by using a sieve with 0.3 mm openings. Products must be stored in plastic or cloth bags in a dry place. Under such storage conditions the products might last for one year without loss in quality or attack of insects.

V.5.5. - Introduction of cowpea meal in 3-day menu for the villagers.

The approach of introducing cowpea meals in the form of 3-day menu was used to put into perspective the part that cowpea may take into the villagers' diet. Table 52 shows the menu proposed for the two villages during the second visit and after the party.

Table 52 : Three-day menu for villagers in Louga region

Meal	Day		
	1	2	3
Breakfast	Coffee/tea - bread or biscuit	Bouillie from millet, coffee/tea - bread or biscuits.	Coffee/tea, bread or biscuits.
Lunch	Tiebou Ketiakh with toasted cowpeas (rice with dried-smoked fish and cowpeas)	Tiebou Djeun (rice with fish)	Tiebou Yap (rice with meat)
Dinner	Couscous of millet or blended cereals with cowpeas	NDambe or Lakhoul Neuteri (cowpeas)	Neleng of cowpeas or Lakhoul Gar

Diet habits such as eating rice with fish or meat at Lunch were respected in the proposed menu with the modification of introducing rice with toasted cowpea in the Tiéboú Kétiakh dish in one day out of three. Dinner meals proposed several recipes as couscous prepared from cereal/cowpea blend, or Neleng of toasted cowpea grits provide the cereal base for dinner and normally consumed with sauces of tomato and other ingredients. Lakhou Neuterí is based on toasted cowpea grits, peanut butter, and/or the flour of the fruit from baobab tree.

Lakhou Gar is prepared from fermented cowpea grain formed into paste, fish, millet or corn grits, tomato concentrate and condiments. The recipes for these dishes are shown in annex 1.

V.5.6. - Evaluation of villagers' acceptance and adoption of technology

Evaluation of villagers' acceptance of information and techniques that were demonstrated during the first two visits was accomplished in the third visit.

The criteria for evaluation were : the number of carrés who adopted the techniques shown in the first visit, the number of carrés who followed the menu for 3-day meals as proposed, and the villagers' perception of the difference between the grain stored with and without calcium oxide/ash mixture.

In Mayaye II village none of the attendants knew how to toast cowpeas or to store it as was described to them in the first visit. Five out of thirty-three carrés stated during the second visit that they tried roasting cowpeas and preparing it as they were informed. On the last visit all the carrés practiced the roasting method and processing, and nineteen out of thirty-three followed the three-day menu. The most striking development is witnessing the creativity of villagers in presenting modified recipes on Neleng, and Lakhou Sow or Thiere.

Also toasted cowpea flour was agglomerated as in couscous to prepare large granules used in a dish with sauce. We also saw the roasting of cowpeas to prepare a coffee-bean substitute as a drink. No complaints were registered by the villagers other than the crop failure in 1988 season, and the problem of locust.

On the methods of storage the villagers voiced their observations on the significant difference between the treated and untreated grain samples.

In Thiamène village we discovered that there were another village "Maïmouna" as an extension to Thiamene and that was where the first visit and processing demonstration of techniques on storage and processing were made. None of the carrés practiced the toasting or preparation of cowpea as of the second visit. The instructions were repeated before the parcy, as described in Mayaye II village, and as the same preparation of Neleng and sauce Maffé was presented. On the last visit there were four out of eleven carrés who tried the techniques of toasting and preparation of cowpea. None indicated that they followed the 3-day menu as was presented. The importance of toasting cowpeas for storage and consumption was remphasized to the villagers. Also the difference between the treated and untreated samples of grain was registered by the villagers.

On the final visit and with the assistance of the CER, social development representatives, and the local home-economist, the demonstration of grain roasting was repeated and the grain was prepared as Tiébou Kétiakh (rice, cowpeas, and smoked dried fish).

The lack in community spirit and leadership in Thiamene-Maïmouna village made a great difference between it and Mayaye II which demonstrated their willingness to improve their welfare.

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V.6. - Transfer of technology of cowpea processing to private sector

This part is by far the most difficult one to achieve because it is affected by uncontrollable variables such as Government policies towards investment in the agribusiness sector, overall economic and financial situation or GDP, and mostly the availability of borrowing money in the banking sector. Discussions with several would-be investors revealed great concerns for the risk in starting new business at this time, and reluctance to enter in new ventures such as processing cowpeas.

The project took advantage of the President's address on the Independence day* in which he announced broad policies to encourage investments in agrobusiness among others by providing funds for borrowers on reasonably easy terms**. The strategy to achieve our objective covered two steps : publicity through the press and radio-television media, and a presentation to potential entrepreneurs, cowpea producers, and equipment designers/builders.

V.6.1. - Press-cocktail

Arrangements with the Press-Club of Dakar were made so that the General Director of ITA was invited to address the media on the results and viability of processing cowpeas for urban senegalese, and possibly export markets.

Approximately sixty-five members and associates from the local and foreign press corps attended the cocktail and presentation. The text of presentation was distributed

* The Soleil of 5 April 1989

** Eight billion CFA were appropriated for borrowers on 13-year term at 9.5% annual interest. Cost of energy and shipping will be reduced.

with a booklet of recipes for cowpea products, highlights of the socio-economic studies in Louga - St.-Louis and Dakar, and a brief on ITA activities. Cocktails were served to demonstrate the variety of preparations from cowpea products such as : croquettes, quiche, akara, gateau, and tiakry. Two daily journals presented short columns on the event. Radio broadcasts were monitored in local language and Radio France Internationale, and for BBC. If we use the number of interested entrepreneurs who contacted ITA as the criteria for success of this cocktail-press one concludes that it fell short of the objective. If the impact of this presentation on the press corps is used to evaluate this publicity-approach one may find it adequately effective.

V.6.2. - Presentation to entrepreneurs, grain producers, and equipment manufacturers

The objective of this presentation was to assemble all interested parties : grain suppliers, processors, and equipment-manufacturers, at ITA to show them the feasibility of cowpea processing and what was needed to do it. This interaction between the principals should combine all factors for the entrepreneur/processor in one place, and for future contacts. Sixteen entrepreneurs were invited with three grain-producers from Louga region. Only nine representatives and/or entrepreneurs attended the presentation and four expressed willingness to risk their funds while the other five showed interest but no commitments at that time.

Table 53 shows the names/address of entrepreneurs and grain-producers who participated in the presentation at ITA. One potential entrepreneur was ready to invest more than 40 million CFA for semi-industrial units depending on the results of the test market that he will discuss with ITA.

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Another entrepreneur was willing to invest up to 20 million CFA to install cowpea processing line. Two investors were ready to invest five millions CFA for artisanal-scale operations for cowpea products.

The three grain producers from Louga Region indicated their willingness to participate in cowpea processing with investments of one million CFA at maximum. Four companies or small enterprises indicated interest in the potential markets for cowpea products but did not specify what investment they would be willing to put at the time of the presentation. These companies were S.I.C., SAFIC, Nestlé (SENEGAL), and FAFS/CEFIVA. Representatives from SODEVA 1/ and from the Bureau of small-business investment 2/ and assistance for repatriation participated in the discussion and explained their respective roles in developing cowpea crop for small investors. Dr. Jacque FAURE from CIRED/IRAT attended the presentation and was willing to invest five million CFA !

ITA is expected to follow up on this event and provide the technical assistance and/or support to the entrepreneurs who are willing to test-market one or more of the developed cowpea products.

1/ Société de Développement et de Vulgarisation Agricole
2/ Délégation à l'Insertion.

Table 53 : List of entrepreneurs and producers who attended the presentation on cowpea potentiality in Senegal.

Name/address of entrepreneur/producer	Possible investment million , CFA
1. Papa Senghane DIOUF Villa 16 - Cité CFAO Derklé - DAKAR (E)	More than 40
2. Djibril FALL Agro-Pasteur de la Petite Côte Cité Millionnaire - DAKAR (E)	10 - 20
3. Demba SY PROCOSEN/SOTRASEN Km 7.5 - Route de Rufisque BP. 3664 - DAKAR (E)	1 - 5
4. François GAYE Tel. 34-08-86 (E)	1 - 5
5. El-Hadji Pathé MBENGUE Sakal Village - LOUGA (P)	Less than 1
6. Moustapha DIENG Sine-Dieng Arrondissement MBediène - Louga (P)	Less than 1
7. MBaye LO Keur MBarrick Arrondissement MBediène - Louga (P)	

(E) = Entrepreneur

(P) = Producer

VI. TECHNICAL DEVELOPMENT STUDIES

The work plan, presented earlier, comprises two strategies that required the technical support of ITA. These strategies were set-up to resolve the problems of grain storage and control of infestation at the small grain producers, and to develop processed cowpea products that satisfy consumers' habits, taste, and demand for quality.

The following studies were carried out at ITA except those related to technology transfer as extrusion-cooking, concentration of cowpea protein, and nutritional analyses. The latter were done at Hazelton Laboratories America, Inc. and the former were made in collaboration with the Food Protein Research and Development Center at the University of Texas A & M.

VI.1. - Selection of cowpea varieties

A survey was made at ISRA, CNRA, SODEVA, USAID/ADO, seed-service department of Ministry of Rural Development on cowpea varieties that have been widely grown and in development. It was necessary to focus product development on 3 - 4 varieties, and by necessity limit the study to processing rather than production aspects.

There was a consensus on varieties : California Black-eye pea (CB-5), 58/57, Mougne, Ndiambour. The results of the inquiry in Louga and St.-Louis regions confirmed the dominance of 58/57 and the small number of producers of Ndiambour and Mougne. In 1988 crop-year there was a scarcity of CB-5 seed therefore there was no production of this variety in these regions. Rambey 21 variety is a new one and is in the seed multiplication stage by CNRA and SODEVA. It was practically unknown to

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the small producers in Louga and St.-Louis - Matam who participated in the inquiry. Results from the inquiry in Dakar area showed however consumer preference to this variety because of its resemblance to white beans. Mougne and CB-5 were more in demand than 58/57 or NDiambour.

Exploratory tests on Mougne variety showed that it did not yield satisfactory and appealing flour or grits because the color was dark gray. This variety has been used mostly as a vegetable garnish in sauces which did not amount to a significant volume. Another variety that was discarded other than Mougne was TVX-3262 which the consumer rejected because of its poor cooking quality.

Experimental and development work in the USA was concentrated on CB-5, 58/57, and Bambey 21 which proved to have exceptionally good quality. At ITA processing was carried out on 58/57 and Bambey-21.

VI.2. - Methods to control cowpea-beetle infestation during storage

One of the most important, if not the most important, problem for cowpea producers and distributors is infestation and the risk of loss in value if the grain is not correctly treated and handled after harvest. This conclusion was confirmed by the inquiry in Louga and St.-Louis - Matam regions, and by retailers in Dakar area.

Cowpea pods are infested in the field during the final stage of maturity. Neglect in spraying the pods with the appropriate insecticide against the flying cowpea-beetle normally results in great economic loss as many farmers experienced in Louga region during the 1988 season.

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Crop protection is a must if the responsible authorities want cowpeas to succeed and flourish in Senegal. It is unproductive to depend on fumigation or other ways to kill the insects after they attacked the grain. Consumers refuse to eat infested grain and it is unethical to process products from such crop.

ITA developed the method of storing cowpeas, or other grains, in sealed, metallic drums "Cana-Grenier" with reasonable degree of success^{1/}. The principle is so simple that with the elimination of air, oxygen, from the closed barrel the insects will die and infestation will be stopped. The big drawback of this method has been the relatively high cost of empty 55-gallon barrels, which each reaches 20,000 CFA, and the need to fill the latter with cowpeas which ranges between 155 - 170 kg depending on the variety. Several wholesalers and retailers use this method in protecting the grain after collecting it from the production zones.

Table 1 shows per cent infestation in cowpea varieties stored in drums and on farm during 1986/1987. Unfortunately there was no control test where the grain was stored with air so that a comparison may be made. The method to determine infestation is important because of the hidden insects in the grain that are not easy to spot in dry grain. We modified the method, as will be shown later on, to determine total and apparent infestation.

^{1/} For more information, see the report by I. Pattison on "Description d'une méthode de stockage de grains à la ferme par un procédé de conservation hermétique utilisant des fûts métalliques" FAO report - May 1969.

Table 1 : Per cent infestation in cowpea varieties stored on-farm in sealed-drums for five months^{1/}

Variety	Region, % infestation	
	Louga	Diourbel
58.57	13.6 <u>a/</u>	5.5 <u>b/</u>
NDiambour	4.8 <u>b/</u>	
B-21	8.2 <u>c/</u>	6.7 <u>d/</u>
CB-5	7.4 <u>e/</u>	-
Mougne	-	6.6 <u>e/</u>

a/ Average of 9, b/ Average of 8, d/ Average of 7

e/ Average of 5 tests. c/ Average of 10.

1/ From 1987 annual report on cowpeas for Senegal, U. of Cal, Riverside Campus.

VI.2.1. - The effect of chemical elements on cowpea beetle during storage

Research was directed to find out safe, economical chemical elements that will stop insects' growth or kill them during their life cycle. Treating cowpea grain or pods with such elements must not cause detrimental changes to affect their sensory quality, or their viability as seeds.

Active calcium oxide powder or calcium carbide, and sulphur were considered promising elements that met our criteria. The former two act as dehydrating agents where they bind with moisture to yield calcium hydroxide or calcium hydroxide and acetylene. Sulphur is known to be toxic to lower living classes as molds and bacteria and probably may interfere with the beetles metabolism.

Ped sorghum contains high level of tannins and trypsin inhibitor (TI) antimetabolite which are, to a large part,

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responsible for protecting it from insect attack and/or birds. TI that is naturally present in cowpeas provide resistance against pests however it is ineffective against the beetle (Callosobrochus maculatus). It is hypothesis that increasing the concentration of tannin, and by turn TI, may block the growth of beetles. So cowpeas were coated with red sorghum bran to find out its effect.

Experiments were designed on a three-step approach :

The first was done in petri-dishes on 20 gms grain samples which were observed and evaluated after approximately two months from date when adult and male female insects were put in the dishes.

The second step was done on 5 kg. grain samples packaged into burlap or plastic bags which were inoculated with 16 - 20 insects ;

The third step was done at the producers' carrés in two villages, as described under chapter V.5 on the transfer of techniques. All experiments included at least one control treatment for comparison.

The following varieties were tested one at-a-time : CB-5, 58/57, Mougne, and Bambey 21. Seed quality grains were purchased from CNRA from 1986 season except Mougne that was purchased from Dakar markets.

Two criterias were used to evaluate each experiment : per cent loss in weight and per cent of grain infested after 2 months. For the latter test, we added a step in calculating the number of infested grain without apparent holes. The grain was soaked for 10 minutes in hot water to facilitate separation of seed-coats and therefore see immature insects imbeded in the cotyledons. Humidity per cent was

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determined at the initiation and termination of experiments to correct for weight differences resulting from treatment and storage time.

Table 2 shows the results of treating the following cowpea varieties with mixtures of salts or elements to find out their effects on infestation control: 58/57, CB-5, NDiambour, and Mougne.

The first series of experiments mixtures of ash and elemental-sulphur were used in the range of zero to 5% of each based on 20 grams of grain. The sample that was treated with 2.0% ash plus 3.0% sulphur had the minimal loss in weight and in infestation after two months. Only the sample of NDiambour showed relatively high infestation which was probably due to human error and/or to the high humidity of the sample (11.5%).

The second series of experiments were prepared with mixtures of calcium oxide and elemental-sulphur in concentrations of zero to 5.0% of each basis grain-weight. The least loss in weight and in infestation was found in the treatment with 3.0% CaO plus 2.0% sulphur. Also the sample treated with 2.0% CaO plus 3.0% sulphur was effective except in the cases of NDiambour and Mougne. These varieties were purchased from Dakar markets and contained relatively high moisture content, 11.5% and 12.6%.

The third series of experiments were prepared with calcium carbide, in powder form, at concentrations that ranged from zero to 10% based on grain-weight. This chemical was effective at concentrations of 2.5% or higher in controlling infestation. Only varieties 58/57 and Mougne were tested with 1.5% calcium carbide which was found to be equally effective. The only drawback of using calcium carbide in Senegal was the high cost when on kilogram was sold at 9,000 to 10,000 CFA.

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VI.2 - Extrusion-cooking of CB-5 cowpeas

This work was done at the Food Protein R & D Center Of Texas A & M University in 1987 as a part of the transfer of technology objective in this project. CB-5 seeds were purchased from Pennigton Seeds Co. in Madison, Georgia. Fifty pounds (22.5 kg) grain were transferred to a single-stack french^(R) cooker and moisture was adjusted to 16%, then steam-heated for 15 minutes at 180° F (92.5°C) to inactivate oxidising enzymes as polyoxygenase which causes rancid odor/flavor in cowpeas. The grain was dried in National^(R) tray-dryer to approximately 7% moisture for dehulling. Ferrel-Ross cracking rolls were used to reduce the grain into large grits which were sparated into meats and hulls by Kice separator and Oliver gravity-table.

The cleaned grits were adjusted in humidity to 25 - 27% by adding the necessary amount of water to the grits as being fed into a 4 1/2" Anderson International extruder-cooker. The expanded ropes were dried to approximately 10% before grinding in a hammer-mill equiped with an 80 mesh screen. The flour had the following granulation: 7% larger than 0.25 mm and the balance was smaller. Viscosity of extruded and control (uncooked) samples were 180 BU, and 600 BU, respectively. This modification reduced cooking time for preparation of extruded flour to approximately 20 minutes. The most significant difference between the extruded and raw flour was the final viscosity or thickness of the paste after cooking which was in a ratio of 1 : 4, respectively. So when extruded flour was prepared as "bouillie" it was more fluid, cools faster and more acceptable to serve within a short time after preparation. The nutritional advantages and aspects of extruded flour are discussed in part VIII.

Table 2 : Per cent weight-loss and infestation in cowpea varieties stored for two months in petrie dishes with and without chemical mixtures.

Chemical mixture $\frac{1}{\%}$	% loss in weight				% infestation			
	I	II	III	IV	I	II	III	IV
0 (control)	32	0.0	0.0	1.5	68	0.0	0.0	0.0
5.0 C + 0.0 S	24	1.0	0.5	0.5	73.5	0.0	0.5	1.5
4.0 C + 1.0 S	22	0.0	0.0	1.0	75	0.0	0.0	1.0
3.0 C + 2.0 S	10	0.0	4.0	1.5	62	0.0	41.5	0.5
2.0 C + 3.0 S	0	0.0	3.0	1.0	0.0	0.0	(29.0)	0.0
1.0 C + 4.0 S	13.5	17.0	3.5	0.5	75	28.0	23.5	0.0
0.0 C + 5.0 S	22.5	0.0	0.0	0.0	76	0.0	0.0	0.0
0 (control)	0.0	18.5	13.5	1.5	1.0	75.0	78.5	0.0
5.0 CaO + 0.0 S	0.0	0.0	0.5	0.5	0.0	0.0	0.0	1.0
4.0 CaO + 1.0 S	15.0	0.0	0.5	1.5	66.0	0.0	0.0	0.0
3.0 CaO + 2.0 S	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0
2.0 CaO + 3.0 S	0.5	0.0	13.5	9.0	13.5	0.0	84.0	27.5
1.0 CaO + 4.0 S	8.5	0.0	0.0	1.0	69.0	0.0	0.0	0.5
0.0 CaO + 5.0 S	21.0	0.0	0.0	1.0	78.5	0.0	0.0	0.0
0 (control)	28.5	4.5	6.5	7.0	71.5	0.0	28.5	22.0
1.5 CaC2	0	-	-	0	1.1	-	-	1.0
2.5 CaC2	0.0	0.0	1.5	3.0	0.0	1.0	0.0	0.0
5.0 CaC2	2.0	0.0	2.0	3.0	(30.0)	1.0	0.0	0.0
7.5 CaC2	0.0	0.0	2.0	2.5	2.0	0.0	0.0	0.0
10.0 CaC2	0.0	3.0	2.5	1.5	1.0	0.0	0.0	0.0

I. 58/57, H₂O 10.7 - II. CB-5, H₂O 10.2% - III. NDiambour 11.5%
 IV. Mougne 12.6% - $\frac{1}{\%}$ By weight of grain. CaO = Calcium oxide,
 S = Sulphur, CaC2 = Calcium carbide.

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VI.4. - Development of precooked, dry cowpeas

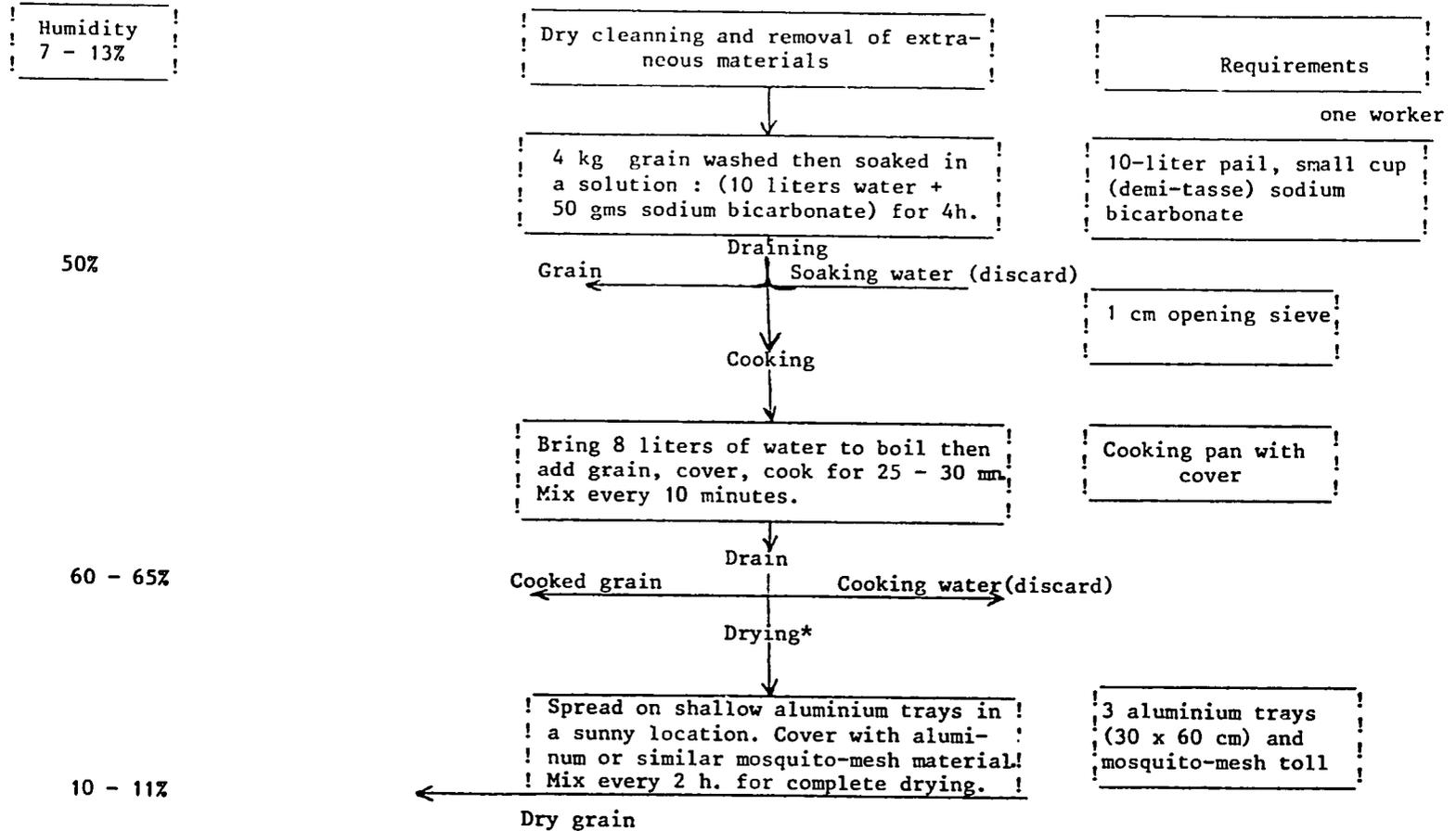
The concept of marketing precooked, dry cowpeas is based on two major advantages to consumers : convenience in preparation, and quality at a reasonable price. Normally cowpea grain require two hours to cook, and quality varies from market to market, and from one crop to the next. Precooked, dry Bambey-21 grain will cook in 15 minutes, and has a quality equal to cooked white beans. Bambey -21 was selected because of the large grain size and practically absence of black hilum. CB-5 is another variety that may be acceptable to consumers in Senegal.

In the following artisanal and semi-industrial methods are described and illustrated in chart 3 and 4. The artisanal method may be followed to produce daily approximately seven kilograms of finished product. Two workers can do the following steps : cleaning of grain, soaking and cooking, then drying. Material requirements are simple so that all is needed is : two plastic pails, sieve, cooking pan, aluminium trays and mosquito toll to cover the grain during drying. It is recommended to use a solar dryer and cleaner drying conditions.

On the semi-industrial scale chart 4 shows a line to process approximately 280 kg/day which yields 200 - 240 kg. of finished product. Step 1 is for washing and soaking the grain for four hours in 250-liter capacity plastic bins. Step 2 requires a large sieve (50 cm x 100 cm) to separate the grain from soaking water. Step 3 is for grain cooking which requires two 200-liter steam-jacketed kettles where each will handle approximately 50 kg of soaked grain plus 100-liters water. The latter may be heated first before adding to the grain. Total time for this step is approximately one hour. Step 4 separates the cooked grain from water and washing the grain with fresh water to remove starch and/or sugars from the grain before drying.

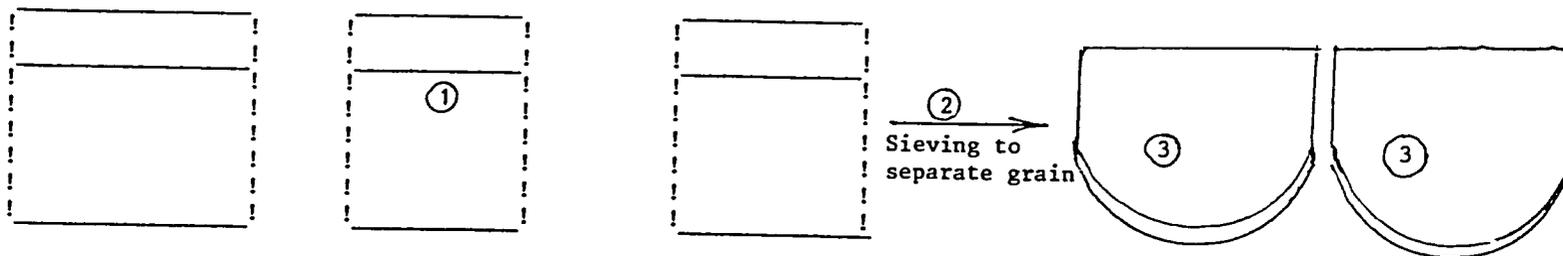
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Chart 3 : A laboratory or artisanal method to process 3.5 kg of cooked, dry cowpea grains.



* Use of solar dryers is recommended to reduce time of drying and to have better quality.

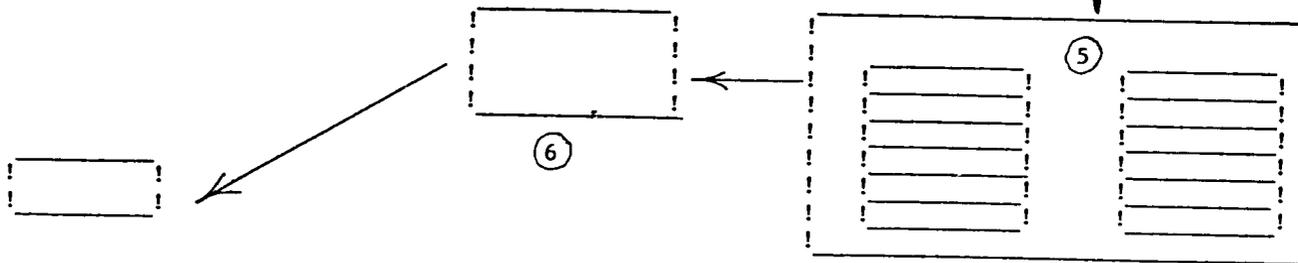
Chart 4 : Semi-industrial schema for processing precooked, dry cowpeas a 50 - 60 kg finished product/hour.



6 x 250-liter plastic bins for washing and soaking 70 kg grain in each for 4 hours.

2 x 200-liter stainless steel, steam jacketed each will take a charge of 50 kg. Soaked grain + 100 liters water.

④
Sieving to separate grain from excess water



40-tray steam-dryer grain to 10-11% H₂O in 1 1/2 to 2 hours.

Warehouse and shipping ← Packaging

Step 5 covers drying the grain by loading each tray with approximately 3 kg then drying @ 100°C for 1 1/2 hours to reduce humidity to 10 - 11%. Step 6 is for the control on quality and assurance that the product is satisfactory. It is necessary to leave the grain to cool to room temperature before packaging in step 7 to avoid condensation of humidity in the sealed packages. The line can be operated by 4 - 5 persons, and will require steam boiler for steam generation for the cooking, drying, and overall cleaning steps. Chemical and nutritional quality and characteristics are discussed in chapter VIII.

VI.5. - Processing toasted grain, grits, and flour from cowpeas

When humidity is reduced below 4% in cowpea grains chemical reactions such as dehydration, caramelization, interactions between carbohydrates and other components, take place which result in desirable, physical, functional, and organoleptic changes. Roasting peanuts, coffee beans, chestnuts etc. are examples to follow. This technology requires good control on the end-point at which the toasting must be stopped. Women-vendors of peanuts in Dakar have experience in roasting peanut without burnt-flavor. This technology was adapted to toast cowpeas after observing a pilot-scale operation at Texas A & M used to toast navy beans.

The artisanal method was developed for use by villagers and small vendors, or households in preparing toasted grain and products. It requires : round-bottom pan, clean sand, a ladle, appropriate stove or set-up to make a fire, one millimeter-opening sieve, a tray or board to spread the grain for cooling.

If the grain will be used as is in preparations such as cowpea-rice casserole, or ragout the step of humidifying the grain before toasting is eliminated. This step is added when the toasted grain is processed for making grits and flour. Addition of water to 13 - 15% humidity facilitates the separation of seed-coat and hilum from the cotyledons (dehulling).

The best results were obtained when one volume of dry grain was mixed with two volumes of sand. The latter should be heated first before adding in the grain. The mixture must be stirred frequently in circular motion to assure uniform toasting. After 9 - 10 minutes depending on the intensity of fire, the color of grain changes to very light tan. A few grain should be examined by removing the coat to determine the degree of toasting.

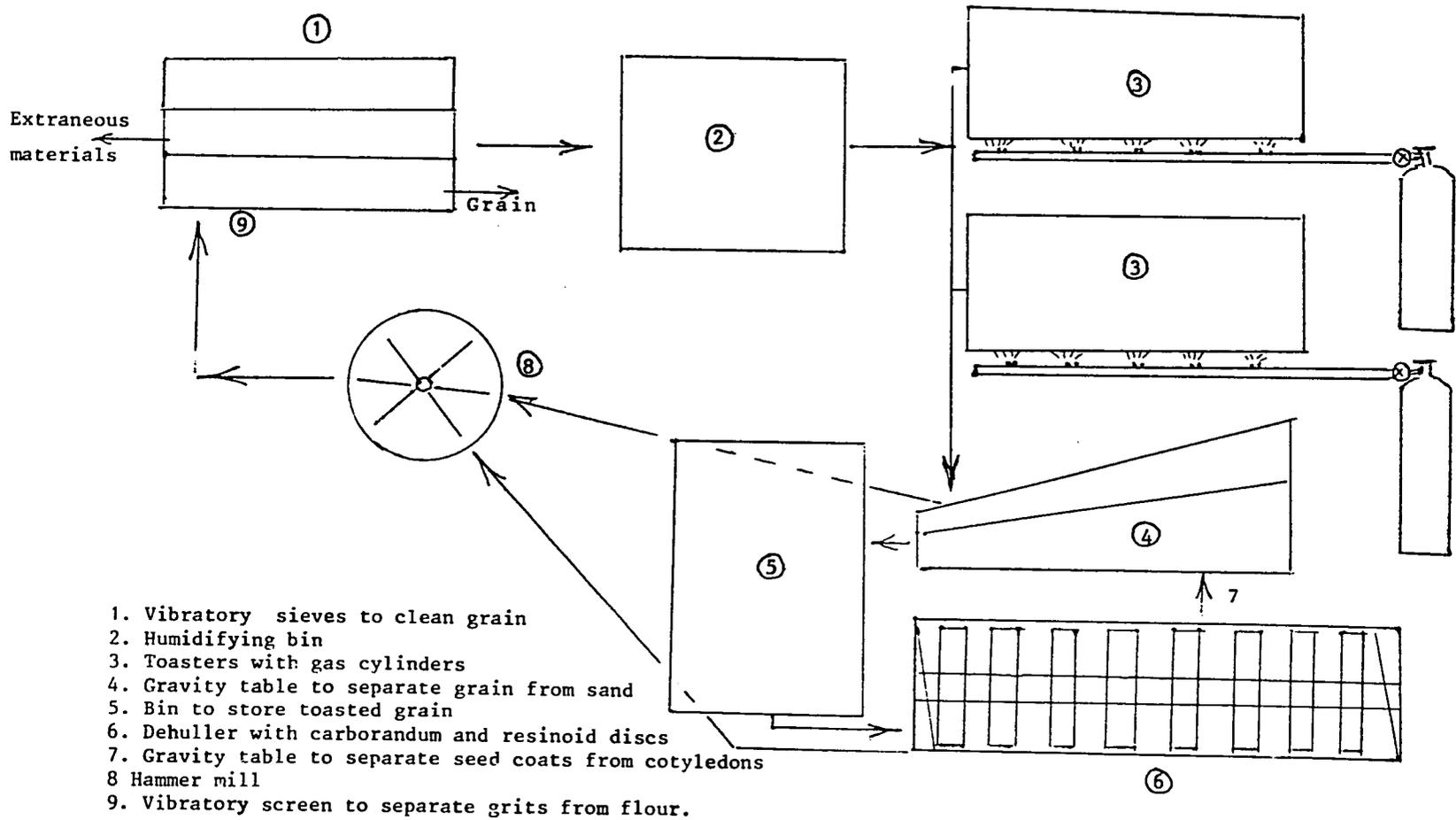
The sand is returned to the toasting-ustensil by sieving out the grain and transferring it to a mortar for dehulling, if desired, or spreading it on a cloth to cool.

Dehulling is achieved by the pestle and rubbing the grain against the walls of the portar, and light pounding. After separating the seed coats from the cotyledons it is possible to grind the latter in a commercial mill equipped with sieve 1.0 to 1.5 mm openings. Separation of flour from grits is done by using a sieve for "sungguuf" approximately 0.3 mm opening.

A scheme for toasted grain on a semi-industrial scale is presented in chart 5. Production is scaled at 150 kg of finished products per 8 hour shift, or 200 kg of raw material. The prototype of this line is assembled at ITA laboratory, and methods to improve productivity must be tested further. The limiting operation is the toasting which requires approximately 1 3/4 hours for 50 kg batch of grain. The flow sheet shows nine steps or operations which are :

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Chart 5 : Scheme for toasting cowpea grain on semi-industrial scale to yield 150 kg/day (8 hours shift)



1. Vibratory sieves to clean grain
2. Humidifying bin
3. Toasters with gas cylinders
4. Gravity table to separate grain from sand
5. Bin to store toasted grain
6. Dehuller with carborandum and resinoid discs
7. Gravity table to separate seed coats from cotyledons
8. Hammer mill
9. Vibratory screen to separate grits from flour.

1. - Grain cleaning by vibratory-sieve unit;
2. - humidifying the grain in a bin to increase humidity by 3-4%;
3. - toasting the grain with hot sand in rotary - heated roaster at a charge of 50 kg grain (dry) + 30 kg sand;
4. - separation of toasted grain from sand by a gravity-table ;
5. - bin to store toasted grain for dehulling;
6. - PRL carborandum and resinoid-disc dehuller for 15 kg batches;
7. - separation of seeds from seed-coat and hilum by the same vibratory-table in step 4 above;
8. - grinding the cotyledons in a hammer-mill @ 100 kg/hr capacity;
9. - screening grits-flour on the vibratory screen 80 mesh (0.125 mm).

100 kg grain a 10% moisture yield 75.0 kg of grits and flour in a ratio of 2 : 1 and at 2 -3% humidity in 4 1/2 hours at maximum. Chemical and nutritional characteristics of grits and flour are discussed in part VIII.

VI.6. - Development of fermented cowpea flour

One of the most common preparation from cowpea in Senegal is "Akara" which is deep-fat fried balls of naturally fermented ground grain. The time necessary for soaking, and frying reaches 24 Hours. The concept of developing fermented flour that requires 30 minutes to prepare the batter, and a few minutes to fry the latter lend maximum convenience, and consistent quality to the consumer.

The effects of fermentation time, drying of grain, and flour granulation on the final quality of "Akara" were studied in the laboratory. Batches of 1/2 to 3 kg were prepared and the final products were organoleptically evaluated by taste panels.

Fermentation time varied from 19 to 27 hours depending on the ambient temperature and the source of grain. The latter retained some astringency if fermentation was shorter than 19 hours and the best results were up to 24 hours.

Oven drying of fermented grain should be done at a temperature that does not exceed 100°C to avoid discoloration particularly browning. Sun-drying for small batches is acceptable if the weather conditions permits so. Seed-coats and hilum are easily removed by using an abrasive dehuller or by the mortar and pestle methods as described in part 5.

Grinding through 1.0 to 1.5 mm screen yielded the desirable "flour-fine grits" mixture for making "Akara". the flour has a granulation of approximately: 2/3 on 40 mesh screen (0.25 mm) and the balance through that screen and on 80 mesh.

Chart 6 shows a semi-industrial scale production-line for fermented flour. The plan should yield 200 - 230 of finished products per day (8 hour shift). The process line may be combined with that for precooked, dry-grain, described earlier.

The first step after removing foreign grain and extraneous materials is to wash and soak the grain into plastic bins.

Four batches each of 70 kg may be programmed on two-hour intervals from 10 $\frac{00}{a.m.}$ to 4 $\frac{00}{p.m.}$. These should be ready for drying the following day starting 8 $\frac{00}{a.m.}$ to 2 $\frac{00}{a.m.}$.

After separation of grain from soaking water in step two, the former is loaded on the trays of the steam-heated dryer of step three. Temperature is set at 100°C to dry the grain from approximately 50% moisture to 10% in less than two hours.

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Dry grain is stored in a plastic bin in step four. then dehulled on a batch-system in step five. Seed-coats and hilum are separated from the cotyledons in step six by a vibratory gravity-table. The cotyledons are ground in a hammer-mill equipped with 1.2 - 1.5 mm screen in step seven followed by screening on vibratory screens as shown in step eight. Grits larger than 40 mesh are recycled, the product is between the 40 and 80 mesh screens. By adjusting grinding conditions it is possible to obtain 65 - 70% of product, fine grits, and the balance between coarse grits and fine flour. It is possible to eliminate the 40 mesh screen . Packaging is done in step nine. Product characteristics and chemical, nutritional quality are discussed in part VIII.

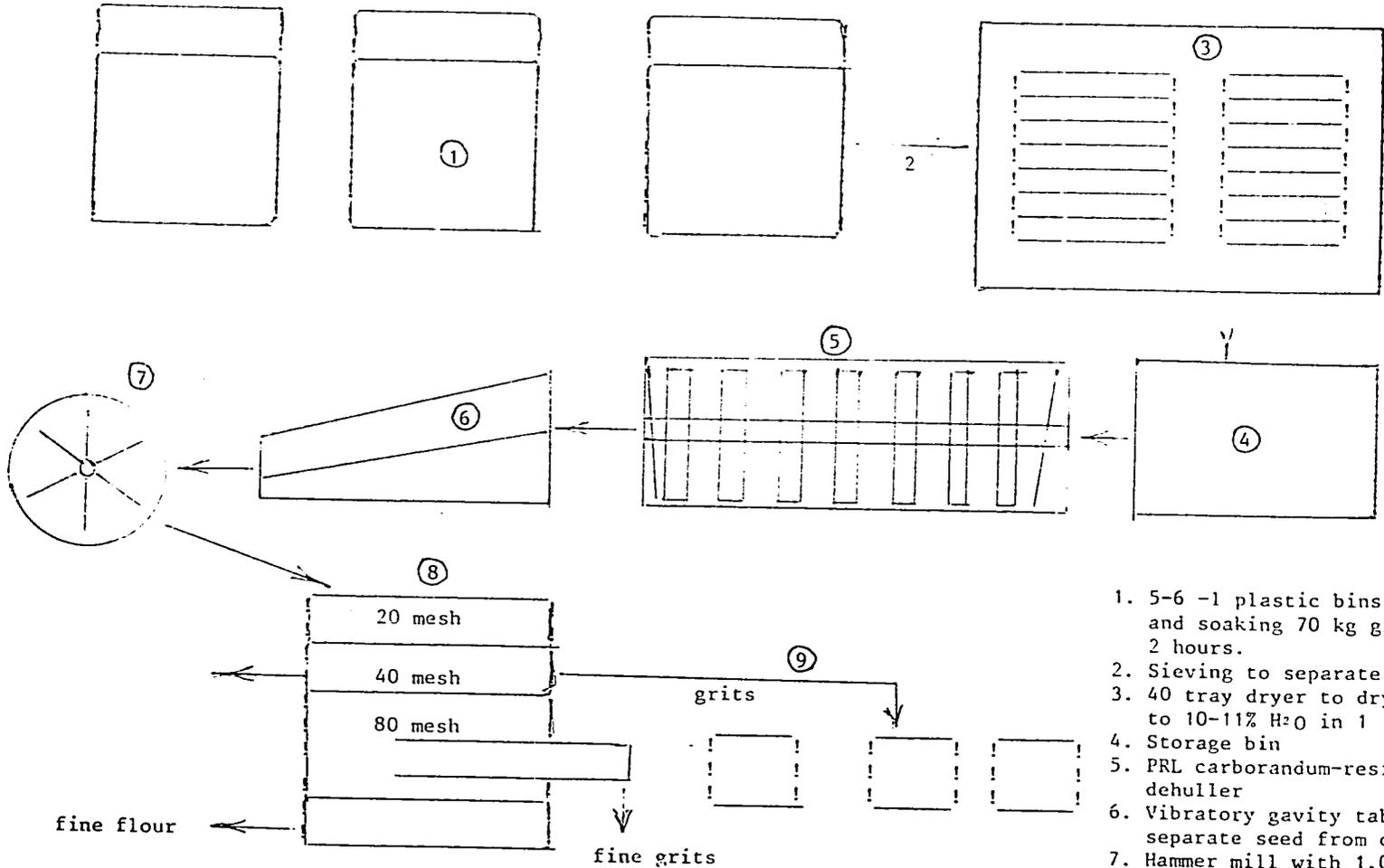
VI.7. - Development of pickled grain and/or pods

Conservation of fresh vegetables by pickling is one of the well-known methods to keep excess crops from the markets, and to prolong the season of consumption. The concept here is to pick the green pods in the tender stage after grain formation, and to pickle the portion that is not sold in the market ^{1/} . Either the seeds and/or the pods are steam-treated to inactivate the trypsin inhibitor (TI) before pickling in salt solution @ 12 - 15% concentration. Microflora of fermentation is introduced in the pickling solution by adding portions of cucumber, carrots, onions or whatever vegetable available. To secure anaerobic conditions in the fermentation jars or pots a layer of oil and/or paraffin wax is added on the surface before sealing.

The following tests were done on cooked grain since there were no green crop available at the time of this work.

^{1/} Green-pod cowpeas normally appear in the months of September when snap beans are rare on the market and are expensive.

Chart 6 : Semi-industrial schema for processing fermented cowpea flour at 200 kg to 230 kg per day.



1. 5-6 -l plastic bins for washing and soaking 70 kg grain every 2 hours.
2. Sieving to separate grain
3. 40 tray dryer to dry each batch to 10-11% H₂O in 1 1/2-2hours.
4. Storage bin
5. PRL carborandum-resinoid disc dehuller
6. Vibratory gavity table to separate seed from coats.
7. Hammer mill with 1.0-15 mm sieve
8. Vibratory screens : 20, 40, 80 mesh
9. Packaging.

Variety 58/57 was chosen and the fermentation was carried out on cooked grain^{1/}. One liter, wide-mouth jars were filled half-way with grain then brine solution (salt solution) was added to fill the jars. Salt concentrations were 10%, 13%, and 16%. After three weeks samples were tested organoleptically and the 13% treatment was chosen for best quality. Shorter periods of fermentation were not sufficient to develop the desirable characteristics.

The finishing step for conservation was done by transferring the fermented grain to clean jars and adding a solution of 3% salt and 1% vinegar to cover the grain and fill the jar. As options it is suggested to add in garlic cloves, red pepper, laurel leaves, or thyme according to taste preference. Also it is recommended to add a thin layer of oil on the surface to block mold growth.

This method is adaptable to rural and urban population by using clay jars or pots for fermentation, and glass or plastic container for the finished product. It is advisable to pack in each container a quantity that will be consumed within two weeks to avoid spoilage with the growth of undesirable organisms.

^{1/} Cleaned grain was soaked for 1 - 2 hours then cooked for an extra hour or until tender.

VI.8. - Development of cowpea sprouts

Sprouted seeds are widely consumed in the Orient as garnish or salad-vegetable. In general the chemical changes during the sprouting stage are desirable so that the levels of antimetabolites as phytic acid or its salts are reduced. From the sensory standpoint sprouting reduces bitterness normally found in soybean and many beans. The concept of developing cowpea sprout was well accepted by urban consumers^{1/}. Laboratory tests however showed several technical problems to sprout seeds without mold growth. Simple additives such as vinegar were effective in controlling mold growth but in the meantime inhibited sprouting. Technical efforts were therefore concentrated on the other products that were mentioned above.

VI.9. - Development of cowpea-protein concentrate

Cowpea protein is fairly rich in the amino acid lysine particularly when compared to cereal proteins. Milk protein or casein, is actually used in food preparations to correct part of the deficiency in this amino acid. All dry milk powders, whole or skim, are imported and are expensive. One gram of milk protein is estimated at 21 CFA while cowpea protein may cost 19 CFA at the market price of 200 CFA/kg grain. The difference will become much larger once the surplus stock of milk powder in exporting countries is depleted. End uses for such ingredient is in making baby or child food-blends, and possibly in texturing to extend meat or animal protein.

^{1/} 52% of households liked the concept.

The following work was done at Texas A & M Food Protein R & D Center as part of the technology transfer and training goal. The Center published papers on the preparation of a protein rich fraction from dry roasted navy beans by air classification^{1/}. Also they applied the wet-processing technology to make protein concentrates by adapting the methods used in soybean industry. Varieties CB-5 and B-21 were tested in preparing protein-rich samples.

The principle of air-classification is to separate flour particles rich in protein from those in carbohydrates by the difference in their density. Several trials were made to apply this principle but constraints in equipment set-ups and time did not allow for achieving our objective.

The technology of wet-processing to make protein concentrates involves the extraction of soluble carbohydrates selectively. Laboratory and pilot -scale essays on B-21 and CB-5 showed no selectivity in extracting the carbohydrates therefore the proportions of protein and the latter in spray-dried, finished products, was practically the same as in the starting flour.

These results led to conclude that the methodology used on cowpeas was not effective, and it required further research and development to make protein concentrates. It was decided to terminate the work on this product, and to give priority to the product/technology available at ITA.

^{1/} JAOCS, vol. 60, n° 7 (July 1983); J. Food Sci, Vol. 49 p.543 (1984).

VI.10 - Development of sandwich-spread from toasted flour.

The concept of sandwich-spread is adapted from peanut butter-based spreads as "Chocoleca"^{1/} that is widely used in Senegal. Consumers' perception of a spread made from cowpea was favorable by 52% of the population-sample in Dakar and suburbs. Product development was stopped at the prototype stage and several formulations were tested at ITA for acceptability. Formulations were based on toasted-cowpea flour (finer than 80 mesh or 0.125 mm), vegetable oil, sugar, water, and flavorings such as chocolate, caramel or vanilla. As substitute for peanut butter spread, it is essential that there is adequate economic advantage for the processor and vendor to make or to sell this product. Investment for making sandwich-spread is modest and require high-shear mixer/emulsifier and proper packaging such as plastic containers (similar to those used for yoghurt), or plastic bags. The products tested were stable for minimum two weeks when stored at ambient conditions.

^{1/} Trade mark for chocolate-flavored peanut butter.

VII. RECIPES FOR COWPEAS AND PROCESSED PRODUCTS

Recipes for cowpeas grain and products were developed to show urban and rural population how to prepare them, and where do they fit in their diet. Most of senegalese Households are familiar with "Akara" which they buy from vendors. All products are considered new ingredients because they are non-existent on the market, and because the methods of preparation are different. Annex 1 shows the menu and recipes recommended for villagers and Dakar households. Chart 7 is presented here for discussion but the final analyses on the effectiveness of these menus are shown in chapter V.5.5. and V.5.6. under the transfer of information and publicity to the selected villages and home-test.

The menus may be used for three consecutive days and repeated thereafter, or the meals prepared with cowpea products may be introduced twice weekly if so desired.

Breakfast meals are composed of what actually the consumers eat and drink. No cowpea preparations are suggested for this meal. However there are situations such as couscous of millet/cowpea leftover from the dinner served the previous night, or the cowpea pudding "Crème de niébé".

Lunch meals are based on rice or corn cereals with fish or meat sauce. The habit of eating the national dish "fish and rice or "Tiébou Djeun" is well respected by serving it on one out of three days. Rice with smoked fish and cowpea "Tiébou Kétiakh" is also known, however cowpea grain are added in small amount as garnish and rice in a 50 : 50 ratio. The recipe was modified to use toasted cowpea grain. The eating quality of this dish was enhanced with the toasted grain furthermore there was cost saving to the consumer of up to 500 CFA per meal depending on the quantity of rice and cowpea prepared. Smoked fish or meat are added to enhance the sauce flavor more

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than their nutritional aspect since cowpeas provide adequate source of protein.

Toasted cowpea flour is used in the meat with tomato sauce dish as a thickner and a protein supplement which increases the consumers' daily intake of the latter nutrient. The same idea is applied to the well known plate "Soupe Kandia".

Dakar menu included three snacks to be served late afternoon when guests arrive and the children need something to eat. Akara is a deep-fat fried snack prepared from fermented grain or fermented flour. Thiakry is rolled small granules made from toasted cowpea flour, butter milk, and sugar. Cakes as in the recipe may be prepared from toasted fine grits.

Dinner meals from precooked or toasted cowpea grain, grits or flour are suggested. Grains, precooked or toasted, may be prepared with meat and tomato or peanut sauces, or simply in salad. Grits may be served as couscous with sauces of the household choice. Flours are suggested for blending with millet in couscous preparation, and/or for sauce thickening as mentioned earlier.

It is known that many households in Dakar and other regions can afford eating twice daily so the recipes were made with adequate flexibility to suit their means.

Chart 7 : Three-day menu for households in Dakar region, or for villagers in Louga Region.

Meal	Dakar region			Louga region		
	1	2	3	1	2	3
BREAKFAST	Hot drinks (coffee, teas, Kin-kelibah), bread, biscuits	same	same	Hot drinks, bread	Bouillie from millet or bread or and hot drinks	Hot drinks & biscuits
LUNCH	Rice & smoked fish & toasted cowpeas or meat in tomato sauce with vegetables & cowpeas toasted flour.	Fish & rice or corn grits and rice	Fish or meat sauce with okra and palm oil and cowpea flour "Soupe Kandia"	Rice with smoked fish & toasted cowpeas	Fish & rice (Tiébou Djeun"	Rice with meat sauce or "Soupe Kandia"
SNACK	Akara	Thiakry with toasted cowpea flour or grits	Cake from toasted cowpea grits	-	-	-
DINNER	Millet couscous and sauce	Precooked or toasted cowpea grain with meat & tomato or peanut sauce	Precooked cowpea grain salad or toasted cowpea grits with meat sauce	Millet/cowpea couscous with sauce	Toasted cowpea grain with tomato or toasted cowpea grits with peanut butter and St. John's bread	Fish with tomato sauce & fermented cowpea flour.

VIII. NUTRITIONAL STUDIES ON COWPEA PRODUCTS

Nutritional studies covered the composition of each product to determine its nutritive value, the level of antimetabolites that are detrimental to digestability, the quality of protein and essential amino-acids (EAA) profile, fatty acids in both saturated and unsaturated forms, vitamins, minerals, flatulence factors and fiber content.

VIII.1. - Chemical composition of cowpea products

Proximate analyses were done on cooked, dry Bambey 21 grain; toasted, dehulled 58/57 grits; extruded, dehulled CB-5 flour; and fermented, dehulled 58/57 flour. The results are shown in table 3. Fat content in processed products varied from 2.1 to 2.7%, with no significant difference between varieties. Protein level was highest in fermented dehulled 58/57 flour at 25.9% and lowest at 24.2% in extruded, dehulled CB-5 flour. Toasting 58/57 grain apparently destroyed 6.5% of protein components. Cooked Bambey 21 grain had 4.9% total sugars^{1/} while toasted dehulled 58/57 contained 10.1% which is the highest among the products tested. Soaking and cooking Bambey 21 grain resulted in leaching out the sugars contrary to toasting which increased and/or concentrated sugars. Dehulling reduced crude fiber levels to 2.2 to 2.4% in fermented and toasted products, respectively. Whole grain as in Bambey 21 had 6.4% crude fiber. Total dietary fiber (TDF) includes crude fiber, and polysaccharides, other than starch, that are normally present in whole seeds. Bambey 21 cooked grain had 29.7% which was highest

^{1/} Sugars include : glucose/fructose, sucrose, raffinose and stachyose.

among the products tested. Extruded CB-5 sample had 8.4% TDF which is very low. It is possible that extrusion-cooking degraded the polysaccharides in the sample however the level of total saccharides does not confirm this hypothesis. Fermentation apparently resulted in TDF reduction to 16.8%. Ash content ranged from 2.6% in cooked Bambey 21 to 4.0% in toasted 58/57 sample. Starch ranged from 34.2% in cooked Bambey 21 to 52.6% in extruded CB-5 sample. The latter results plus TDF levels yielded caloric energies of 263 calories per 100 gram of precooked grain to 328 calories in extruded CB-5 flour. Toasted and fermented 58/57 samples had 296 calories per 100 gram.

VIII. 2. - Antimetabolites

Trypsin inhibitors (TI) are wide-spread antimetabolites in the seeds of legumes that are inactivated by thorough cooking.

They interfere with protein digestion so that food is not well absorbed by the small intestines. Table 4 shows the levels of TI in CB-5 grain and products. Extruded flour had a residual of 28-30% TI activity in comparison to raw grain. Extrusion at 25-27% humidity was not adequate to inactivate TI completely. Toasted CB-5 had 71-73% TI activity which was expected since TI, being protein complex-molecules was inactivated in the presence of adequate humidity (steam) as it was the case in extrusion. Toasting dehydrates the grain from 10-11% to 2-3% moisture. Cooking toasted grain normally reduces TI activity to less than 5% which is deemed harmless.

Phytic acid is another antimetabolite that bind with important elements as calcium, iron, and zinc so that the body cannot absorb them. Deficiency in these elements cause several diseases related to skeletal and teeth structure, and anemia. Table 5 shows phytic acid per cent in cooked, dry Bambey 21 grain; toasted, dehulled

Table 3 : Proximate analyses of cowpea varieties and products

Product	Gms/100 gms product, (DWB)								Calorie ^{3/} per 100 gms
	Moisture	Fat	Pro- tein ^{1/}	Total sugars	Crude fiber	Total dietary fiber	Ash	Carbohy- drate ^{2/}	
Raw B-21	15.9	1.5	26.5	-	5.1	-	5.4	-	-
Cooked dry B-21	7.2	2.6	25.0	4.9	6.5	29.7	2.6	34.2	263
Raw CB-5	13.9	1.4	23.1	-	5.6	-	7.1	-	-
Extruded CB-5	10.7	2.7	24.2	8.8	-	8.4	3.2	52.6	328
Toasted, dehulled 58/57	4.4	2.0	25.1	10.1	2.4	21.3	4.0	37.4	296
Fermented, dehul- led 58/57 flour	10.4	2.3	25.9	8.7	2.2	16.8	3.3	42.8	296

^{1/} N x 6.25

^{2/} By difference, mostly starch and other polysaccharides.

^{3/} Calculated on total dietary fiber(TDF) method, USDA handbook n°8 on composition of food.

58/57 grits ; extruded, dehulled CB-5 flour ; and fermented, dehulled 58/57. Bambey 21 sample had 0,92% phytic acid which was the highest relative to the levels in the other varieties. Part of this difference is attributed to the seed hulls present in the cooked grain. Extruded CB-5 flour sample had a relatively high level of phytic acid, 0.86%, because of the incomplete dehulling of that sample. Toasted 58/57 grits had 0.40% which was the lowest level. Fermented, dehulled flour from 58/57 variety contained 0.77% phytic acid. It appears that toasting changes phytic acid structure or created complex molecules with other seed components to make it appear in the analysis. Fermentation on the contrary did not significantly reduce phytic acid level.

Table 4 : Trypsin inhibitor in CB-5 cowpea products*

Sample	Trypsin inhibitor (TI), μ /gm
Raw CB-5	9,803 - 11,907
Extruded CB-5	2,837
Roasted CB-5	7,101

* Analyses made in Texas A & M Protein R & D Center

Table 5 : Percentage of phytic acid, dietary fiber, stachyose, and PER in cowpea products.

Sample	Phytic acid %	Dietary fiber %	Stachyose %	Corrected PER %
Cooked, dry B-21	0.92	29.7	3.4	1.84
Toasted, dehulled 58/57 grits	0.40	21.3	6.1	1.16
Extruded CB-5 flour	0.86	8.4	4.7	-
Fermented, dehulled 58/57 flour	0.77	16.8	5.2	1.18

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VIII.3. - Protein quality and EAA profiles

Protein quality is determined on laboratory-rat bioassay by determining their weight gain ratio per gram protein ingested after 4 weeks. Table 6 shows that Bambey 21 cooked, dry grain had the highest protein efficiency ratio (PER) at 1.87. Toasted or fermented 58/57 grits/flour were at 1.16 and 1.18, respectively. As reference milk protein, casein, is the standard and has a 2.5 ratio. Extruded CB-5 was not tested because of the lack in sufficient product to do the test.

Toasting apparently did not reduce the protein quality as it is similar to the raw grain values^{1/}. The same conclusion may be drawn on fermented flour which did not suffer significant loss in protein quality during the fermentation and drying processes. Cooking and consequently the low trypsin inhibitor level may be considered the most significant factor that contributed to the high PER value in Bambey 21 sample. High total dietary fiber may have reduced the effect of other anti-metabolites particularly phytic acid on rat growth.

Essential amino-acid (EAA) profile of a protein reveals the deficiencies and the imbalance of these protein-building blocks. Normally egg, milk protein, or FAO reference pattern are used as standards for comparison. Table 6 shows EAA patterns of cowpea products, milk proteins, and FAO reference.

1/ Raw grain ranges from 1.1 to 1.2 in PER.

Table 6 : Essential amino-acid (EAA) profiles and PER in processed cowpea varieties and products.

Product	Amino acid concentration in mg per gram protein								PER	% protein
	Lysine	Threonine	Cystine	Methionine	Isoleucine	Leucine	Valine	Tryptophane		
Cooked, dry B-21	69.2	38.9	8.5	15.2	43.6	80.8	49.3	8.5	1.87	26.0
Toasted, dehulled 58/57 grits	54.2	37.8	8.3	14.4	14.4	40.8	77.9	47.1	1.16	25.1
Extruded, dehulled CB-5	71.9	40.9	9.7	15.0	43.2	83.0	49.3	9.5	1.18	24.2
Fermented, dehulled 58/57 flour	60.5	36.9	8.6	14.2	38.9	74.4	44.1	7.2	-	25.9
Casein ^{1/}	80.6	43.0	3.8	31.0	65.9	101.1	74.4	13.4	2.5	100
Non-fat dry milk powder ^{1/}	79.4	47.0	9.1	25.0	65.1	100.2	70.0	14.4	3.1	100
FAO WHO reference ^{2/}	55.0	40.0	-	35.0	40.0	70.0	50.0	10.0	2.5	100

^{1/} USDA Home Economic Research Report n°4, December, 1957

^{2/} Handbook on human Nutrition Requirements, Rome, 1974.

Cystine, methionine, and tryptophan are the three limiting amino-acids in all cowpea products. Lysine was present at 80-87% in the processed products relative to milk proteins. Toasting and fermenting/drying cowpeas lowered the quantities of available lysine, nevertheless the residual levels were sufficiently above that recommended in the FAO pattern.

In comparing cooked, dry B-21 with extruded CB-5 flour we observed that the latter had lower concentration of all EAA except cystine. The significant difference between PER in the two products, 1.87 versus 1.18, may be attributed to varietal difference, lower EAA levels in CB-5, and the levels of residual antimetabolites after processing.

VIII.4. - Fatty acids profiles

Cowpeas in general contain 2.0 to 2.7% fat which does not contribute a significant part to human nutrition. The importance of knowing the types of unsaturated fatty acids and their proportion to the saturated ones is in projecting the stability of products in storage. Table 7 shows the most predominant fatty acids in samples of processed cowpeas. Unsaturated fatty acids : oleic, linoleic, and linolenic ratios to saturated acids ratios range from 55 : 45 in toasted 58/57 grits to 61.6 : 38.4 in B-21 grain. Extruded CB-5 flour and fermented 58/57 samples had the ratios of 56.9 : 43.1 and 58 : 42, respectively. From the nutritional aspect the preference in order for cowpea varieties and products are follows : cooked Bambe-21, fermented 58/57 flour, extruded CB-5, and toasted 58/57 grits or flour.

Linolenic and linoleic acids are oxidized in the presence of oxygen to develop rancid odor and taste to oil-containing foods. Concentration of linolenic acid is

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the most critical because it is the most labile in oxidation, so cooked B-21 and extruded CB-5 are the most susceptible to oxidation and toasted 58/57 is the least labile

Table 7 : Fatty acid profile and concentration in samples of processed cowpeas.

Fatty acid	% by weight of sample			
	Extruded CB-5	Fermented 58/57	Toasted 58/57	Cooked B-21
Palmitic, C16 : 0	0.48	0.41	0.42	0.45
Stearic, C18 : 0	0.09	0.09	0.08	0.08
Oleic, C18 : 1*	0.12	0.14	0.13	0.14
Linoleic, C18 : 2*	0.47	0.41	0.37	0.56
Linolenic C18 : 3*	0.28	0.25	0.21	0.28
Arachidic, C21 : 0	0.02	0.01	0.01	0.01
Beheric, C22 : 0	0.04	0.05	0.05	0.04
Lignoceric, C24 : 0	0.03	0.02	0.02	0.03
Total	1.53	1.38	1.29	1.59

* Unsaturated fatty acids.

VIII.5. - Vitamins

Cowpea is not a rich source of vitamins however it was necessary to document the presence and level of the most important ones in the varieties/products developed in this project. Table 8 shows vitamin concentration in cooked, dry CB-5 flour, fermented 58/57 flour, and the Recommended Dietary Allowance (RDA) of each vitamin for adult male American. The latter is presented as a reference to show the magnitude for daily requirements of selected vitamins.

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Table 8 : Vitamin profiles in processed cowpea varieties

Product	Mg/100 gms product except A						
	A*	B1	B2	B6	Niacin	Panhotenic acid	C
Cooked, dry B-21	< 100	0.22	0.12	0.26	1.00	0.26	< 1.0
Toasted, dehulled 58/57 grits	< 100	0.03	0.15	0.27	0.95	0.43	< 2.0
Extruded CB-5	< 100	0.63	0.16	0.52	0.23	0.47	< 1.0
Ferment, dehulled 58/57 flour	< 100	0.50	0.08	0.36	2.42	0.49	< 1.0
RDA**	1 000	1.4	1.6	2.2	18	(2.7)***	60.0

* Iu/100 gms product

** Recommended Dietary Allowances in USA for adult male moderately active, Hoffman-La-Roche, Internal Report (1980).

*** There is no established RDA for this vitamin and the figure cited is used as a reference.

CB-5 extruded flour had in general the highest levels of vitamins except for niacin, while B-21 cooked - grain had the lowest levels for vitamin B1. Toasting as known, destroys vitamin B1, while fermentation reduced level of vitamin B2. The effects of processing were insignificant in reducing the vitamin quality of cowpea products on the assumption that average daily per capita consumption is 50 gms of uncooked product.

VIII.6. - Minerals

Table 9 shows the results of macro and micro-elements in the four products covered in this project. Also Recommended Dietary Allowance (RDA) in USA is listed for each element except for potassium, sodium, manganese, barium, or boron. All cowpea samples were poor sources for calcium, iron, zinc, and iodine, when their content were compared to RDA levels. They were satisfactory sources for phosphorus, potassium, magnesium, and copper. Cooked Bambe 21 sample had the highest level of sodium (121 mg) because sodium carbonate was added in soaking-water.

VIII.7. - Sugars and flatulence factors

Sugars in cowpeas vary from 7.7% to 14.7% of total carbohydrates as the results showed in cooked Bambe 21, and extruded CB-5 samples, respectively. Table 10 shows sugar contents in each product. Monosaccharides (C1) as glucose and fructose were found at concentrations below 0.4 gram per 100 gram product. Sucrose and maltose (C2) sugars varied from 1.0% to 3.1% in cooked Bambe 21 and toasted 58/57 samples, respectively. Flatulence factors are raffinose (C3) and stachyose (C4) sugars which are indigestible by human beings. Microflora in the large-intestines are capable of digesting these sugars and in the process develop gases such as methane, hydrogen, and carbon dioxide which cause discomfort to some individuals.

Table 9 : Macro, and micro-elements (minerals) in processed cowpea varieties^{1/}

Sample	Macro-elements, mgm/100 gms					Micro-elements, mgm/100 gms						
	Calcium	Phosphorus	Magnesium	Potassium	Sodium	Iron	Zinc	Iodine	Magnesium	Barium	Boron	Copper
Cooked, dry B-21	98.7	456.0	155.0	674.0	121.0	5.1	4.5	<0.005	1.8	< 2.0	< 2.0	0.3
Extruded CB-5	52.9	460.0	168.0	998.0	<30.0	9.4	3.6	<0.005	1.3	< 2.0	< 2.0	0.8
Toasted, dehulled 58/57	44.9	440.0	167.0	935.0	<30.0	5.0	3.2	<0.005	2.4	< 2.0	< 2.0	0.6
Fermented, dehulled 58/57	57.1	407.0	161.0	752.0	<30.0	4.4	3.2	<0.005	2.4	< 2.0	< 2.0	0.6
RDA	1000	970	400	-	-	18	15	0.15	-	-	-	2

^{1/} All samples contained less than 2.0 milligram/100 gm of the heavy metals strontium, chromium, or aluminium

^{2/} Recommended Dietary Allowance (RDA) in the USA Elements with no established levels are presented by a dash.

Table 10 : Sugars in cowpea products/varieties, mg/100 gms.

	Sugars, % ^{1/}			
	C ₁	C ₂	C ₃	C ₄
Cooked, dry B-21 grain	< 0.4	1.0	0.4	3.4
Raw grain ^{2/}	-	3.2	0.3	3.5
Toasted, dehulled 58/57 grits	< 0.4	3.3	0.7	6.1
Extruded, dehulled CB-5 flour	< 0.4	3.2	0.9	4.7
Raw grain ^{2/}	-	2.5	0.1	2.8
Fermented 58/57 flour	< 0.4	2.7	0.8	5.2

- ^{1/} C₁ = Glucose and fructose
 C₂ = Sucrose and maltose
 C₃ = Raffinose
 C₄ = Stachyose

^{2/} Analyses made at Texas A & M Food Protein R & D Center, 1987.

Bambey 21 cooked-grain had the lowest levels of raffinose and stachyose relative to CB-5 and 58/57 varieties. The latter had the highest flatulence sugars at 6.1% and 5.2% in toasted and fermented products, respectively. These results show an added advantage to variety B-21 which is in the seed propagation phase.

CONCLUSIONS

Bambey 21 had the best attributes among cowpea products/varieties tested. Cooking in water and/or steam practically inactivated the antimetabolites such as trypsin inhibitor so that digestability and nutritive quality was improved by more than fifty per cent, PER 1.87 versus 1.18. Phytic acid presence in cowpea products will not affect to a great extent the absorption of calcium, iron, or zinc at concentrations below 1%. Caloric content is low, average of 295 cal/100 gms, and total dietary fiber averaged 22.6% which render cowpeas as a good source for fiber. Cowpeas may be good source of the essential amino acids except for cystine-methionine.

Processing techniques as cooking/drying, toasting, extruding, or fermentation did not reduce significantly the levels of stackyose which is the most important flatulence factor. Varietal selection, as is the case for Bambey 21, would be the best approach to overcome this negative aspect in cowpeas.

IX. SHELF-LIFE AND STABILITY OF PROCESSED PRODUCTS

Storage tests are done to determine the maximum shelf-life of grocery-products such as cowpea products. Shelf-life is normally a function of variables such as : product characteristics, type of packaging, temperature/humidity conditions under which the products are stored.

Projections of commercial development of cowpea products are that they will be produced on a small-scale and distribution to markets will not surpass a few days. Points of distribution will probably be at super-markets, grocery, boutiques, Sonadis, etc... where there will be some protection from "outside elements" as sunlight, rain etc...

Tests were done on products packaged in :

(a) polyethylene bags of 4-5 mil thickness, (b) 3 mil polyethylene bags with carton. A control was stored at zero time in glass jars that were kept at freezer temperature. The packages were kept on-shelf in the laboratory at ambient temperature, however there was air conditioning during the months of July to November. Organoleptic evaluation on dry and cooked products were carried out biweekly to determine if there were detrimental changes that affected product acceptability.

All products : precooked grain, toasted grits, and flour, fermented flour were stable after 12 months in storage. This stability was due to low humidity in the stored products which did not exceed 11%.

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X. TECHNICAL DATA SHEETS AND PRODUCT-SPECIFICATIONS

Technical data sheets identify product characteristics which are important in production and quality control. The indices were selected depending upon the form and functionality of each product, that is to say grain versus grits or flour and applications in casserole or sauce recipes.

Table 11 shows the technical data on precooked, dry Bambe 21 cowpea grain. Tolerance or acceptable range from average was determined based on products made at the pilot-scale line in ITA. Variations in chemical composition may be expected with the grain source/region and crop year. The most important indices are subjective to consumer preference such as appearance, and rehydration time or cooking time. Bulk density and water absorption should not vary to any significant degree if the processing guidelines are followed.

Table 12 shows product characteristics for toasted grain, grits, and flours. Toasted grain may be used in cooking and appearance and organoleptic characteristics are crucial in product acceptability. Rehydration time by cooking may be changed to include a soaking step for 30 minutes at room temperature plus cooking for 30 minutes, however since the latter is so variable it is preferred to adhere to cooking.

Granulation specifications for grits were based on the product presented in the home-test and on best consumers' acceptability. It is possible to introduce finer grits for applications such as Thiakry and couscous as desired. Flour granulation is that used in restaurant/vendors and home-tests to prepare sauces, couscous, etc...

Table 11 : Technical data sheet for precooked, dry Bambey 21 cowpea grain.

Characteristic/Index	Acceptable range
<u>APPEARANCE</u>	Cream color with no blemished, dark spots or holes
Bulk density, gm/cc	0.170 \pm 0.03
Humidity	10.0 \pm 1.0
Water absorption, %	115 \pm 5
Rehydration time by cooking, minutes	12 \pm 2
<u>Organoleptic</u>	Bland taste with no astringency or musty odors
<u>Chemical*, %</u>	
Lipides	2.3 \pm 0.3
Protein	24.0 \pm 1.0
Fiber total	27.0 \pm 1.0
Ash	2.4 \pm 0.2
Crude fiber	6.0 \pm 0.5
Total sugars	4.5 \pm 0.5

* As is

Rehydration time and water absorption per cent are simple indicators on processing and quality control.

Table . presents the technical data for fermented flour. Granulation specifications and PH ranges are critical to product acceptability since the former controls texture perception in the snack Akara, and the latter influences that for taste

Table 12 : Technical data sheet for toasted cowpea products from 58/57

Characteristic/Index	Acceptable range		
	Whole grain	Semolina, grits	Flours
<u>APPEARANCE</u>	Light tan color without burned spots. No insects holes or extraneous material	Very light colored with no black hilum or extraneous material.	Light-tan flour with no black particles or extraneous material
<u>GRANULATION</u>			
on 1.0 mm (10 mesh)	-	1.0% max.	0.0
on 0.5 mm (35 mesh)	-	70.0% min.	0.0
on 0.25 mm (60 mesh)	-	25% min.	0.0
on 0.125 mm (100 mesh)	-	5.0 max.	20.0 to 50.0%
Through 0.125 (100 mesh)	-	0.0	80.0 to 50.0%
Bulk density, gm/cc	0.800+ 0.3	0.800+ 0.3	0.560 + 0.06
Humidity, %	3.0 + 0.5	3.0 + 0.5	3.0 + 0.5
Water absorption, %	170 + 5.0	180 + 5.0	210 + 5.0
Rehydration time, by cooking, min	60 mn	40 mn	10 mn
<u>ORGANOLEPTIC</u>	Light-toasted aroma & taste, no bitterness	same	same
<u>Chemical* %</u>			
Lipides	12.2 + 0.2	12.0 + 0.2	2.5 + 0.2
Protein	24.0 + 1.0	24.0 + 1.0	23.0 + 1.0
Total fiber	24.0 + 1.0	20.0 + 1.0	20.0 + 1.0
Crude fiber	4.5 + 0.2	2.3 + 0.2	2.5 + 0.2
Sugars	10.0 + 0.5	9.5 + 0.5	9.5 + 0.5
Ash	4.0 + 0.2	3.8 + 0.2	4.0 + 0.2

* As is

..//..

Table 13: Technical data sheet for fermented cowpea from 58/57 variety-flour

Characteristic/Index	Acceptable range
<u>APPEARANCE</u> :	Off-white color without black particles or extraneous materials.
<u>GRANULATION</u> -:	
- on 1.0 mm (10 mesh)	max. 0.5%
- on 0.5 mm (35 mesh)	35.0 \pm 2.0%
- on 0.25 mm (40 mesh)	34.0 \pm 2.0%
- on 0.125 mm (100 mesh)	30.0 \pm 2.0%
- Thru 0.125 mm (100 mesh)	max. 7.0 1/2
<u>HUMIDITY</u>	10.5 \pm 1.0
Bulk density, gm, gm/cc	0.70 \pm 0.03
Water absorption, %	250
<u>ORGANOLEPTIC</u>	Light fermented odor & slightly acidic taste.
PH	6.55 - 6.70
<u>Chemical*</u> , %	
Lipides	2.1 \pm 0.1
Protein	23.0 \pm 1.0
Total fiber	15.5 \pm 1.0
Crude fiber	2.0 \pm 0.2
Total sugars	7.5 \pm 0.5
Ash	3.0 \pm 0.2

* As is

A N N E X 1

COMMUNE	CULTURE	1975 (en)						ETHNIE DOMINANTE	1976 (en)						1977 (en)										
		SUPERFICIE CULTIVEE		RENDIMENT		PRODUCTION			SUPERFICIE CULTIVEE		RENDIMENT		PRODUCTION		SUPERFICIE CULTIVEE		RENDIMENT		PRODUCTION						
		ha	kg/ha	kg	kg/ha	kg	kg/ha		ha	kg/ha	kg	kg/ha	kg	kg/ha	ha	kg/ha	kg	kg/ha	kg	kg/ha					
SARR	SARR	137	134	19.205	37	1.768	11	0																	
	VOLEINE SARR	76	244	4.010	37	954	10	0																	
	LEONA	100	204	12.862	42	1.296	10	0																	
MBEDIENE	NIDRE	46	220,4	10.925	47			0																	
	NSUIDILE	63	193	11.541	60	900	17	0	244																
	MBEDIENE	83	225	10.948	49	1.026	11	0		4.442	550	2.554	6.285	400	2.514	1422,6	5.197	8527	4.426	3.445	313	11.078			
	KEL GUEYE	40	120	6.908	53	670	10	0																	
K. SARR	SYER	28	450	5.656	13	580	10	P																	
	NGUER MALAL	65	726	13.398	18	1.390	10	0	218,6	21	462	625	288.745	3.673	275	1.0107	373,2	21	110	782	86	969	327	210	
	YEUP M. SARR	66	786	12.937	16	1.160	11	0																	
	SANDE	39	800	6.454	8	756	8	F																	
KOKI	ZHIZAMENE	51	275	11.212	47	1.259	9	D																	
	PETE QUARACK	16	187	3.662	30	387	9	0	221																
	NDIAGNE	42	227	11.936	48	1.194	10	0			8.465	389	3.292	4.900	449	2.200	372	3.253	867	2.820	7.673	350	2.686		
	KOKI	59	325	17.079	52	1.615	10	0																	
DEPARTEMENT	LOUGA																								
											24.593		14.632	39.260		113.839		110.980	925	8.976	16.670	313	5.220		
YANG - YANG	TESSEKERE FO-KABE																								
	KBOULA	138	4.214	26.909	8	-	-	-			15.753	1.013	15.958	1.305	600	784	-	416	810	337	97	280	27		
	KBEULEKHE KABO																								

N.B. La Surface cultivée est exprimée en hectare
 Le rendement " " en kilogramme/hectare
 la production " " en tonne

FICHES DE RENSEIGNEMENTS SUR LES COMMUNES

RURALES DE LA REGION DE SAINT LOUIS

DEPARTEMENT DE BAKAMA

ARRONDISSEMENT	COMMUNAUTE RURALE	NOMBRE VILLAGES	SUPERFICIE Km2	POPULATION	DENSITE HBS/Km2	NOMBRE CARRRES	POPULATION /NOY CARRRE	ETHNIE DOMINANTE	DONNEES AGRICOLES 1986 (PAR ARRONDISSEMENT)						DONNEES AGRICOLES 1987 (PAR ARRONDISSEMENT)										
									PLUVIOSITE (mm)	NOMBRE JOURS DE PLUIE	ARACHIDE			NIEBE			PLUVIOSITE (mm)	NOMBRE JOURS DE PLUIE	ARACHIDE			NIEBE			
											SURFACE CULTIVEE (SC)	RENDEMENT (R)	PRODUCTION (P)	SC	R	P			SC	R	P	SC	R	P	
BSANE	BSANE	63	1741	21741	12	-	-	T	1366.2	20	-	-	-	-	-	-	-	1173.7	18	-	-	-	-	-	-
DEPARTEMENT BAKAMA	-	-	-	-	-	-	-	-	1231.0	18	1075	313	336	499	235	117	1256.5	20	1687	659	1112	807	228	184	

DEPARTEMENT DE PODOR

CAS - CAS	AERE - LAD	31	1981.7	28872	14	-	-	T																	
	MEDINA NDIATH	26	823.8	26364	32	-	-	T	1372.9	18	0	0	0	203	150	30.450	1235.9	21	0	0	0	116	216	25.056	
	MBOMBA	19	310.6	16252	52	-	-	T																	
SALDE	GALDYA TOUCOUL	28	804.1	20510	25	-	-	T	1213.7	19	0	0	0	468	170	79.560	1309.3	23	0	0	0	361	219	79.059	
	PETE	42	1574.8	22875	14	-	-	T																	
DEPARTEMENT PODOR									1268.6	16	0	0	0	930	162	151	1224.9	19	0	0	0	1280	202	258.560	

DEPARTEMENT DE MATAM

KANEL	KANEL	43	3052	24911	8	1731	14	T																	
	STANTHOU SAKH	23	2550	23500	9	1485	16	T	346	22	0	0	0	115	320	36.800	1476.1	33	0	0	0	183	199	26.417	
DIROSENGUI	BOYDIKANE	28	695.7	26264	49	-	-	T																	
	NAMOUJI CIVIL	25	550.5	20027	36	-	-	T																	
	DOO	15	2485.6	28676	11	-	-	T	320.2	20	0	0	0	450	310	141.450	1457.9	24	0	0	0	330	152	20.160	
	KANEPOU	41	1074.7	7855	-	-	-	T																	

N.B. : La surface cultivée est exprimée en hectare
 Le rendement " " en kilogramme/hectare
 La production " " en tonne

RECIPES FOR THE RURAL COMMUNITIES

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MENU JOURNALIER POUR ZONE RURALE: Suggestion pour trois repas
à base de niébé sur trois jours.

Repas	Jours	1	2	3
Petit - Déjeuner		Café + Biscuit ou Thé pain	Fondé (bouillie de mil) Café ou Thé + Biscuit ou pain	Café ou thé + Biscuit ou pain
Déjeuner		Tiébou Kétiakh au niébé	Tiébou Djeun	Tiébou Yapp
Diner		Couscous	NDambé ou lakhou Neuteri	Nelen de niébé ou lakhou Gar

NB : Pour les 3 repas à base de niébé :

- Tiébou Kétiakh au niébé
- NDambé
- Nelen de niébé

cf : Recettes jointes

NDAMBE

INGREDIENTS

- Viande	250 g
- Tomate (double concentré)	100 g
- Huile	1/8 de litre
- Oignons	2
- Poivre	1 petite cuillerée
- Sel	1 " "
- Eau	2 litres
- Niébé grillée	1 mesure équivalente à 1/4 de litre soit 200 g
- Cube Maggi	2

TECHNIQUE DE PREPARATION

1. Préparer séparément du niébé grillé bouilli par cuisson dans un litre d'eau bouillante pendant 25 - 30 mn.
2. Chauffer l'huile dans une marmite, ajouter la viande lavée et couper en morceaux, un oignon émincé et la tomate concentrée et laisser réduire.
3. Ajouter l'eau (2 litres) et continuer la cuisson.
4. Transférer le niébé bouilli essoré dans une marmite dès ébullition atteinte puis saler.
5. Hacher finement le reste des oignons et l'introduire dans la marmite.
6. Ajouter le poivre et le cube Maggi et cuire à feu doux pendant 20 mn.

Servir chaud.

Nombre de personnes : 6 à 8

Temps de préparation: 1 heure.

NELEN

INGREDIENTS

- Viande	100 g
- Tomate en purée	100 g ou 2 cuillérées à soupe pleines
- Huile	2 grandes cuillérées
- Pâte d'arachide grillées	1 louche rase
- Vinaigre	2 cuillérées
- Poisson sec	50 g ou 1 morceau moyen
- Piment	2 gros
- Oignon	2 gros
- Manioc, carotte, patate	1 à 2 morceaux de chaque
- Maggi, poivre	à volonté
- Sel	"
- Eau	3 à 4 litres
- Sanxal de niébé	200 g
- Gombo	200 g

TECHNIQUE DE PREPARATION

1. Mélanger le sanxal avec l'huile (1 cuillérée à soupe et un peu d'eau salé)
2. Cuire le mélange à la vapeur
3. Au bout de 10 mn, remettre le sanxal dans unealebasse et l'humecter.
4. Procéder à une nouvelle cuisson à la vapeur : étape à répéter jusqu'à obtention d'un produit complètement cuit.
5. Ajouter du gombo en purée.

.../...

SAUCE :

1. Chauffer l'huile dans une marmite, ajouter la viande coupée et lavée, puis laisser dorer.
2. Ajouter l'oignon réduit en morceaux et la tomate, laisser réduire et mettre l'eau.
3. Ajouter le "tiguadégué" (pâte d'arachide grillée) et les légumes, le poisson sec et le piment, saler et laisser cuire.
4. Au bout d'une heure, vérifier si la viande et les légumes sont cuits, mettre le poivre, le Maggi et vérifier l'assaisonnement.

Servir chaud : sanxal + sauce

ND : On peut mettre du gombo dans la sauce (facultatif)

Temps de préparation : 1 heure 30

Nombre de personnes : 4 à 5.

LAKHOU NEUTERI

INGREDIENTS

- | | |
|--------------------------|----------------------------------|
| - Sanxal de niébé grillé | 200 g ou 1/2 "liber" |
| - Pâte d'arachide | 200 g ou 5 cuillérées
à soupe |
| - Pain de singe | 200 g ou 1 pot. de "canari" |
| - Sucre | 250 g ou 1/2 "liber" |

TECHNIQUE DE PREPARATION :

LAKH : Mettre de l'eau (2 litres) dans une marmite et laisser bouillir. Y ajouter le sanxal de niébé et saler. Laisser cuire à feu doux.

NEUTERI :

1. Laver le pain de singe, le tremper dans de l'eau et laisser macérer.
2. Bien pétrir pour séparer le pain de singe de ses pépins.
3. Ajouter l'arachide grillée (tiguadégué). Bien mélanger.
4. Passer le tout au tamis fin, puis sucrer (à volonté).
5. Parfumer avec vanille, eau de fleur d'oranger, muscade.

Servir lakh + Neuteri.

Nombre de personnes : 3 à 5.

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LAKHOU GAR

INGREDIENTS

- Poisson frais	500 g
- Farine de niébé fermentée	200 g
- Sanxal de maïs *	300 g ou 1 pot de 500 g rase
- Tomate concentrée	200 g ou 4 grosses cuillérées
- Manioc	1 morceau moyen
- Oignon	5 à 6 morceaux moyens
- Huile	1/2 louche
- Eau	2 litres.

TECHNIQUE DE PREPARATION

1. Mettre un tout petit peu d'huile dans une marmite, et dès que ça commence à frémir, y ajouter un oignon émietté, puis la tomate.
2. Laisser mijoter un peu et ajouter la quantité d'eau nécessaire.
3. Ajouter le poisson, les légumes et saler.
4. Ajouter la farine de niébé et laisser cuire.
5. Vérifier l'assaisonnement, enlever les ingrédients et mettre en pluie le sanxal dans la sauce. Laisser cuire à feu doux.
6. Quand le sanxal est cuit, servir

Temps de préparation : 1 heure.

Nombre de personne : 6 - 7 personnes.

* A défaut de maïs, le remplacer par du mil.

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TIEBOU KETIAKH

INGREDIENTS

- Riz	500 g ou 1 pot "liber"
- Niébé trempé*	500 g " "
- Kétiakh	3 poissons moyens ou 200 g
- Huile	1 louche
- Tomate concentrée	200 g ou 4 grandes cuillérées
- Oignon	150 g ou 2 gros
- Carotte	100 g ou 2 morceaux

TECHNIQUE DE PREPARATION

1. Dans une marmite, mettre l'huile. Emietter les oignons et les mettre dans l'huile chauffante.
2. Laisser dorer, ajouter la tomate délayée dans un peu d'eau.
3. Laisser mijoter quelques minutes et ajouter l'eau (3 litres environ)
4. Mettre le kétiakh lavé, le niébé et laisser cuire. Saler.
5. Mettre un oignon préalablement réduit en purée, deux piments.
6. Cuire le riz à la vapeur.
7. Quand le niébé est cuit, vérifier l'assaisonnement et introduire dans la sauce le riz déjà cuit à la vapeur.
8. Diminuer le feu et faire cuire.

NB : Ne pas enlever le niébé.

Temps de préparation : 1 heure

Nombre de personnes : 6 à 8.

* Le niébé doit être trempé pendant 30 mn à 1 heure.

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RECIPES FOR THE URBAN HOUSEHOLDS

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MENU JOURNALIER POUR ZONE URBAINE

Repas	Jours	1	2	3
Petit déjeuner		Boissons chaudes (café - thé - lait - kinkélibah - etc.) + Produits de cuisson (pain - biscuit - cakes etc.)	Idem	Idem
Déjeuner		Tiebou kétiakh au niébé ou Naffé	Tiébou Djeun ou Maïs au poisson	" Soupe Kandia"
Goûter		Akara	Thiakry au niébé	Gâteau Aïta II
Dîner		Couscous de mil	Ndambé ou Thialal	Salade de niébé + Nelen de niébé

NDAMBE

INGREDIENTS :

- Viande	500 g
- Tomate (double concentrée)	200 g
- Huile	1/4 l. ou une louche
- Oignons	4
- Poivre	1 petite cuillerée
- Sel	1 " "
- Vinaigre	1 grande "
- Ail	1 gousse
- Eau	2 litres
- Niébé précuit	200 g ou 1 mesure équivalente à 1/2l.

TECHNIQUE DE PREPARATION

1. Préparer séparément du niébé précuit bouilli par cuisson dans un litre d'eau bouillante pendant 25 - 30 mn.
2. Chauffer l'huile dans une marmite, ajouter la viande lavée et coupée en morceaux, un oignon émincé et la tomate concentrée et laisser réduire.
3. Ajouter l'eau (2 litres) et continuer la cuisson
4. Transférer le niébé bouilli essoré dans la marmite ; et dès ébullition atteinte, saler.
5. Hacher finement le reste des oignons et l'ail et l'introduire dans la marmite.
6. Ajouter le poivre et le vinaigre et laisser cuire à feu doux pendant 20 mn.

- . Servir chaud
- . Temps de préparation : 1 heure
- . Nombre de personnes : 6 à 8.

THIALAL

INGREDIENTS :

- | | |
|------------------|---------------------------------------|
| - Niébé précuit | 200 g ou 1/2 pot de "liber" |
| - Arachide pilée | 100 g ou 4 cuillérées à soupe pleines |
| - Oignon | 3 (moyens) |
| - Piment | 1 |
| - Eau | 2 l. ou 2 pots de "canaris" |
| - Sel | à volonté |
| - Cube maggi | 2 |

TECHNIQUE DE PREPARATION

1. Cuire dans deux litres d'eau les graines de niébé
2. Laisser bouillir pendant 10 à 15 mn.
3. Ajouter l'arachide en poudre
4. Mettre les oignons finement hachés, le piment, les cubes maggi. Saler.
5. Cuire à feu doux jusqu'à ce que les niébés deviennent moux.

- En fin de préparation, le produit doit être consistant
- Mettre du beurre de vache (facultatif)

- . Servir chaud
- . Temps de préparation : 1 heure
- . Nombre de personnes : 6 à 8.

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SALADE DE NIEBE

INGREDIENTS :

- Niébé précuit	250 g ou 1/2 pot "liber"
- Oignon	2
- Ail	1 gousse
- Citron	2
- Sel	à volonté
- Poivre	"

TECHNIQUE DE PREPARATION

1. Bouillir le niébé pendant 10 mn dans un peu d'eau salée.
2. ELiminer l'eau et laisser égoutter.
3. Hacher finement les oignons et réduire l'ail en purée.
4. Dans un bol, mélanger les oignons, l'ail réduit, le poivre, le citron, un peu de sel, vérifier l'aissaisonnement et mettre le niébé déjà égoutté.

NB : Il est possible de mélanger à cette salade, des crevettes et des moules cuites à l'eau et décortiquées.

- . Servir c .me entrée
- . Nombre de personnes : 5
- . Temps de préparation : 20 à 30 mn.

HELEN

INGREDIENTS :

- | | |
|--|--|
| - Viande | 1 kg |
| - Tomate en purée | 200 g ou 2 cuillérées
à soupe pleines |
| - Huile | 1 louche et demi |
| - Pâte d'arachides grillées | 200 g ou 1 louche rase |
| - Vinaigre | 2 cuillérées |
| - Poisson sec | 50 g ou 1 morceau moyen |
| - Yet | 50 g ou " |
| - Piment | 2 gros |
| - Oignon | 3 gros |
| - Aubergine amer | à volonté |
| - Manioc, patate douce, maggi,
poivre, carottes | à volonté |
| - Sel | " |
| - Eau | 3 à 4 litres |
| - Sanxal de niébé grillé | 1 kg |

TECHNIQUE DE PREPARATION : Nelen

1. Mélanger le sanxal avec 1/2 louche d'huile et un neu d'eau salée
2. Cuire le mélange à la vapeur
3. Au bout de 10 mn, mettre le sanxal dans une calebasse et l'humecter.
4. Procéder à une nouvelle cuisson à la vapeur : étape à répéter jusqu'à obtention d'un produit complètement cuit.
5. Ajouter du lalo ou du gombo en purée.

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SAUCE :

1. Chauffer l'huile restante dans une marmite, ajouter la viande coupée et lavée, puis laisser dorer.
2. Ajouter l'oignon réduit en morceaux et la tomate, laisser réduire et mettre l'eau.
3. Ajouter le "tiguadégué" (pâte d'arachide grillée) et les légumes, le poisson sec, le yet et le piment, saler et laisser cuire.
4. Au bout d'une heure, vérifier si la viande et les légumes sont cuits, mettre le poivre, le vinaigre et vérifier l'assaisonnement.

. Servir chaud : sanxal + sauce

. NB : On peut mettre du gombo dans la sauce (facultatif)

. Temps de préparation : 1 heure 30

. Nombre de personnes : 8 à 12.

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GATEAU AÏTA

INGREDIENTS

- Semoule fine de niébé grillé 100 g ou 2 verres à thé (rases)
- Sucre en poudre 100 g
- Beurre 35 g ou 4 portions individuelles
- Oeufs 2
- Sachet de vanille 2
- Gingembre en poudre 1 pincée
- Levure chimique 1/2 sachet.

TECHNIQUE DE PREPARATION

1. Battre le beurre, le sucre et le sucre vanille.
2. Ajouter les oeufs un à un en mélangeant.
3. Mélanger les autres ingrédients et cuire 40 mn à four moyen.

- . Temps de préparation : 50 mn.
- . Nombre de personnes : 4

1/2

NAFFE

INGREDIENTS

- | | |
|---|--|
| - Viande | 500 g ou 1 "liber" |
| - Huile | 1/4 l. ou 1 louche |
| - Tomate concentrée | 250 g ou 1/2 "liber" |
| - Poisson sec | 50 g ou 1 morceau moyen |
| - Yet | 50 g " " |
| - Eau | 3 l. ou 3 pots de "canaris" |
| - Légumes : Pomme de terre,
choux, manioc,
patate | à volonté |
| - Sel | à volonté |
| - Vinaigre | " |
| - Farine de niébé grillé | 50 g ou 2 cuillérées à
soupe pleines. |

TECHNIQUE DE PREPARATION :

1. Dans une marmite, mettre l'huile et faire chauffer.
 2. Au bout de 10 mn, mettre la viande lavée et coupée en morceaux.
 3. Ajouter un oignon émincé, la tomate en purée, laisser réduire.
 4. Ajouter l'eau, le poisson sec, le yet et les légumes épluchés et lavés.
 5. Piler le reste des oignons et les mettre dans la sauce, saler et laisser cuire.
 6. Retirer les légumes cuits.
 7. Délayer la farine de niébé et la mettre dans la sauce en remuant pour éviter les grumeaux.
 8. Laisser cuire à petit feu et en fin de cuisson, ajouter le vinaigre et vérifier l'assaisonnement.
- . Servir chaud avec riz cuit à l'eau
. Temps de préparation : 1 heure 30
. Nombre de personnes : 8 à 12.

COUS COUS DE NIEBE / MIL

INGREDIENTS :

- Farine de niébé 350 g
- Farine de mil 650 g
- Lalo 5 g (une cuillère à soupe)
- Eau.

MATERIEL

- 2 Calebasses
- 1 couscoussier
- 1 tamis de 1 mm
- 1 tamis de 2 mm
- 1 louche.

TECHNIQUE DE PREPARATION

Elle consiste à réduire la farine en fins granulés de 1 mm environ.

1. Les deux farines sont mises dans une calebasse
2. En brassant, ajouter de l'eau par petite quantité
3. Poursuivre le brassage jusqu'à l'obtention de granulés pouvant passer au travers du tamis de 1 mm.
4. L'opération est renouvelée jusqu'à l'épuisement complet de la farine.
5. Cuire à la vapeur les granulés de couscous au moyen du couscoussier.
6. En fin de cuisson, verser le contenu du couscoussier dans une calebasse.
7. Ecraser, à l'aide d'une louche ou koog les mottes de couscous
8. Passer le couscous sur un tamis de 2 mm

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9. Procéder à seconde cuisson
10. Ajouter à la fin de la deuxième cuisson le lalo.
 - . NB : Si nécessaire, il est possible de faire une troisième cuisson en répétant 6-7-8-et 9.
 - . Servir avec la sauce de votre choix.
 - . Nombre de personnes : 8
 - . Temps de préparation : 45 mn.

THIAKRY

INGREDIENTS

- Farine de niébé grillé*	500 g
- Lait caillé	2 litres
- Vanille	3 sachets
- Fleur d'oranger	2 petites cuillérées
- Lait concentré non sucré	1 boîte de 410 g
- Sucre	250 g
- Beurre	250 g
- Muscade	1 cuillérée.

TECHNIQUE DE PREPARATION

1. Brasser la farine pour former des granulés un peu plus gros que ceux du couscous.
2. Faire cuire à la vapeur une 1ère fois
3. Retirer et écraser les mottes
4. Humidifier un peu, ajouter un peu de sucre et repasser à la vapeur.
5. Ajouter le beurre en fin de cuisson.

PREPARATION DU LAIT

Dans un bol, mettre le lait caillé et le lait concentré, ajouter le restant du sucre, un peu de muscade rapée, puis mélanger

- . Servir le mélange : Lait + thiakry
- . Nombre de personnes : 8

* Il est possible d'utiliser le sanxal de niébé grillé à la place de la farine. Pour ce faire, il suffit d'humecter le sanxal, et de passer à l'étape 2 de la préparation.

AKARA

INGREDIENTS

- Farine de niébé fermenté 250 g ou 1/2 pot "liber"
- Huile 1/4 l. ou 1 louche
- Eau 300 ml ou 1 louche
- Ail 1 gousse
- Tomate 100 g ou 1 cuillère à soupe pleine
- Oignon 3 gros
- Piment 2 gros
- Poivre 1/2 cuillère
- Vinaigre 1 cuillère
- Levure chimique 1 sachet et demi.

TECHNIQUE DE PREPARATION

1. Prendre 250 g de farine de niébé fermenté
2. Ajouter la levure.
3. Mettre l'eau et bien mélanger pour obtenir une pâte.
4. Couvrir et laisser reposer pendant 30 mn.
5. Chauffer l'huile dans une casserole.
6. Former de petites boules et les cuire dans l'huile chaude.

SAUCE

1. Couper les oignons ou les concasser moyennement dans un mortier.
2. Chauffer un peu d'huile, mettre les oignons, ensuite la tomate en purée.
3. Saler, ajouter le piment et la gousse d'ail réduite en purée.
4. Laisser mijoter à feu doux.
5. Ajouter le vinaigre et le poivre en fin de cuisson.

- . Servir de préférence chaud : Akara + sauce
- . Temps de préparation : 60 mn
- . Nombre de personnes : 8 à 12.

TIEBOU KETIAKH

INGREDIENTS :

- Riz	500 g ou 1 pot "liber"
- Niébé grillé trempé*	500 g
- Kétiakh	3 poissons moyens ou 200 g
- Huile	1 louche
- Tomate concentrée	200 g ou 4 grandes cuillérées
- Oignon	150 g ou 2 gros
- Carotte	100 g ou 2 morceaux.

TECHNIQUE DE PREPARATION :

1. Dans une marmite, mettre l'huile. Emietter les oignons et les mettre dans l'huile chauffante.
2. Laisser dorer, ajouter la tomate délayée dans un peu d'eau.
3. Laisser mijoter quelques minutes et ajouter l'eau (3 litres environ)
4. Mettre le kétiakh lavé, le niébé et laisser cuire. Saler
5. Mettre un oignon préalablement réduit en purée, deux piments.
6. Cuire le riz à la vapeur.
7. Quand le niébé est cuit, vérifier l'assaisonnement et introduire dans la sauce le riz déjà cuit à la vapeur.
8. Diminuer le feu et laisser cuire.

NB : Ne pas enlever le niébé.

- . Temps de préparation : 1 heure.
- . Nombre de personnes : 6 à 8

* le niébé doit être trempé pendant 1 heure.