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MILLET SUPPLY STUDY

ADDITIONAL MEMORANDUM ON SUPPLY PROSPECTS FOR A MIXED MILLET AND CORN COMPLEX

PRESENTED BY

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INTRODUCTION AND SUMMARY OF CONCLUSIONS

The present memorandum is an addition to the study on millet supply to a processing plant. Its objective is to analyze an alternative plan of supplying a plant with 50% millet and 50% corn.

The present study led to two conclusions:

- Corn production development prospects are far more promising than those for millet. Production tends to increase faster than population and could double by the year 2000. An interventionist development program would make it possible to bring production to 228,000 m.t. by 2000 with a maximum scenario.

- Under such a hypothesis, supply and demand could be balanced by adopting an appropriate industrial policy to promote new forms of corn consumption in order to replace other grains that will remain at a deficit production level, especially by the industrial production of mixed corn and millet couscous, semolina or corn rice (cracked corn).

The alternative studied consequently has a certain national priority over the initial hypothesis of millet processing alone. This is because it is of less use to promote millet consumption in that the production development prospect is lower and self-sufficiency more problematic.

As concerns project feasibility, the alternative studied offers the advantage of involving far less risk of insufficient supply. While such a risk will continue over the short-term for corn at the present production level, it should disappear rapidly when production expands. Moreover, should harvests be catastrophic, imports (which are difficult for millet) can always be turned to.

As concerns supply cost and methods, the alternative studied will require no modification to the initial hypothesis.

Finally, although such is not the object of the present memorandum, a mixed corn and millet couscous, which is already made on an artisanal level, would be popular with consumers.

1. PRODUCTION

1.1. Characteristics

1.1.1. Regional breakdown and evolution

Corn is grown mainly in four regions of Senegal: Senegal Oriental, Sine-Saloum, Casamance and Fleuve.

A. In Casamance and Senegal Oriental, and more particularly in Middle Casamance, Upper Casamance and Kedougou province, corn has been farmed and consumed traditionally in rural areas. These areas have the most favorable climatic conditions for corn growing.

After a sharp drop from 1960 to 1975, areas under corn have again progressed in Upper and Middle Casamance.

In Senegal Oriental, the increase in areas has been more regular over the long-term, except for drought years.

Increase in areas in both these regions has been partially through replacement of sanyo millet and sorghum whose longer growing cycle is a source of greater risk in case of insufficient rainfall as has been the case over the past years. In addition, damage caused to sorghum by parasitic attack over recent years has accentuated this transfer.

B. The Sine-Saloum is the climatic zone that makes up the northern limit for corn growing, which has increased rapidly over the last ten years. Paradoxically for a grain which requires more water than souna millet, the expansion is the result of a decrease in rainfall in Sine-Saloum. Grain stocks are more limited; problems of carrying the supply over to the next harvest are greater than before. As corn can be eaten "green" three to four weeks before the souna harvest, this difficult period can be overcome.

C. In the Fleuve region, this crop is a traditional one and is grown after flooding of the Senegal River. The hydro-agricultural projects under way are leading to a replacement of this practice by irrigated farming; consequently, prospects for this area will be studied in a separate section of this chapter.

If we take the corn statistics from the Agricultural Production Office (Direction Générale de la Production Agricole) into consideration, we find that corn is presently produced fairly equally by the three main rainfed agriculture regions. The Fleuve region does not produce more than 10% of the national total (see Tables 1 and 2).

1.1.2. Relative advantages and dynamics of corn growing

As for millet, corn is, first and foremost, a crop grown for family consumption. Though first limited to plots behind the homes, its extension corresponds to a progressive introduction into fields, either in addition to existing crops or as a substitute for millet and sorghum.

This substitution phenomenon and the resulting dynamics can be explained by a series of specific advantages offered by corn:

- In the harvest cycle, corn is generally ripe before other grains, thereby offering a dual advantage: for family nutrition in case of carry-over difficulties, for sale in case money is needed urgently. (Groundnut and cotton which are the main sources of income fall far later in the year.) Early corn harvests have been verified in comparison to sorghum and sanyo with longer cycles, but also in comparison to souna, as corn can be harvested green.

- Its relatively precocious harvest makes corn less vulnerable to the danger of a shorter rainy season than are sorghum or sanyo. Consequently, it incites farmers in Upper Casamance and Senegal Oriental to diversify their crops by introducing corn in order to make production more secure.

- Corn productivity is higher than that for other grains, especially if it is grown with good fertilizer conditions. This makes it of interest for home plots enriched by organic manure and as a rotation crop in cotton fields, thereby benefitting from the after-effects of fertilizers used.

- Finally, corn benefits from certain consumption advantages (analyzed in Chapter 2) which make it a good crop for self-consumption as well as marketing, green or dried, in urban centers.

TABLE 1

EVOLUTION OF AREAS UNDER CORN (UNIT: HECTARE)

YEARS	REGIONS						SENEGAL
	CAP-VERT	CASAMANCE	FLEUVE	SENEGAL ORIENTAL	SALE SALOUM	THIES	
1970/71	-	25 159	8 359	16 553	569	-	50 640
1971/72	-	19 540	10 088	18 499	707	-	48 884
1972/73	-	13 018	352	18 184	765	-	32 319
1973/74	-	14 080	4 609	19 822	675	-	39 186
1974/75	-	15 297	7 698	24 411	1 218	-	48 624
1975/76	50	13 607	5 600	27 138	2 920	708	50 083
1976/77	100	16 013	3 000	15 770	12 920	770	48 573
1977/78	-	15 013	2 500	22 346	12 777	-	53 642
1978/79	-	22 780	5 621	17 883	10 123	-	56 407
1979/80	-	25 799	2 810	23 856	15 220	-	67 685
1980/81	166	24 393	5 855	22 859	24 952	-	78 059
1981/82	70	29 599	6 597	27 412	14 256	-	77 934
1982/83	150	25 485	8 807	24 949	27 000	-	86 391
1983/84	-	17 680	3 768	25 739	7 400	-	54 617
1984/85	-	N.D.	N.D.	N.D.	N.D.	-	82 680
1985/86	-	38 083	797	30 141	31 090	-	100 201

Source : MDR statistics

TABLE : 2

EVOLUTION IN CORN PRODUCTION (UNIT: METRIC TON)

YEARS	REGIONS						SENEGAL
	CAP-VERT	CASAMANCE	FLEUVE	SENEGAL ORIENTAL	SALE SALOUM	THIES	
1970/71	-	18 549	5 272	8 879	375	-	33 075
1971/72	-	16 245	6 616	14 167	574	-	37 602
1972/73	-	9 726	191	9 857	436	-	20 210
1973/74	-	13 929	2 722	16 220	1 010	-	33 881
1974/75	-	16 470	5 747	19 012	2 038	-	43 267
1975/76	30	14 891	0	23 379	5 640	447	44 387
1976/77	45	19 380	0	7 192	16 264	540	41 421
1977/78	-	11 382	1 207	10 625	9 893	-	35 107
1978/79	-	19 082	4 069	16 478	14 419	-	54 048
1979/80	-	23 490	3 553	16 327	2 943	-	46 293
1980/81	238	19 132	4 723	12 972	19 950	-	57 015
1981/82	52	23 684	4 467	39 409	27 213	-	94 825
1982/83	120	22 794	3 246	26 797	29 311	-	82 268
1983/84	-	15 859	1 610	16 206	7 408	-	41 083
1984/85	-	N.D.	N.D.	N.D.	N.D.	-	60 595
1985/86	-	59 502	2 321	37 676	46 910	-	146 484

Source : MDR statistics

1.1.3. Limitations specific to corn

In opposition to its advantages, corn implies certain specific limitations to its development.

- It only reaches its productivity potential if the soil is enriched. This is a problem in the Senegalese context as concerns cost, risk and credit to buy fertilizer for field agriculture.

- Corn requires major work time and a strict farm calendar. This is particularly problematic in Upper Casamance and Senegal Oriental, regions which have a low population density and are ill-equipped in farm implements.

- It is vulnerable to climatic difficulties, especially during the critical phases of flowering and fructification. This limits its development to regions where rainfall is more regular and generally increases the risk corresponding to the necessary inputs investment and work time required.

1.1.4. Development actions and projects in progress

There are presently two corn projects in progress:

- the German-Senegalese Sine-Saloum project whose main goal is to produce seed (some 800 m.t. in rural region);

- the Senegal Oriental rural development project which, in addition to cotton, includes promotion of corn-growing through the supply of seed, herbicides, fertilizer and commercial and technical assistance to producer groups. This project is headed by SODEFITEX and at completion it should cover 13,000 ha of corn throughout its intervention zone (Sine-Saloum, Senegal Oriental, Upper Casamance).

Research is far more advanced on corn than on millet in Senegal. Varieties have been selected (but not widely distributed) for a potential far superior to that of the local varieties. There is a perfectly-suited herbicide which offers the possibility of removing the bottleneck posed by weeding time.

1.2. Quantities produced and forecast evolution

1.2.1. Present rainfed areas and trend evolution

Statistics available for areas are summarized in Table 1.

The analysis of statistics shows a fairly regular progession in areas under corn for the past 15 years, due to the factors discussed below. The average area for the past 15 years is 54,000 ha and the trend evolution is some 4.6% per year. Consequently, the trend area for 1985 corresponding to the law of trend evolution, and not taking into consideration any peak variation, is 85,000 ha.

As the growth in surfaces is partially to the detriment of millet and sorghum, estimates for the year 2000 can only be made based on overall evolution hypotheses for areas under grain. Then the growth can be broken down between the two main rainfed grains based on the forecasts defined in the millet supply report.

- In Sine-Saloum, overall "millet/sorghum plus corn" areas increase by 1.06% per year, i.e. some 4,600 ha (1), essentially through clearing of reserved land not yet farmed and through a reduction in fallow land. If this trend continues until 2000, the overall increase will be 65,000 ha over the 1985 surface figure (see Table 4). By extrapolation of past trends, this gives 20,000 ha for corn and 35,000 ha for millet and sorghum. Thus the area under corn would tend to increase from 22,000 ha to 42,000 ha for this same period.

- In Upper and Middle Casamance, as well as Senegal Oriental, overall "millet/sorghum + corn" surfaces have grown only slightly over the past 15 years (0.42%/yr (1)), in spite of the existence of major reserves, given the limited manpower available in these sparsely populated regions and the poor level of farm equipment at hand. A projection of the trend for 2000 gives an overall increase of only 14,000 ha. Areas under corn are progressing far more rapidly, however, due to a replacement of sorghum and sanyo. Areas under corn will increase from 31,000 ha in 1985 (trend surface) to 50,000 ha in 2000 in Casamance, and from 32,000 ha to 55,000 ha in Senegal Oriental, if the present trends persist.

- Floodland corn is disappearing in the Fleuve region and is being replaced by irrigated farming. Consequently, we can presume that all future corn production in this region will be irrigated (see paragraph 1.2.5.).

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(1) According to Millet Supply Study by Louis Berger, Jan. 1986, and FAO Grain Policy Study (November 85).

EVOLUTION IN RAINFED SURFACES

(THOUSANDS OF HA)

	SINE SALOUM	CASAMANCE	SENEGAL ORIENTAL	TOTAL
TREND SITUATION 85				
. millet/sorghum	375	← 143 →		522
. corn	22	31	32	85
Total	397	← 210 →		607
TREND GROWTH RATE (1)				
TOTAL	1,06 %	← 0,42 % →		0,84 %
TREND PROJECTION 95				
. millet/sorghum (2)	410	← 117 →		527
corn	31	48,5	53,5	133
Total	441	← 219 →		660
TREND PROJECTION 2000				
. millet/sorghum (2)	420	← 117 →		537
corn	42	50	55	147
Total	462	← 224 →		684
INTERVENTIONIST ANNUAL GROWTH RATE FOR AREAS UNDER GRAIN (2) 1985 - 2000	1,3 %	← 2,8 % →		
INTERVENTIONIST PROJECTION 2000				
.. millet/sorghum (2)	437	← 147 →		584
.. corn	45	81	89	215
Total	482	← 317 →		799

(1) Source : FAO report on Grain Policy

(2) Source : Louis Berger report on Millet Supply

CORN YIELD (KG/HA)

	SENEGAL ORIENTAL	CASAMANCE	SINE-SALOUM	DOMESTIC YIELD
1970 - 71	536	737	659	653
1971 - 72	765	831	811	769
1972 - 73	542	747	569	611
1973 - 74	818	989	1 496	864
1974 - 75	778	1 076	1 673	889
1975 - 76	861	1 094	1 931	886
1976 - 77	456	1 210	1 258	893
1977 - 78	475	710	774	617
1978 - 79	921	837	1 424	958
1979 - 80	684	910	193	684
1980 - 81	567	784	799	728
1981 - 82	1 437	800	1 908	1 216
1982 - 83	1 074	894	1 085	952
1983 - 84	629	1 180	539	752
1984 - 85	N.D.	N.D.	N.D.	733
1985 - 86				
TREND 85	950		1 100	985

Source : MDR statistics

The total areas under rainfed corn would therefore grow from 85,000 ha in 1985 to 147,000 ha if past trends persist, i.e. if the economic conditions of grain growing do not change in favor of one of the two grains and provided no new steps are taken to reduce the obstacles blocking an expansion in surfaces.

1.2.2. Present and trend production and yield (rainfed corn)

The estimated mean yield evolution over the past 15 years (1) has increased slightly, contrary to the trend for millet. This must be viewed in light of a concentration of corn in the most favorable zones, thus those with high yields, as well as to the results of projects presently under way.

The trend yield in 1985 is 985 kg/ha for the national average (under the real yield estimated for 1985-86, a particularly good year for rainfall). The regional analysis underlines a variation: 1,100 kg/ha in Sine-Saloum compared with only 950 kg/ha in Senegal Oriental and Upper Casamance, probably due to a poorer distribution of projects rather than a difference in agro-climatic conditions.

By extrapolating the trend for the year 2000, we get a mean yield of 1,200 kg/ha. It would be logical to say that an improved distribution of projects will cause yield in Senegal Oriental and Upper and Middle Casamance to catch up with that for Sine-Saloum.

Based on trend projections for surfaces and yield for 1985 and 2000, overall rainfed corn production for this period would increase from 84,000 m.t. to 176,000 m.t. This is a major increase of 5% per year (2), obtained merely by continuing the subsitution efforts and development work in progress.

1.2.3. Possibility of more rapid growth in surfaces

Overall growth in millet/sorghum + corn surfaces could be accelerated in the three regions where these grains are in competition without a correlated drop in cash crops (groundnuts and cotton). This can be achieved by taking steps to increase farm equipment in order to limit the manpower bottleneck, and also by making more intensive use of manure to reduce fallow land without losing soil fertility.

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(1) See Table 4
(2) See Table 5

The effect of such action would probably be limited in Sine-Saloum where available land is becoming rare, and any increase would probably come from a reduction in fallow land. The above-mentioned studies estimate that the annual growth rate for areas under rainfed grain could increase 1.3%; by 2000 this would mean an additional 20,000 ha as compared with the trend extrapolation. Given the growth hypotheses for areas under millet/sorghum in the Millet Supply Study, this would only leave a potential growth for corn of 30,000 ha as compared with the 2000 trend surface (see Table 3).

In Upper and Middle Casamance and in Senegal Oriental, the lifting of some manpower limitations will lead to greater growth in overall surfaces on the contrary, given the available land in reserve. The above-mentioned studies evaluate the potential annual growth at 2.8% (instead of 0.4% for the trend), thereby giving an overall increase of 95,000 ha by 2000 as compared with the trend situation. The Millet Supply Study presupposes that this overall increase will make it possible to maintain millet/sorghum production at their present level, in spite of substitution phenomena. This would leave corn a potential growth of 31,000 ha in Casamance and 34,000 ha in Senegal Oriental as compared to trend surfaces for 2000 (Table 3).

In total, rainfed corn surfaces could reach 215,000 ha by the year 2000 if appropriate steps are taken (see Table 3).

1.2.4. Potential intensification

The present mean yields, as well as the relatively unambitious projects for 2000, far from express the real potential for corn. Tests on experimental farms and results from certain pilot farm units have shown that it is possible to reach mean yields of 2,200 kg/ha in rural areas, as foreseen in the above-mentioned FAO study. This held true for farms using suitable varieties selected by Research with an average dose of fertilizer, the use of herbicides and improved farm techniques.

By carrying out an adequate intervention program, whose components will be discussed in Section 3 of the present chapter, 20% of all farms could use the complete technical program by the year 2000, thereby reaching a mean yield of 2,200 kg/ha; 50% would use part of the program to reach an intermediary yield of 1,900 kg/ha and 30% will remain at the trend level of 1,200 kg/ha. Under these conditions, a realistic intervention objective would be a mean domestic yield which would correspond to the weighted average, i.e. 1,910 kg/ha.

1.2.5. Irrigated production potential

The potential for irrigated corn production was covered in a specific evaluation in the above-mentioned FAO study on grain policy (1)(see attached Table A.1).

The study stated that corn could be grown as a possible second crop in the cold season, as the high temperatures reached during the hot season could endanger the yield. Potential is concentrated in the Senegal River Valley, due to the hydro-agricultural projects presently under way.

Under the present conditions, the two-crop system is still only limited over the 26,000 ha of grain irrigated in 1985. According to official statistics, corn only accounts for 3,400 ha at a maximum production of 8,000 m.t. For the 2000 horizon, corn surfaces and production could increase considerably through the progressive introduction of two crops on the existing perimeters and through the development of new perimeters.

The objective proposed by the above-mentioned study is the use of corn as a second crop for 20% of the existing SAED perimeters (24,500 ha in 1985) as compared to 60% for rice. Based on an average yield of 5 m.t./ha, the corresponding corn production would be 24,500 ha x 0.2 x 5 m.t./ha = 24,500 m.t.

The intensification rates and yields would initially be slightly lower for the new perimeters to be developed by 2000. If we choose a realistic objective of 3,500 ha/yr to be developed (2), i.e. 35,000 ha by 1995 and 52,500 ha by 2000, corn production by this time would be 52,500 x 0.18 x 4.5 m.t./ha = 42,500 m.t.

Outside of the River Valley, only the Anambé irrigation project is in a position to produce a significant quantity of corn by 2000. Smaller area projects could prove too expensive for grain growing. The above-mentioned study evaluates the potential production for Anambé at 1,000 ha x 5 m.t./ha in the year 2000, i.e. 5,000 m.t./yr.

The total irrigated corn production could therefore increase from 8,000 m.t. in 1985 to 72,000 m.t. in 2000.

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(1) See Appendix I - FAO Report, November 1985.
(2) Present development rate: 2,800 ha/yr. Forecast of VIIth Plan: 5,000 ha/yr (financing not granted).

CORN PRODUCTION SCENARIOS

	FLEUVE	SINE-SALOUM	CASAMANCE	SENEGAL ORIENTAL	TOTAL
NFED SURFACES (ha)					
rend 1985		22 000	31 000	32 000	85 000
rend 2000		42 000	50 000	55 000	147 000
nterventionist 2000		45 000	81 000	89 000	215 000
LD (rainfed) (kg/ha)					
rend 1985		1 100	950	950	985
rend 2000		1 200	1 200	1 200	1 200
aximum 2000		2 200	2 200	2 200	2 200
bjective 2000		1 750	1 750	1 750	1 750
UCTION :					
afed					
rend 1985		24 200	29 450	30 400	84 000
rend scenario 2000		50 400	60 000	66 000	176 400
ax. scenario 2000 (1)		78 750	141 750	155 750	376 250
igated					
bjective 2000	67 000		5 000		72 000
L					
otal maximum 2000	67 000	78 750	146 750	155 750	448 200
otal trend 2000	67 000	50 400	65 000	66 000	248 400

Maximum production 2000: interventionist surface x objective yield

1.2.6. Production trend scenarios for 2000

The combination of the various hypotheses envisaged in this section leads us to consider two contrasting production scenarios (see Table 5).

- A trend scenario corresponds to a situation in which existing projects would continue but with no new steps taken to do away with any limits to growth in surfaces in the south/east zones nor to accelerate the rate at which the recommended technical programs are spread. The irrigation development program, on the contrary, would be carried out in compliance with the government's interventionist objectives. Competitive conditions (relative prices and outlets) between millet and corn would not be modified in comparison with the present situation.

  In this scenario, the area under corn would increase considerably by replacing millet/sorghum. Yield would tend to level off at an intermediary level of 1,200 kg/ha. Rainfed production will reach 176,000 m.t. in 2000 and total production 248,000 m.t. as compared with 84,000 m.t. with the 1985 trend value.

- A maximum scenario includes the same steps taken to promote corn as those taken for millet and sorghum in the Millet Supply Study: improvement of farm equipment, generalized use of quality seed, generalized extension of existing projects to the entire corn production zone and use of average doses of fertilizer and herbicides by advanced farmers.

  In this scenario, the progression of surfaces would be far greater due to a higher rate of cleared land in the south/east zones. Mean yield would reach 1,750 kg/ha for a maximum potential of 2,200 kg. Rainfed production could reach 376,000 m.t. by 2000, i.e. a total production of 448,000 m.t. with irrigated production remaining unchanged compared to the preceding scenario.

1.3. Production development conditions and limitations

As concerns production conditions, the forecasts made in the preceding paragraphs show that even if no specific additional steps are taken, corn production should rise considerably over the medium-term, contrary to that for millet and sorghum. Such a projection obviously implies that outlets will increase at the same rate, and consequently that demand for human consumption will increase in order to maintain the parity pre-

sently observed with millet prices. It also implies that marketing conditions for all grains will improve as recommended in the Millet Supply Study, i.e. through a complete liberalization of the marketing system, parallel to a reinforced intervention structure for guaranteed minimum prices and the composition of a buffer stock in case of a surplus harvest.

To reach the level corresponding to the maximum scenario, however, it will be necessary to implement a development program aimed at doing away with factors limiting the intensification and extension of cultivated areas. Some of these limitations are common to both millet and corn, and steps to be taken to develop corn are only an extension of the program proposed to develop millet. Others are more specific and will consequently require actions specific to corn.

1.3.1. Seed supplies

The yield objectives envisaged in the maximum scenario presuppose the use of quality seed. High-yield varieties have been selected by Research for the various ecological zones. The present production and distribution levels remain quite low, nevertheless, in view of a theoretical demand which should reach 2,500 m.t. by 2000 (1).

The limitations and steps to be taken are the same as for millet and sorghum, i.e.:

- the reorganization of production and distribution channels, in the private sector wherever possible;
- the need for a temporary subsidy to set multiplication seed prices at a level which is not prohibitive (forecast cost of 225 F/kg);
- the indispensable creation of a fund for advanced seed production financing.

1.3.2. Fertilizer supplies

The present limitations in the fertilizer channel have far more effect on the potential development of corn than on that of millet, in that the recommended doses are higher for corn which responds better to fertilizer and corresponds to an agro-climatic zone where risks are sufficiently low to make average doses of fertilizer possible, generally speaking.

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(1) For composite varieties, renewable every 3 years for seeding at 35 kg/ha.

To the limitations and actions common to corn and millet (organization and privatization of import and distribution functions, need for temporary subsidy to increase profit-to-cost ratio to over 2) must be added a specific credit limitation. The doses recommended by Research (1) in order to reach maximum yield are 240 to 330 kg/ha, which represents a cost per hectare of 37,000 F at present prices. This is not compatible with the available financing of an average farm. It will therefore be indispensable to set up a generalized inputs credit system, as none exists presently except in projects in progress.

1.3.3. Herbicide supplies

The technology recommended to reach the yield objectives set implies the use of herbicides (1 to 1.5 l/ha), thereby considerably reducing the worktime obstacles, especially in Senegal Oriental and Upper Casamance.

Herbicide supplies, however, do not imply any specific limitations except for the creation of a distribution network, a problem similar to that for seed and fertilizer.

1.3.4. Farm equipment supplies

The renewal and extension of the present equipment has been almost stopped since the Farm Program shut down. In order to improve farming practices and reach the yield objectives, this will need to be revived; this will also be necessary for the extension of surfaces in Upper Casamance and Senegal Oriental.

The limitations and steps to be taken in this field are the same as those identified in the millet program: implementation of a general equipment credit system, organization of a private distribution system for material and spare parts.

1.3.5. Extension services

The propagation of the recommended technical packages obviously implies the development of an extension service network outside of zones already covered by present projects. The same structure, based on informed producer groups, could handle extension services for corn and millet.

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(1) All technical data in this section are taken from the FAO report on Grain Policy.

APPARENT CORN CONSUMPTION (in thousands of m.t.)

YEAR	NET PRODUCTION (1)	IMPORTS (2)	AID (3)	TOTAL	CONSUMPTION IN FLOATING AVERAGE OVER 3 YRS		POPULATION (thousands of inhabitants) (5)	INDIVIDUAL CONSUMPTION (flour equivalent) kg/ha
					GROSS	NET (4)		
1976	40	15		55				
1977	39	14		53	58	38	5 211	7
1978	30	35		65	59	39	5 357	7
1979	49	9		58	65	44	5 507	8
1980	41	20	11	71	63	42	5 661	7
1981	51	--	10	61	72	50	5 820	9
1982	85	--	--	85	75	52	5 982	9
1983	74	--	5	79	79	55	6 150	9
1984	61	5	8	74				

NOTES :

(1) MDR data minus 10% for loss and seed: production for year N corresponds to harvest N - 1/N.

(2) Source: USAID

(3) Source: USAID and balance sheet for food crops (Ministry of Planning)

(4) After deduction of processing losses (20%) and animal consumption (10,000 m.t./yr)

(5) According to Plan e

1.3.6. Returns on technical packages

Measured in terms of added value per hectare or income per work day (see Appendix A.2), the technical package corresponding to the proposed intensification level appears clearly more profitable for corn than for millet, due to its potentially high productivity. The integral application of the technical package will make it possible to pay 1,260 F for a work day instead of only 925 F at most for millet/sorghum.

2. CONSUMPTION AND PROSPECTS FOR BALANCED SUPPLY/DEMAND

2.1. Present consumption and trend

In the Senegalese nutritional system, corn can be eaten:

- green: in which case it does not compete with the other grains;
- in couscous prepared from semolina: in which case corn can partially or totally replace millet. Partial replacement should not change the taste in the eyes of Senegalese consumers, although no acceptance study has been made on this topic;
- as boiled broken corn: in which case the preparation obtained is similar to broken rice, although its taste and aspect are clearly identifiable.

Domestic corn demand is covered by domestic production (after deduction of a loss rate set at 10%), imports (free and not subject to any monopoly) and some years by food aid. The sum of these three supply sources, calculated as a three-year average to eliminate the effect of any differences in stock, measures the apparent national corn consumption. This consumption grows regularly (see Table 6) at a trend rate of about 4% annually, i.e. faster than population growth, reaching 79,000 m.t. in 1983-84, the last year for which figures are available.

Animal consumption is limited to the production of feed for modern aviculture and its present needs are some 10,000 m.t. per year. If this is excluded, demand is totally absorbed by human consumption, i.e. 69,000 m.t. in 1983-84. Apparent individual consumption, i.e. calculated on the population, increased from 7 kg per inhabitant per year in 1977 to 9 kg per inhabitant per year in 1984 (in flour equivalent).

As concerns this average consumption, the few specific surveys on consumption recently made show that there is a clear difference between rural consumption (10 kg/inhab/yr) and urban consumption (10 kg/inhab/yr).

In reality, these overall averages cover up major regional differences which are difficult to express in quantities:

- In rural areas, green or dried corn is traditionally consumed in Senegal Oriental and in some parts of Casamance where it is a complementary food crop to millet, consumed in broken form, as couscous or as gruel.

In Sine-Saloum where production is more recent, corn consumption has progressed, first as green corn between harvests when other grains are not ripe yet, then dried as an alternative to millet. Corn seems quite popular in this region where there are many artisanal mills, as it can be ground without any preliminary manual hulling, which is not the case for millet. It is always preferred to imported sorghum when local millet is short.

The same progressive introduction of corn seems to be occurring in the River Valley where irrigated production is developing.

In rural non-producer zones, consumption is almost nil.

- In urban areas, consumption is only traditional in regions that traditionally produce corn (Ziguinchor, Kolda, Tambacounda). Consumumption of green and dried corn is developing in the cities of Sine-Saloum and in Dakar to a lesser extent. The main form of development seems to be mixing more or less kernels of corn with hulled millet in preparing the artisanal cracked grain used for couscous.

Consequently, if consumption of green corn is excluded, being similar to the seasonal consumption of fruit and vegetables, the general progression of corn in human consumption is coming about "gently", without any breakdown in eating habits, as a partial replacement of millet in traditional dishes. In this process, corn benefits from certain advantages that probably explain its expansion:

. It can be ground directly, with no preliminary manual hulling (contrary to millet) in the numerous mills of Dakar and Sine-Saloum. This eliminates a long, fastidious operation.

. When ground without hulling, there is only limited loss in weight, while millet loses about 20% of its initial weight. This advantage means a monetary savings, even though small-scale corn grinding is slightly more expensive (difference of about 10 F/kg).

. As it does not need to be moistened for hulling, corn, as flour or semolina, can be stocked longer (several weeks rather than several days).

There is another way of expanding corn consumption which is not yet exploited in urban areas, or only on an experimental basis, but which is traditional in Senegal Oriental: as a replacement for rice (in preparing fish and rice especially) in broken form (corn rice). In this process, however, replacement does not appear to be spontaneous, although the experimental corn rice production unit in Sine-Saloum (part of the German-Senegalese project) has offered encouraging

results for product acceptability. In order to promote this new product, it would be a good idea to create a difference in price between corn and rice, in favor of the former. At the present gross grain prices on the market, this implies a subsidy.

2.2. Market prospects for 2000

According to Plan forecasts, corn needs for modern aviculture should not grow by more than 10% per year over the medium-term. By 2000 animal consumption should be some 25,000 m.t.

Human consumption needs by 2000 will be some 125,000 m.t. if the present market growth rate is extrapolated: 4%/yr, i.e. one point more than demographic growth and therefore a slow progression in human consumption. The overall market by this date will thus be 150,000 m.t.

In comparison, production forecasts are 248,000 m.t. according to the trend scenario (i.e. 223,000 m.t. after 10% deduction for losses) and 448,000 m.t. according to the maximum scenario (i.e. 403,000 m.t. after reduction and losses). Consequently in comparison with the trend consumption, there will be a net surplus of 73,000 to 253,000 m.t. of corn by 2000 according to the intensity of development efforts made for this crop.

Moreover, it should be remembered that the Millet Supply Study predicted a theoretical deficit of millet and sorghum of 301,000 m.t. by 2000 according to the trend scenario and 149,000 m.t. according to the interventionist scenario (with intensification, but without transfer of surfaces from groundnuts to millet).

A comparison of the provisional balance sheets for the two grains gives the following results (Table 7):

A. If no additional development action is taken (trend scenario), the theoretical millet deficit (301,000 m.t.) will be far more than the theoretical corn surplus (73,000 m.t.). This means that part of the theoretical demand not covered by millet could be filled by corn.

   Given the favorable attitude toward corn and the price equivalence between the two grains, demand will transfer naturally, especially through a growing incorporation of corn in domestic couscous preparation.

   This transfer in demand could easily concern a volume equivalent to the corn surplus (73,000 m.t.) in that this volume is only one-tenth of the theoretical millet de-

TABLE 7

MILLET/SORGHUM/CORN BALANCE BY THE YEAR 2000

SCENARIOS	MILLET/SORGHUM		CORN		TOTAL	
	TREND 2000	INTERVENTION 2000	TREND 2000	INTERVENTION 2000	TREND 2000	INTERVENTION 2000
Available domestic production (m.t.)	415 000	612 000	198 000	378 000	613 000	998 000
Theoretical demand (by 2000)						
• Individual (kg/inhab)	69	73	11	11	80	84
• Total (m.t.)(3)	716 000	761 000	125 000	125 000	841 000	886 000
Surplus/deficit (m.t.)	- 301 000	- 149 000	+ 73 000	+ 25 300	- 228 000	+ 104 000
Possible adjustment in demand (m.t.)	- 73 000	- 149 000	+ 73 000	+ 149 000	-	-
Surplus/deficit (m.t.) after adjustment	- 228 000	0	0	+ 104 000	-	-

(1) According to Millet Supply Study.

(2) Net of loss, in consumable equivalent, after deduction of animal consumption

(3) 1985 population: 6,519,000 inhab. 2000 population: 10,425,000 inhab.

mand (1). Consequently, only one-tenth of the theoretical millet demand needs to shift to corn to absorb the entire corn surplus. This shift would mean a doubling of the mean individual corn consumption compared to the present figures, i.e. 18 kg/inhab/yr by 2000 (2).

This leaves a large share of the theoretical millet demand unsatisfied by domestic production of millet or corn (301,000 - 73,000 = 228,000 m.t.). This must be covered by rice, imported sorghum, imported corn or wheat.

B. If, on the contrary, production development efforts make it possible to reach the interventionist scenario level, the theoretical millet/sorghum deficit would be reduced to 149,000 m.t. while the theoretical corn surplus would reach 253,000 m.t. Under these conditions, the corn surplus, in comparison with the trend demand, would not be totally absorbed by a transfer of unsatisfied theoretical millet demand to corn, even if sorghum imports are discontinued.

In order to increase domestic demand to the production level, it would be necessary to promote corn consumption to the detriment of rice (and also wheat), for which the balance will continue to show a strong deficit by 2000.

The total absorption of the corn surplus in comparison to theoretical demand (253,000 m.t.) would require an additional rise in consumption to the detriment of rice and wheat of 104,000 m.t. (i.e. 10 kg/inhab/yr), added on to an increase in consumption to the detriment of millet of 149,000 m.t. (i.e. 14 kg/inhab/yr, or the equivalent of the theoretical millet deficit at this date).

For such a millet transfer to occur, corn should benefit from the same consumer promotion efforts as millet, and especially from the promotion of industrial processing in a form directly usable by the consumer in making couscous.

Substitution of corn for imported grains (rice and wheat) would require the promotion of other industrial channels:

- the production of corn rice and the promotion of this new product at a competitive, and perhaps subsidized, price;

- the use of corn meal as a substitute for durum wheat in the manufacture of pasta and biscuits, although the quantities involved are very limited;

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(1) 716,000 m.t. in 2000 according to Millet Supply Study.
(2) Human consumption = Net production (223,000 m.t.) minus animal production (25,000 m.t.), i.e. 197,000 m.t. Population 2000 = 10,426,000 inhab (see population forecast. Appendix 4 - Millet Supply Report)

- the use of corn flour in the manufacture of bread. Experimentation has shown that this is technically possible without causing any problems up to a content of 15%. It would cause complex logistic, psychological and economic problems, however, as proven in the Pamiblé operation;

- the use of corn by breweries.

2.3. Conclusion

The analysis of consumer habits shows that there is a natural possibility of replacing millet by corn in the Senegalese context.

The trend which aggravates the millet/sorghum deficit will probably accentuate this substitution phenomenon, with domestic corn production continuing to grow faster than will population and millet/sorghum growth stagnating. In the trend scenario, that is to say without any intervention to develop grain production, this natural substitution phenomenon should be sufficient to absorb corn production which will continue to increase spontaneously.

On the other hand, as the interventionist scenario corresponds to a vigorous action to develop grain production, there may be a resulting overproduction of corn on the medium-term horizon if nothing is done to encourage replacing imported grains by corn. Under these circumstances, additional corn production would far exceed the theoretical millet/sorghum deficit and the mere substitution of one grain for another would not lead to its absorption.

These observations lead us to set a priority: the promotion of corn in urban and rural consumption as part of a long-term self-sufficiency strategy.

For rural consumption, corn promotion means the multiplication of artisanal mills in zones where they are lacking. This would provide ground corn without hulling and thereby give this grain a user advantage over millet.

For urban consumption, offering the consumer a processed industrial product at a competitive price would be an added incentive for consumption. Here two channels should be considered:

- the flour channel (couscous, thereby accelerating the replacement of millet/sorghum by corn);

- the "corn rice" channel to initiate the replacement of rice by corn.

3. COMMERCIALIZATION AND POSSIBLE CORN SUPPLIES

3.1. Commercialization

There are two general corn marketing possibilities:

- commercialization of green corn, highly seasonal and similar to that for fruit and vegetables;
- commercialization of dried corn, presenting the same characteristics as millet commercialization.

As millet marketing circuits were analyzed in the Millet Supply Study, only the main characteristics of the circuit will be reviewed here, along with the specific points of corn marketing.

. The privileged marketplaces for both grains are the weekly markets where producers sell their goods in small quantities.

. The main operators on these circuits are the rural wholesalers and the grain wholesalers in cities in the interior. While all millet wholesalers do not deal in corn, all corn wholesalers, on the contrary, deal mainly in millet. This results in a greater concentration of corn marketing than millet, with the inherent risk of lesser competition and "arrangements" between operators. Therefore, while the market is highly competitive for millet, there is a far greater margin for speculation for corn.

. Corn, as well as millet, commercialization is marked by obvious seasonal rhythms: wide-spread sales (at a minimum price) between the grain and cash crop harvests, sharp slowdown during the cotton and groundnut payments, slight upturn (at far higher and rising prices) until the next harvest.

Official, government-set prices are the same for both grains (70 F/kg in 1985-86). Average market prices are also identical or very similar, which shows that consumers could easily substitute one for the other.

Although statistics on corn are very limited, it would seem that the greater concentration of operators, the limited nature of the urban demand and the greater geographic concentration of production, especially in regions far from urban centers (Senegal Oriental, Upper Casamance), lead to producer prices far more sensitive to variations according to the harvest. In case of a surplus harvest, real producer prices

in Senegal Oriental drop below the official minimum prices and below real prices for millet/sorghum.

While corn marketing presents the same general characteristics as for millet, the weaknesses of the system seem aggravated: major fluctuations in producer prices according to the harvest, irregular outlets in case of a good harvest, lack of any price and stock regulation organization. The reinforcement of the role theoretically played by the CSA at present within a more appropriate framework (1) appears to be a high priority prerequisite for the development of corn production.

3.2. Plant supply possibilities and methods

The initial project (2) for first and second millet processing plants sets an annual supply rate of 10,000 m.t. from Year 1 to Year 5, then 20,000 m.t. from Year 5 to Year 10 and 30,000 m.t. as of Year 10. The project study proposed a supply system which bought from regional wholesalers at harvest to cover all annual needs, with a purchase point in Kaolack for Phase One and a second purchase point at Tambacunda for Phase Two. The object of the present paragraph is to study any modification of this supply plan for an industrial alternative hypothesis using 50% millet and 50% corn. This means corn supplies of 5,000 m.t./yr, then 10,000 and 15,000 m.t./yr according to the phase.

The limited data available on regional consumption levels, which probably vary greatly, make it impossible to draw up regional balance sheets defining any eventual surplus to be commercialized. Qualitative evaluations as well as the study of major commercial trends make it possible to provide some information.

The major commercial trends seem to have their source in Sine-Saloum, a producer region which still consumes little corn. Any surplus from Upper Casamance finds a natural outlet in Middle and Lower Casamance, regions with a structural deficit in food crops. Senegal Oriental, a region with strong traditional consumption but a low population, exports its surplus to the Bassin Arachidier, Dakar, Casamance, Gambia or occasionally Mali.

If mean individual consumption is estimated at 15 kg/inhab/yr for Sine-Saloum and Senegal Oriental (3) for a population of 1,694,000 in 1985, the present mean surplus of the zone would be some 23,000 m.t. Consequently, according to these highly

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(1) See recommendations of Millet Supply Study (Chapter 4).
(2) Object of Millet Supply Study.
(3) According to data supplied in FAO Grain Policy Study.

approximate calculations, this zone could supply the required 5,000 m.t. to the plant over the short-term. As for the medium- and long-term, Senegal Oriental will offer the greatest surplus, given its considerable potential and a population which is growing at a medium rate.

These observations are valid for average years. The analysis of variations in yield as a function of climatic conditions (carried out in Chapter 4 of the Millet Supply Study) shows that corn production zones run a risk of a 25% drop in yield one out of every three years. In this case, the Sine-Saloum and Senegal Oriental zone would have a deficit of 11,000 m.t. (1) at present production rates and it would become as difficult to supply the plan with corn as with millet/sorghum. In this last case which would only occur one out of every three years under present conditions, it is always possible to turn to imports; this is not possible for millet which is not covered in international exchanges.

By 2000, and even over the medium-term, this risk of an insufficient supply will disappear, given the sharp growth expected for production and the use of irrigation which limits climatic hazards.

The similarity of the marketing systems makes it possible to envisage using the same supply method for millet and corn, with a purchase point in Kaolack for Phase One and a second purchase point in Tambacounda in Phase Two. As for millet, the present system of one official minimum price for the entire territory would be incoherent for purchases in Tambacounda. This price clearly does not correspond to market realities, as all existing studies show that prices are far lower in Senegal Oriental, a fact which is justified by the additional transport costs from this region. For purchasing to be economically feasible in Tambacounda, the officiel price system must be modulated, or the plant must be authorized to buy at market prices if they are lower. This is a particularly important point for corn, given the potential of Senegal Oriental and the high variability of market prices.

Generally speaking, average millet and corn prices being identical, we can base our calculations on the same provisional supply costs, i.e. 85 F/kg delivered to the Kaolack store. By comparison, the corn import cost (end of 1985) is 100 F/kg at the Dakar warehouse, based on the latest international prices and the customs duties in force (15%). Parity with local costs could be obtained by temporary tax waivers in case of catastrophic harvests.

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(1) Reduced production = (30,400 m.t. + 24,200 m.t.) x 0.75 x 0.9 (mean losses); identical consumption

IRRIGATED GRAIN PRODUCTION FORECAST FOR 1995

SOUTH AND EAST SENEGAL REGIONS	1995/96		1985	
	PADDY T	CORN T	PADDY T	CORN T
RICE water-controlled	126 000 t (55 000 ha)			
RICE irrigated				
. ANAMBE perimeter	30 000 t (5 000 ha x 5 t)	5 000 t (1 000 ha x 5 t)		
. GAMBIA perimeter	5 000 t (650 ha x 8,3 t)	-		
SUBTOTAL	161 000 t	5 000 t	55 000 t	-
SENEGAL RIVER				
. SAED perimeter developed July 1st, 1985	236 000 t (24 600 ha x 1,6 x 6 t)	24 600 T (24 600 x 0,2 x 5 t)	87 000 t (1) (18 000 ha)	8 000 t (1)
. Young workers home (DELTA)	16,200 t (1 500 ha x 1,8 x 6 t)	-	6 000 t (1 500 ha x 4 t)	-
NEW PERIMETERS				
. Grain	262 500 t (35 000 ha x 1,5 x 5 t)	28 350 t (35 000 ha x 0,18 x 4,5 t)		
. Tomato (3,000 ha)	for info.			
SUBTOTAL	514 700 t	52 950 t or 53 000	93 000 t	8 000 t
T O T A L (GRAIN)	675 000 t	58 000 t	148 000 t	8 000 t

Source : FAO Grain Policy report (1985) Appendix I.

APPENDIX A.2

COMPARATIVE PROFITABILITY OF CORN AND MILLET TECHNICAL PACKAGES

TABLE 1: GROSS (FINANCIAL) MARGINS IN CORN GROWING (in constant 1985 CFA Fr)

	YIELD	PRICE	GROSS INCOME	MONE-TARY COSTS	GROSS MARGIN	WORK DAYS	NET INCOME PER W.D.
	(kg/ha)	(F/kg)	(———	(F/ha)	———)	(W.D./ha)	(F)
SINE SALOUM							
Present	1 100	80	88 000	14 660	73 000	85	860
Future without intensification	1 200	80	96 000	17 760	78 240	88	890
Future with intensification	2 200	80	176 000	65 170	110 830	88	1 260
CASAMANCE							
Present	950	80	76 000	13 060	62 040	82	770
Future without intensification	1 200	80	96 000	17 760	78 240	88	890
Future with intensification	2 200	80	176 000	65 170	110 830	88	1 260

TABLE 2: GROSS (FINANCIAL) MARGINS IN MILLET/SORGHUM GROWING (in constant 1985 CFA Fr)

B.A. NORTH							
Present	350	80	28 000	6 300	21 700	50	435
Future without intensification	350	80	28 000	6 300	21 700	50	435
Future with intensification	500	80	40 000	9 250	30 750	60	515
B.A. CENTRAL							
Present	525	80	42 000	6 300	35 700	54	660
Future without intensification	525	80	42 000	6 300	35 700	54	660
Future with intensification	800	80	64 000	14 295	49 705	71	700
B.A. SOUTH							
Present	660	80	52 800	6 300	46 500	60	775
Future without intensification	660	80	52 800	6 300	46 500	60	775
Future with intensification	1 100	80	88 000	19 130	68 870	81	850
CASAMANCE							
Present	730	80	58 400	6 300	52 100	65	800
Future without intensification	730	80	58 400	6 300	52 100	65	800
Future with intensification	1 200	80	96 000	19 130	76 870	83	925

Source : According to FAO Grain Policy study