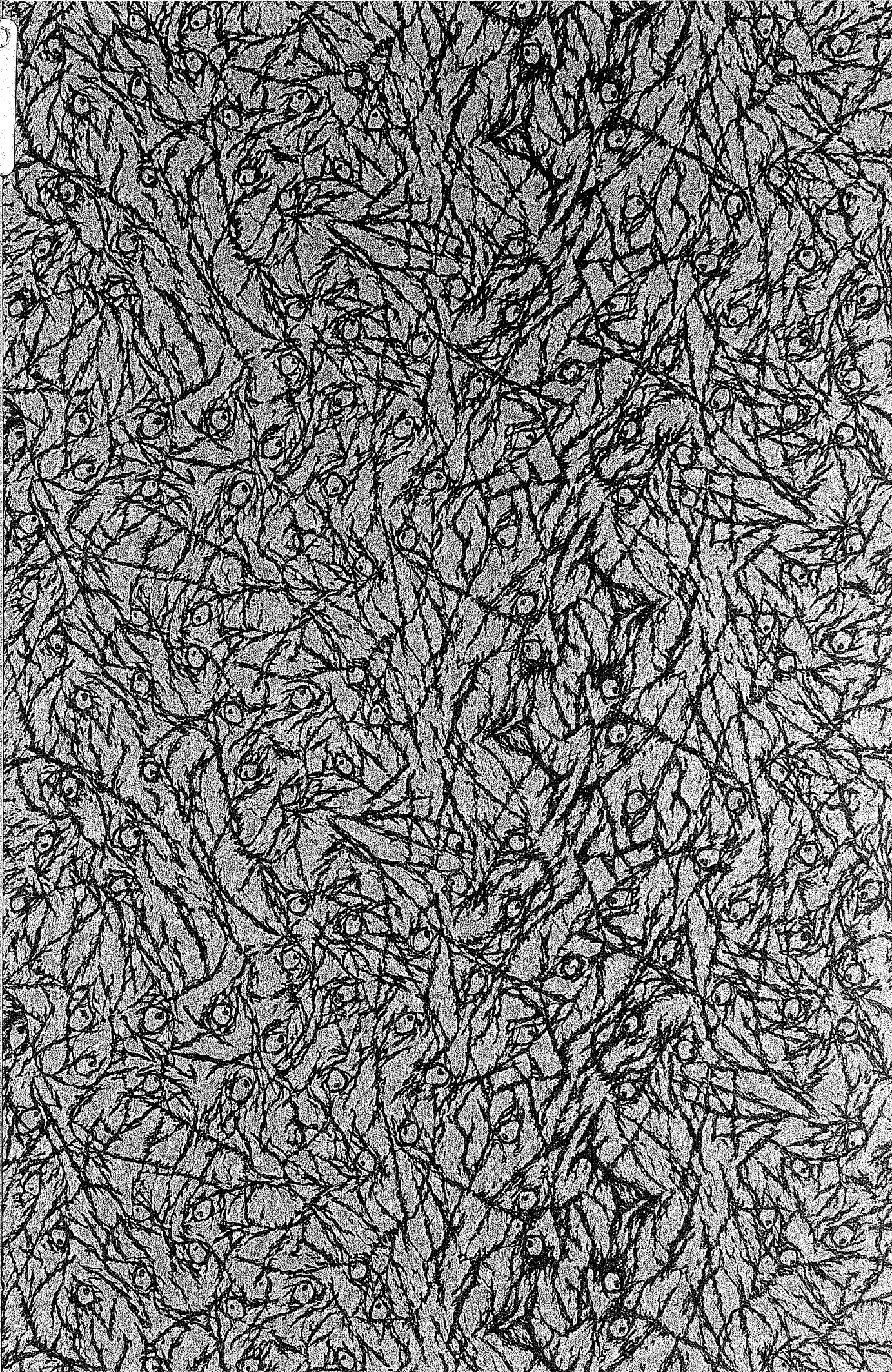


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RURAL INCOME DISTRIBUTION IN SENEGAL:
CHANGES AND INDICATORS

by
Gérard Chambas



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RURAL INCOME DISTRIBUTION IN SENEGAL:
CHANGES AND INDICATORS

by

Gérard Chambas*

Translated by Karin Lindgren

Discussion Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Discussion Papers should be cleared with the author to protect the tentative character of these papers.

* * *

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ABSTRACT

This paper examines the degree of rural income inequality in Senegal and the determinants of the inequalities observed. Two data sets are analyzed. The first contains time-series data on aggregate rural income by region. It is found that in years of abundant agricultural production, income disparities between regions are reduced. The second data set relates to household income in three villages. Despite the general impression that rural incomes in Africa are quite evenly distributed, the village data indicates major inequalities. The inequalities arise from differences in land areas farmed and in yields obtained.

RESUME

Ce rapport examine le degré d'inégalité des revenus ruraux au Sénégal et les facteurs déterminants des inégalités notées. L'analyse porte sur deux séries de données, dont la première consiste en des données temporelles sur le revenu global de chaque région. L'on constate que, lors des années de production agricole abondante, les inégalités de revenu entre les régions sont atténuées. La deuxième série de données concerne le revenu ménager dans trois villages. Malgré l'impression que la distribution des revenus ruraux à travers l'Afrique est tout à fait égale, les données sur les villages indiquent qu'il existe des inégalités importantes. Ces inégalités résultent des différences de superficies cultivées et de rendements obtenus.

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INTRODUCTION

The distribution of income is a fundamental indicator of development in Third World countries. It is therefore crucial to analyze income concentration in these countries and to identify its principal indicators. Considerable research has been done on this subject: in many countries, quantified data on inequality are available¹ because important studies² have identified some indicators of inequality. However, there still exist some gaps in the geographic areas covered, the sectors studied and the nature of the data.

Few studies have focused upon income distribution in African countries south of the Sahara. Nonetheless, this geographic area includes many countries in which income inequalities and widespread poverty are indeed partially responsible for unusually slow development. Moreover, income concentration is often more thoroughly analyzed among modern and informal sectors in urban areas than in rural areas: statistics necessary for computing rural income are often lacking, especially data concerning income earned from products that are marketed without government inventory and inspection. The development of most African countries necessarily depends on progress made by the agricultural sector:³ it is therefore especially pertinent to determine the level of rural income concentration, which is an important indicator of rural development and hence of the general development of African countries. Finally, one rarely has access to statistics that would permit a study of changes of inequality, or changes of certain aspects of inequality, in a given country over a period of several years. Inequalities within the agricultural sector seem subject to considerable changes due to variations of production volumes or prices obtained by rural producers.

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However, the author accepts sole responsibility for any omissions or errors in this paper.

Also, in order to partially compensate for various gaps in the case of Senegal, we will analyze relative distribution⁴ and changes in the distribution of rural income in Senegal. Two phenomena make such an analysis particularly relevant. On the one hand, the relative concentration of farm income in Senegal is a crucial indicator of general income inequality: the rural sector includes the majority of the Senegalese population⁵ and, most likely, an even higher proportion of the poor population. The combination of inequality and low income within the rural sector could partially account for certain economic problems in both the rural and urban sectors of Senegal. On the other hand, during the 1970's Senegal experienced significant fluctuations of farm product values due to various factors (climate, organization of input supplies, organization of marketing activities, producer price policy, etc.). These changes certainly caused considerable variations in income concentration.

The goal of this paper is to analyze relative income concentration in Senegal, and to isolate the major factors responsible for this concentration.

I. RURAL INCOME DISTRIBUTION IN SENEGAL: AN ANALYSIS

Until the present, the Senegalese rural sector has not been the focal point of an income or food consumption survey based upon a statistically representative sample. Thus, we do not have access to any data that would provide a direct estimate of the extent of rural income inequality between households in Senegal.⁶

However, some data concerning changes in rural income inequalities on a regional basis between 1970 and 1977 are available.⁷ Moreover, a recent survey⁸ of three villages in the Diourbel region permits the analysis of income inequalities within rural villages in Senegal.

After analyzing changes in regional income distribution and income inequalities within villages included in the CRED study, we will try to determine the extent of rural income inequality in Senegal using the results of these two studies.

A. Changes in Regional Distribution of Rural Income in Senegal

First, let us specify the definition of income chosen for this analysis of changes in the regional distribution of rural income: income is equivalent to the value added from agriculture, livestock raising, forestry and non-

commercial fisheries. This definition does not include income drawn from commercial fisheries, which, in certain regions, is a significant portion⁹ of the primary nonmining sector's total income. Moreover, this definition of income excludes income from trade and artisan activities in rural areas, as well as money transfers from migrants to persons living in rural areas.

Given this restrictive definition of income, data on rural income distribution will be presented, and changes in distribution will be analyzed.

1. Data on changes in rural income distribution, 1970-1977. -- Table 1 summarizes the data base concerning changes in rural income distribution in Senegal from 1970 to 1977: for each year, there exist data on per capita rural income in various regions.

Graph 1 illustrates changes in rural income distribution. We have chosen to represent rural income of each region in current CFA francs because we are concerned with changes in relative differences among average incomes in various regions during a given year. This relative difference can be appreciated when income is expressed in current CFA francs.

2. Analysis of changes in rural income concentration. -- In order to analyze changes in income concentration, the cumulated distribution for various years is computed as the percentages of aggregate rural income received by groups classed in increasing order of income (Table 2).

A graph of the Lorenz curves associated with income distribution during the years in question would be relevant to our analysis of changes in rural income concentration. However, a brief study of data in Table 2 reveals that graphic representation would be difficult for some distributions. Thus, we have drawn a graph to illustrate the difference between the portion of income actually obtained by various percentiles of the population and the portion that they would have obtained in a situation of "perfect equality."¹⁰ A situation of "perfect equality" is represented by the diagonal associated with the Lorenz curve.

Graph 2¹¹ shows the years of greatest regional inequality (1973, 1974, and to a lesser degree, 1971) and years of less significant inequality (1972, 1975, 1976, 1977). This visual observation is confirmed by computation of the Gini indices that measure relative income inequality among different rural areas from 1970 to 1977.

TABLE 1: RURAL INCOME DISTRIBUTION IN SENEGAL FROM 1969/70 to 1976/77

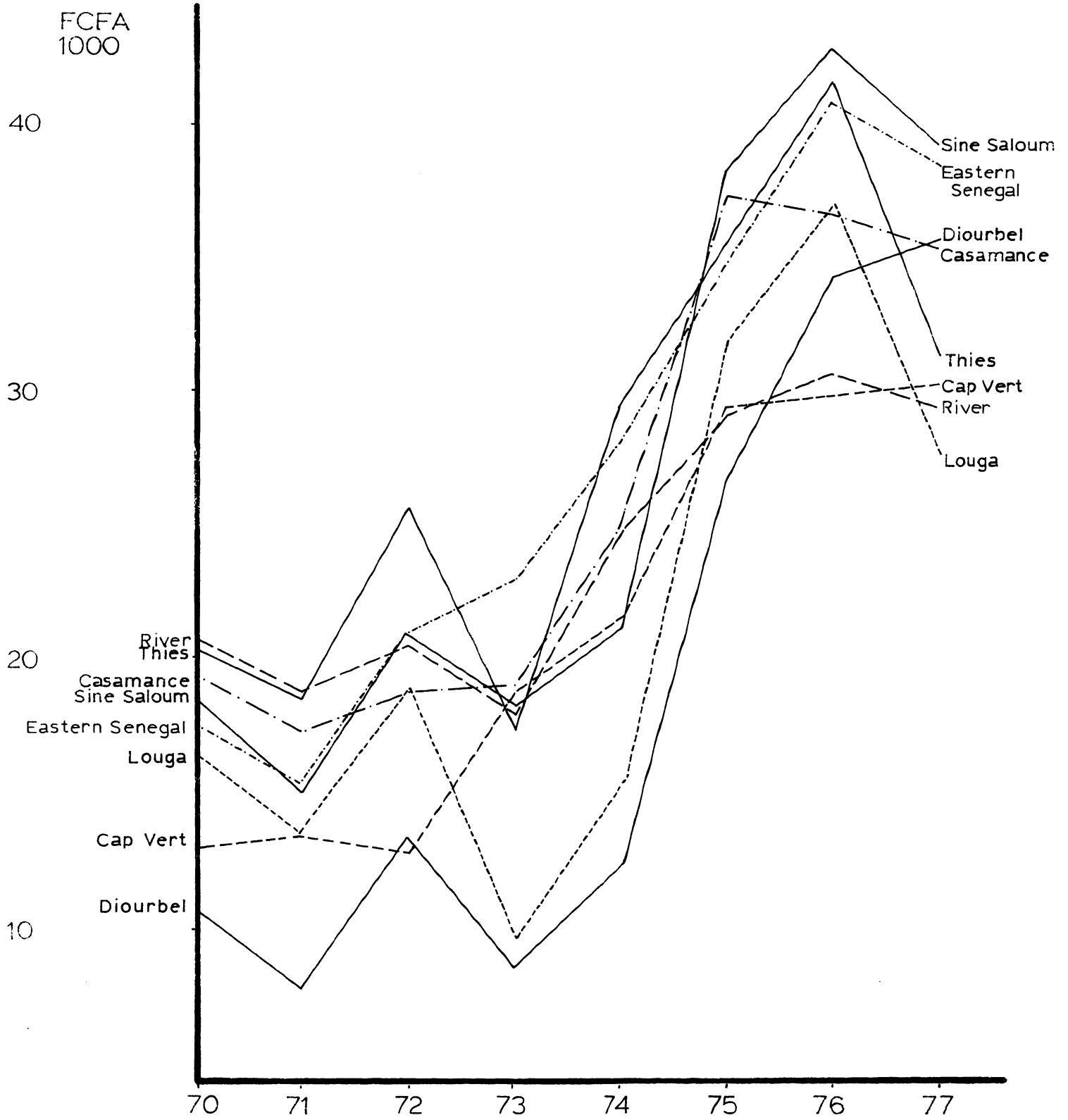
1969/1970			1970/1971			1971/1972			1972/1973		
Region ^a	Income ^b	Population ^c	Region	Income	Population	Region	Income	Population	Region	Income	Population
River	20693	369.4	River	18737	377.7	Thiès	25692	442.0	Eastern Senegal	22849	240.8
Thiès	20368	413.5	Thiès	18585	427.6	Eastern Senegal	20817	233.9	Sine Saloum	18979	805.7
Casamance	19265	573.1	Casamance	17195	580.8	Sine Saloum	20816	784.6	Casamance	18955	595.3
Sine Saloum	18434	744.0	Eastern Senegal	15020	227.3	River	20380	386.4	Cap Vert	18692	168.2
Eastern Senegal	17576	220.7	Sine Saloum	14917	764.1	Louga	18798	352.7	Thiès	18298	457.0
Louga	17413	337.4	Louga	13618	344.9	Casamance	18693	588.2	River	17841	395.1
Cap Vert	12906	171.0	Cap Vert	13536	170.8	Diourbel	13218	314.5	Louga	9415	360.5
Diourbel	10570	301.6	Diourbel	7474	307.9	Cap Vert	12696	169.9	Diourbel	8371	321.0
1973/1974			1974/1975			1975/1976			1976/1977		
Region	Income	Population	Region	Income	Population	Region	Income	Population	Region	Income	Population
Thiès	29399	472.0	Sine Saloum	38200	849.1	Sine Saloum	42878	871.5	Sine Saloum	39231	894.9
Eastern Senegal	28104	275.8	Casamance	37270	608.9	Thiès	41686	504.6	Eastern Senegal	38562	269.1
Casamance	24917	602.2	Thiès	35608	488.2	Eastern Senegal	40815	262.5	Diourbel	35424	349.4
River	24756	403.9	Eastern Senegal	34941	255.2	Louga	37043	384.9	Casamance	35162	622.8
Cap Vert	21277	168.2	Louga	31976	376.6	Casamance	36645	615.2	Thiès	31193	519.7
Sine Saloum	21054	827.1	Cap Vert	29207	162.7	Diourbel	34142	341.4	Cap Vert	30208	154.2
Louga	15202	368.5	River	29060	412.8	River	30671	421.9	River	29366	432.4
Diourbel	12206	327.7	Diourbel	26670	334.5	Cap Vert	29975	158.4	Louga	27598	391.3

SOURCE: Based on information from Ministère du Plan et de la Coopération, Données socio-économiques régionales.

NOTES: (a) Regions are classified by decreasing order of average income.

(b) Income computed here (in CFA Francs) is per capita income; the chosen definition of income is specified earlier in this paper.

(c) Population is in units of 1,000 throughout this paper.



Graph 1 Fluctuations of Per Capita Rural Income from 1970 to 1977, by Region (Source: Table 1)

TABLE 2: CUMULATED RURAL INCOME DISTRIBUTION FROM 1969/70 TO 1976/77

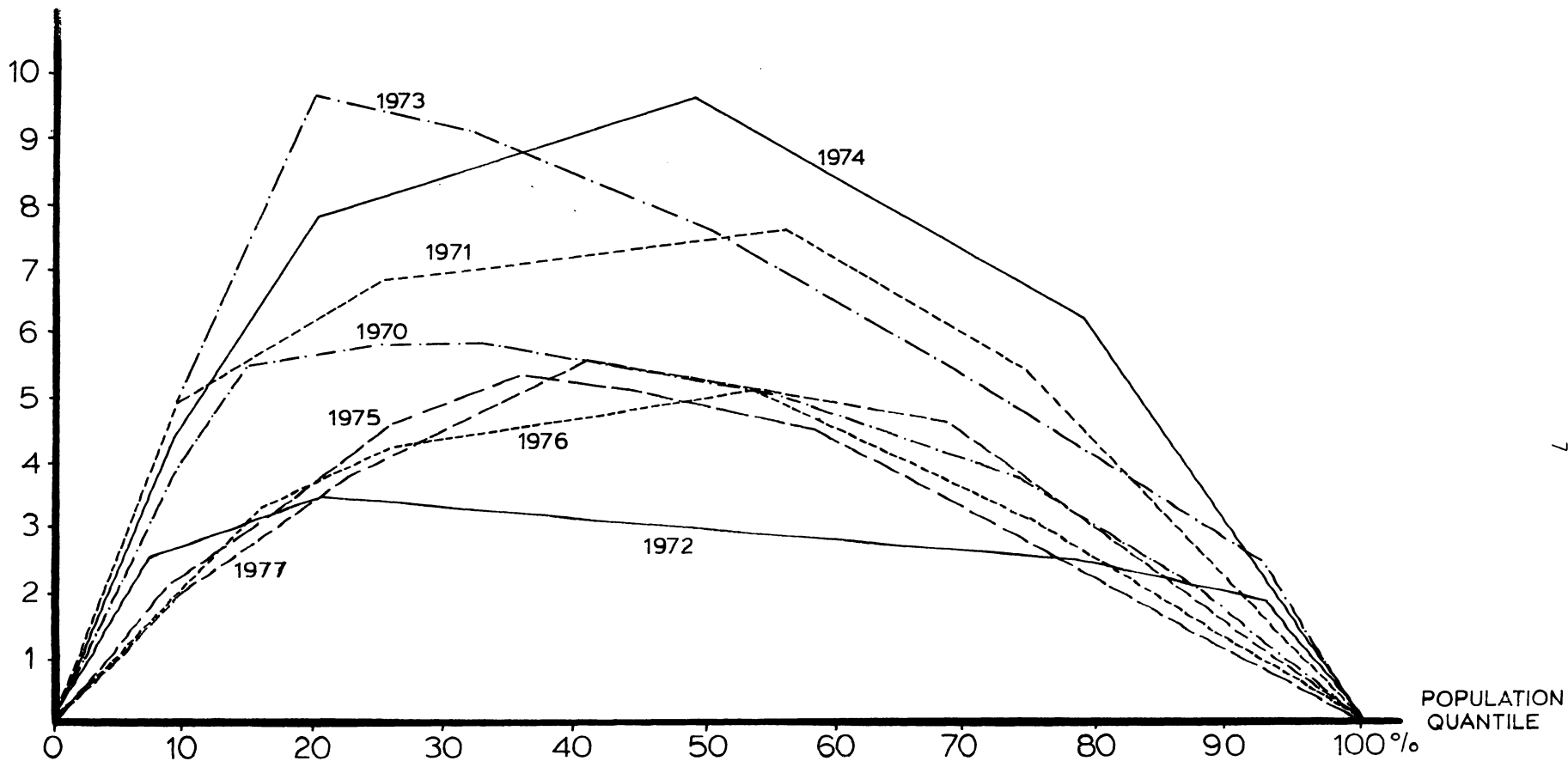
1969/1970		1970/1971		1971/1972		1972/1973	
Cumulated Population ^a	Cumulated Income ^b	Cumulated Population	Cumulated Income	Cumulated Population	Cumulated Income	Cumulated Population	Cumulated Income
9.6	5.7	9.6	4.7	2.5	1.6	9.6	4.7
15.1	9.6	14.9	9.4	7.2	4.7	20.4	10.7
25.9	20.1	25.7	18.9	15.9	12.8	32.2	23.1
32.9	27.1	49.6	42.1	21.1	17.7	45.9	37.9
56.7	51.6	56.7	49.1	78.4	75.9	50.9	43.4
75.0	71.3	74.8	69.4	90.0	88.0	68.7	63.3
88.2	86.3	88.2	85.6	93.4	91.6	92.8	90.3
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1973/1974		1974/1975		1975/1976		1976/1977	
Cumulated Population	Cumulated Income	Cumulated Population	Cumulated Income	Cumulated Population	Cumulated Income	Cumulated Population	Cumulated Income
9.6	5.2	9.6	7.4	4.4	3.5	10.8	8.7
20.4	12.6	21.4	17.6	16.3	13.1	22.7	18.9
44.6	35.3	26.1	21.5	25.9	21.7	26.9	22.7
49.5	40.0	36.9	31.6	43.2	38.4	41.2	35.7
61.3	53.1	44.2	39.1	54.0	48.9	58.3	53.4
78.9	72.7	58.2	53.7	61.3	56.8	68.0	63.4
86.1	81.8	75.6	72.8	75.5	72.4	75.4	71.7
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

SOURCE: Computed from information in Table 1.

NOTES: (a) Population (given in %) is ranked in increasing order of income.

(b) Each region's share of income is calculated by dividing Senegal's total rural income by total income of population of said region.

DIFFERENCE BETWEEN PORTION OF INCOME EARNED BY
VARIOUS POPULATION PERCENTILES AND THE PORTION
THEY WOULD EARN IN A SITUATION OF PERFECT EQUALITY



Graph 2 Changes in regional income inequalities from 1970 to 1977 measured by the difference between the portion of income earned by various population percentiles and the portion they would earn in a situation of "perfect equality" (Source: Table 2)

TABLE 3

GINI INDICES MEASURING REGIONAL RURAL INCOME CONCENTRATION
FROM 1969/70 TO 1976/77

Year	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77
Gini index	0.0810	0.1058	0.0512	0.1170	0.1276	0.0642	0.0644	0.0686

SOURCE: Computations based on Table 2.

Graph 3 represents changes in inequality measured by the Gini index, and reveals two principal phases of change in regional income distribution in Senegal:

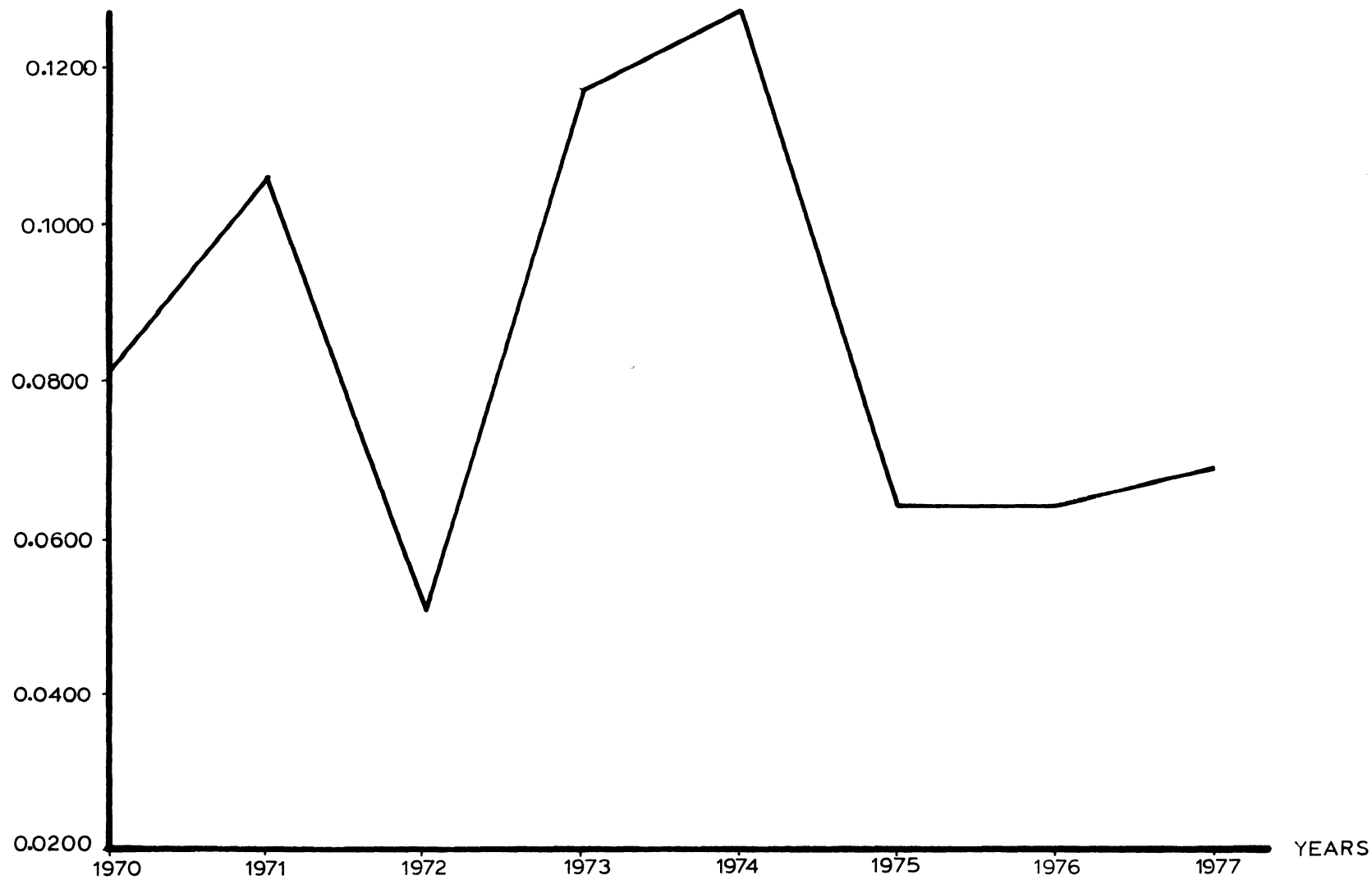
- the years 1970-1974 comprise a period of increasing inequality, with the exception of 1972, when there was a sharp decline in inequality;
- between 1974 and 1977, there was a sharp decline in regional inequality.

It is necessary to indicate that the Gini index indicates changes in regional inequality but does not provide for an objective, year-by-year categorization of the various income concentrations. We are considering cases in which the Lorenz curves intersect¹² (see Graph 2); we should therefore be cautious when interpreting Graph 3¹³ (cf. Graph 4).

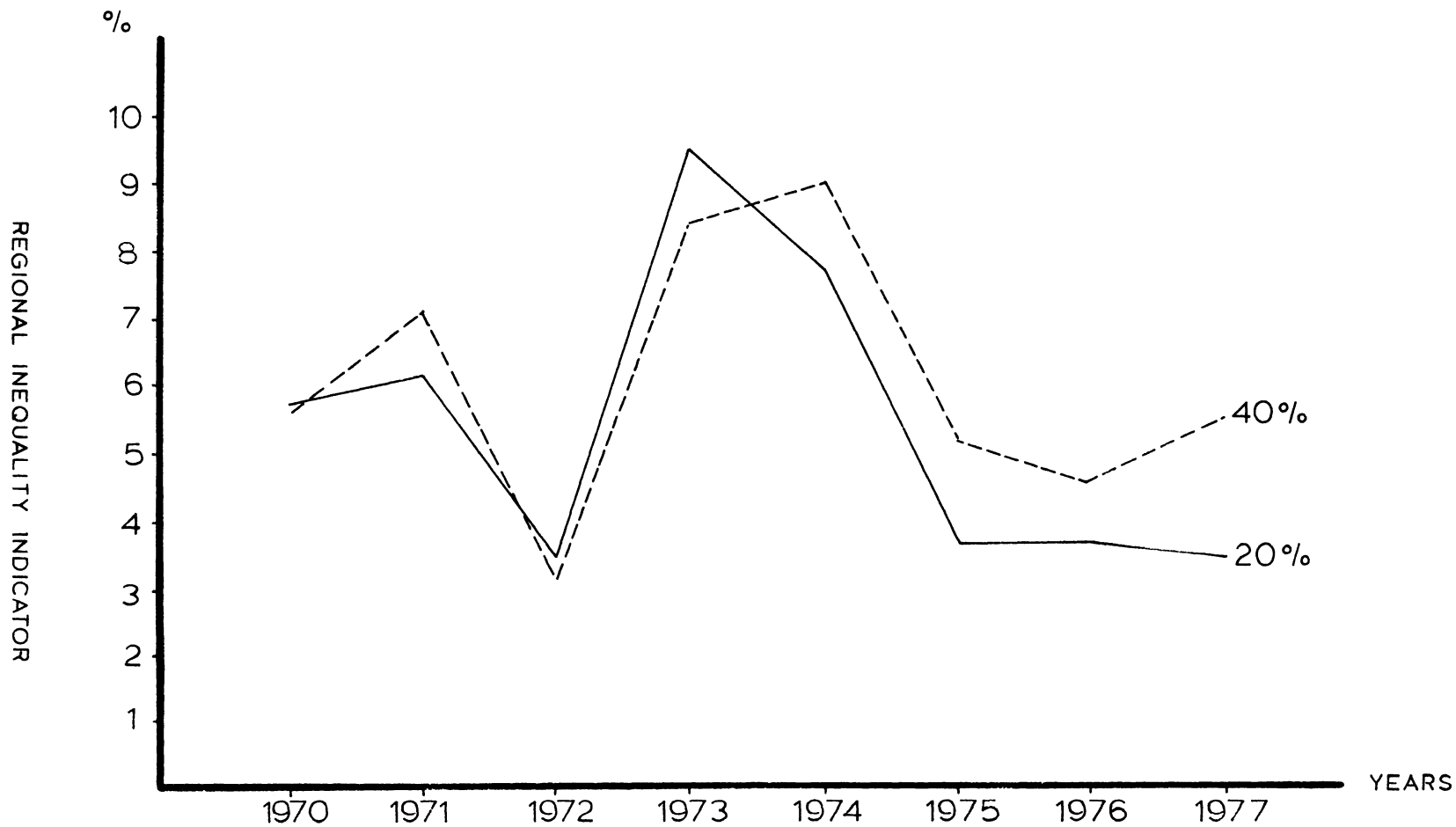
It is equally necessary to be careful when determining the extent of inequality between regions: in particular, the Gini index values are not comparable to those associated with personal income distribution. It will be noted that the rather low Gini index values (Table 3) are compatible with significant relative differences of average income between regions (Table 1, Graph 1).

Having analyzed the changes in regional income distribution, we will determine the extent of rural income inequality using results of a survey conducted in the Diourbel region.

GINI INDEX



Graph 3 Changes in interregional income concentration in Senegal from 1970 to 1977 (Source: Table 3)



Graph 4 Changes in regional inequalities from 1970 to 1977 measured by the difference between the portion of income earned by the lowest 20- 40 percent of the population and the portion of income that they would have earned in a situation of perfect equality (20% and 40% respectively)

B. Income Inequalities within Rural Areas: Diourbel Region Case Study, 1981

The inequalities observed here concern the Diourbel area. The analysis is based on a survey¹⁴ concerning three villages with diverse characteristics. A sample population of 720 persons living in the villages was studied; particular attention was paid to income distribution.

We will summarize the survey results before analyzing their significance:

1. Survey results. -- First, it is necessary to explain the definition of income chosen by the researchers. During this survey, rural income was defined as the sum of the value of the total grain product, the value of marketed products (minus the value of grain sales), and the value of income earned through business and nonfarm activities.

This definition of rural income gives rise to differing opinions concerning what it includes and what it excludes.

a) First, the definition of income chosen for this study is more extensive than the preceding definition in that it includes nonfarm rural income (earned through handicrafts and trade).¹⁵

Moreover, this definition of income includes activities which are, in fact, a liquidation of capital. In Thienthié, enumerators recorded unusually large sales of horses and farm implements.¹⁶ Counting these sales as farm income when they actually are liquidations of assets causes us to underestimate income inequalities, for this liquidation was observed primarily in the poorest sample village.

Finally, the concept of income chosen for this survey is a concept of gross income: the cost of inputs is not deducted from the income value. This choice of concept implies an even more significant overestimation of income, as the cost of inputs is relatively high in proportion to total income. This could cause us to overestimate inequalities if we suppose that farmers with higher incomes use a larger share of inputs.

b) The definition of income does not include certain factors that can have a marked effect on the appraising of rural inequalities.

It excludes the value of subsistence crops other than grains. It is difficult to determine in which way the inequality estimate is biased. Often, the value of subsistence crops increases as income decreases; i.e., production of crops for household consumption and income are inversely related. However, certain factors can produce the opposite effect. For example, household consumption of milk is high in the Serrer village, which is also the wealthiest sample village.

The survey did not take into account income sent by migrants to their village of origin, nor income transfers within villages (transfers between family members,¹⁷ aid provided by religious organizations, etc.). This chosen definition of income seems likely to cause an underestimation of the poorer families' income, and in turn, an overestimation of income inequality.

Having analysed the definition of income chosen for this survey, we will present the principal data needed in order to estimate relative income concentration within the studied population (Table 4).

TABLE 4: RURAL INCOME DISTRIBUTION IN THE DIOURBEL REGION
FOR THE 1980/81 GROWING SEASON

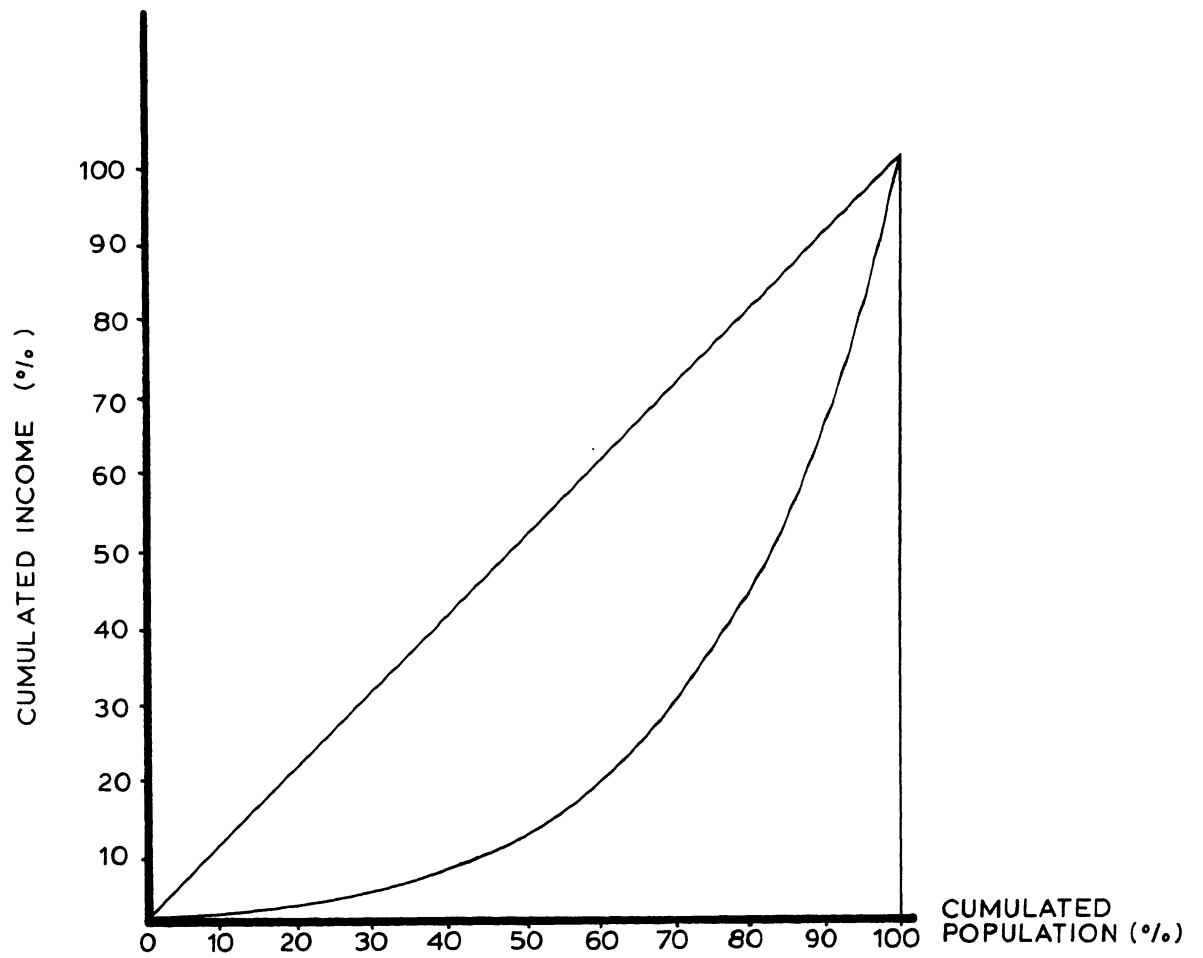
Population decile classified by increasing order of income (%)	Average household income of each population decile (CFA Francs)	Cumulated share of income for various population deciles (%)
1	4017	0.33
2	12203	1.33
3	22169	3.15
4	34295	5.96
5	52667	10.27
6	90547	17.69
7	130114	28.35
8	179307	43.04
9	263279	64.60
10	432003	100.00

SOURCE: Computed data based on Center for Research on Economic Development, Consumption Effects of Agricultural Policies, p. 247.

NOTE: Estimate based on selected sample population in three villages.

The Lorenz curve drawn from the data in Table 4 (Graph 5) and the Gini index estimate associated with this distribution ($G = 0.5506$) indicate that there is a significant relative inequality of rural income within the sample studied. Moreover, it is important to take note of the extremely unfavorable situation of the people in the first deciles: households in the lower forty percent earn only 5.96 percent of the total income.

2. Significance of the results. -- In addition to the inherent effect of the chosen definition of rural income upon the significance of the results discussed in the preceding section, it is necessary to question the sig-



Graph 5 Rural Income Distribution Among Families
in the Diourbel Region

nificance of the estimate of inequality thus obtained. In order to do so, two important questions should be answered: a) How representative is the sample population that was studied? b) Can the 1980-1981 growing season be considered representative of a "normal" growing season?

a) The survey covered 72 households and 720 persons. This sample includes one-third of the entire population of the three villages studied, and was selected in such a way as to be representative of the general population.

The survey has certainly provided a reasonably accurate picture of rural income distribution in the three villages. It is nonetheless appropriate to keep in mind the chosen definition of income and to question whether 1980-1981 was representative of a typical growing season.

b) As was noted by those who conducted the survey, the 1980-1981 growing season was mediocre throughout Senegal. Moreover, the 1980-1981 season followed a poor growing season.¹⁸ The juxtaposition of these two phenomena make 1980-1981 an "atypical" growing season, which in turn diminishes the representativeness of the results.¹⁹

Though it is not possible to prove this assumption in the case of Senegal, rural income inequalities are probably greater during years when harvests are poor than during years when harvests are plentiful. In other words, according to this hypothesis, the wealthiest households seem more likely to successfully curb a decrease in income than do the poorest households. For the sample population in question, the use of more elaborate farming techniques on more fertile land, plus savings which allow the purchase of seed and various inputs, could partially explain this phenomenon. In a study in India,²⁰ J.B. Nugent and R. Walther point out significant short-term variations of rural income inequalities.

Thus far, we have analyzed regional farm income concentration and rural income concentration in a sample population from three villages in the Diourbel region. Our aim is to find out whether it is possible to produce a simulated estimate of the extent of rural income concentration in Senegal.

C. Attempted Simulated Estimate of the Extent of Rural Income Inequality in Senegal for the Year 1981

We will analyze the assumptions necessary for a simulated estimate of the extent of rural income concentration in Senegal before analyzing the inequalities themselves.

1. Analysis of the assumptions necessary for a simulated estimate of the extent of rural income inequality. -- We have access to an estimate of regional farm income concentration from 1970 to 1977 and an estimate of rural income inequality in three villages in the Diourbel region for the 1980-1981 growing season. In order to produce a simulated estimate of rural income concentration in Senegal for a given year, it is necessary to adopt the various assumptions which are analyzed in the following paragraphs:

a) No estimate of regional income concentration is available for 1980-1981, the period for which the extent of inequality among the three villages in the Diourbel region was estimated. If we observe variations of regional income inequalities and of the principal agricultural products,²¹ we see that these two types of fluctuation are related. Thus, in order to estimate the extent of regional inequalities in 1980-1981, it is appropriate to determine regional farm income concentration for a comparable year, which can be chosen with the help of Table 5.

TABLE 5: PRODUCTION VOLUMES FOR PRINCIPAL CROPS
IN SENEGAL FROM 1969/1970 TO 1980/1981
('000 tons)

Year	Peanuts	Millet	Rice	Rainfall Index ^a
1969-70	789	625	141	55
1970-71	583	401	99	110
1971-72	989	583	108	73
1972-73	570	323	44	90
1973-74	675	609	64	55
1974-75	994	703	113	57
1975-76	1412	621	115	80
1976-77	1208	507	118	80
1977-78	519	420	63	65
1978-79	1053	803	140	50
1979-80	650	496	121	90
1980-81	530	553	68	55

SOURCE: Brown, P. and Magnuson, A. Senegal in Tables, USAID Mission in Senegal, 1981.

NOTE: (a) 100 = average for 1931-1960.

This table indicates that production volumes and rainfall for the 1973-1974 growing season were very similar to those for the 1980-1981 growing season. Therefore, if we suppose that regional inequalities depend largely upon the production volume for the main crops, we can assume that regional inequalities of 1980-1981 were notably similar to those of 1973-1974. This hypothesis is all the more justified since regional inequalities are slight with respect to inequalities within the villages and therefore, cannot have a major effect on our estimate of the extent of rural income inequality.

b) In order to analyse rural inequalities when a data base is lacking, we suppose that the selected sample is representative of rural income inequalities within various regions of Senegal. It is necessary to point out the arbitrary nature of this hypothesis which is justified primarily by lack of additional data.²²

c) Finally, we presume that the different definitions of income do not have a significant effect on the inequality estimate. In light of the estimate's relative nature (shares of income are considered), this condition does not seem to be restrictive, especially with respect to the preceding hypotheses.

Having analyzed the assumptions necessary for an estimate of the extent of rural income concentration, we will compute this estimate.

2. Estimate of rural inequalities for 1981. -- By using the hypotheses set forth in the preceding paragraphs and by supposing that average income distribution in each region is the same as it was among the sample population chosen by CRED, it is possible to reconstitute rural income distribution in Senegal for 1981.

The Lorenz curve that illustrates income distribution is much like the one drawn earlier for the three villages in the Diourbel region. Regional inequalities cause a slight but nonnegligible increase in rural income inequality. Computation of the Gini index ($G = 0.5708$) associated with this income distribution confirms that there is significant inequality in rural areas.

Having analyzed the diverse aspects of rural income concentration, we will investigate the principal factors which are responsible for rural income inequalities in Senegal.

II. PRINCIPAL FACTORS RESPONSIBLE FOR RURAL INCOME INEQUALITIES IN SENEGAL

As was previously demonstrated, the extent of rural income concentration is determined by regional rural income distribution and by inequalities within regions. Thus, we will try to determine the influence of certain important indicators of inequality between and within regions.

A. Indicators of Rural Income Inequalities Between Regions

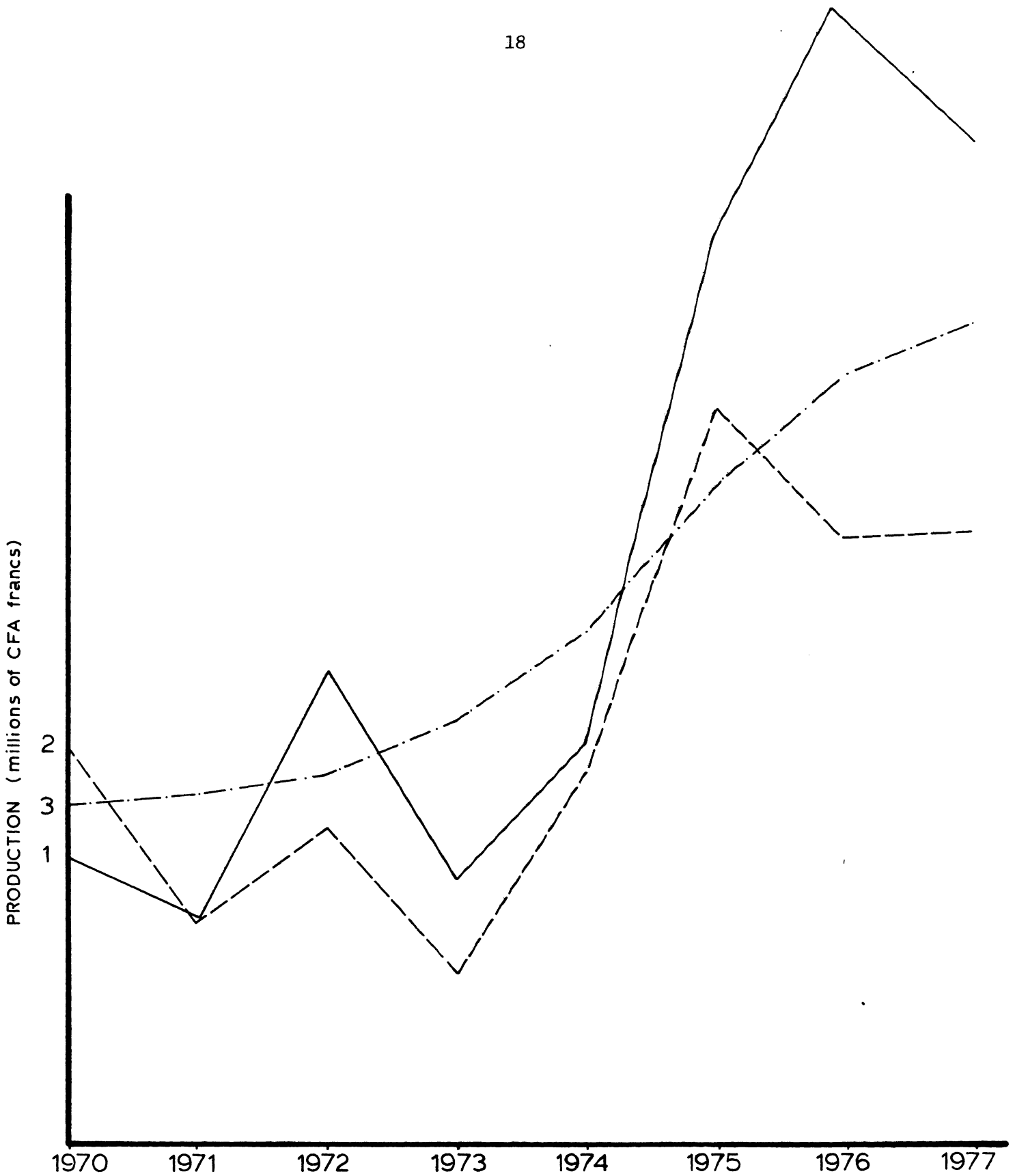
The value of farm income generated by a region depends on the amount of goods produced, the prices of the goods, and the added value associated with each type of product.

Since we have analyzed possible relationships between the value of certain products and regional inequalities, the current debate surrounding farm price policy, plus recent measures taken to raise certain producer prices,²³ thereby causing an increase in production volumes, leads us to explore the respective roles of quantities and prices as determinants of regional inequality.

1. Total value of certain products and regional rural inequalities. -- A comparative examination of Graph 3, which illustrates changes in regional inequalities, and Graph 6, which illustrates changes in values for the principal farm products, shows an indirect relation between the extent of income concentration and the value of the peanut and grain crops. However, we cannot define any relationship between the extent of rural income concentration and changes in value added by livestock raising, utilization of forest resources and noncommercial fisheries. Regression computations confirm this observation (Table 6).

The preceding analysis allows us to isolate an important influence of the total peanut and grain product value upon regional inequality measured by the Gini index. From a standpoint of economic policy, and in order to determine which measures are likely to rectify regional inequalities, it seems important to isolate the respective effects of product prices and production volumes upon regional inequalities.

2. Prices, volumes and regional inequalities. -- In order to determine the effect of changes in producer prices and production volumes upon regional inequalities, we will specify a method that allows us to analyze independently the two effects.



Graph 6 Changes of Principal Farm Product Values from 1970 1977

- CURVE 1 Value of peanut product
- CURVE 2 Value of grain product
- CURVE 3 Value of products from livestock raising

SOURCE: Graph based on data computed with the help of Données socio-economiques regionales Ministère du Plan op cit

TABLE 6: CORRELATIONS BETWEEN CHANGES IN RURAL
INEQUALITY AND FLUCTUATIONS OF CERTAIN PRODUCT VALUES

Correlation Number	Dependent Variable Y	Independent Variable X	Regression Line Equation $y = ax + b$	R	T	F
61	Extent of regional income concentration measured by a Gini index	X ₁ Value of grain product	$y = -0.002x + 0.22$	0.60	1.86	3.45
62		X ₂ Value of peanut product	$y = -0.001x + 0.11$	0.60	1.86	3.47
63		X ₃ Value of pro- ducts from livestock raising	$y = -0.001x + 0.11$	0.36	0.94	0.89
64		X ₄ Value of all farm products	$y = -0.004x + 0.12$	0.61	1.90	3.64

a) Analytical method. -- First, it is important to question the relevance of a separate analysis of the effect of price fluctuations and the effect of production volume variations, for such an analysis implies that these two variables are independent of each other for a brief term. Though it is impossible, especially because of the influence of external factors such as climate²⁴ to quantify this phenomenon, previous experience in Senegal confirms that fluctuations of producer prices do have an effect on production volumes. However, in the short run, the significance of this effect is limited by organizational inflexibilities which, for example, are connected with the method of distributing inputs vital to certain crops (specifically, peanuts). Moreover, climatic factors can have a strong effect on production volumes. Thus, following this analysis, we assume short-term independence between production volumes and prices.

Regional rural income distribution during the year 0 can be represented by a vector \vec{R}_0 having the components $(V_0^i, i = 1, \dots, 8)$.

V_0^i = rural added value per capita in region i for the year 0 with:

$$V_0^i = \frac{1}{h_0^i} \sum_{j=1}^n Q_{j0}^i P_{j0} \quad (1)$$

h_0^i = population of region i during year 0.

Q_0^i = production volume of product; in region i during year 0.

n = number of goods produced.

It is assumed that there occurs between year 1 and year 0 a simultaneous fluctuation of prices and quantities. Income distribution during year 1 can be represented by a vector \vec{R}_1 with the components $(V_1^i, i = 1, \dots, 8)$. (V_1^i is the rural added value in region i for year 1.)

If we let $\delta_0^1 P_j$ represent the producer price fluctuation for product; between year 1 and year 0, $\delta_0^1 Q_j^i$ represent the change in the quantity of product produced in region i between year 1 and year 0, and h_1^i represent the population of region i during year 1, we can express V_1^i as follows:

$$V_1^i = \left| \frac{1}{h_1^i} \sum_{j=1}^n Q_{j0}^i (P_{j0} + \delta_0^1 P_j) + \sum_{j=1}^n P_{j0} (Q_{j0}^i + \delta_0^1 Q_j^i) - \sum_{j=1}^n (Q_{j0}^i P_{j0} - \delta_0^1 Q_j^i \delta_0^1 P_j) \right| \quad (2)$$

$\underbrace{\hspace{10em}}_{V_{1q0}^i} \qquad \underbrace{\hspace{10em}}_{V_{1p0}^i} \qquad \underbrace{\hspace{10em}}_E$

According to equation (2), certain conditions,²⁵ the value of the production of region i for year 1, V_1^i , can be expressed as the product of the vectors representing the effect of price (V_{1q0}^i) and quantity (V_{1p0}^i) variations on production during the year 0, V_0^i .

V_1^i : can be expressed in the following simplified manner:

$$V_1^i = \frac{1}{h_0^i} V_{1q0}^i + V_{1p0}^i - V_0^i \quad (3)$$

V_{1q0}^i : value of the production of region i during year 1 expressed in terms of quantities produced during year 0.

V_{1p0}^i : value of the production of region i during year 1 expressed in terms of prices for year 0.

If \vec{R}_{1q0} and \vec{R}_{1p0} are vectors representing regional inequalities linked respectively to V_{1q0}^i and V_{1p0}^i ($i = 1, \dots, 8$), income distribution for year 1 can be represented by the vector \vec{R}_1 :

$$\vec{R}_1 \approx \vec{R}_{1q0} + \vec{R}_{1p0} - \vec{R}_0$$

By analyzing vectors \vec{R}_{1q0} and \vec{R}_{1p0} , plus concentration indices associated with these vectors, we will be able to isolate the specific effects of producer prices and production volumes on regional rural income inequalities.

b) Application of analytical method to the period 1970-1977. --

1) producer prices and rural regional inequalities.

An analysis of the principal 1970-1977 producer prices of products whose production value is linked to a change in income concentration (Table 7) reveals a significant increase of nominal producer prices between 1974 and 1975.

In order to determine the effect of producer price variations on changes in regional inequalities between 1974 and 1975, following the previously described method, average incomes for various regions in 1975 are computed in terms of the quantities of grain and peanuts produced in 1974. The added values of products whose worth is not linked to changes in rural inequalities were computed in terms of prices and production volumes for 1975 (Table 8).

TABLE 7: PRODUCER PRICES FOR PRINCIPAL PRODUCTS
LINKED BY PRODUCTION VALUE TO REGIONAL INCOME CONCENTRATION

Product Prices (CFA Francs/Kg)	1970	1971	1972	1973	1974	1975	1976	1977
Millet	20	17	17	17.5	25	30	30	34
Rice	21	21	21	21	23	41	41.5	41.5
Corn	18	18	18	19	25	35	35	35
Peanuts for Oil	19.4	19.5	23.1	23.1	29.5	41.5	41.5	41.5
Peanuts for Consumption	28.4	29.0	33.0	33.0	30.5	44.0	44.0	44.0

SOURCE: Figures taken from Ministère du Plan et de la Coopération, Données socio-économiques régionales.

TABLE 8: COMPUTATION OF 1975 RURAL REGIONAL INCOMES
(in Terms of 1975 Prices and 1974 Production Volumes
for Grain and Peanuts)

Regions	Average Per Capita Regional Income (CFA Francs)	1975 Population ^a
Thiès	35251	488.2
Eastern Senegal	33057	255.2
Cap Vert	29111	162.7
River	26892	412.8
Sine Saloum	25829	849.1
Casamance	24087	608.9
Louga	21785	376.6
Diourbel	15533	334.5

SOURCE: Computations based on Ministère du Plan et de la Coopération, Données socio-économiques régionales.

NOTE: (a) in thousands ('000) of inhabitants.

By comparing the extent of income inequality distribution in 1975 (C_{q79}^{p75}), computed in terms of 1974 production volumes, with income concentration in 1974 (C_{1974}), we can determine the effect of grain and peanut price variations on regional income distribution between 1974 and 1975.

A study of Graphs 7 and 8 leads to the conclusion that, all else being equal, the 1974-1975 price increase slightly attenuated regional income inequalities.

In fact, this price increase results in an increase of the share of income owned by the poorest regions and in a less significant increase of the portion owned by the wealthiest regions (cf. C_{q74}^{p75} curve in Graph 8). This observation can be justified by computing the Gini indices associated with each distribution:

$$G_{1974} = 0.1276 \qquad G_{q74}^{p75} = 0.1116$$

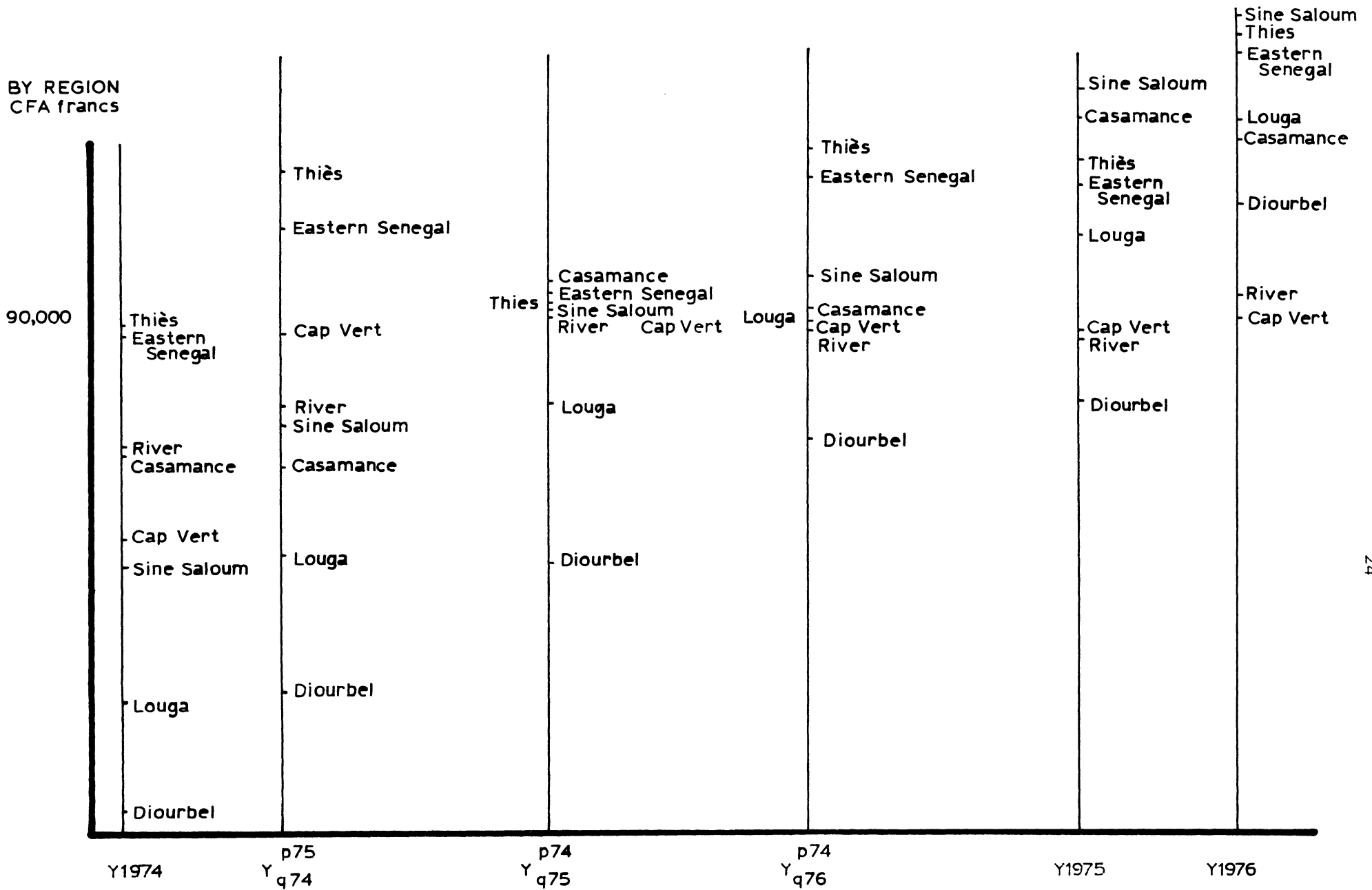
It is necessary to be cautious when interpreting this result, for it is based upon an assumed independence between producer price changes and production volumes.

ii) production volumes and rural regional inequalities.

After studying farm production statistics and Graph 6, one concludes that the year 1975 was distinguished by a simultaneous and significant peanut and grain production increase.²⁶ On the other hand, the year 1976 was characterized by a large increase in peanut production and a significant decrease in grain production. Thus, it seems relevant to compare:

- regional income distribution in 1974 (C_{1974});
- regional income distribution in 1975, the value of grain and peanut production being expressed in terms of 1974 prices (C_{q75}^{p74});
- regional income distribution in 1976, the value of grain and peanut production being expressed in terms of 1974 prices (C_{q76}^{p74}).²⁷

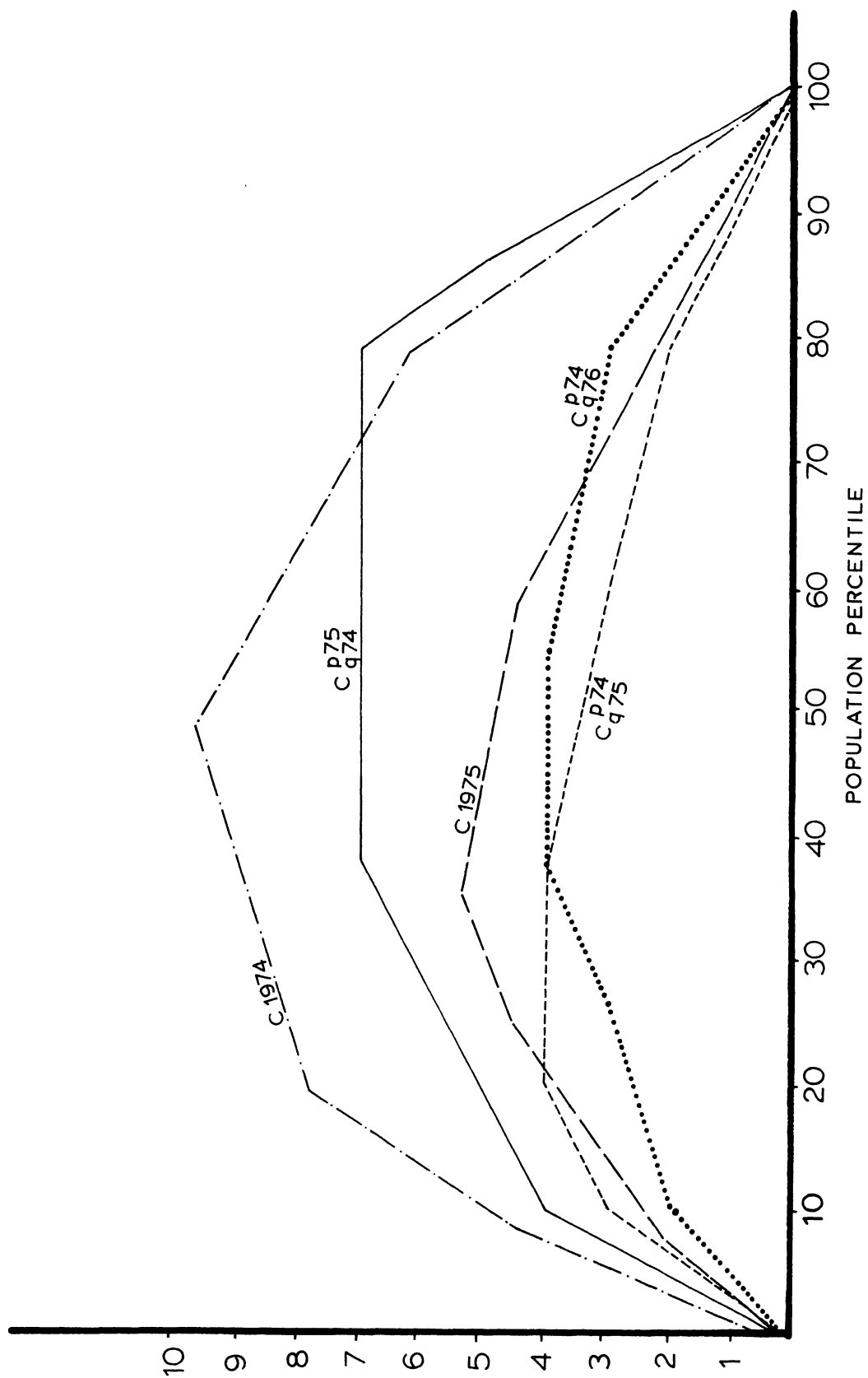
A comparison of various degrees of regional income concentration allows us to determine the effect of a simultaneous increase in peanut and grain production, plus the effect of inverse changes in the production of these two crops. In order to make such comparisons, we have estimated the extent of regional income concentration under various hypothetical conditions. The results appear in Tables 9 and 10, while Graphs 7 and 8 present a visual representation of the changes.



Graph 7 Average Income per Region for Various Hypothetical Prices and Production Volumes

SOURCE: Tables 2 8 9 10

N.B.: Definitions of types of income computed here are found earlier in this article.



DIFFERENCE BETWEEN INCOME SHARES EARNED BY VARIOUS POPULATION QUANTILES AND SHARES THEY WOULD EARN IN A SITUATION OF PERFECT EQUALITY (%)

Graph 8 Changes in Regional Income Concentration Between 1974 and 1976 for Hypothetical Production Volume and Price Variations

SOURCE: Data computed from Tables 2, 8, 9, 10.

TABLE 9: COMPUTATION OF 1975 RURAL REGIONAL INCOMES
(in Terms of 1974 Prices and 1975 Grain and Peanut
Production Volumes)

Regions	Average Per Capita Regional Income (CFA Francs)	1975 Population ('000)
Thiès	32302	488.2
Eastern Senegal	31406	255.2
Casamance	30982	608.9
Sine Saloum	30293	849.1
River	29775	412.8
Cap Vert	29074	162.7
Louga	26623	376.6
Diourbel	20437	334.5

SOURCE: Computed data from Ministère du Plan et de la Coopération, Données socio-économiques régionales.

TABLE 10: COMPUTATION OF 1976 RURAL REGIONAL INCOMES
(in Terms of 1974 Prices and 1976 Grain and Peanut
Production Volumes)

Regions	Average Per Capita Regional Income (CFA Francs)	1975 Population ('000)
Thiès	36119	488.2
Eastern Senegal	35448	255.2
Sine Saloum	32925	849.1
Casamance	30160	608.9
Louga	29876	376.6
Cap Vert	29791	162.7
River	29448	412.8
Diourbel	25305	334.5

SOURCE: Computed data from Ministère du Plan et de la Coopération, Données socio-économiques régionales.

A study of Graph 7 shows that the increase of peanut and grain production volumes caused a significant attenuation of regional income differences compared with 1974. Only the Diourbel area and, to a lesser extent, the Louga area, contradict this tendency.

The increase of the peanut production volume and the attendant decrease in grain production caused less significant regional inequalities than those of 1974. The income concentration level associated with this change in production volumes is very close to the income concentration level resulting from a simultaneous increase in peanut and grain production volumes (cf. Graph 8 and Table 11). In the latter case, the poorest regions benefit from the most favorable of all of the hypothetical situations adopted in this paper.

TABLE 11: GINI INDEX MEASUREMENT OF REGIONAL INCOME DISTRIBUTION INEQUALITY UNDER VARIOUS HYPOTHETICAL SITUATIONS (With Respect to Prices, Peanut and Grain Production Volumes)

Price Production Volumes	1974	1975	1976
1974	0.1276	0.1116	not computed
1975	0.0522	0.0642	not computed
1976	0.0537	not computed	0.0644

SOURCE: Calculated from Tables 8, 9, 10.

We have examined the principal factors which account for changes of regional rural income inequalities during the years 1974, 1975 and 1976. However, inequalities between regions comprise only one facet of general rural income concentration. Therefore, it is necessary to investigate the factors which account for income inequalities within regions. In order to do this, we shall try to determine the causes of income inequalities among the population studied by CRED.

B. Factors Accounting for Rural Income Inequalities Within Regions: Diourbel Area

This analysis will be based on CRED's 1981 survey of a sample population in three villages in the Diourbel region (Layabé, Sessène, Thienthié). Before investigating the main factors which account for rural income inequalities, it is relevant to point out the limits of the survey in question.

1. Limits of the research on inequality indicators. -- The principal constraint encountered is the lack of adequate data, which is explained by the specific nature of the survey goal assigned to CRED: the principal goal was to analyze "the effects of agricultural policies upon food consumption," not income inequality indicators.

Thus, the variables that were quantified during the survey allow only a very fragmented analysis of inequality indicators. In fact, one would have needed access to detailed information on all possible inequality indicators, i.e., availability and employment of production workers, utilization of certain production techniques, the size and structure of the various families. Because of its objectives, the survey provides information only on certain indicators. Finally, as was previously stated,²⁸ the chosen definition of income does not include money transfers made within a village or those coming from outside the village, while it does include cash flows from liquidation of capital.

2. Empirical analysis of inequality indicators within three villages in the Diourbel area. -- The survey results reveal marked disparities between the villages of Layabé, Sessène and Thienthié. These disparities could be factors which account for inequality. Furthermore, the survey made it possible to quantify a certain number of variables for the entire sample (total area planted; area allocated to millet and peanuts; production volumes; yields; and sales of peanuts and millet). It is likely that each of these variables is partially responsible for income disparities.

Thus, we will determine first to what extent disparities between villages influence the inequality observed in the selected sample population. Then we will determine whether certain variables which are potential indicators of disparities are empirically responsible for the observed inequalities.

a) Disparities between villages, indicators of inequality. -- First of all, we will determine whether disparities between villages are important factors which account for income inequalities observed among the total sample population, then we will try to determine the causes of these disparities between villages.

i) Observations on average income and on income distribution and concentration.

Table 12 shows that the average income level in Sessène is relatively high in comparison with the average income documented in the other two villages. The total average incomes of Layabé and Thienthié were, respectively, 54.7

percent and 43.1 percent of Sessène's total income. The village of Sessène incorporates a much higher proportion of high-income compounds than do the other two villages. Forty-six percent of the compounds in Sessène (11 compounds) have a total annual income higher than 100,000 CFA francs, whereas only thirty-three percent of the compounds in Layabé and eight percent of those in Thienthié have a total annual income this high.

TABLE 12: AVERAGE TOTAL INCOMES, INCOME DISTRIBUTION AND CONCENTRATION OBSERVED IN THREE SAMPLE VILLAGES

	Layabé	Sessène	Thienthié	Total Sample
1. Average total income per compound per year (CFA francs)	77,120 (80,691)	140,936 (143,895)	60,725 (108,002)	92,927 (114,843)
1.1. Average nonfarm income per compound per year (CFA francs)	46,725 (75,069)	27,165 (29,709)	17,865 (67,857)	30,185 (61,559)
2. Ratio 1.1/1	30.6%	19.3%	29.4%	33.2%
3. Number of compounds	24	24	24	72
3.1. Annual income > 300,000 CFA francs	0	5	1	6
3.2. Annual income > 200,000 CFA francs	3	7	1	11
3.3. Annual income > 100,000 CFA francs	8	11	2	21
3.4. Annual income > 50,000 CFA francs	13	9	16	38
4. Gini index measuring total income concentration	0.5378	0.5440	0.6263	0.5506

SOURCE: Data computed from 1981 Center for Research on Economic Development survey.

NOTE: Numbers in parentheses are standard deviations.

On the other hand, the village of Thienthié,²⁹ and, to a lesser degree, the village of Layabé, incorporate a significantly higher proportion of compounds earning less than 50,000 CFA francs per year (67 and 146 percent,

respectively). In Sessène, only 21 percent of the compounds have incomes of less than 50,000 CFA francs per year.

As can be observed with the help of Graph 9, income disparities between villages partially account for the significant inequality observed among the total sample population. The village of Thienthié incorporates the greatest number of low-income compounds (less than 100,000 CFA francs per year). Layabé incorporates the most compounds with incomes between 100,000 and 300,000 CFA francs per year. Finally, the village of Sessène incorporates five of the six sample compounds with incomes greater than 300,000 CFA francs per year.

ii) Indicators of inequalities between villages.

The available data do not permit a detailed and quantified analysis of factors which account for inequalities between villages. Nonetheless, it seems possible to isolate a few factors which are partially responsible for such inequalities. These factors are associated with the role of farm work in the general activity of each village and with the system of agricultural development.

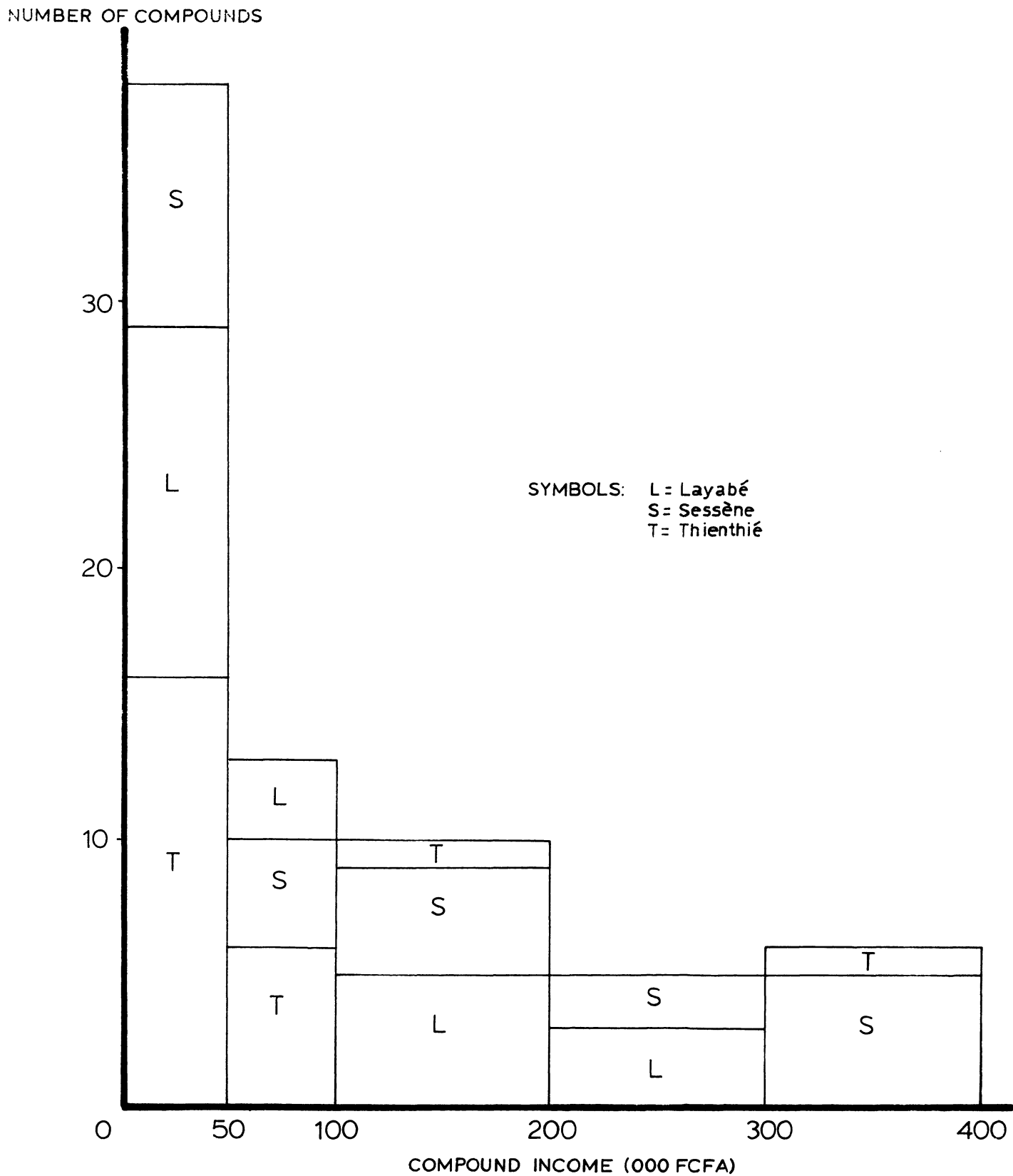
- Influence of the Role of Farm Activity

Table 12 shows that, in the village of Layabé, nonfarm income accounts for the greatest portion of the total income. Layabé's average farm income is lower than that of Thienthié (30,405 CFA francs per year as opposed to 42,860 CFA francs per year). In Sessène, however, nonfarm income represents only 19.3 percent of the total income.

Table 13 confirms that nonfarm income attenuates the inequalities between villages that are measured by ratios 4, 5 and 6. Moreover, nonfarm income reverses the ranking of average income per compound in Layabé and Thienthié.

- The Influence of the System of Agricultural Development

The survey allows us to observe that the system of agricultural development in Sessène differs significantly from that of the other two villages. Inhabitants of Sessène are primarily farmers. They raise livestock, and therefore have manure for fertilizer, which partially accounts for yields that are high in comparison to the yields in the other two villages. Moreover, the inhabitants of Sessène benefit from soils of a better quality than those in Layabé and Thienthié.



Graph 9 Number of Households Belonging to Different Income Classes

SOURCE: 1981 CRED Survey

TABLE 13: INEQUALITIES OF AVERAGE TOTAL AND AVERAGE FARM
INCOME BETWEEN VILLAGES

	Average Total Income Per Compound (CFA Francs) Per Year	Average Farm Income Per Compound (%) Per Year
1. Layabé	77,120	30,405
2. Sessène	140,936	113,771
3. Thienthié	60,725	42,860
4. Ratio $\frac{1}{2}$	54.7%	26.7%
5. Ratio $\frac{3}{2}$	43.09%	37.6%
6. Ratio $\frac{1}{3}$	127.00%	$\frac{3}{1}$ 141.00%

SOURCE: Data computed from 1981 Center for Research on Economic Development survey.

These differences signify that farm yields are much higher in Sessène than in the other two villages. Yields in Layabé prove to be particularly poor (see Table 14).

We have demonstrated the important role of disparities between villages as a factor which accounts for inequalities observed in the chosen sample population. We have also shown that the extent of these disparities is partially determined by varying efficiency levels of the agricultural development system in each village, while nonfarm income tends to reduce inequalities between villages.

We will now try to determine the effect of certain variables on inequality among the sample population. Quantified data are available for these potential inequality indicators, which include total area planted, area allocated to peanuts and millet, production volumes for peanuts and millet, and respective sales of these crops. In light of the differences between villages, we will analyze each of these variables for the entire sample population, and then for each village.

b) Empirical analysis of the effect of certain variables on inequalities among the sample population. -- The CRED survey made possible the quantification of variables which could account for farm income inequalities,

TABLE 14: PRODUCTION VOLUMES, AREA PLANTED, YIELDS FOR PEANUTS
AND MILLET IN THE SAMPLE VILLAGES

Village	Area planted in peanuts per per compound (square meters)	Area planted in millet per per compound (square meters)	Peanut Production (kg.)	Millet Production (kg.)	Peanut ₃ Yield = $\frac{3}{1}$ kg/hectare	Millet ₄ Yield = $\frac{4}{2}$ kg/hectare
1. Layabé	26,166	35,024	358	1,373	136.8	392.0
2. Sessène	21,959	23,202	948	1,690	431.7	728.4
3. Thienthié	11,219	19,428	163	408	145.3	210.0
4. Ratio $\frac{1}{2}$	--	--	--	--	31.7%	53.8%
5. Ratio $\frac{3}{2}$	--	--	--	--	33.6%	28.8%

SOURCE: Data computed from 1981 Center for Research on Economic Development study.

but not for total income inequalities. However, as is shown in Table 15, each sample family's total income is largely determined by the amount of farm income (correlation 15.4). This linear correspondence is particularly close in the case of Sessène (correlation 15.2). It is less marked in the case of Layabé (correlation 15.1).

- In the case of 72 documentations (sample IV)

R 0.23, + 2.01, F 4.00

The following factors are likely to account for the amount of farm income (Ya) for each compound. The CRED survey quantified these factors for each compound:

X ₁	total area planted
X ₂	area planted in peanuts
X ₃	area planted in millet
X ₄	volume of peanut production
X ₅	volume of millet production
X ₆	peanut yield ($\frac{X_5}{X_2}$)
X ₇	millet ($\frac{X_6}{X_3}$)
X ₈	value of peanut sales
X ₉	value of millet sales

After studying the graphs, we tested the existence of linear correspondences between Ya and the independent variables (X₁, X₂, ..., X₉). In light of the specific features of the three villages, an analysis is done for each village (samples I, II, III), and then for the entire sample (IV). Results of this analysis appear in Table 16, and various conclusions can be drawn:

- The farm income of each compound is a positive linear function of the total area planted, and of the area allocated to peanuts or to millet in samples I, II, and IV. This conclusion cannot be reached in the case of Thienthié (correlations 16.3, 16.7, 16.11).

- The farm income of each compound is also a linear function of the peanut and millet production volumes in sample II (village of Sessène) and in the entire sample. In the case of Layabé (sample I), the lack of a significant linear correspondence can be partially explained by the important role of other crops in earning income. In

TABLE 15: ANALYSIS OF THE CORRESPONDENCE BETWEEN FARM INCOME PER FAMILY AND TOTAL INCOME PER FAMILY^a

Correlation Number	Sample ^b	Dependent Variable	Independent Variable	Regression Line Equation	R	T	F
15.1	I	Total Income per family	Farm Income per family	$y=0.74x+49.09$	0.42	2.12	4.74
15.2	II			$y=1.19x+7.98$	0.99	29.64	878.76
15.3	III			$y=2.14x-22.79$	0.81	6.56	43.05
15.4	IV			$y=1.18x+17.29$	0.86	13.59	193.04

SOURCE: Computations based on 1981 Center for Research on Economic Development survey.

NOTES: (a) Signification threshold of various parameters if a confidence level of 95% is assumed:

- in the case of 24 observations (samples I, II, II)
 $R > 0.40$, $T > 2.07$, $F > 4.30$

(b) In following passages, samples I, II and III are associated respectively with the villages of Layabé, Sessène, and Thienthié. Sample IV is the total sample population.

TABLE 16: ANALYSIS OF CORRELATIONS BETWEEN HOUSEHOLD FARM INCOME
AND VARIOUS INDEPENDENT VARIABLES

Correlation Number	Sample	Dependent Variable y	Independent Variable x	Regression Line Equation	R	T	F	dW
16.1	I	Ya	X ₁	$y=0.92x-18.04$	0.54	2.99	8.97	1.56
16.2	II	Ya	X ₁	$y=2.25x+9.87$	0.55	3.11	9.77	1.96
16.3	III	Ya	X ₁	$y=0.05x+32.28$	0.03	0.16	0.02	1.98
16.4	IV	Ya	X ₁	$y=1.01x+15.03$	0.35	3.16	9.98	1.68
16.5	I	Ya	X ₂	$y=1.25x+6.58$	0.45	2.39	5.71	1.68
16.6	III	Ya	X ₂	$y=3.37x+39.38$	0.45	2.33	5.42	2.10
16.7	III	Ya	X ₂	$y=0.17x+25.59$	0.04	0.20	0.04	1.96
16.8	IV	Ya	X ₂	$y=1.87x+25.70$	0.35	3.10	9.64	1.80
16.9	I	Ya	X ₃	$y=0.56x+18.24$	0.21	1.02	1.04	1.87
16.10	II	Ya	X ₃	$y=4.77x+0.71$	0.62	3.69	18.63	1.82
16.11	III	Ya	X ₃	$y=0.19x+30.11$	0.09	0.44	0.19	1.98
16.12	IV	Ya	X ₃	$y=1.20x+29.82$	0.26	2.23	4.96	1.71
16.13	I	Ya	X ₄	$y=23.14x+29.75$	0.24	1.17	1.36	1.87
16.14	II	Ya	X ₄	$y=70.77x+44.27$	0.47	2.50	6.23	1.96
16.15	III	Ya	X ₄	$y=55.06x+29.58$	0.21	0.99	0.98	1.87
16.16	IV	Ya	X ₄	$y=69.56x+28.99$	0.54	5.33	28.44	1.86
16.17	I	Ya	X ₅	$y=6.06x+29.73$	0.19	0.91	0.83	1.92
16.18	II	Ya	X ₅	$y=28.77x+62.76$	0.41	2.14	4.59	2.28
16.19	III	Ya	X ₅	$y=23.59x+28.20$	0.26	1.25	1.58	1.95
16.20	IV	Ya	X ₅	$y=23.35x+28.20$	0.40	3.69	13.61	1.94
16.21	IV	Ya	X ₆	$y=992.86+37.14$	0.36	3.26	10.64	2.01
16.22	III	Ya	X ₇	$y=1140.98x+23.05$	0.43	2.28	5.21	2.17
16.23	I	Ya	X ₈	$y=1.41x+20.84$	0.57	3.23	10.45	2.00
16.24	II	Ya	X ₈	$y=2.02x+72.10$	0.40	2.08	4.32	2.00
16.25	III	Ya	X ₈	$y=0.77x+34.77$	0.07	0.33	0.11	1.98
16.26	IV	Ya	X ₈	$y=2.10x+38.07$	0.48	4.53	20.49	1.83
16.27	I	Ya	X ₉	$y=1.55x+29.81$	0.30	1.49	2.23	1.80
16.28	II	Ya	X ₉	$y=15.06x+91.36$	0.35	1.76	3.11	2.28
16.29	III	Ya	X ₉	$y=23.35x+35.38$	0.40	3.69	13.61	1.94
16.30	IV	Ya	X ₉	$y=1.76x+57.20$	0.12	1.04	1.07	1.82

SOURCE: Computations based on Center for Research on Economic Development survey.

the case of Thienthié (sample III), it is necessary to point out an important positive linear correlation between total income (Y) and peanut production (X_4), and between total income and millet production (X_5). Results of the computations are as follows:

$$Y = 119.53 X_4 + 41.27 \quad R = 0.49 \quad T = 2.71 \\ F = 7.34$$

$$Y = 57.78 X_5 + 37.15 \quad R = 0.49 \quad T = 2.72 \\ F = 7.42$$

It seems difficult to explain the results of 16.15 and 16.19 by any means other than the presence of certain errors in the computation of Thienthié's farm income. Specifically, liquidations of capital were counted as farm income for this sample.³⁰

- Relationships 16.21 confirms that high-income compounds in the entire sample IV have more abundant peanut yields than do low-income households. Better access to inputs and availability of more labor are likely to account for this greater efficiency level among high-income households.

It has also been observed that relatively high-income compounds in Thienthié have greater millet yields. Millet accounts for the largest portion of farm income in this village.

Correlations 16.23, 16.24 and 16.26 confirm that farm income of compounds in the various samples is dependent on peanut sales, which account for an important portion of cash income for the compounds in samples I and II. It is not possible to demonstrate the existence of such a correlation in the case of Thienthié (sample III) because of the small quantities of peanuts marketed in this village. On the other hand, in Thienthié there exists an important linear correspondence between farm income and millet sales.

When factors that could account for farm income inequalities are each considered separately, they prove to be too fragmentary to offer a meaningful explanation for farm income inequalities among the entire sample population. Therefore, we have analyzed linear correspondences in which farm income (Y_a) is expressed as a function of various factors (X_1, \dots, Y_q). The combination appears in Table 17.

By examining correlation 17.4, we can conclude that, for the entire sample population, farm income (Y_a) can be expressed as a linear calculation of the

TABLE 17: ANALYSIS OF FACTORS ACCOUNTING FOR THE AMOUNT OF FARM INCOME EARNED (by Households in Samples I, II, III, IV)

Correlation Number	Sample	Dependent Variable	Independent Variable	Regression Equation
17.1	I	Ya	X ₂ X ₃ X ₆ X ₇	$y=1.20x_1+0.42x_2+127.14x_3-17.90x_4-8.19$ $T_1=2.10 \quad T_2=0.75 \quad T_3=0.20 \quad T_4=0.07$ $R=0.48 \quad F=1.42$
17.2	II	Ya	X ₂ X ₃ X ₆ X ₇	$y=1.84x_1+7.12x_2+912.99x_3+71.98x_4-69.26$ $T_1=2.84 \quad T_2=0.76 \quad T_3=1.59 \quad T_4=0.55$ $R=0.70 \quad F=4.64$
17.3	III	Ya	X ₂ X ₃ X ₆ X ₇	$y=0.28x_1+0.15x_2+376.70x_3+12.51x_4+22.56$ $T_1=0.29 \quad T_2=0.30 \quad T_3=0.48 \quad T_4=1.53$ $R=0.45 \quad F=1.22$
17.4	IV	Ya	X ₂ X ₃ X ₆ X ₇	$y=1.38x_1+0.84x_2+1126.40x_3-41.36x_4-11.83$ $T_1=2.08 \quad T_2=1.43 \quad T_3=3.58 \quad T_4=0.46$ $R=0.53 \quad F=6.49$

SOURCE: Computations from Center for Research on Economic Development data.

land area allocated to peanuts and millet (X_2 , X_3) and the yields documented for these crops (X_6 , X_7).

Correlation 17.4 reveals the significant positive effect of land area planted in peanuts and of the peanut yield on farm income inequalities.

This result confirms the crucial importance of the peanut crop to an estimation of the extent of rural inequalities. It is relevant to point out that the land area used for peanuts seems to be largely determined by the place of each family in the social structure. Moreover, the fact that the more well-to-do families enjoy easier access to inputs is indeed partially responsible for their more abundant yields. The fact that most of the families with the highest incomes live in Sessène, where productivity is better than in the other two villages,³¹ also explains why the wealthiest families obtain the highest yields.

CONCLUSIONS

During this study, we tried first to determine the extent of rural income inequalities in Senegal. It was necessary to accept some debatable hypotheses which affect the validity of this estimate. In order to obtain a higher degree of validity, we would have required access to data on income distribution for villages in other regions of Senegal and also for other less atypical years. However, the results of this study challenge once more the current belief that rural income distribution is relatively equal, for they tend to reveal significant rural income inequalities. In addition, noticeable changes in regional inequalities were detected for the years 1970-1977.

We then tried to determine the principal factors which account for rural inequalities in Senegal. To do this, we sought to isolate important indicators of change in regional inequalities and in the extent of inequality within regions.

While analyzing changes in regional inequalities, we concentrated on the years 1974-1976 in order to determine whether the decline in regional income concentration between the periods 1970-1974 and 1975-1977 was due to a change in producer prices or in production volumes for grains and peanuts. While emphasizing the possibility of significant interaction between these prices and volumes, we were able to isolate the effect of a price or volume increase on the period 1974-1976.

All other factors being equal, the 1975 price increase caused an increase in the share of income going to the poorest and wealthiest regions at the expense of average-income regions. Regional inequality measured by the Gini index diminished slightly following this price increase. The simultaneous increase of the peanut and grain production volumes in 1975 brought an increased share of income to the least favored regions, causing a significant decline in regional inequalities with respect to 1974. The increase in peanut production and the accompanying decrease in grain production had a similar effect. In light of this example, it seems that only conditions conducive to an abundant harvest can attenuate regional inequalities. These conditions must include an incentive price policy which, though it did not have a very noticeable equalizing effect in 1975, is likely to considerably attenuate regional inequalities through its effect on production volumes.

Various observations concerning inequalities within regions were based on the study of a sample population in three villages in the Diourbel area. First, inequalities among villages are a significant determinant of rural inequalities. Moreover, there are marked inequalities within each village. It was not possible to analyze in detail the indicators of inequalities within the villages. However, land area allocated to the peanut crop and yields for this crop appear to be the factors most responsible for differences in farm income. The wealthiest households have more land under peanuts and obtain higher yields than do lower-income households.

NOTES

¹Cf. M.S. Ahluwalia, N.G. Carter and H.B. Chenery, "Growth and Poverty in Developing Countries," Journal of Development Economics (September 1979), p. 299-341, and World Bank, Rapport sur le développement dans le monde de 1982 (Washington, D.C.: 1982), esp. p. 174-175 and p. 188.

²An inventory of such studies appears in G. Chambas, "Financement extérieur et répartition des revenus dans les pays en voie de développement," Cahier de Développement International, No. 10, Thèse de Doctorat d'Etat (Clermont: 1981), Chap. 2.

Concerning indicators of inequality in the rural sector, see A.P. Castro, N.T. Hakansson and O. Brokensha, "Indicators of Rural Inequality," World Development (May 1981), p. 401-427.

³See World Bank, Le développement accéléré au sud du Sahara (Washington, D.C.: 1981), esp. Chap. 5.

⁴We are concerned with a particular aspect of income distribution. In fact, the state of income distribution depends on the percentage shares of the various income classes (the relative income distribution that is being analyzed here), as well as on the aggregate amount of income earned by the population in question. To make allowance for the latter aspect, which is not treated in this paper, we keep in mind the number of poor people living in developing countries. See G. Chambas, "Financement extérieur et répartition des revenus," p. 114-127.

⁵According to World Bank statistics, 75 percent of the Senegalese population lived in rural areas in 1980. See World Bank, Rapport sur le développement dans le monde, p. 164. (This figure is slightly overestimated, for the 1976 census showed that 72.6 percent of the working population lived in rural areas.)

⁶This gap is pointed out in the survey conducted by the BIT PECTA mission. See BIT PECTA on employment in Senegal, Revenus, prix et commerce international (Dakar, 1980).

⁷See Ministère du Plan et de la Coopération, Données socio-économiques régionales (Dakar, March 1978).

⁸This survey was conducted by H. Josserand and C.G. Ross. Results were published in CRED, Consumption Effects of Agricultural Policies: Cameroon and Senegal (Ann Arbor: University of Michigan, August 1982), p. 203.

⁹Income earned through commercial fishing is particularly significant in the Cap Vert area. In this region, the added value from this sector for certain years is double the added value from agriculture, livestock raising, forestry, and noncommercial fisheries. See Ministère du Plan et de la Coopération, Données socio-économiques régionales.

¹⁰See M. Paglin, "The Measurement and Trend of Inequality: A Basic Revision," American Economic Review (September 1975), p. 598-609.

¹¹The inequality becomes more significant as the area between the curves in Graph 2 and the axis of the abscissa increases. Conversely, the inequality becomes less significant as this area decreases.

¹²These properties of the Gini index were examined in G. Chambas, "Financement extérieur et répartition des revenus," p. 128-133.

¹³If the various years are classified as a function of regional inequality with the help of partial income indicators (portion of income earned by the two or four lowest deciles, for example), the resulting curve has a shape very much like that of the first. However, the resulting classification is not exactly the same as the one based on the Gini index (cf. Graph 4).

¹⁴The three-month survey was undertaken in May 1981 by a research team from CRED (University of Michigan). One of the surveyed villages is inhabited by Serrers (Sessène), whereas the other two are inhabited by Wolofs (Layabé and Thienthié).

Results of this study were published by H. Josserand and C.G. Ross, "Consumption Effects of Agricultural Policies: Senegal Case Study," in CRED, Consumption Effects of Agricultural Policies, p. 203-369.

¹⁵See CRED, Consumption Effects of Agricultural Policies: Cameroon and Senegal, p. 246.

¹⁶See CRED, Consumption Effects of Agricultural Policies: Cameroon and Senegal, p. 242-243.

¹⁷According to a survey concerning the River region, approximately 14 percent of the net farm income was redistributed during the period 1976-1977, whereas income transfers from migrants in 1976 amounted to approximately 8 percent of the beneficiaries' total income. See World Bank, Senegal: Sharing of Food and Resources in the Extended Family System (Washington, D.C.: September 1981).

¹⁸Cf. Table 5.

¹⁹This stumbling block could be avoided only through a repetitive survey covering several growing seasons.

²⁰See J.B. Nugent, R. Walther, "Short-Run Changes in Rural Income Inequality: A Decomposition Analysis," The Journal of Development Studies (January 1982), p. 239-269.

²¹This point is examined later in this paper.

²²In the near future, CRED will analyze income concentration in villages in other parts of Senegal. Then it will be possible to use more realistic hypotheses and to modify this first estimate.

²³Specifically, the official producer price of peanuts rose from 50 CFA francs/kg. in 1980-1981 to 70 CFA francs/kg. for the 1981-1982 growing season. (We are speaking in terms of gross price, we have not subtracted the reimbursement for seed and fertilizer.)

²⁴It would be pertinent to define a supply function for each region. Such functions cannot be computed here due to the lack of regional data.

²⁵It is assumed that the population remains constant in the short run: $n_1^i = n_0^i$. Moreover, we assume that the value of the second-order term

$$\sum_{j=1}^n \delta_0^1 Q_j^i \delta_0^1 P_j \quad \text{is negligible by}$$

comparison with $\sum_{j=1}^n Q_{j0}^i \delta_0^1 P_j$ and $\sum_{j=1}^n P_{j0} \delta_0^1 Q_j^i$.

²⁶Production volume.

²⁷In Graph 7, similar notations are used for regional income.

²⁸See definition specified earlier in this article.

²⁹In Thienthié, the juxtaposition of very low income compounds and compounds having very high incomes with respect to the former causes significant inequality within the village. For Thienthié, the Gini index is 0.6263 (see Table 12), whereas the Gini index for Layabé and Sessène is very close to 0.54.

³⁰See definitions of income earlier in article.

³¹Cf. preceding passages.

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