AFRICAN RURAL ECONOMY PROGRAM

WORKING PAPER

AN INTERIM EVALUATION OF TWO AGRICULTURAL PRODUCTION PROJECTS IN SENEGAL: THE ECONOMICS OF RAINFED AND IRRIGATED AGRICULTURE

by

Steven Franzel

Working Paper No. 28 June 1979

Department of Agricultural Economics
Michigan State University
East Lansing, Michigan 48824

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**Graduate Research Assistant, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

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FOREWORD

The African Rural Economy Program was established in 1976 as an activity of Michigan State University's Department of Agricultural Economics. The African Rural Economy Program is a successor to the African Rural Employment Research Network which functioned over the 1971-76 period.

The primary mission of the African Rural Economy Program is to further comparative analysis of the development process in Africa with emphasis on both micro and macro level research on the rural economy. The research program is carried out by faculty and students in the Department of Agricultural Economics in cooperation with researchers in African universities and government agencies. Specific examples of ongoing research are "Poor Rural Households, Income Distribution and Technical Change in Sierra Leone and Nigeria," "Rural and Urban Small-Scale Industry in West Africa," "Dynamics of Female Participation in the Economic Development Process in West Africa," and "The Economics of Small Farmer Production and Marketing Systems in the Sahelian Zone of West Africa."

Carl K. Eicher
Professor of Agricultural Economics
Michigan State University

1. INTRODUCTION

In the past several years the United States Agency for International Development (USAID) has increased its contribution for the economic development of the Sahelian countries. In response to the desires of the governments of these countries to achieve food self-sufficiency and improve rural welfare, principal attention is given to agricultural development. Another important goal, improved reliability of food supply, is emphasized in the aftermath of the 1968-73 drought.

USAID has identified three areas of action for agricultural production programs in the Sahel:

1. Improving rainfed agriculture through cultural techniques and technological packages for rainfed farmers.
2. Developing irrigated agriculture along river basins with large-scale or small-farmer irrigated perimeters using pumping and/or gravity systems.
3. Introducing "new lands" through projects that move farmers from densely populated areas to areas of virgin land.

AID channels its aid primarily towards the first two areas, recognizing the extremely high costs of the third alternative. Within the category of irrigation projects, small farmer perimeters have been given priority over large-scale, heavily mechanized projects, because of their lower costs and more widespread distribution effects [Morris, undated; Tinsler, 1978].

USAID currently supports a number of irrigation and rainfed projects in the Sahel, although data on the impact of these projects are extremely limited. As a step toward providing some of this needed data, this paper presents the results of a study which evaluates and compares the economic impact of a rainfed project with the economic impact of a small farmer irrigation project in Senegal.[1] The two projects examined are the Senegal Cereals Production Project (rainfed) and the Bakel Small Irrigated Perimeters Project. Since both projects have been underway for several years,[2] it is possible to examine their impact. A comparison of the projects should offer some tentative guidance on the trade-offs between small-scale irrigation and rainfed projects.

Although the assumptions behind the data are given in the notes to tables and appendices, the nature of the two forms of analysis--financial and economic--should be clarified. Financial analysis presents the costs and benefits to the participants in a project. Actual market prices are used to measure the costs and benefits. Financial analysis permits the analyst to examine the levels and distribution of project benefits among participants and to assess the attractiveness of the project to participants. Economic analysis, on the other hand, measures the costs and benefits of a project which accrue to the nation as a whole. For example, income transfers such as government subsidies and export

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[1]The data for this analysis was collected during a six week period in November-December 1978.

[2]Irrigated production in Bakel began in 1975 and USAID funding for the Bakel Small Irrigated Perimeters Project became available in 1977. The Senegal Cereals Production Project began in 1975.

taxes, are excluded in an economic analysis. In addition, shadow prices are used to remove distortions which may exist in the prices of foreign exchange,[1] inputs, and outputs [Gittinger, 1972].

It should also be emphasized that financial and economic analyses represent only one dimension of project evaluation. Development literature is replete with cases of projects which showed high economic returns on paper, yet failed because of a variety of other factors--sociological, environmental, etc.--which were not carefully considered.

In Section 2 the background of each of the projects is presented. In Sections 3 and 4 farm budget analysis is used to examine the accomplishments, problems, and impact of each of the projects. In Section 5 the two projects are compared and project issues and recommendations are discussed.

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[1]Foreign exchange costs and receipts: $1.00 = 265 CFA. This rate has been adjusted upward by 15 percent over the prevailing 1977 rate ($1.00 = 230 CFA) because the CFA is overvalued by 15 percent, according to a World Bank estimate. Local costs and receipts, i.e., those not involving foreign exchange, are valued at the prevailing 1977 exchange rate.

2. PROJECT BACKGROUND

2.1. Bakel Small Irrigated Perimeters Project

The Bakel Small Irrigated Perimeters Project is designed to develop about 1,900 hectares of irrigated farmland along the Senegal River in the area of Bakel. Bakel area farmers currently farm two cycles--one during the rainy season (May to October) on high ground and a second cycle which takes advantage of receding floodwaters along the river banks (October to January). Major crops are sorghum, millet, maize, groundnuts, and rice; all farms are hand cultivated. The principal ethnic group in the Bakel area is the Sarakolle, who are noted for their propensity to emigrate. It is estimated that one out of five farm families[1] has a member working in France. As a result, remittances from abroad account for an important percentage of total income in the area.

Irrigated agriculture was introduced in the Bakel area in 1975 and the following three agencies have financed the expansion of irrigation: Société d'Amenagement et d'Exploitation du Delta (SAED, a Senegalese government development agency), Centre International du Développement Rural (CIDR, a Paris-based international voluntary organization), and USAID. By the 1977 rainy season, the last rainy season before the Bakel Small Irrigated Perimeters Project was initiated,

[1] A farm family is composed of six to eight persons.

sixty-five hectares of irrigated rice had been brought into cultivation. The second-cycle dry-season crop consisted of maize (15 hectares) and vegetables (6 hectares). In addition to farming their project land, families involved in the project continued to farm their rainy season and flood recession fields.

Over a four year period, USAID will contribute about 2.6 of the 3.5 million dollars budgeted for the agricultural production component of the project. About 53 percent of the costs are for farm infrastructure and 20 percent are for technical inputs. Twenty-five percent of the total cost of the project is estimated to be in foreign exchange [USAID, 1977]. Following the four years of USAID financing, it is projected that SAED will continue to finance the project at a level of 53 million CFA per year ($230,000).

The USAID project will extend the irrigated perimeters in the same manner as had been done by previous agencies. For example, establishment of the perimeters and annual cultivation methods will continue to be labor intensive and small pumps will be used to bring water from the Senegal River to the perimeters. The major irrigated crops to be cultivated are rice (particularly during the rainy season) and maize (during the dry season). Although it is hoped that double-cropping will be adopted, the analysis conducted in the Project Paper [USAID, 1977] does not assume double-cropping. It is also envisaged that farmers participating in the project will continue to cultivate their rainfed fields. Farmer groups will be established to manage pump use, allocate farm plots, and articulate the concerns of farmers to project authorities. Irrigated land will be parceled out to individual farm families, with some areas reserved for collective cultivation. Proceeds from collective plots will be used for village-level projects.

2.2 Senegal Cereals Production Project

The Senegal Cereals Production Project seeks to increase agricultural production among rainfed farmers in the departments of Thies, Diourbel, and Bambey in the Groundnut Basin. From 1975 to 1979, USAID contributes $3.1 million to the overall $4.9 million program and the Société du Développement de la Vulgarisation Agricole (SODEVA), a Senegalese government development agency, contributes the remaining $1.8 million. The project area has a rural population of over a quarter of a million people. The area is characterized by high variation in farm size and cultivated area per adult, and an overall shortage of cultivable land [SODEVA, 1977]. Rainfall is low, about 500 to 700 mm per year, and there is a high degree of variability of quantity and distribution of rainfall during the rainy season, which lasts only 45 to 50 days.

Two crops, groundnuts and millet, account for about 90 percent of the area cultivated. Millet is the primary food staple while groundnuts, which cover more area in most of the region, are primarily a cash crop. Light animal traction with horse or donkey is employed on nearly all cultivated land. Even before the project began, one third to one half of the farmers used fertilizer on at least a portion of their farms [SODEVA, 1978, 1977/78].

SODEVA, the implementing agency, extends improved cultural practices and provides supplies and equipment to farmers in order to increase the production of both millet and groundnuts. The major components of the package, which are based on extensive research carried out by the Institut Sénégalais de Recherche Agricole (ISRA) at Bambey, are:

(1) the application of inorganic fertilizers on both millet and groundnuts;

(2) the use of improved implements for donkey and horse traction and the introduction of oxen traction; and,

(3) the adoption of improved cultural practices--early planting, thinning of millet, etc.

The Project Paper stated that project benefits were to be realized primarily through increased net returns on cultivated land. Additional benefits were to be realized by diverting fallow land to cereal production, through greater use of fertilizers and soil maintenance [USAID, 1974].

During the first three years of the project (1975/76 to 1977/78), staff salaries accounted for over half of project expenditures. The other major areas of expenditure were operation costs, construction of offices and warehouses, a credit program for input supply, and the establishment of the Cellule de Liaison to coordinate more closely research and extension. The foreign exchange component of total project expenditures is about 17 percent [USAID, 1974].

3. BAKEL SMALL IRRIGATED PERIMETERS PROJECT: FINANCIAL AND ECONOMIC ANALYSIS

This section presents the methodology for evaluating the Bakel project, an analysis of representative farm budgets, an examination of the costs and returns to the project, and a discussion of major issues and problems faced by the project.

3.1 Methodology

Although 1977 was the first year of project implementation, irrigated cultivation began in Ballou, a village in the Bakel area, in 1975. Since project expansion is based on experience gained at Ballou, it is assumed that Ballou farm budgets for 1977 can give a good indication of project costs and benefits in future years.

In 1977, Ballou was the largest perimeter in the Bakel Project area, accounting for over one-third of the total rainy season cultivated area. According to SAED's yield study [SAED, 1978], Ballou's rice yields were close to project-wide average yields per hectare. In 1977, 18 hectares were farmed individually by 88 families (0.2 hectare/family), whereas the remaining 12 hectares were farmed collectively by the village as a whole. SAED officials project that collective farms will decrease in importance in future years and that individual family farms will increase in size.

Since no systematic collection of data on labor use, costs, and returns had been carried out, it was necessary to secure needed data through interviews with SAED field workers and farmers. Data on rice yields were obtained by revising SAED's own yield estimates [SAED, 1978] downward by 25 percent on the recommendation of USAID staff. The data for maize yields are the subjective estimates of SAED field staff, revised downward by 25 percent. In both cases, USAID staff believed that SAED overestimated the actual yields. Some cost figures, for pump costs, fuel costs, etc., were obtained from project records. Since all farms in Ballou are located on one perimeter, farmers are closely supervised, and conditions with respect to cost components for fertilizer use, seed use, etc., are relatively uniform. Project overhead costs for construction, administration, personnel, etc., are taken from estimates made in the Project Paper [USAID, 1977].

3.2 Farm Budget Analysis

Few data are available to provide an economic profile of a farm family in the Bakel area. The USAID Project Paper estimates that the average non-participating farm family consists of six persons cultivating three hectares of rainfed land (two hectares during the rainy season and one hectare during the period of flood recession) and obtains a net income of 80,000 CFA from farm activities.

Project analysis involves the comparison of with-project benefits and without-project benefits. Without the project, it is estimated that non-participating farmers would continue to earn 80,000 CFA per year from rainfed cultivation. With the project, farmers participating in the project will earn returns from both rainfed and irrigated farming. The economic returns from the irrigated farms are the project's benefits. On the non-irrigated farms of project participants, it is likely that returns will decrease due to reduced labor inputs. For this reason, the value of labor inputs into irrigated cultivation (see Appendix 1) is included as a cost to the project.

Table 3.1 presents costs and returns at the farm level for irrigated rice (rainy season) and maize (dry season) for the 1977/78 rainy season crop and second season crop at Ballou. For a farm of 0.2 ha., net returns to land under financial analysis are 10,492 CFA for rice and 6,382 CFA for maize. These figures represent the returns to farmers after the value of their own labor and their family's labor has been deducted from net returns.

The results are less impressive under economic analysis, in which fertilizer, pump maintenance, and pump replacement are valued at their economic costs and rice is valued at its economic price.[1] For a farm of 0.2 hectares, net returns to land are 1,851 CFA for rice and -395 CFA for maize.

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[1] In the economic analysis for this study, two different methods were considered for valuing foodgrains produced for import substitution (millet, rice, and maize). The first method, the adjusted border price method, follows the conventional methodology of project analysis. Prices of import substitutes are based on border prices, adjusted upward by 15 percent to reflect the real scarcity of foreign exchange. This approach evaluates the benefits of the project according to the foreign exchange saved through reduced imports.

The second method, the government-policy price method, looks to the policy objectives of Senegal. Since Senegal pursues a policy of foodgrain self-sufficiency, it values an additional ton of locally produced foodgrain at a higher price than a ton of imported grain. To value locally produced foodgrains, this approach uses the government's official prices for foodgrains, which are 25 to 40 percent higher than border prices. This approach assumes that the 25 to 40 percent premium added to the border price represents the value the government places on producing foodgrains locally instead of importing them. In addition, a premium of 15 percent of the border price is added for the same reason it was added in the first approach--to adjust for the overvalued currency. The following numerical example for rice is presented to clarify the two approaches: [N.B. Footnote is continued on page 15.]

Table 3.1. Bakel Small Irrigated Perimeters: Irrigated Rice (Rainy Season) and Maize (Dry Season) Enterprise Budgets for Ballou Perimeter, 1977/78[1]

	Rice		Maize	
	Financial Analysis[2] CFA	Economic Analysis[3] CFA	Financial Analysis[4] CFA	Economic Analysis[3] CFA
1. Value of output/ha.	150,000	139,500	90,000	82,600
2. Variable costs/ha.				
a) Fertilizer				
1) NPK	3,750	8,280	3,750	8,280
2) Potassium chloride	2,500	4,370	2,500	4,370
3) Urea	5,250	9,315	7,000	12,420
Total	11,500	21,968	13,250	25,070
b) Seed	4,000	4,400	1,125	1,233
c) Pumping costs				
1) Fuel	26,250	30,187	17,475	20,096
2) Oil	5,250	6,037	3,500	4,025
3) Maintenance	0	4,285	0	2,857
Total	31,500	40,509	20,975	26,978
3. Gross margin/ha.	103,000	72,626	54,650	29,319
4. Tools, equipment, depreciation/ha.				
a) Tools	3,275	3,275	340	340
b) Payments to farmer group for hired workers	2,667	2,667	2,000	2,000
c) Payments to farmer group for pump replacement	3,600	16,427	2,400	10,952
5. Net returns to land and labor/ha.	93,458	50,257	49,910	16,027
6. Net returns to land and labor/0.2 ha. farm	18,692	10,051	9,982	3,205
7. Value of family labor/0.2 ha. farm[5]	8,200	8,200	3,600	3,600
8. Net returns to land/0.2 ha. farm	10,492	1,851	6,382	-395
9. Farm data				
a) Yield per ha. (tons)	3.0	3.0	2.0	2.0
b) Fertilizer use (kg./ha.)				
1) NPK	150	150	150	150
2) Potassium Chloride	100	100	100	100
3) Urea	150	150	200	200
c) Fuel (litres gas-oil/ha.)	350	350	233	233
d) Oil (litres/ha.)	15	15	10	10
e) Seed rate (kg./ha.)	80	80	25	25
f) Product price/kg.	50	46.5	45	41.5
g) Person-days of work/0.2 ha. farm[5]	82	82	36	36

Footnotes to Table 3.1

[1]Budgets are expressed in CFA/hectare except where otherwise stated.

[2]Rice budget based on financial analysis

Value of output: Average yield/hectare in Ballou for 1977/78 was estimated at 3.0 tons/ha., revised downward by 25 percent from the SAED figure [SAED, 1978] of 3.9 tons. This revision was recommended by USAID staff. Project-wide yields were reported by SAED to be 3.8 tons/ha.

The price of rice used is the average annual market price for paddy at Bakel, 50 CFA/kg., as estimated by local field staff. There is little fluctuation in this price at various times of the year. The official price of rice is 41.5 CFA/kg., but SAED is not yet buying rice in the area.

Fertilizer: Farm level quantities and prices:

150 kg. NPK	25 CFA/kg.
100 kg. Potassium chlorate	25 CFA/kg.
150 kg. Urea	35 CFA/kg.

Farmers receive fertilizer on credit before the crop year begins and pay SAED after the harvest. No interest is charged. Almost all farmers use recommended quantities of fertilizer.

Seed: Almost all seed is obtained from the previous year's stock. Price is average market price of output, 50 CFA/kg.

Pumping Costs: In 1977/78, an Italian pump was used to supply water at Ballou. Since the majority of pumps in use and to be installed in the project are Gorman HR2s, data for this pump are more appropriate for this study. Thus pumping costs/ha. for 1977/78 in this analysis were taken from Arroundou, which is close to Ballou, and where such a pump is in operation. Project staff claim that quantities of water used in the two perimeters were about the same.

Fuel and oil costs were taken from records of actual quantities used. 1,400 liters of gas-oil (fuel) and 60 liters of oil were used for 2 ha. of rice (rainy season) and 3 ha. of maize (second season). Figures are higher than what could be considered normal (see SAED, 1975) because of the low rainfall in the 1977 rainy season (392 mm vs. an annual average of 712 mm) and operational problems. Cost of fuel and oil are 75 CFA and 350 CFA/litre respectively.

Sixty percent of the total annual costs are charged to rice while the remaining 40 percent are charged to maize, in accordance with their estimated relative water consumption.

Maintenance is not costed in the financial analysis because it is carried out free of charge by SAED.

Tools and equipment:

Tools	no./ha.	Price/ Tool	Life (yrs)	Percentage of price charged against rice prod.	Annual Charge (CFA)
Seeders	0.2	12,890	5	100	516
Picks	0.3	1,991	5	67	88
Shovels	0.3	1,991	5	67	88

table cont'd. on next page

Tools and equipment:

Tools	no./ha.	Price/ Tool	Life (yrs)	Percentage of price charged against rice prod.	Annual Charge (CFA)
Hoes	10	500	5	50	500
Sickles	10	750	5	50	750
Bags	40	100	3	100	1,333
					3,275

The farmer group owns 6 seeders, 10 picks and 10 shovels. Since most of the tools are used for alternative purposes, only a proportion of this cost is allocated to rice.

Although it is technically incorrect to use the depreciation method for appraising tool and equipment costs in financial analysis, it is likely that results would be the same if actual financial costs could be calculated.

Hired workers: The farmer group hires a pump operator and a watchman for 10,000 CFA/month each for 4 months for the 30 ha. perimeter.

Pump replacement fund: Although no payment to this fund was made in 1977/78, SAED personnel plan to collect 300,000 CFA/yr. at Ballou starting in 1978/79 (during which 50 ha. were cultivated) as the farmers' annual contribution to pump replacement. In this analysis, 60 percent of the contributions to this fund are charged to rice production (rainy season) and 40 percent to maize production (second season).

The life of the pump is estimated to be 7 years, and total cost, including accessories and installation, is estimated to be 2.5 million CFA.

Land costs: There is no charge for farming land in the project, nor is there any rental system. In the short run, it is probable that supply of irrigated land will exceed the demand. Therefore land costs are assumed to be zero.

Establishment costs: Establishment of irrigation works is not costed in the farm level analysis because all monetary costs (mechanical equipment, material, etc.) were paid for by SAED. Farmers contributed only slack season labor.

[3]Rice and maize budgets based on economic analysis

Differs from financial analysis in following ways:

a) A 15 percent premium is added to the economic costs of fertilizer, fuel, oil, and pump replacement to compensate for the overvaluation of the CFA (see Section 1).

b) Fertilizers costed at 1977 cost-of-production [MDR, 1977]. A 15 percent premium is added since most of cost is in foriegn exchange:

NPK	48 CFA/kg.
Potassium chloride	38 CFA/kg.
Urea	54 CFA/kg.

c) Pump annual maintenance and repair costs are 30 percent of depreciation. Total cost of Gorman HR2 pump including installation costs - 2,500,000 CFA according to SAED personnel at Bakel. Annual amortized payment (pump life of 7 years, pump serves 15 ha., assume zero salvage value) is 23,809 CFA. Annual maintenance cost is thus 7,142 CFA. Sixty percent of each of these costs is charged to rice and 40 percent to maize. Fifteen percent is added (see "a" above).

d) Economic prices of maize and rice are calculated using the government-policy price method, described in Section 3.2. Adjusted border prices for rice and maize for 1977 were 38.4 and 29.7 CFA, respectively [USAID, 1978b].

e) Although it is technically incorrect to use the depreciation method to appraise pump costs in economic analysis, the results would not differ significantly if the pump cost had not been annualized.

[4]Maize budget based on financial analysis

Value of Output: The average yield per hectare in the Bakel area is about 2.0 tons according to rough estimates made by USAID staff.

SAED personnel estimated that the average price of maize during 1977/78 was 45 CFA, compared to the official price of 37 CFA/kg.

Fertilizer

Farm level prices and quantities:

150 kg. NPK	25 CFA/kg.
100 kg. Potassium chloride	25 CFA/kg.
200 kg. Urea	35 CFA/kg.

Seed: Price is average market price as estimated by SAED personnel.

Pumping Costs: See footnote no. 2.

Tools and Equipment: 1/3 of shovel and pick costs under rice tool costs are charged to maize production. 1/4 of hoe costs are charged to maize production.

Hired Workers: The farmer group hires a pump operator and a watchman for 10,000 CFA/month for 3 months for the 30 ha. perimeter.

Pump Replacement: See footnote no. 2.

[5]See Appendix 1.

The budgets also show the relatively high costs of inputs at the farm level. For a 0.2 hectare farm, total financial costs of fertilizer, seed, pumping costs, tools, and payments to farmer groups amount to 19,326 CFA: 11,308 CFA for rice and 8,018 CFA for maize. This amounts to about 25 percent of what the average family farm income in the area would be without the project. Most of the inputs are supplied to farmers on credit during the crop year and are repaid after the harvest.

Table 3.2 presents irrigated-farm budget data with farm returns projected for years 1 to 5 and 6 to 15. The data for the analysis of years 1 to 5 are taken from Table 3.1. Because of the large expansion in area cultivated per year (300 to 600 hectares per year) during the first five years, increased yields and returns over those realized

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Adjusted Border Price Method

1) Border price of rice	33.4 CFA
2) Adjustment for overvalued currency	5.0 CFA
3) Economic price	38.4 CFA

Government-Policy Price Method

1) Border price of rice	33.4 CFA
2) Adjustment for overvalued currency	5.0 CFA
3) Contribution towards self-sufficiency = official price (41.5 CFA) minus border price	8.1 CFA
4) Economic price	46.5 CFA

This study uses the government-policy price method for valuing foodgrains in economic analysis, since this method takes into account 1) the foreign exchange saved through reduced imports and, 2) the contribution of local production to foodgrain self-sufficiency. The results of economic analysis using the adjusted border price method for valuing foodgrains are also included, however, to demonstrate the costs of pursuing a policy of import substitution. Government-policy prices for foodgrains are higher than the corresponding adjusted border prices for foodgrains. Therefore, economic analysis using government-policy prices presents the projects in a more favorable light than economic analysis using adjusted border prices.

Table 3.2. Bakel Small Irrigated Perimeters Project: Irrigated Farm Budget Analysis for Projecting Project Benefits, 1978-82 and 1983-91

	Per Year Year 1-5[1] 1978-82		Per Year Year 6-15[2] 1983-91	
	Financial	Economic	Financial	Economic
A. SINGLE-CROPPING[3]				
RICE				
Value of output/ha.	150,000	139,500	166,000	186,000
Gross margin/ha.	103,000	72,626	119,000	119,176
Net returns to land and labor/ha.	91,058	39,305	107,058	85,805
Net returns to land and labor/farm[4]	18,212	7,861	53,529	42,902
Net returns to land/farm[5]	10,012	-339	37,429	26,802
B. DOUBLE-CROPPING				
RICE				
Value of output/ha.	150,000	139,500	170,150	186,000
Gross margin/ha.	103,000	72,626	123,150	119,126
Net returns to land and labor/ha.	93,458	50,257	113,608	96,757
Net returns to land and labor/farm[4]	18,691	10,051	56,804	48,378
Net returns to land/farm[5]	10,491	1,851	40,704	32,278
MAIZE				
Value of output/ha.	90,000	82,600	92,500	103,250
Gross margin/ha.	54,650	29,319	57,150	49,969
Net returns to land and labor/ha.	49,910	16,027	52,410	36,677
Net returns to land and labor/farm[4]	9,982	3,205	26,205	18,338
Net returns to land/farm[5]	6,382	-395	19,105	11,238
TOTAL-RICE AND MAIZE				
Value of output/ha.	240,000	222,100	262,650	289,250
Gross margin/ha.	157,650	101,945	180,300	169,095
Net returns to land and labor/ha.	143,368	66,284	166,018	133,434
Net returns to land and labor/farm[4]	28,673	13,256	83,009	66,717
Net returns to land/farm[5]	16,873	1,456	59,809	43,516

[1]Based on Table 3.1. Net returns will remain at these levels through the first five years. With 300-600 ha. of additional land being brought into cultivation each year it is doubtful whether net returns can be improved during this period.

[2]Rice and maize yields are projected to average 4 and 2.5 tons/ha. respectively compared to 3 and 2 tons/ha. during the first five years. Costs per hectare are assumed to remain at year 1-5 levels. Financial product prices are the official prices - rice - 41.5 CFA/kg. and maize - 37 CFA/kg. since saturation of the local market will force farmers to sell produce to SAED at official prices. Economic prices are the same as in Table 3.1.

[3]Assumes a single rice crop during the rainy season. Pump replacement costs are charged solely to rice production.

[4]Irrigated farm size is assumed to be 0.2 ha. in years 1-5 and 0.5 ha. in Years 6-15. These fields are in addition to rainfed and flood recession fields already under cultivation without the project.

[5]Net returns to land are net returns to land and labor minus the value of family labor inputs. Labor inputs are obtained from Appendix 1. Labor inputs for the 0.5 ha. farm (years 6-15) are half of the labor-inputs per ha. figures shown in Appendix 1.

in the Ballou perimeter during 1977/78 (Table 3.1) are unlikely. The total net returns to land for double-cropping rice and maize are 16,873 CFA per .02 hectare farm under financial analysis and 1,456 CFA under economic analysis. Thus, a farm family entering the project and double-cropping only 0.2 hectare increases its annual financial farm income by 21 percent, from 80,000 CFA to 96,873 CFA. If only a single rice crop is cultivated, Table 3.2 shows financial net returns to land are 10,012 CFA per 0.2 ha. farm, or a 13 percent increase in farm income. Economic net returns to land per hectare during years 1 to 5 are projected to be 1,456 CFA for double-cropping and -339 CFA for single-cropping.

Columns 3 and 4 of Table 3.2 show projected financial and economic results of farm budget analysis for years 6 to 15. Average farm size is projected to increase from 0.2 hectare in years 1 to 5 to 0.5 hectare in years 6 to 15. Yields per hectare are assumed to increase from 3 to 4 tons per hectare for rice and from 2 to 2.5 tons per hectare for maize as farmers gain experience in irrigated cultivation and as pumping and water-flow problems are resolved. Product prices for rice and maize under financial analysis are assumed to decline in years 6 to 15 from the local market prices used in the analysis for years 1 to 5 down to the government's official prices. As the local market becomes saturated with produce from the project, farmers will have to sell their output to SAED at official prices (see Table 3.2, footnote 2).

The net results of increased yields and lower product prices during years 6 to 15 are financial net returns per 0.5 hectare farm of 59,809 CFA for double-cropping and 37,429 CFA for single-cropping, or increases in farm income of 75 percent and 47 percent respectively over the income of a non-participating farm. Under economic analysis, net returns per hectare are projected to average 43,516 CFA for double-cropping and 26,802 CFA for single-cropping.

The analysis thus far has shown that the project is relatively profitable from the perspective of the individual farm unit. In the following section, project overhead costs will be compared with project benefits to evaluate the economic performance of the project.

3.3 Project Benefits and Costs

Project benefits are shown in Table 3.3.[1] In each year, it is assumed that half the area cultivated during the rainy season is cultivated during the dry season.[2] Rice is the rainy-season crop and maize is the dry-season crop. In Table 3.3, part A, domestic labor costs (for explanation, see Appendix 1) are subtracted from the net returns to land and labor. During years 1 to 5, average net returns to land are 13,544 CFA per hectare, rising to an average of 70,420 CFA per hectare in years 6 to 15.

In Table 3.3, part B, annual project benefits are computed by multiplying net returns to land per hectare by the project area cultivated in a given year. Total project benefits rise to an annual level of 138 million CFA per year in years 6 to 15. The assumptions behind these calculations are shown in the footnotes to Table 3.3.

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[1]These benefits are based on economic net returns presented in Table 3.2.

[2]In 1977, the proportion was only one-third, but officials expect it to increase.

Table 3.3. Bakel Small Irrigated Perimeters: Project Benefits Employing Economic Values[1]

A. Project Benefits: Net Returns on Irrigated Land (CFA/year)

	YEARS 1-5 DOUBLE-CROP	YEARS 1-5 SINGLE-CROP	YEARS 6-15 DOUBLE-CROP	YEARS 6-15 SINGLE-CROP
Net Returns to Land and Labor/ha.[1]	66,284	39,305	133,434	85,805
Labor cost/ha.[2]	46,300	32,200	46,300	32,200
Net Returns to Land/ha.	19,984	7,105	87,234	53,605

Assuming half the land is double-cropped, net returns/ha. are:[3]

Year 1-5	13,544 CFA/ha.
Year 6-15	70,420 CFA/ha.

B. Project Benefits/Year

YR.	PROJECT AREA (HA)[4]	NET RETURNS PER HA. (CFA)	ANNUAL PROJECT BENEFITS (1000 CFA)
1	190	13,544	2,573
2	487	13,544	6,109
3	921	13,544	12,474
4	1456	13,544	19,720
5	1961	13,544	26,560
6	1961	70,420	138,093
7-15	same as year 6		

[1]Projections of net returns to land and labor are from Table 3.2.

[2]Labor valued at 100 CFA/person-day. For calculations of labor requirements and labor costs see Appendix 1.

[3]Assuming half the land is double-cropped, average net returns/ha. are the average of the net return/ha. double-cropped and net return/ha. single-cropped.

[4]Project area per year is obtained from USAID [1974], although the year one figure is the actual 1978 area cultivated. The 65 ha. being cultivated before the project began are included and it is assumed that net returns per ha. realized as a result of the project will be the same as for project-developed area. Total area to be developed by the project is 1896 ha.

Project costs per year and by category are shown in Table 3.4. A breakdown of total costs by category and government is shown in Appendix 2. Since only a small fraction of the funds allocated had been spent at the time of the writing of this paper, cost projections from the Project Paper are employed (see Appendix 2). Project costs and benefits not directly related to the production component of the project (e.g., health) are not included, nor are costs and returns associated with the solar pump component, which was added to the project after the Project Paper had been completed.

A comparison of net farm benefits and project costs reveals the likelihood that the project will produce rather poor results. Table 3.4 shows that the benefit-cost ratio is .53,[1] using government-policy product prices (see Section 3.2) and a discount rate of 12 percent to calculate net present worth. This ratio falls to .30 when a discount rate of 18 percent is used. The internal rate of return is negative. Table 3.4 also presents the results of economic analysis using adjusted border prices for maize and rice, instead of the government-policy prices (see Section 3.2) used in Tables 3.1 to 3.3. Since the adjusted border prices of rice and maize are lower than the government-policy prices, the results of economic analysis using the adjusted border prices are even poorer than those using the government-policy prices. The benefit-cost ratio is .08 using a discount rate of 12 percent to calculate net present worth, falling to less than .01 using a rate of 18 percent. The internal rate of return is again negative.

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[1]According to the benefit-cost ratio criterion, projects with a ratio of less than 1.00 are unacceptable, since not all the capital invested in the project is recovered.

Table 3.4 Bakel Small Irrigated Perimeters Project: Economic Analysis[1]

	Yr. 1	Yr. 2	Yr. 3	Yr. 4	Yr. 5	Per Year Yr. 6-15
Net Farm Benefits[2]	2,573	6,109	12,474	19,720	26,560	138,093
Project Costs[3]						
Central Infrastructure	84,919	3,996	6,993	3,996	10,856	10,856
Farm Infrastructure	227,856	54,854	71,732	67,513	0	0
Technical Inputs	25,884	41,111	57,858	27,406	9,890	9,890
Administration	13,225	13,225	13,225	13,225	13,225	13,225
Miscellaneous	18,485	8,493	10,492	12,490	12,490	12,490
Subtotal	370,369	121,679	160,301	124,630	46,461	46,461
Contingency (15%)	55,555	18,252	24,045	18,695	6,970	6,970
TOTAL	425,925	139,931	184,346	143,325	53,431	53,431
Net Benefits (undiscounted)	-423,352	-133,822	-171,872	-123,605	-26,871	+84,662

	Using Economic Product Prices Based on Government Policy[4]	Using Economic Product Prices Based on Border Prices[5]
Internal Rate of Return	Negative	Negative
Benefit-Cost Ratio (12% discount rate)	.53	.08
Benefit-Cost Ratio (18% discount rate)	.30	.003

[1]Expressed in thousands of CFA. For cost breakdown by government, see Appendix 2.

[2]From Table 3.3, part B.

[3]Data are taken from project paper estimates and include only those costs directly related to the production component of the project [USAID, 1977]. For data for years 1-4 see Appendix 3. Distribution of costs between years is from [USAID, 1977]. Data for years 5-15 are also from [USAID, 1977]. Pumps and equipment are excluded since these are accounted for in Net Farm Benefits. Other costs are calculated on an annual basis. Administrative costs and miscellaneous costs are the same as for year 4. Personnel costs are included under Technical Input. For cost breakdown by government, see Appendix 2.

[4]See Section 3.2.

[5]Rice: 38.4 CFA/kg. and maize: 29.7 CFA. These prices are the C.I.F. Dakar prices [USAID, 1978b] plus 15 percent to compensate for the overvaluing of the CFA franc. Transportation costs are not included since it is a reasonable assumption that transportation costs from the point of production to the point of consumption would equal transportation costs from the port of entry to the point of consumption.

These figures contrast sharply with those in the Project Paper, which estimated internal rates of return of 13 percent to 27 percent under a variety of assumptions. Although the Project Paper is extremely sketchy in describing the methodology employed, some of the reasons for these differences can be stated as follows:

1. The Project Paper used excessively high paddy rice prices of 65 and 75 CFA per kg. for its economic analysis. The government-policy price used in this study is 46.5 CFA per kg. and the adjusted border price of rice for 1977 was 38.4 CFA per kg., C.I.F. Dakar [USAID, 1978b].

2. Pumping costs, including fuel and maintenance, were projected to be 9,750 CFA per hectare for single-cropping and 22,640 CFA for double-cropping. According to the data collected in this study, actual per-hectare costs were 40,509 CFA and 67,487 CFA per hectare, respectively. Actual quantities of fuel used were found to be significantly higher than those which had been projected.

3. Labor requirements per hectare, according to this study, were 322 person-days per hectare for rice and 141 person-days per hectare for maize. Projections in the Project Paper, which assumed use of animal traction, were 239 and 47 person-days, respectively. Labor was valued at 75 CFA per person-day in the Project Paper and 100 CFA per person-day in this study.

4. According to the Project Paper, the only project costs after the fourth year are for building maintenance, vehicles, pumps, and equipment. In this analysis, personnel, administrative, and miscellaneous costs are assumed to continue and have thus been added (see Table 3.4).

3.4 Summary and Implications

Although the financial analysis shows that there will be significant increases in family incomes, the economic analysis of the project yields a low benefit-cost ratio and a negative internal rate of return. Benefits produced at the farm level simply do not cover farm level costs and project overhead costs.

Several assumptions used in this paper may be criticized, however, for being excessively conservative. Data on crop yields, for example, were obtained by revising SAED's own yield estimates [SAED, 1978] downward by 25 percent. The economic analysis of the project was revised, however, to evaluate the project using SAED's own yield estimates.[1] Project performance was still unacceptable, even with the higher yield estimates. The benefit-cost ratio using government-policy prices for rice and maize (see Section 3.2) and a discount rate of 12 percent was .93 and the internal rate of return was 10.4 percent. Using adjusted border prices for rice and maize and a discount rate of 12 percent, the benefit-cost ratio was .65 and the internal rate of return was 5.7 percent.

Aside from increased yields, two other developments may increase project benefits at a more rapid rate than those projected in this study. It is possible that the high pumping costs shown in the farm budget (Table 3.1) can be reduced by improving pump efficiency and the water-flow network. It is also possible that more than 50 percent

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[1] This study assumes that rice and maize yields per hectare are 3 and 2 tons, respectively, during years 1 to 5, rising to 4 and 2.5 tons, respectively, during years 6 to 15. Using SAED figures, rice and maize yields per hectare are 3.8 and 2.5 tons, respectively, during years 1 to 5, rising to 4.5 and 3 tons, respectively, during years 6 to 15.

of the irrigated area will be double-cropped in future years.

On the other hand, it is likely that the following problem areas will limit project benefits in future years:

1. Seasonal labor shortages: Although the enthusiasm of the Bakel area residents for the project seems to be well documented [USAID, 1977], there is a strong possibility that sufficient labor will be lacking to farm the additional 1,890 hectares of irrigated land envisaged. The Project Paper acknowledges that the increased returns to participants will not be sufficient to attract large numbers of emigrants back to the Bakel area. With a projected 1985 population of 42,000 it would be necessary for 3,750 families, 75 percent of the 5,000 families in the Bakel area, to cultivate an average of 0.5 hectare of irrigated land per family in order to farm the additional area. Even if 3,750 families participated in the project, they would require a large number of hired laborers, especially during the peak seasons of rice weeding (July to August) and rice harvesting (November to December, which is also the period for harvesting rainfed millet, maize, and peanuts). In 1976, the rains came late, resulting in a conflict between rice weeding and the sowing of rainfed crops. Because of this conflict, 45 of the 105 ha. of rice planted were abandoned [SAED, 1977]. There is an obvious need to identify appropriate technology or changes in management practices which could reduce such seasonal labor bottlenecks and allow farm size to increase.

2. Pumping inefficiencies: With 300 to 600 ha. of land being brought into cultivation each year during the first five years, it is likely that the initial pumping inefficiencies will continue to plague

the project. These problems include inefficient use of fuel, waste of water due to imperfections in the water-flow network, and maintenance and repair problems. Bakel's distance from SAED's headquarters in St. Louis and the poor quality of roads exacerbate these problems. Project officials must identify the reasons for the excessive use of fuel and take steps to reduce fuel consumption.

3. Decreased yields and returns due to increased size of holdings: It is possible that as the size of holding increases, the yield per hectare and net returns per hectare will decrease due to labor bottlenecks and management problems. This is especially important with respect to rice, a highly labor-intensive crop requiring performance of tasks on a timely basis. In a study of irrigated-rice farmers in Cameroon during the first years of a development project, yields dropped 39 percent as farm size increased from .01 to .30 ha. to .70 to 2.0 ha. [Franzel, 1975]. It is recommended that a policy discouraging excessively rapid increases in farm size per family be considered in order to insure that proper management is maintained.

4. Stifling of local participation: In early January, 1978, the Bakel Area Farmer Federation disapproved of some of the conditions offered in the SAED "contract," specifically SAED control over federation funds for pump replacement, marketing options, etc. Most important, federation representatives complained that the contract was drawn up without their participation. The results of an analysis at the nearby Matam perimeters highlight the significance of the complaint. The Matam study found that three conditions strongly influenced the success of small irrigated perimeters: a decentralized

organization giving responsibility to farmer groups, a flexible production model, and formulation of project objectives by the participants themselves [Fresson, 1977]. Thus, unless there is increased local participation, there is a danger that the project will not become self-sustaining. Local participation must be fostered with the goal of giving local farmer groups greater responsibility for project management as well as paying a greater proportion of project costs, i.e., pump replacement, pump maintenance, etc.

4. SENEGAL CEREALS PRODUCTION PROJECT: FINANCIAL AND ECONOMIC ANALYSIS

4.1 Methodology

Because the Senegal Cereals Production Project involves a large number of improved cultural methods and technological innovations, it is extremely difficult to construct representative farm budgets and analyze either the financial or economic impact of the project. The task is complicated by five additional problems:

1. The difficulty of arriving at an "average year" for the farm budget, given the high degree of variation in both levels and distribution of rainfall in the area.

2. The lack of consistent and well-understood terms of reference to categorize farms at different levels of technology. For example, both the Project Paper [USAID, 1974] and the 1978 evaluation [USAID, 1978a] base their analysis on SODEVA data detailing the number of farmers at various levels: "light level," "oxen traction level," and "oxen traction-heavy fertilizer level." But whereas the AID studies interpret "light level" to mean an improvement in performance as compared to an implicit traditional level, SODEVA officials claim that "light level" refers to all farmers not in the two highest levels. These differences lend to corresponding divergences in appraisals of the project's accomplishments. The favorable appraisal of the USAID evaluation in 1978 was based on increases of "light level" farmers.

In contrast, SODEVA officials claim that the increase in "light level" farmers in their data was simply an increase in light level farmers contacted by extension workers. Most officials contacted, however, had either abandoned farm categorization or adopted the terms "semi-intensified" and "intensified" for which there are also no consistent, well-understood definitions.

3. The lack of data for comparing results of farm fields with and without the adoption of the recommended technical package. Several studies have used farms as their base units [Fall, 1977b; SODEVA, 1978]. But since a farm using improved technology adopts it on only a small percentage of its area, studies of improved technology on specific fields are needed to demonstrate the effects of using improved technology.

4. The high degree of variation among farms, especially with respect to area cultivated and area cultivated per adult.

5. The lack of consistency between the data of the two data-collecting units operating in the project area, the Cellule de Liaison and the Bureau d'Economie Statistique et de Planification of SODEVA.

Given the above considerations, it is not surprising that there was much difficulty in drawing up the representative farm budgets presented in this study. Nor is it surprising that the two project evaluation studies conducted in 1978 arrived at opposite conclusions about the incidence of project benefits. The USAID evaluation claimed that most of the project's success was achieved with the "light level" of technology [USAID, 1978a], whereas SODEVA's own evaluation stated that all project benefits resulted from adoption of the heavier technological packages [SATEC-SODEVA, 1978].

The following analysis compares with-project benefits with benefits which would accrue if the project were not implemented. Without the project, it is assumed that there would be no changes in the level of farm returns; adoption of new methods to improve productivity would be offset by the slowly diminishing fertility of the soil in the area [Labonne and Legagneux, 1977]. With the project, base farms not affected by the project will be transformed into "intensified farms," farms which have adopted many of the recommended practices and inputs on portions of their areas. Project benefits will be measured by comparing the returns on an intensified-farm hectare with returns on a base-farm hectare. The incremental returns per hectare of intensification multiplied by the number of hectares intensified during the project period will yield the benefits of intensification. Additional benefits are also generated through "semi-intensification," the adoption of a few of the recommended practices and inputs.

Data for the following analysis were taken from studies conducted by SODEVA [SODEVA, 1975/76, 1976/77, 1977/78, 1978] and the Cellule de Liaison [Fall, 1977a, 1977b]. But for the most part, the analysis relies on subjective opinions of the officials and field staff consulted. While the budgets are subject to a high margin of error, it is believed that they are indicative of the costs and benefits associated with the project.

4.2 Farm Budget Analysis

Farm budgets are shown for two theoretical standard farms--a "base farm" not affected by the project and an "intensified farm" which has adopted many of the recommended practices and inputs on a portion of its area. Although data exist on the number of intensified hectares in the project area, there is not a standard definition of intensification. The most common characteristics of an intensified farm are that on some portion of it 1) land is plowed by oxen, 2) a corrective dose of phosphate fertilizer has been applied, 3) the use of NPK fertilizer is above average (100-150 kg. NPK/hectare), and 4) improved cultural practices are used , such as early planting, millet thinning, etc.

The two theoretical standard farms studied are assumed to have thirteen cultivated hectares, 60 percent groundnut and 40 percent millet, in line with sample survey results [SODEVA, 1978; Fall, 1977b]. These studies also show that the two crops account for about 90 percent of total cultivated area. The family consists of fourteen members of whom eight are adults. The year from which cost data are calculated is 1977/78 [Ministère du Développement Rural, 1977], whereas yield figures are based on the opinions of field personnel and officials for an average year.

Table 4.1 shows economic and financial enterprise budgets on a per-hectare basis for millet and groundnuts on both a base farm and an intensified farm.[1] Line 5 shows net returns to land and labor per hectare. Using financial prices, groundnuts are over twice as profitable as millet on the base farm. Intensification doubles net returns to millet while increasing groundnut returns by 24 percent.

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[1]Enterprise budgets for the intensified farm in this table reflect costs and returns for an intensified hectare. Tool and equipment costs are per-hectare costs for the entire farm.

Table 4.1 Senegal Cereals Production Project: Enterprise Budgets for a Base Farm and an Intensified Farm 1977/78 Crop Year[1]

	BASE FARM				INTENSIFIED FARM			
	MILLET		GROUNDNUT		MILLET		GROUNDNUT	
	Fin[13]	Econ[14]	Fin[13]	Econ[14]	Fin[13]	Econ[14]	Fin[13]	Econ[14]
1. Value of output/ha.[2]	14,000	15,600	31,000	64,883	28,000	31,200	40,000	83,720
2. Variable costs/ha.								
a) Seed[3]	175	195	5,720	9,209	280	280	5,200	8,372
b) Fertilizer (NPK)[4]	1,275	2,815	750	1,656	3,125	6,900	3,125	6,900
c) Maintenance of equipment[5]	176	153	176	153	326	372	326	372
d) Total	1,626	3,163	6,646	11,018	3,731	7,552	8,651	15,644
3. Gross margin/ha.	12,374	12,437	24,354	53,865	24,269	23,648	31,349	68,076
4. Depreciation on Tools, Livestock, and equipment/ha.[6]	1,766	1,535	1,766	1,535	3,256	3,720	3,256	3,720
5. Net returns to land and labor/ha.[7]	10,608	10,902	22,588	52,330	21,013	19,928	28,093	64,356
Index (Base farm = 100)	100	100	100	100	198	183	124	123
6. Oxen appreciation/ha.[8]	0	0	0	0	2,154	2,154	2,154	2,154
7. Net Returns to land and labor/ha.[7]	10,608	10,902	22,588	52,330	23,167	22,082	30,247	66,510
Index (Base Farm = 100)	100	100	100	100	218	202	134	127
8. Technical Data								
a) Yield per ha. (kg.)[9]	400	400	775	775	800	800	1,000	1,000
b) Fertilizer use (kg. NPK/ha.)[10]	51	51	30	30	125	125	125	125
c) Seed rate (per ha.)[11]	5	5	110	110	4	4	100	100
d) Product price/kg.[12]	35	39	40	83.72	35	39	40	83.72

[1]Budgets expressed in CFA/hectare except where otherwise noted. Enterprise budgets for the intensified farm reflect costs and returns for an intensified hectare. Tool and equipment costs are per hectare costs for the entire farm.

No allowance is made for the costs of feeding animals used for traction or the value of groundnut and millet straw, which are used mostly for animal feed. Estimates of these were not available. Since the feed costs and the value of the straw probably balance out, this omission does not affect the results of the analysis.

[2]Value of output: Product price x yield/ha. (see below).

[3]Seed: Product price x seed rate (see below) with exception of groundnut seed price (financial analysis): 52 CFA/kg. and millet seed (intensified farm): 70 CFA/kg.

[4]Fertilizer prices--Financial: 25 CFA/kg. Economic: 55.2 CFA/kg. (cost of production [MDR, 1977] plus 15 percent to adjust for undervaluing of foreign exchange, since most production costs are in foreign exchange).

[5]Maintenance: 10 percent of depreciation on tools, livestock and equipment. See Appendix 3.

[6]Tools, livestock and equipment/ha.: See Appendix 3.

[7]Labor use: Given the inconsistent opinions about relative labor use on the two farms it is assumed that labor use is the same.

[8]Oxen appreciation: Sold for 140,000 CFA/pair after 5 years. 28,000 CFA/year/13 ha.

[9]Yield per ha.: Subjective estimates of officials and field workers for an average year.

[10]Fertilizer use: [SODEVA, 1978].

[11]Seed rate [Fall, 1977a; SODEVA, 1978].

[12]Product Price: a) Financial - Millet: 35 CFA/kg. is the official price of millet. Although only a small percentage of the area's millet was sold to the government in 1977, this price is used in the absence of private sector price data. Groundnut: The government's official price is 41.5 CFA/kg. at which most of the produce is sold. 1.5 CFA is deducted by the cooperatives for expenses. b) Economic - Millet: 35 CFA/kg. (the official price) plus 15 percent of the border price (.15 x 27.1/kg.) [USAID, 1978b] to compensate for undervaluing of foreign exchange saved through import substitution (see Section 3.2). Groundnut: The price used for groundnuts is the border price (77.1 CFA FOB Dakar) adjusted for transportation, handling, and overvaluing of foreign exchange [USAID, 1978b]. See Section 3.2.

[13]Financial analysis.

[14]Economic analysis.

On an intensified hectare, groundnuts yield a net financial return of 30,247 CFA per ha. which is 30 percent more than the net financial returns per ha. of millet.

Using economic prices, the benefits of intensification are similar, though the difference in returns between the crops is even greater. Groundnut returns are five times higher than millet returns on the base farm and three times as high on the intensified farm. When oxen appreciation on the intensified farm is taken into account, the difference between base-farm returns and intensified-farm returns is, of course, even greater.

The financial value of tools and equipment depreciation is almost twice as high on the intensified farm as on the base farm. Variable cost increases associated with intensification are 30 percent for groundnuts and over double for millet. The costs of livestock, tools, and equipment for each of the standard farms are shown in Appendix 3.

Table 4.2 summarizes the benefits per hectare generated through intensification. In the financial analysis, the chief benefits of intensification are realized in millet production. But in the economic analysis, which uses prices corrected for market distortions and government transfers, the greatest benefits accrue through groundnut production. The average increase in economic net margin per hectare resulting from intensification is 12,980 CFA.

Thus far, the analysis has been on a per-hectare basis. But since intensified farms intensify on average only about a third of their area, it is necessary to ask whether intensification is profitable at the farm-wide level. Table 4.3 shows that the benefits of intensification

Table 4.2. Senegal Cereals Production Project: Net Returns Added Through Intensification Per Hectare[1]

	Financial Analysis	Economic Analysis
A. Not Including Oxen Appreciation		
Millet intensification	+ 10.405	+ 9,026
Groundnut intensification	+ 5,505	+ 12,026
Weighted average[2]	+ 7,465	+ 10,826
B. Including Oxen Appreciation		
Millet intensification	+ 12,559	+ 11,180
Groundnut intensification	+ 7,659	+ 14,180
Weighted average[2]	+ 9,619	+ 12,980

[1] Computed by subtracting base-farm net returns/ha. from intensified-farm net returns/ha. for each crop (from Table 4.1).

[2] Millet 40 percent, groundnuts 60 percent reflecting distribution of intensified area cultivated between the two crops.

Table 4.3. Senegal Cereals Production Project: Net Returns for a Base Farm and an Intensified Farm

	Financial Analysis		Economic Analysis	
	Base Farm	Intensified Farm	Base Farm	Intensified Farm
1. Farm Area (Ha.)[1]	13.0	13.0	13.0	13.0
a. Base Groundnut Area	7.8	4.9	7.8	4.9
b. Base Millet Area	5.2	3.3	5.2	3.3
c. Intensified Groundnut Area	0.0	2.9	0.0	2.9
d. Intensified Millet Area	0.0	1.9	0.0	1.9
e. Intensified Area	5.2	3.3	5.2	3.3
2. Net Returns[2] (CFA/farm not including oxen appreciation)				
a. Intensified Groundnut	0	81,469	0	186,632
b. Intensified Millet	0	39,924	0	37,863
c. Base Groundnut	176,186	110,681	408,174	256,417
d. Base Millet	55,161	35,006	56,690	35,976
e. Net Returns/farm	231,347	267,080	464,864	516,888
f. Index (Base Farm = 100)	100	115	100	111
g. Net Returns/ha.	17,795	20,545	35,759	39,760
3. Net Returns[2] (CFA/farm including oxen appreciation)				
a. Oxen appreciation	-	28,000	-	28,000
b. Net returns/farm	231,347	295,080	464,864	544,888
c. Index (Base farm = 100)	100	127	100	117

[1]Proportions of farm area under different crops and systems is obtained from [SODEVA 1976/77, 1978; Fall 1977b].

[2]Net returns are computed employing net returns per hectare for intensified farm and base farm peanut and millet as shown in Table 4.1. Net returns are returns to land and labor.

are modest but not insignificant. An intensified farm of 13 hectares (4.8 of which are actually intensified and 8.2 of which are not) would have financial net farm returns of 267,080 CFA, 15 percent greater than the base farm. Economic net farm returns for the intensified farm are 516,888 CFA, 11 percent greater than for the base farm. When oxen appreciation on the intensified farm is included, the financial and economic returns are 27 percent and 17 percent higher.

It should be noted that labor is not considered in the above analysis since neither data nor consistent opinions about labor use on the two types of farms were found. For example, there is a range of opinions that the intensified farm required more, about the same as, and less labor than the base farm. Therefore, it is assumed that labor use is the same for both farms.

4.3 Project Benefits and Costs

It is unrealistic to include only the farm level benefits associated with intensification in the analysis. What has been defined as "intensified"[1] in the farm budget analysis represents only those farms which have adopted most of the recommended practices. Project benefits have no doubt accrued on semi-intensified farms which have adopted only a few of the improved inputs and methods. SODEVA officials define semi-intensive farms as farms which have adopted some of the recommended inputs and methods but too few of them to merit designation as intensified farms. In the discussion which

[1] Intensified farms were defined as having 4.8 of 13 hectares under intensified cultivation.

follows, project benefits will be divided into two components--benefits achieved through intensification and benefits achieved through semi-intensification.

Table 4.4 shows a rough estimate of project benefits achieved through intensification. The economic net returns added per hectare during an average year are multiplied by the number of hectares intensified under the project to reach 32.8 million CFA in the project's fourth year. This figure is 18 percent less than the Project Paper's estimate of fourth year benefits resulting from "oxen traction-heavy fertilizer," a level of improvement similar to, but somewhat more advanced than, intensification. That the net returns added per hectare are 39 percent higher than those projected in the Project Paper is primarily due to the higher product prices employed in the present economic analysis. Yields per hectare for intensified farms fell far short of those projected for the "oxen traction-heavy fertilizer" level in the project paper.

The benefits achieved through semi-intensification are more difficult to estimate. There are no data for the number of semi-intensified hectares. A glance at changes in input use during the project period (Table 4.5) provides some tentative insights. Fertilizer use, the most important source of benefits along the continuum towards intensification, actually declined during the first two years of project implementation in response to a price increase of 25 percent. The number of pairs of oxen tripled, but the area plowed by oxen increased much less significantly. It is not clear whether the low increase in area plowed by oxen is due primarily to unavailability

Table 4.4 Senegal Cereals Production Project: Benefits from Intensification And Semi-Intensification During the First Four Years of Project Intervention (Using Economic Prices)

	1975	1976	1977	1978	Project Paper 4th Year Projections[1]
1. Area intensified (ha.)[2]	1,367	2,104	2,744	3,896[3]	5,100
2. Economic net returns added/ha. (CFA)[4]	0	12,980	12,980	12,980	9,360
3. Area intensified by project (ha.)[5]	0	737	1,377	2,529	4,300
4. Benefits of farm intensification (1000 CFA)[6]	0	9,566	17,873	32,826	40,248
5. Benefits of semi-intensification (1000 CFA)[7]	0	9,566	17,873	32,826	40,248
6. Total net farm benefits (1000 CFA)[8]	0	19,132	35,747	65,653	291,640

[1] [USAID, 1974].Area intensified roughly corresponds to "TBFF" as employed in this source.

[2] From [SODEVA 1975/76, 1976/77, 1977/78].

[3] Projected from growth rates for area intensified, achieved in 1976 and 1977.

[4] From Table 4.2.

[5] Annual area intensified minus 1975 area intensified. For definition of "intensified" see Section 4.2.

[6] Row 3 multiplied by row 4.

[7] Roughly estimated to equal benefits of farm intensification (line 4). For definition of these benefits, see Section 4.3.

[8] The benefits without the project are assumed to be zero. The total farm benefits shown here thus represent "with-project benefits" minus "without project benefits."

Table 4.5 Senegal Cereals Production Project: Progress Indicators During First Three Years of Project Intervention[1]

	1975	1977	Net Change	Project Paper Projections: Net Change Two Years After Base Period[2]
Groundnut fertilizer (MT, NPK)	3,495	3,437	-58	+2430[3] (groundnut and millet fertilizer combined)
Millet fertilizer (MT, NPK)	5,610	4,738	-872	
Oxen pairs	1,062	3,253	+2191	+2260
Area plowed by oxen (ha.)	730	1,094	+364	+9450[3]
Phosphated area (ha.)	1,738	4,561	+2823	NA
Urea fertilizer (MT)	0	16	+16	+176

[1] From [SODEVA 1975/76, 1976/77, 1977/78; USAID, 1974, 1978a].

[2] Project Paper used a base period of 1974.

[3] Projections for 3 years after base period.

NA - not available.

of equipment, labor bottlenecks associated with the recommended end of cycle plowing, inexperience with oxen and poor oxen training, or the increased labor inputs required for oxen-plowing relative to horse or donkey-plowing. The area receiving phosphate increased considerably, though a program to introduce urea on millet barely got underway. On the basis of subjective evaluation of SODEVA field staff, total benefits on semi-intensified farms per year (Table 4.5) are roughly estimated in this analysis to be equal to total benefits associated with achieving intensification.

Total net farm benefits are shown in Table 4.6. Following the fourth year of project implementation, when USAID financing was to be terminated,[1] benefits are assumed to increase at a more modest 10 percent rate reaching 207 million CFA in year 15.

Project costs are shown in Table 4.6. Personnel costs make up the greatest portion of USAID expenditure (53 percent) followed by administration and construction. During the first four years, the Government of Senegal was to contribute about one-third of the total costs. Beginning in the fifth year, the government will take over all project costs, roughly estimated at 133 million CFA per year ($578,000).

A comparison of these costs with net farm benefits (Table 4.6) under economic analysis reveals the poor performance of this project. Using the government-policy price for millet (see Section 3.2) and a

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[1] It is likely, however, that a second phase of the project will begin in 1979.

Table 4.6. Senegal Cereals Production Project: Economic Analysis (Thousand CFA)

	Yr. 1 1975/76	Yr. 2 1976/77	Yr. 3 1977/78	Yr. 4 1978/79	5-15 Per Year
Net Farm Benefits[1]	0	19,132	35,747	65,653	78,543 → 207,443[1]
Project Costs					
USAID[2]					
Construction	12,997	28,129	38,858	NA	0
Materials	3,568	17,883	5,954	NA	0
Personnel	61,506	87,301	116,123	NA	0
Administration	18,761	31,583	41,629	NA	0
Training	-	734	162	NA	0
Miscellaneous	9,333	12,015	11,719	NA	0
Subtotal	106,165	177,517	213,685	221,154	0
Total including 15% Surcharge on Foreign Exchange[3]	122,090	204,144	245,738	254,327	0
Senegal[4]	104,000	104,000	104,000	104,000	133,120
Total	226,090	308,144	349,938	358,327	133,120
Net Benefits	-226,090	-289,012	-314,191	-292,674	-54,577 → +74,323[1]

	Using Economic Millet Prices Based on Government Policy[5]	Using Economic Millet Prices Based on Border Prices[6]
Internal Rate of Return	negative	negative
Benefit-Cost Ratio (12%)	.40	.30
Benefit-Cost Ratio (18%)	.29	.22

[1] After year 4, annual benefits are estimated to increase 10 percent per year. Data from Table 4.4.

[2] From Budget data, USAID Mission, Dakar.

[3] See Section 1 for explanation

[4] Year 1-3 based on 3-year total. Year 5-15 based on percentage increase projected in [USAID, 1974].

[5] See Section 3.2.

[6] Groundnuts: 83.7 CFA/kg., millet: 31.2 CFA/kg. These prices are the border prices [USAID, 1978b] plus 15 percent to compensate for the undervaluing of foreign exchange (see Section 3.2).

Table 9 SENEGAL CEREALS PRODUCTION PROJECT: ECONOMIC ANALYSIS (THOUSAND CFA)

	Yr. 1 1975/76	Yr. 2 1976/77	Yr. 3 1977/78	Yr. 4 1978/79	5-15 Per Year
Net Farm Benefits[1]	0	19,132	35,747	65,653	78,543 → 207,443[1]
Project Costs					
USAID[2]					
Construction	12,997	28,129	38,858	NA	0
Materials	3,568	17,883	5,954	NA	0
Personnel	61,506	87,301	116,123	NA	0
Administration	18,761	31,583	41,629	NA	0
Training	-	734	162	NA	0
Miscellaneous	9,333	12,015	11,719	NA	0
Subtotal	106,165	177,517	213,685	221,154	0
Total including 15% Surcharge on Foreign Exchange[3]	122,090	204,144	245,738	254,327	0
Senegal[4]	104,000	104,000	104,000	104,000	133,120
Total	226,090	308,144	349,938	358,327	133,120
Net Benefits	-226,090	-289,012	-314,191	-292,674	-54,577 → +74,323[1]

	Using Economic Millet Prices Based on Government Policy[5]	Using Economic Millet Prices Based on Border Prices[6]
Internal Rate of Return	negative	negative
Benefit-Cost Ratio (12%)	.40	.30
Benefit-Cost Ratio (18%)	.29	.22

[1]After year 4, annual benefits are estimated to increase 10 percent per year. Data from Table 4.4.

[2]From Budget data, USAID Mission, Dakar.

[3]See Section 1 for explanation

[4]Year 1-3 based on 3-year total. Year 5-15 based on percentage increase projected in [USAID, 1974].

[5]See Section 3.2.

[6]Groundnuts: 83.7 CFA/kg., millet: 31.2 CFA/kg. These prices are the border prices [USAID, 1978b] plus 15 percent to compensate for the undervaluing of foreign exchange (see Section 3.2).

12 percent discount rate, the benefit-cost ratio is .40, falling to .29 using a discount rate of 18 percent. The internal rate of return is negative. Table 4.6 also presents the results of economic analysis using the adjusted border price for millet instead of the government-policy price (see Section 3.2) used in Tables 4.1 through 4.5. Since the adjusted border price for millet is considerably lower than the government-policy price, the results of economic analysis using the adjusted border price are poorer than those using the government-policy price. The benefit-cost ratio is .30 using a discount rate of 12 percent and .22 using a rate of 18 percent. The internal rate of return is negative. The Project Paper, on the other hand, projected internal rates of return of 11 percent to 17 percent.

The short-falls of the project in terms of area intensified and inputs used (Table 4.5) have already been discussed. In addition, about 20 percent of the projected project benefits were to come from the diversion of fallow land to cereal production, presumably because of greater fertilizer use and soil maintenance. Officials and field workers interviewed did not believe that any such diversion of fallow land had taken place for such reasons.

Project costs, however, also fell short of the projections made in the Project Paper [USAID, 1974]. Excluding a 15 percent premium on foreign exchange, total USAID costs during the four years were estimated to reach 718 million CFA as compared to the projected 980 million CFA in the Project Paper. SODEVA's costs, projected to be 490 million CFA in the Project Paper were estimated to reach 416 million CFA (see Table 4.6).[1]

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[1]Using the Project Paper's own conversion rate of 245 CFA = $1. These estimates were obtained from budget data, USAID, Dakar.

4.4 Summary and Implications

Although the Senegal Cereals Production Project offers some financial benefits to the participants and some economic benefits to Senegal, the costs of this project far outweigh the benefits accrued. This conclusion should be supplemented by a review of four considerations not addressed in the preceding analysis.

1. Labor inputs were not used in this analysis because of the unavailability of monthly labor profiles showing time allotted to specific tasks for each of the farm types analyzed. The differences in labor required and the nature of labor bottlenecks for each system are not known. Research on labor inputs is urgently needed in order to compare farms at different levels of technology and to identify seasonal labor bottlenecks.

2. The budgets mask the enormous differences in farm size and areas cultivated per adult that exist in the area [SODEVA, 1977]. It is certain that farms operating at different levels of labor intensity and with different areas to cultivate have different costs and returns. The standardized "average" farm budget which was used in this analysis glosses over such differences.

3. By focusing on an average year, this study does not deal with the effects of intensification in a drought year such as 1977. Indeed, during 1977, SODEVA officials believe that an intensified farm had lower net returns than a base farm of similar characteristics. The risk involved in going into debt in a bad year (even though farm budgets show increased returns in average and good years) probably discourages intensification.

4. No allowance is made in this study for the costs of feeding animals used for traction or the value of groundnut and millet straw, which are used mostly for animal feed. Estimates of these were not available. Since the feed costs and the value of the straw probably balance out, this omission does not greatly affect the results of the analysis.

In conclusion, it is evident that the Project Paper was over-optimistic about the degree and speed at which project benefits would accrue. Although the Project Paper claims to draw upon years of research and a "production system already available which can lead to greatly increased levels of production" [USAID, 1974], this package does not appear to have been tailored to farm conditions. Although the analysis of farm budgets shows that the adoption of project recommendations results in increased farm incomes, the adoption rate has been very low. One reason is the risk of drought, as noted above. Others include:

1. The labor bottlenecks appear to be especially constraining under intensification. The most constraining peak period is the period of millet thinning-peanut weeding. The unavailability of labor is also a constraining factor at the end of the cycle, when plowing is recommended.

2. The introduction of technical change and the diffusion of technical change from the fields of the compound head to other compound members is not understood [Kleene, 1976]. The mechanisms by which such changes can be affected and the nature of the contract between the compound chief and adults living in the compound need to be studied.

3. There is a need for research on the needs of low-income farmers, i.e., farmers with small areas and/or a small land base per adult. Although data are not available to demonstrate it, SODEVA officials believe that intensification is much more common among large farmers than small farmers. SODEVA officials point to several problems inhibiting intensification by small farmers: too small a surface cultivated to supply feed for a pair of oxen, the amount of credit available for a farmer is tied to the quantity of groundnuts sold in the past, and that credit is not available to cultivators other than the compound head.

The tremendous amount of "guesstimation" involved in carrying out an economic analysis of the project is a result of the inadequate job done in monitoring the progress made. Acknowledgment of the uncertainty in the figures presented does not, however, modify the strongly negative results of the analysis conducted.

5. A COMPARISON OF THE TWO PROJECTS: THE ECONOMICS OF IRRIGATED AND RAINFED AGRICULTURE

In an effort to increase agricultural production, promote food security, and improve rural welfare in Senegal, USAID is helping the government of Senegal to initiate a small-scale irrigation and a rainfed agricultural production project. The purpose of this study is to carry out an interim economic evaluation of the two projects, the Senegal Cereals Production Project (SCP) and the Bakel Small Irrigated Perimeters Project (BSIP). Although the analysis is subject to wide margins of error due to the poor quality of data available, it is believed that the results obtained are valuable both in providing guidance for the individual projects and in offering some tentative results on the implications and trade-offs involved in small-scale irrigation and rainfed agricultural projects. In addition, further insights may also be drawn concerning the design and implementation of USAID projects.

5.1 Comparison of Selected Performance Indicators

In Table 5.1, selected performance indicators are presented to provide a summary comparison of the two projects. Although SCP has a life-of-project cost only 40 percent higher ($4.9 million vs. $3.5 million), the project encompasses a rural population about seven times greater than that of BSIP (295,000 inhabitants vs. 42,000 inhabitants). SCP project beneficiaries are estimated to reach 73,750 compared with 31,300 for BSIP.

Table 5.1. Selected Performance Indicators for a Comparison of the Economic Impact of the Senegal Cereals Production Project (SCP) and Bakel Small Irrigated Perimeters Project (BSIP)

	Dollars		CFA Francs	
	SCP	BSIP	SCP	BSIP
I. Physical Indicators				
A. Cultivated Ha. Benefitted by Project[1]		1,956	26,760	
B. Rural population in Project Area (8th yr.)[2]		42,000	295,000	
C. Farms in Project Area (8th yr.)[2]		5,250	21,410	
D. Estimated No. of Project Beneficiaries[3]		31,300	73,750	
E. Number of farms aided by project		3,912	5,352	
II. Project Cost Indicators				
A. Life of Project Cost (4 yrs.)[4]				
i) USA	3,124,000	2,608,000	827.9 m.	691.3 m.
ii) Senegal	1,809,000	879,000	416.0 m.	202.2 m.
iii) Total	4,933,000	3,488,000	1,243.9 m.	893.5 m.
B. Life of Project Cost/Potential Beneficiary	$17	$83	4,217	21,273
C. Life of Project Cost/Beneficiary	$67	$111	16,866	28,546
D. Average Annual Project Cost[5]/Beneficiary	$11	$14	2,444	3,155
E. 8th Year Project Cost/Beneficiary	$ 8	$7	1,805	1,707
F. Life of Project Cost/Ha.	$184	$1783	46,483	456,800
III. Farm Level Indicators (Financial Analysis)[6]				
A. Average Family Farm Income Without Project	$1,006	$348	231,347	80,000
B. Average Family Farm Income With Project	$1,283	$559	295,080	128,618
C. Index (Without Project Income = 100)	127	161	127	161
D. Net Returns/Ha. Without Project	$ 77	$116	17,710	26,660
E. Net Returns/Ha. With Project	$119	$159	27,370	36,748
F. Index (Without Project Net Returns/Ha. = 100)	154	138	154	138
IV. Farm Level Indicators (Economic-Analysis)[7]				
A. Net Returns/Ha. Without Project	$155	$211	35,650	48,530
B. Net Returns/Ha. With Project	$212	$303	48,760	70,369
C. Index (Net Returns/Ha. Without Project = 100)	136	144	136	144
V. Cost of Production/Metric Ton (MT)[8]				
A. Cost of Prod./MT Grain (using average project yr. costs)	$202	$173	46,399	39,826
B. Cost of Prod./MT Grain (using yr. 8 project costs)	$174	$154	40,037	35,482
C. 1977 Border Grain Price/MT	$135	$145	31,100	33,400

	Using Economic Product Prices Based on Government Policy[9]		Using Economic Product Prices Based on Border Prices[10]	
VI. Economic Indicators	SCP	BSIP	SCP	BSIP
A. Benefit-Cost Ratio (12% discount factor)	.40	.53	.30	.13
B. Benefit-Cost Ratio (18% discount factor)	.29	.30	.22	.03
C. Internal Rate of Return	negative	negative	negative	negative
D. Internal Rate of Return Projected in Project Papers	11-17%	13-27%	11-17%	13-27%

Footnotes to Table 5.1

[1]For SCP, 5 ha. benefited/beneficiary household [SODEVA, 1975/76]. BSIP project area is total irrigated area to be developed plus previously irrigated area.

[2]Based on estimates in USAID [1974, 1977]. The annual population growth rate is assumed to be 2 percent and there is no projected change in numbers of farms. Persons per farm in BSIP is from SAED-SATEC, 1977.

[3]Rough, subjective estimates. BSIP beneficiaries based on 0.5 ha./family, eight members/family [SAED-SATEC, 1977]. Beneficiaries as a percentage of total project area population are 75 percent (BSIP) and 25 percent (SCP).

[4]All project cost figures are undiscounted. From Appendix 2 and USAID budget data, USAID Mission, Dakar. USAID dollar figures for SCP are converted back from actual CFA expenditures at 265 CFA = $1. For Senegalese expenditures, 230 CFA = $1.

[5]Over 15-year period (see Tables 3.4 and 4.6).

[6]Family farm income and net returns are returns to land and family labor. For SCP data, lines A through C are from Table 5.1, lines D through F from Table 4.3. For BSIP, without-project farm is from USAID, 1977. With-project farm returns based on Table 3.2, Column 3, assuming half of farm is double-cropped.

[7]Economic prices for foodgrains are government-policy prices (See Section 3.2). "With-project" in SCP refers to an intensified hectare. BSIP without-project data is from USAID, 1977, with economic prices used in this paper substituted in. BSIP with-project data is from Table 3.2, Years 6-15. Without-project data is from USAID, 1974. Net returns are returns to land and family labor.

[8]Economic analysis is used here for rice (BSIP) and intensified millet (SCP) in Year 8. BSIP cost of production includes farm level costs (Table 3.1), project costs/year (Table 3.4), and household labor (Table 3.1). Four tons/ha. is the estimated yield, half of area is double-cropped, and rice is substituted for maize as a second crop.

For SCP, costs are for an intensified hectare. Farm costs are from Table 4.1, household labor costs are 10,800 CFA/ha. [CRED, 1977], and annual project costs/ha. are multiplied by 0.4 (the percentage of intensified area in millet), 0.5 (the percentage of project funds devoted to intensification), and divided by 1,482 (the number of intensified millet hectares in 8th year of project (Table 4.4), assuming 10 percent increases after Year 4).

Border prices are CIF Dakar plus 15 percent to compensate for undervaluing of foreign exchange (see Introduction).

[9]See Section 3.2.

[10]Using international product prices [USAID, 1978b], plus 15 percent to compensate for undervaluing of foreign exchange (see Introduction). Transportation costs are not included since it is a reasonable assumption for both projects that transportation costs from the point of production to the point of consumption will equal transportation costs from the port of entry to the point of consumption.

Project costs (undiscounted) are analyzed in Section II of Table 5.1. Life-of-project cost per beneficiary is $111 for BSIP, about 67 percent higher than that for SCP at $67. The gap between the two projects lessens when one looks at the project cost per beneficiary for an average project year (over a period of 15 years). Project cost per beneficiary in the eighth year, after capital costs have been completed, is actually lower for BSIP than for SCP. The high life-of-project cost per beneficiary of BSIP is explained by the high capital costs involved in establishing the irrigated perimeters. The low ratio for the eighth year, on the other hand, reflects the relatively low recurrent costs as compared to SCP's heavy personnel cost burden. Life-of-project cost per hectare for BSIP, $1,783 per hectare, is almost ten times that of SCP.

The results of the financial farm-level analysis in Section III of Table 5.1 reflect two important aspects. First, they show whether there are farm-level incentives for adopting project practices; second, they show real income changes at the farm level. Percentage farm income increases for BSIP (61 percent) are much greater than for SCP (27 percent). Returns in BSIP are also less subject to variable rainfall, which characterizes both project areas. It is questionable whether the 27 percent increase in income achieved by applying the SCP recommendations in an average year is an adequate incentive for their adoption, given the risk involved. In drought years, for example, SODEVA officials claim that net returns on intensified farms are lower than on unintensified farms.

The percentage increases in economic returns per hectare[1] achieved through the two projects are, on the other hand, quite similar--44 percent for BSIP and 36 percent for SCP (Table 5.1, Section IV). The high disparity in financial returns between the two projects is largely a reflection of differing government policies towards the two kinds of projects. In BSIP, farm inputs (pumping costs, fertilizer, etc.) are heavily subsidized, whereas in SCP, project benefits are heavily taxed through the maintenance of an artificially low groundnut price.

Section V of Table 5.1 compares the cost of producing foodgrains in the projects with the cost of importing foodgrains. SCP production costs for millet are estimated to be 50 percent higher than the equivalent costs for imported millet. For BSIP rice, the cost of production is 20 percent higher than the cost of imported rice. These data reflect the high costs which Senegal incurs in pursuing a policy of import substitution.

Last and most important, Table 5.1 shows the results of the economic analysis carried out in this study. Using government-policy prices to value foodgrains (see Section 3.2), benefit-cost ratios (using a 12 percent discount factor) for both projects are extremely low, .40 for SCP and .53 for BSIP. Internal rates of return are negative for both projects. Results are even poorer when adjusted border prices are used to value foodgrains, since these are lower than the corresponding government-policy prices. Benefit-cost

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[1] Using government-policy prices for foodgrains, as explained in Section 3.2.

ratios using discount rates of 12 percent are .30 for SCP and .13 for BSIP. Thus while economic analysis using government-policy prices to value foodgrains ranks BSIP higher than SCP, the reverse is true when adjusted border prices are employed.

These results are especially noteworthy when compared with those projected in the Project Papers. SCP's projected internal rate of return was 11 to 17 percent whereas BSIP's was 13 to 27 percent [USAID, 1974, 1977]. Reasons for the SCP overestimates of the internal rate of return in the SCP Project Paper were the use of unrealistically high adoption rates for fertilizer and oxen cultivation, over-optimistic yield projections, and misconceptions about the project's capability of diverting fallow land into production. Overestimates of project viability in the BSIP Project Paper result from the use of unrealistically high rice prices and underestimates of farm labor inputs, pumping costs, and post-project recurrent costs.

5.2 Project Performance

The performances of the projects are compared with respect to three major goals: economic viability, income distribution, and food self-sufficiency and security.

1. Economic viability: The economic performance of both projects is clearly unacceptable, since project costs far outweigh project benefits. When analyzed with respect to government-policy objectives as reflected by official prices for foodgrains, the evaluation of BSIP is somewhat less unfavorable than SCP. SCP, on the other hand, involves a less inefficient use of resources

than BSIP when opportunities to import foodgrains are taken into account. Improving performance in BSIP requires increasing yields, reducing farm-level costs, and rapidly expanding the area cultivated. These will be extremely difficult objectives to obtain. In SCP, improved performance depends on the development of technical packages which are suited to the needs of different groups of farmers.

2. Income distribution: With respect to income distribution between regions, SCP has the advantage of being more easily replicable. Two-thirds of Senegal's rural population live in the Groundnut Basin, compared to less than 10 percent along the Senegal River who could benefit from irrigated projects [Labonne and Legagneux 1977]. SCP has a life-of-project cost per beneficiary of $67, 40 percent lower than that of BSIP. Following the initial period of capital expenditures, however, annual project costs per beneficiary are similar for the two projects, between $7 and $8.

Preliminary investigations indicate that, in both projects, a disproportionate share of project benefits are earned by large, high-income farmers. In SCP, officials note that adoption of recommendations is much more common among large farmers than small farmers. Several factors inhibit intensification by small farmers: the surface cultivated is too small to supply feed for a pair of oxen, the amount of credit available to a farmer is tied to the quantity of groundnuts sold in the past, and credit is not available to cultivators other than the compound head. BSIP seems to offer greater possibilities to improve incomes of within-project poor farmers because of its greater accessibility to the group (liberal credit, low equipment costs, etc.).

3. Food security and self-sufficiency: The acute vulnerability of recommended practices to drought in SCP was demonstrated in 1977, when it is likely that net returns on intensified farms were lower than on unintensified farms. Thus the project exposes participants to increased risk with only marginal increases in income. The contention that food production in BSIP is more secure because of irrigation should be qualified by the project's heavy dependence on external inputs and expertise (pumps, fuel, bulldozers, maintenance, repairs, etc.). Although both projects contribute to foodgrain self-sufficiency, economic analysis reveals the high costs of pursuing this goal, given the opportunities available to import foodgrains.

5.3 Project Issues and Recommendations

To improve the performance of these projects, the following issues and problems must be addressed:

5.3.1 The Bakel Small Irrigated Perimeters Project

1. Area-efficiency trade-off: A central issue facing project officials is whether to use scarce resources to meet targets for expanding cultivation or to maintain and improve efficiency on existing perimeters. Given the heavy management requirements and time constraints in rice cultivation, an overly rapid expansion in area cultivated can adversely affect yields and returns.

Recommendation: Project efficiency must not be sacrificed for attempts to meet projected targets for cultivated area. A more deliberate pace of perimeter expansion than the pace recommended in the Project Paper is therefore advised.

2. Excessive use of fuel: Pumping costs at the perimeter investigated are three times as high as those originally projected in the project paper, due primarily to an excessive use of fuel. It is likely that the primary reasons are pump inefficiency and/or waste of water due to an imperfect water-flow network.

Recommendation: The SAED unit responsible for pump maintenance should investigate these problems and take the corrective action.

3. Seasonal labor shortage: Seasonal labor shortages seriously restrict the labor available for cultivating the 1,900 hectares of irrigated land. In 1976, for example, weeding irrigated rice conflicted with sowing rainfed crops, and as a result, over one-third of the irrigated hectares under cultivation were abandoned [SAED, 1977].

Recommendation: There is a need to conduct studies of new technological changes and changes in management practices which could release seasonal labor bottlenecks and allow farm size to expand. Such investigations should include possibilities for the introduction of technological change in rainfed cultivation.

4. Stifling of local participation: Representatives of the farmer groups have quarreled with SAED over their degree of participation in the design and implementation of the project. The groups have expressed disapproval of alleged SAED encroachments on their authority to choose crops, marketing opinions, handle

federation funds, etc. Unless there is increased local participation, there is a danger that the project will not become self-sustaining.

Recommendation: SAED and AID should encourage the farmer groups to exercise increased financial responsibility and managerial control over the project.

5. Lack of an information system: Without an adequate information system, project officials will not have the detailed information on project impact necessary to evaluate the project and to guide implementation.

Recommendation: An information unit to monitor project impact must be established. Sample surveys and ad hoc studies should focus on project-level delivery problems and on problems and constraints faced by farmers. In addition, the units should provide current analyses of the levels and distribution of returns among participants.

5.3.2 The Senegal Cereals Production Project

1. Unsuitability of technical package: The technical package which SCP seeks to extend does not suit the needs of the majority of farmers in the project area. Although adoption of the project recommendations can increase farm income, the adoption rate has been low. Constraining factors include:

--According to SODEVA officials, adoption of the package requires an increase in labor use during the peak periods of activity. Most farmers lack the labor, or the resources to hire labor, required to release these labor bottlenecks.

--Adoption of the package appears to be limited to the fields of compound heads. Credit is not available to cultivators other than the compound heads.

--Two factors inhibit small farmers from adopting the package: too small a surface cultivated to supply feed for a pair of oxen, and the amount of credit available for a farmer is tied to the quantity of groundnuts sold in the past.

--SODEVA officials claim that in a drought year, such as 1977, it is likely that a farm adopting project recommendations has a lower income than a farm of similar characteristics, outside the project. In other words, the risk of going into debt is seriously increased.

Recommendation: Establishment of an applied, on-farm research unit. The applied research component recommended in the Phase II Project Identification Document of the Senegal Cereals Production Project offers available opportunity for the Institut Sénégalais de Recherche Agricole to develop technical packages which are suitable for large numbers of farmers. The program should employ a farming systems approach, which focuses on the farm as a system and analyzes the incorporation of improvements into the system [Norman, 1978]. The objectives of this research should be:

--the identification of the critical constraints to increasing the production and incomes of different groups of farmers, and

--providing guidance in the development of technologies which can be incorporated into existing farming systems to overcome these constraints.

The farming systems approach thus employs a "bottom-up" strategy beginning with the needs of the farmer. Conventional strategies, on the other hand, begin by analyzing new technologies, under the assumption that if they are profitable at the research station or under controlled farm conditions they will be accepted by the farmer. In-depth studies of labor use patterns are necessary to identify seasonal labor bottlenecks and compare the labor requirements of different technologies. Information is also lacking concerning the sociology of adoption within the compound. Possibilities for farm diversification, as discussed in AASC (1978) also merit investigation.

Project efforts should be redirected away from extension and towards an applied, on-farm research program. The program should seek to introduce new enterprises into the project area, as well as to improve millet and groundnut production.

2. High recurrent costs: Whether USAID should be supporting a project with high recurrent costs is also at issue. The 1978 USAID evaluation of SCP [USAID, 1978a] noted SODEVA's inability to absorb project salary costs in the foreseeable future. This presents another argument for deemphasizing extension.

3. Poor quality of available information: Available data are not adequate for the evaluation of the project. There is no consensus over the meaning of terms of reference (*intensification*, *thèmes léger*, *thèmes-bovine*, etc.) to categorize farms at different levels of technology.

Recommendation: An effective information system to monitor project impact should be established. This unit should generate data, through sample surveys and ad hoc studies, concerning a set of well-defined, consistent indicators for evaluating project performance

[Cernea and Tepping, 1978]. The data needed include costs and returns analyses for farms and individual fields at different stages of package adoption, and data on the number of farms and areas cultivated at each stage.

The collection of data is currently divided between the Bureau d'Economie Statistique et de Planification of SODEVA and the Cellule de Liaison of USAID. The existence of two organizations for the collection of socio-economic data is not justified, given the acute problems of coordination and the lack of skilled manpower and resources.

5.4 Issues Concerning the Design and Implementation of AID Projects

The following issues are important for improving project design in general and for improving the availability of information to evaluate USAID projects.

1. Poor actual performance compared to projected performance: The Project Papers under review tended to underestimate farm-level costs--labor, pumping costs, fertilizer, etc.--and overestimate projected yields per hectare. Neither project paper adequately addressed the issues arising from the institutional framework and environmental conditions under which the projects are implemented. The SCP Project Paper, for example, did not account for the effects of the poor input supply system, the rise in the price of fertilizer, or the likelihood and effects of drought. As a result, the actual benefits of the project were far less than the projected benefits.

2. Standardized guidelines for economic analyses in Project Papers: The lack of a standard methodology in USAID economic analyses makes it impossible for decision-makers to compare the

projected performance of different projects. As a result, it is difficult to choose projects for implementation among those proposed, to compare the performance of different groups of projects (irrigated vs. rainfed, for example), or to update the analyses at a later time.

Recommendation: Standardized guidelines for economic analysis are needed. Although a certain degree of flexibility is desirable to allow economic analyses to be tailored to the specific conditions of each project, the guidelines should insure that the analyses are based on accepted economic theory and that all assumptions and calculations are presented clearly. Mission economists should be responsible for reviewing economic analyses to be sure that they adhere to the guidelines.

3. Information units in projects to monitor project impact and provide ongoing evaluation: Without detailed information on project impact, it is impossible to evaluate project successes and weaknesses and to guide project implementation.

Recommendation: Project papers should be required to include or identify an ongoing monitoring and evaluation unit and precisely describe the kinds of data which are needed and how these data will be collected.

4. Mission libraries and the assembling of reports pertaining to projects: Because of the lack of assembled information in developing countries, USAID personnel and consultants spend great amounts of time searching for reports relevant to their needs. The costs of conducting analyses and making decisions, without knowledge of already existing information, are extremely high compared to the low costs of maintaining libraries.

Recommendation: Libraries should be established in every USAID mission. Information links should be built with other donor agencies and government institutions, as well as with other organizations outside the country which undertake similar projects.

Appendix 1. Bakel Irrigated Perimeters: Farm Labor Profiles and the Cost of Family Labor

I. ANNUAL AVERAGE FARM LABOR PROFILE

A. Rice

	0.2 ha. Hours	1 ha. Hours
Ditches and canal maintenance	70	140
Leveling	28	140
Land preparation	60	300
Fertilizing	4	20
Direct seeding	8	40
Irrigation	14	70
Weeding	108	540
Birdscaring	80	160
Harvesting	24	120
Threshing and Winnowing	12	60
Collective work	4	20
Total	412	1610
Person-days (5 hours/day)	82	322

This table was constructed from an interview with several Bakel extension workers and farmers. Since birdscaring is done by children the number of hours is divided by 2, i.e., 1 child-day = .5 person-day. All other work is assumed to be carried out by adults. For some activities, such as birdscaring, an increase in farm size is not associated with a proportional increase in labor requirements.

B. Maize

No labor estimates were available for maize cultivation at Bakel. Data from nearby Matam, however, show maize requirements to be about 141 person-days/ha. [SAED-SATEC, 1976]. This coincides with the opinion of field workers at Bakel that a maize crop requires about half the labor of a rice crop.

labor per ha.	141 person-days (450 person-hours)
labor per 0.2 ha. farm	36 person-days (180 person-hours)

II. COST OF FAMILY LABOR

Labor in this study is estimated to cost 100 CFA/day. Although this figure is somewhat arbitrary, the following calculations for an irrigated, double-cropped 0.2 ha. farm indicate that it approximates the opportunity cost of farm labor. These calculations are based on the labor data shown in "Annual Average Farm Labor Profile" above.

Although the average farmer does not use hired labor, some farmers with large farms and/or small families employ hired laborers during the peak seasons (weeding and harvesting--threshing--winnowing) for 300 CFA/day. Assuming that the labor market is efficient, the value of family labor during these periods (28.8 person-days per 0.2 ha. farm per year) is 300 CFA/day. Labor during other periods of the year is assumed to be valued at 50 CFA/person-day. For a 0.2 ha. farm the opportunity cost of labor can be calculated as follows:

$$\frac{(300 \text{ CFA/day} \times 29 \text{ peak days}) + (50 \text{ CFA/day} \times 89 \text{ slack days})}{118 \text{ total days}} = 111 \text{ CFA/day}$$

Appendix 2. Project Costs for Bakel Irrigated Perimeters by Category and Government

	($US 000)			(CFA 000)[2]		
	Senegal	USA	Total	Senegal	USA	Total
Central Infrastructure[1]	0	377	377	0	99905	99905
Farm Infrastructure	225	1397	1622	51750	370205	421955
Technical Inputs	155	440	595	35581	116679	152260
Administration	230	0	230	52900	0	52900
Miscellaneous	155	54	209	35650	14310	49960
Subtotal	765	2268	3033	175881	601099	776980
Contingencies (15%)	115	340	455	26382	90165	116547
Total	879	2608	3488	202263	691264	893527

Includes only costs for the 4 years of USAID involvement. Data are taken from USAID, 1977.

[1]Total pump equipment, hand tools, and farm annual supplies are excluded because these are accounted for in net farm returns (see Table 3.1).

[2]The last three columns are simply the first 3 columns converted into CFA from US dollars according to the following rates (see Section 3.1).

Senegal costs - $1.00 = 230 CFA
USA costs - $1.00 = 265 CFA

Appendix 3. Senegal Cereals Production Project: Fixed Costs for a Base Farm and an Intensified Farm[1]

A. WITHOUT PROJECT BASE FARM FIXED COSTS (CFA)

Equipment	FINANCIAL ANALYSIS Unit Price	Total Cost	Life (Years)	Annual Charge	ECONOMIC ANALYSIS Unit Price[1]	Total Cost	Life (Years)	Annual Charge
1 Donkey	5000	5000	10	500	5000	5000	10	500
1 Horse	55000	55000	15	3666	55000	55000	15	3666
2 Seeders	27027	54054	10	5405	21648	43296	10	4330
2 Occidental Hoes	13058	26116	6	4353	10440	20880	6	3480
1 Donkey Cart	59791	59791	8	7474	47802	47802	8	5975
1 Arara Groundnut Lifter	5600	5600	8	700	4540	4540	8	567
1 Bati Arara	6928	6928	8	866	11511	11511	8	1439
		222489		22964		188029		19957
	Fixed Cost Charge/ha. 1,766				Fixed cost charge/ha. 1,535			

B. INTENSIFIED FARM FIXED COSTS (CFA)

	FINANCIAL ANALYSIS Unit Price	Total Cost	Life (Years)	Annual Charge	ECONOMIC ANALYSIS Unit Price	Total Cost	Life (Years)	Annual Charge
1 Corrective Application of Phosphate Fertilizer[2]	0	0	20	0	23040	23040	20	1152
1 Horse	55000	55000	15	3666	55000	55000	15	3666
1 Pair of Oxen	70000	70000	5	14000	70000	70000	5	14000
2 Seeders	27027	54054	10	5405	21648	43296	10	4330
1 Sine Hoe	14276	14276	10	1428	22607	22607	10	2260
2 Occidental Hoes	13058	26116	6	4353	10440	20880	6	3480
1 Plow Sine Ariana	13071	13071	6	2178	13071	13071	6	2178
1 Cart "Mixte"	35000	35000	5	7000	54560	54560	5	10912
1 Firdou Groundnut Lifter	5032	5032	8	629	6416	6416	8	802
1 Oxen Accessories	8000	8000	4	2000	8000	8000	4	2000
1 Arara Frame	6928	6928	6	1155	11511	11511	6	1918
1 Whiffletree	3108	3108	6	518	2485	2485	6	1667
		290585		42332		313518		48365
	Fixed cost charge/ha. 3,256				Fixed cost charge/ha. 3,720			

[1] Prices from [MDR, 1977].
Transport, handling and credit costs for economic analysis are included in project-level costs.
Since most equipment is used for both groundnuts and millet, costs are charged equally against both.
Although it is technically incorrect to use the depreciation method to appraise tool, equipment and livestock costs, it is likely that the results would be the same if actual annual costs could be determined.

[2] 400 kg./ha. 12 CFA/kg. economic cost. Applied on 4.8 ha.

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