Midterm Evaluation Report

Irrigation and Water Management I Project

Bakel, Senegal

July, 1990

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LIST OF ACRONYMS

A.I.D.	Agency for International Development
BSIP	Bakel Small Irrigated Perimeters Project
EIRR	Economic Rate of Return
FIRR	Financial Rate of Return
GMP	Groupe Motopompe
GOS	Government of Senegal
IWM-I	Irrigation and Water Management I Project
PACD	Project Assistance Completion Date
PIV	Village Irrigated Perimeters
SAED	Société d'Aménagement ed d'Exploitation des Terres du Delta
TA	Technical Assistance
USAID	Country Mission of the United States Agency for International Development

EXECUTIVE SUMMARY

The purpose of this midterm evaluation was to assess the validity of the Irrigation and Water Management I (IWM-I) Project in Bakel and to evaluate the potential for achievement of its goals and objectives.

A. Goals and Purpose

1. Increase food production, farm employment and income of farmers.

2. Expand and improve Village Irrigated Perimeters (PIV) by constructing new PIVs over 800 hectares and rehabilitating 400 hectares.

3. Demonstrate the profitability of the PIVs with private sector involvement for replication throughout the Senegal River Basin.

B. Objectives and Outputs

1. Eventual crop yields of seven tons/ha (mt/ha) of paddy and five mt/ha of maize and a crop intensity of 1.5 that would provide financial and economic rates of return (FIRR/EIRR) of 15.7 and 16.9 percent, respectively.

2. Production surpluses from 1,200 hectares of PIVs that would be commercialized through emerging private market enterprises.

3. Agricultural construction, improvement and maintenance services to be provided primarily by local contractors.

4. A feasibility study that would show the possibility of expanding medium-scale irrigation systems in the Middle and Upper Valleys.

5. An improved training program that would introduce animal traction technology involving 100 pairs of oxen.

C. Major Findings and Constraints

1. The Project Paper assumptions were unrealistic. Crop yields and costs of production were respectively overestimated and underestimated by about 50 percent. The FIRR calculated for PIVs under various crop mixes proved negative. Thus, the PIVs in their present form are not replicable.

2. An increase in crop intensity/ha did not occur. It remains at 0.7-0.8 with a declining trend. This trend relates to an increase in constructed, planted and harvested

areas reaching 1,992, 1,400 and 1,300 hectares, respectively. As well, the Project Paper underestimated the farmers' main goal of achieving subsistence production, with only a secondary interest in commercial production from a few groups.

3. Although the PIVs are neither viable nor replicable for the crop mixes that were tried, onion was found to be a promising crop. Besides rice, sorghum, which is a subsistence crop, was commonly grown on the PIVs during the rainy season. Maize was less frequently cultivated in either the rainy or dry season. Crop diversification, therefore, mostly pertained to dry-season, irrigated vegetables and fruits. Lack of marketing outlets, nevertheless, remains a constraint and disincentive to irrigated crop intensification.

4. PIV designs are generally acceptable, but construction for the most part is unsatisfactory. This may be due to unfulfilled expectations of good work at cheap construction rates and to poor on-site supervision.

5. Good PIV construction with the present cropping system would not improve profitability. Poor PIV construction resulted in complaints from farmers, who are discouraged when hard labor does not translate into promised yields.

6. Construction of more PIVs to meet the objectives of the Project Paper, without modification of these objectives, would not have been fruitful.

7. SAED's disengagement from all services except for extension and training created a void. Attempts to fill it through privatization will be delayed in the absence of an adequate reorientation of farmer groups.

8. Although construction and rehabilitation of PIVs were two of the main project objectives, PIVS covering only 239 hectares were built and 50 hectares rehabilitated from 1986 to 1988.

9. There is ineffective communication between SAED, Harza and USAID. Absence of a clear line of authority caused unsatisfactory working relationships between SAED/Bakel and the technical assistance (TA) team. This should be remedied.

10. The TA team failed to accomplish a significant number of required outputs. Harza's integration within SAED is poor and has resulted in duplication and divergence of activities unsatisfactory to both parties. This is a major constraint to project implementation.

11. There is a lack of both capacity and demand for a private sector at Bakel that could provide agricultural services.

12. The approval of SAED for farmer groups to qualify for credit is not based on investment viability but rather on payment of debt to SAED. Nonpayment can be traced to unprofitable irrigated crop production. This is partly a result of poor PIV construction by SAED, which makes it difficult to pay back loans.

13. The historic notion of PIVs geared towards subsistence production and equitable distribution of benefits is in conflict with the project's emphasis on profitability and economic viability.

14. The observation tour to ONAHA irrigation schemes along the Niger River in Niger is inappropriate to the PIV experience.

15. Bovine traction appears to have natural potential in this region. There is a well-developed market in which these animals can be purchased and sold. Yet only a few animals have been trained so far. Extension efforts are required to deal with cultural constraints.

D. Recommendations

The evaluation team considered three possible alternatives toward which to orient its recommendations--termination of the project, redesign of the project in its entirety, or modification of the project's goals and objectives. The team recommends the third alternative. The recommendations which follow are given in the context of modifying the project's goals and objectives.

1. The project's goals should be reviewed to a level that can be realistically achieved. Goals should be scaled down with the purpose of determining what new PIV concept will prove financially viable and therefore replicable.

2. The TA team and SAED have succeeded jointly in their demonstration farm approach and training program, despite personnel and budgetary constraints. Project funds for further development are needed.

3. Crop diversification to be practiced on four model PIVs, of which two would be converted into drip irrigation pilot projects, is crucial for achieving a cropping intensity of 1.5 during the life of the project. A FIRR of at least 10 percent, based on accurate data by the end of the project, may then determine PIV replicability.

4. The life of the project should be extended by 15 months to December, 1993. Two years will not provide sufficient data for assessment of replicability.

5. The TA team should be reorganized with three appropriately qualified TA team members whose expertise is tailored to the revised project goals and purpose. Additional support from short-term specialists in specific fields would also be required.

6. To maximize the demonstration effect, selection of the four model PIVs, including two drip/subsurface irrigation pilot schemes, should be based on the most cooperative and progressive PIVs.

7. It is premature to make major efforts to involve the private sector in providing agricultural services in Bakel. The project should first concentrate on improving

food production. Nonetheless, the marketing of surplus produce will need the TA team/SAED's joint organizational support.

8. The Federation of Organized Farmers of Bakel, in light of its initiatives and service programs, should have a future role in the project as part of the private sector.

9. Four local development organizers, one per zone, should be hired to motivate farmers and improve participation of women on PIVs and in training and extension.

10. The Socio-Economic Monitoring System is one of the few concrete and functioning accomplishments of the project. It should be fully integrated into SAED's routine operations towards sustainability beyond the project.

11. The monthly tripartite meetings between SAED, USAID and Harza have been ineffective. The USAID Project Officer should make two-day visits twice a month to the project site and one-day visits to SAED/St.Louis headquarters every other month. More authority should be given to the Project Officer for on-the-spot decision-making commensurate with his responsibilities.

E. Lessons Learned

1. Conclusions of the Project Paper were not based on factual data. Crop yields for the PIVs were estimated to reach world records and costs of irrigation water were grossly underestimated. These erroneous assumptions led to financial and economic rates of return speculated to exceed 15 percent. The assumptions of the Project Paper were not critically evaluated by competent experts.

2. Large-scale implementation should be preceded by pilot projects to verify whether claims made are justified. In this project, the benefit of hindsight was not needed to dispute unrealistic goals--pilot testing would have sufficed.

3. Paddy needs three times more water than most crops to produce a good yield. Pumping water is always expensive and not usually recommended for rice production. Similar future projects should be discouraged.

4. Good communication among all parties in a project is essential. Lack of communication between USAID, SAED and the TA team was in large part responsible for the dissipation of funds without any tangible results.

5. A clear line of authority and responsibilities should be specified in all contracts. Adequate delineation of responsibilities between the TA team and its counterpart team was not forthcoming in this project, leading to a conflict over authority between SAED's Ingenieur Delegue and the TA team leader.

6. The expertise, qualifications and experience of expatriates should be carefully evaluated for relevance to the work that needs to be done, both initially and then periodically during their term.

MID-TERM EVALUATION REPORT

IRRIGATION AND WATER MANAGEMENT I

Project Number:	**685-0280**
Project Area:	**Bakel, Senegal**
Authorization Date:	**20 August 1985**
Agreement Date:	**30 August 1985**
Project Funding:	**$ 9,500,000**
GOS Contribution:	**FCFA 190 million**
Farmers' Contribution:	**FCFA 40 million**
Project Completion Date:	**30 September 1992**

I. BACKGROUND

The Irrigation and Water Management I (IWM-I) Project is the follow-on project of the Bakel Small Irrigated Perimeters (BSIP) Project obligated in 1977 and evaluated in 1985. A draft Project Paper was submitted in October, 1982 and revised in December, 1983. Project design began following discussion between AID/Washington and the Government of Senegal (GOS) concerning policy guidance.

USAID supported the GOS New Agricultural Policy of April, 1984 which reduced the role of the Société d'Aménagement et d'Exploitation des Terres du Delta (SAED), the regional development authority in the Fleuve region, in the construction and operation of irrigated perimeters. The parastatal organization was to retain its functions in planning, monitoring and extension, but under the IWM-I Project, SAED was to begin transferring its responsibilities over to farmer groups and contracting out to private sector enterprises. It was anticipated that the private sector would respond to investment opportunities with the advent of the operation of the Manantali and Diama dams which would regulate the flow of the river to permit double-cropping on an annual basis while eliminating flood recession agriculture throughout the Senegal River Basin.

Under the BSIP, irrigated agriculture was introduced into the Bakel region of the river valley. The Delegation of Bakel, an administrative unit, is the region furthest upstream on the Senegal River's Left Bank, bordering Mauritania on the Right Bank and Mali at the confluence of the Senegal and Faleme Rivers. Bakel is situated primarily in the Sudano-Sahelian climatic zone, extending into the Sudanian zone along the Faleme River, which it encompasses as far south as the village of Dounde (see Figure 1).

Through the BSIP, 1,250 hectares of small irrigated perimeters were installed in 23 villages. These Village Irrigated Perimeters (PIVs) were managed by "groupements de producteurs" (farmer groups) and continue to retain this same structure.

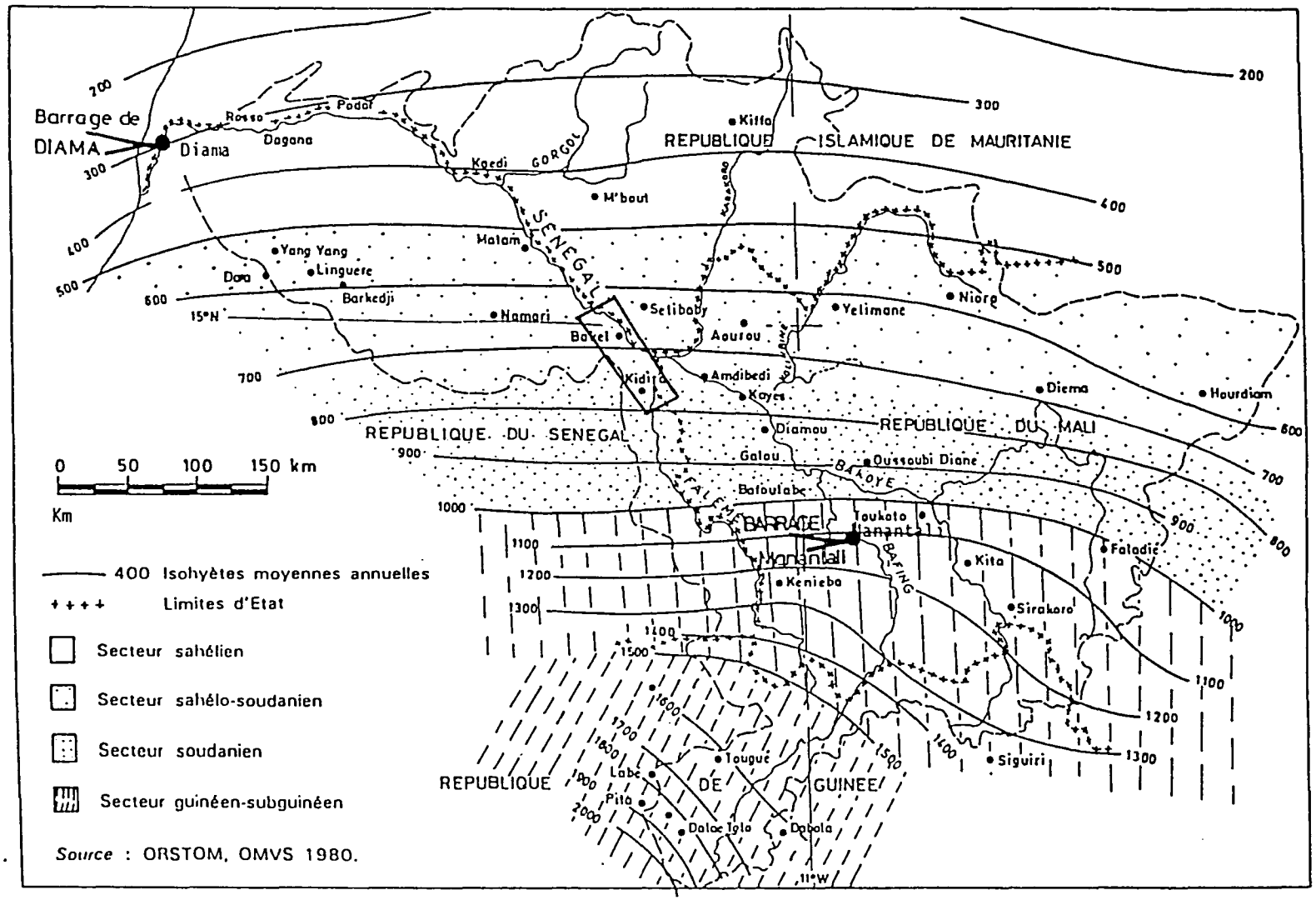


Figure 1: Map of Project Region

Project area shown in box has its lower limit along the Senegal River and its upper limits on the Faleme

The 1982 evaluation of BSIP criticized the quality of SAED design and construction of the irrigation systems and concluded that poor design and construction were the reasons that several farmer groups were no longer operating. In the absence of a technical assistance (TA) team from 1986-88, USAID agreed to public sector construction and rehabilitation. A contract was signed in April, 1988. Due to numerous adjustment delays, the Harza technical assistance team did not begin work until the end of 1988. The decision to extend the project assistance completion date (PACD) beyond September, 1992 will be contingent on the findings and recommendations of this evaluation.

II. PROJECT GOALS

The project was designed to accelerate development of PIVs in Bakel. The PIVs were seen as a way to increase food production, farm employment and farmers' income.

The goals were not limited to the Bakel area. An important aspect of the project was that the PIVs constructed in Bakel would demonstrate a financial internal rate of return (FIRR) of 15.7 percent and an economic internal rate of return (EIRR) of 16.9 percent. Achieving these goals would indicate that the PIV concept could be replicated throughout the Senegal River basin.

The development goal of serving the "poorest of the poor" may have made Bakel a good candidate but, at the same time, a bad choice for proving the replicability of the PIVs. Weather is inclement and rainfall relatively heavy in the Faleme zone, one of four in the Bakel Delegation. Pumping costs are high because the slope of the embankments in the upstream region of the river is steep, increasing the hydraulic head differential. The scarcity of clay soils and flood recession land compared to other regions along the river militates against rice cultivation. For this reason, very little rice is grown there. Bakel's distant location from market centers and its general marginality are negative factors in such a complex experimental undertaking.

The Project Paper assumed an increase in functional irrigated area of 1,200 hectares during the life of the project, with what it called "modest projections." Paddy yields were expected to reach seven metric tons/hectare (mt/ha), maize five mt/ha, and a crop intensity of 1.5 crops/ha/year.

However, the evidence shows that the Project Paper's assumptions were extrapolations based on unsupported data (see Annex F). Not a single PIV constructed in the Bakel area since 1977 has been financially successful. In the Project Paper, the well-established curvilinear yield response curve to increased application of water and fertilizer came close to becoming a straight line relationship (see Annex E). The obtainable yields for both paddy and maize were largely overstated, and the pumping costs required to replace water lost through evapotranspiration and percolation were grossly underestimated. Because the financial viability of a PIV is essentially a factor of pumping costs and increased yields, underestimation of costs and overestimation of yields have a compounded effect on both the EIRR and FIRR.

The assumptions of the Project Paper perhaps represented SAED's belief that it could achieve high yields as part of the GOS policy to increase paddy production at all costs. SAED's philosophy is illustrated through the comments of one of its executive representatives to the evaluation team in May, 1990: "La philosophie d'aménagement des PIV répondait à un souci d'autosuffisance alimentaire ... C'est pourquoi une réhabilitation/consolidation est plus que nécessaire pour sauvegarder les acquis et augmenter les possibilités d'exploitation par l'existence de périmètres très fonctionnels et productifs." To quote from USAID Evaluation Special Study No.34 (M. Seymour et al, 1985): "General SAED objectives appear to open as much irrigable land as possible...The financial and physical resource constraints, although recognized, appear to be relegated to a place of lesser importance in the calculation of the objectives..."

Food Production

Farm families are reported to rely on irrigated agriculture as a supplement to dryland crop cultivation to cover household consumption needs. Yet, expected increases in food production have been modest at best and mostly attributable to the expansion of irrigable areas to 1,992 hectares. Accurate yield figures for the last 15 years were unobtainable. There are two reasons for this: (1) no year-to-year record could be made available for yields aggregated at the level of individual PIVs in Bakel from one project to the next, and (2) yields recorded under the IWM-I Project, furnished by SAED's surveys and reappearing in the Project Paper, were suspiciously high (e.g., 5-7 t/ha of paddy). It was conceded that some data collectors failed to obtain yield figures empirically. Further, an across-the-board problem revealed during the evaluation was SAED's method for measuring yields, heretofore uncontested; it was based on area harvested rather than planted. Also, sampling procedures for sack counting (estimated at 80 kg of paddy) from single 10 square meter plots to provide estimates of paddy yield per hectare are statistically unscientific and unreliable (see Annex E).

The evidence suggests that improvement of yields as a result of the construction of PIVs has been negligible except in a few isolated farmer groups where construction and maintenance were satisfactory (e.g. Diawara 2). Paddy yields not exceeding five mt/ha in a few fields of these PIVs were accepted by the evaluation team on the basis of reasonable doubt. This is not to say that these PIVs were financially viable if the maximum water and fertilizer inputs associated with high yields were utilized. (See Annex F - Table F.8).

Farm Employment

The construction of the PIVs covering a total area of 1,992 hectares in 1990 increased both planted and harvested areas (see Figure 2), membership size of farmer groups, and total crop production. There has been only a minimal multiplier effect on employment in the private sector. Some farmer groups have organized themselves in fertilizer trading. There is no evidence of a reversal in the long-term outmigration trend characteristic of the Bakel population, one of the primary goals of the original project.

Farmers' Income

There is no available data indicating an increase in farmers' income as a result of construction of PIVs. There is an indication, however, that some farmers are practicing crop diversification and marketing some bananas and onions, with a slight increase in their income. The limited market potential of the Bakel Region has been the bottleneck with which farmers have had to contend.

III. PROJECT PURPOSE

A. Expand and Improve PIVs in Bakel

There has been a definite expansion of PIV areas in Bakel as depicted in Figures 1 and 2 of Annex E - Agriculture Annex. However, the mere expansion of PIV areas is not indicative of meaningful progress towards the project purpose. A large number of hectares constructed in the previous project (500 of 1250 ha) have been abandoned. Of the new construction--more than 239 hectares constructed by the present project from 1986-88 and 122 hectares constructed and funded by SAED in 1989--several hectares need rehabilitation because of bad initial construction. The most prevalent evidence of this, noted by farmer groups, was the poor levelling job, a serious constraint to rice cultivation.

No PIVs have been constructed with project funds since the 1988 arrival of the Harza TA team. There was a substantial delay in fielding the team by Harza, and personnel substitution in mid-1988 created a lag in performance. However, the project was extended by two years, and at mid-term nothing was completed in terms of PIV construction and rehabilitation, one of the main terms of the contract. It was found that the inability of the TA team and SAED to accomplish any new construction or rehabilitation was ultimately the result of a stalemate over a private sector strategy, to wit, ***who*** should undertake the responsibility.

The TA team was also supposed to design an acceptable prototype design for a viable PIV. Such a design should have been completed in less than six months after the team was fielded, but only a draft preliminary copy is available.

B. Development of Replicable PIVs

The Project Paper called for construction and development of financially viable PIVs for replication throughout the Senegal River Valley. The assumption was that if replicability is proven, then the same model could be used over 240,000 hectares. However, the assumption that the replicable PIV would serve as a prototype for the entire river basin was highly improbable from the start, given the competing presence of other donors and their individual approaches. In fact the PIVs so far have ***not*** been proven to be financially viable and are therefore ***not*** replicable in their present form. The evaluation team recommends continued support for the four model PIVs only on the condition

that attempts be made at crop diversification (to include high-value cash crops such as onions) to reach a crop intensity of 1.5.

The growing of paddy alone or in combination with maize or sorghum is not financially viable with pump water in Bakel as shown in the financial analyses using several combination of crops (see Annex F). Fifty per cent of soils in the Bakel area are not suitable for paddy production. Other crops should be grown in these areas. Again, pump water for surface irrigation of other crops, although much less costly than for paddy because of smaller water volume requirements, is still very expensive because of the low efficiency of water conveyance, application and distribution which is much less than the assumed 50 percent.

Current crop mixes were based on the assumption that production would be carried out in both the rainy and dry seasons to achieve a crop intensity of 1.5 after five years. It is currently 0.7-0.8 with no indication of an increase over the past decade. Recent years have witnessed less and less dry season maize and vegetable production (see Annex E).

The areas during the dry season ("contre-saison-froide" [CSC] from November to March) elude the project's expectations for securing a double-cropping system; they remain at levels well inferior to totals for rainy season cultivation on the PIVs.

TABLE 1: AREA (HECTARES)

	1988 RAINY SEASON			1988-89 DRY SEASON (CSC)		
Zone	Rice	Maize	Sorghum	Maize	Sorghum	Maraichage*
Lower Goy	171.75	22.25	349.7	11.25	0.00	16.71
Bakel Commune	134.5	2.5	12.65	18.15	4.3	7.46
Upper Goy	271.5	58.65	53.25	11.97	0.00	10.81
Faleme	36.34	19.00	43.7	16.51	0.00	9.32
TOTAL	**614.09**	**102.40**	**459.30**	**57.88**	**4.3**	**44.30**
TOTAL	**1,175.79**			**106.48**		

Source: SAED end-of-season surveys.

*Includes vegetable gardening: any combination of onions, eggplant, cabbage, okra, gombo, lettuce, tomatoes, chili peppers, green peppers, carrots; and fruit trees: limes, oranges, mandarins, grapefruit, mangoes, bananas.

The crop mixes tried include the current mix of 60 percent rice, 20 percent maize and 20 percent sorghum grown during the rainy season, and 70 percent maize and 30 percent onions during the dry season. (Dry season production was therefore allowed to increase to a level of 50 percent of the available irrigated area). The FIRR was found to be -7.6 percent. Rice production was not found to be viable due to high water use and cost.

Since maize and sorghum showed promise of being better alternatives than rice, and onions proved highly profitable, even with a farm gate price of 50 FCFA/kg (less than 50 percent of the reported farm gate price), the crop mix tried was 60 percent maize and 40 percent sorghum during the rainy season and 50 percent maize and 50 percent onions during the dry season. This mix also did *not* prove to be financially viable (before capital cost financing, FIRR was -1.2 percent).

These results point to the need to do further research at the demonstration farm level, and afterwards on-farm, to find other high value cash crops that can be used alongside onions during the dry season to improve the profitability of PIV agriculture, particularly considering the relatively higher costs of irrigation during the dry season. These crops would need to be nonperishable, since marketing channels are not well developed at this time. As well, further work is needed to improve the profitability of grain production (rice, maize and sorghum), since these crops provide the basis of the local diet and, with the exception of rice, continue to be grown on rainfed fields along with peanuts, cowpeas and millet. Their production would not be expected to be dropped by farmers, although the prominent position of rice in the crop mix may not continue after SAED stops acting as a reliable purchaser of large quantities at a fixed price.

The drip/subsurface irrigation technique for row crops has proven successful in other developing countries, and only its adaptability in Bakel remains to be proven. The high water conveyance efficiency (100 percent) and application and distribution efficiency (95 percent) could reduce pumping costs by more than half. Further, because of constant humid conditions in the crop root zone and high fertilizer application efficiency as a result of this technique, crop yields are normally 50 to 75 percent higher than with furrow irrigation systems, depending on the crops. Instead of continuing the construction of PIVs on an industrial scale in Bakel, it is recommended that two pilot projects of 50 hectares each utilize the drip/subsurface irrigation method.

IV. PROJECT OBJECTIVES

A. Development of PIVs Over 1,200 Hectares

The project called for the construction of 800 hectares of new PIVs and 400 hectares of rehabilitated ones to be completed by September, 1990, which has been subsequently extended to September, 1992. The Project Paper assumptions, expected accomplishments and actual construction and rehabilitation are summarized in Table 2.

TABLE 2

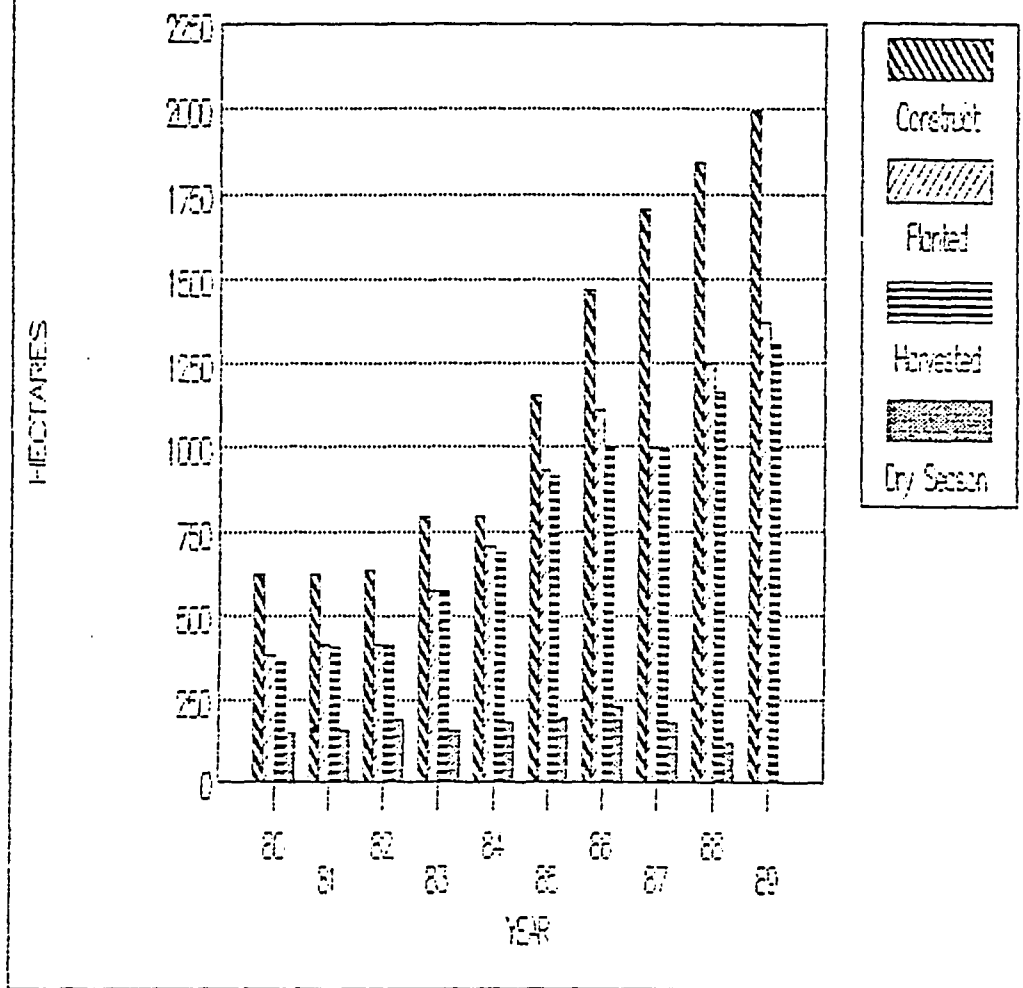
Project Paper Assumptions	Expected Accomplishments June 1, 1990	Actual Construction June 1, 1990					
Rehabilitation	40% of Planned Output	1986	1987	1988	1989	1990	Total
400 ha of PIVs	160 ha	50	0	0	0	0	50
New Construction with USAID Funds	40% of Planned Output						
800 ha	320 ha	50	98	91	0	0	239
With SAED Funds Outside Project					122	0	122
							361

The Project Paper assumption of a trend towards increasing cropping intensity has thus far proven illusory. With the expansion of area as a result of PIV construction, it is easier for farmers to practice extensive rather than intensive farming, and subsistence farming prevails over commercial operations. Besides, there is no market infrastructure to absorb increased production.

The Project Paper assumed that PIV construction would proceed in practice in fulfillment of projected outputs. A substantial number of hectares in PIV construction from 1986-88 need rehabilitation. In the previous project, 500 of 1250 hectares were abandoned for various reasons, most notably, poor construction. SAED's design and construction for the 122 hectares (outside the project because it did not receive USAID approval for those PIVs), while underscoring the PIV expansion philosophy of SAED/Bakel, highlights the lack of coordination among SAED, Harza and USAID. Although perimeter designs are for the most part technically sound, problems arise because of faulty implementation, inadequate supervision during construction, and poor subsequent maintenance and operation (see Annex D). SAED is now requesting that $25,000 be approved by USAID to purchase PVC pipes to convey water from the pumps to the field. This money should be conditionally approved as proposed in the recommendations below.

Fig. 1 - Bakel Delegation

Areas Constructed, Planted & Harvested



B. Participation of the Private Sector

A second purpose of the project was to develop private sector participation with a view to providing construction services and supplying agricultural inputs through local outlets.

SAED gradually withdrew from construction activities and the supply of agricultural inputs, following directives from a series of four "Lettres de mission" of the GOS. In the Bakel area at least, farmer groups apparently have been reluctant to believe SAED's withdrawal. While the message is gradually sinking in, a void exists as far as private sector participation is concerned. The concept of an instant birth of the private sector has not materialized. Some farmer groups stock agricultural inputs for sale to their members, but that seems to be the only trading activities at the PIV level.

The PIV was supposed to generate marketable crop surpluses, with revenues applied towards more PIV construction and for the purchase of agricultural inputs. Since the PIVs did not develop into financially viable, surplus-oriented enterprises, increased trade did not come about, as was expected. The private sector, if it were commercially established, would have almost nothing to trade from the project outputs. There is no local group in Bakel capable of PIV construction activities, although some individuals are now trying to organize.

There are limited signs of local private enterprise development. Some local farmers in Mouderi have become fertilizer distributors. An individual who has his own perimeter in Collanga and has formed a GIE with two other farmer groups at Mouderi is interested in buying a tractor to provide these services to Bakel farmers. Some villages have even purchased small-powered grain mills and are selling these services to households. The president of the farmer group from Sebou is preparing to train oxen for traction and sell them.

The Federation of Organized Farmers of Bakel is the region's largest private purveyor of services in the areas of plowing, training, and input supply and delivery. Farmer groups who benefit from its services pay membership dues and pay for services on a cash basis. The Federation discourages credit for concern over the risk of debts.

In the end, SAED's disengagement and the concomitant development of the private sector constituted a difficult issue for the project and stood in the way of actions that needed to be taken in a timely manner for the project to really "take off." At the policy level, the GOS mandate in conformance with its New Agricultural Policy to reduce the role of parastatal organizations and the USAID thrust to build a private sector were perfectly compatible. Yet, discord arose at the project level over a private sector strategy (SAED and the TA team each elaborated its own), with direct implications for who would acquire responsibility for construction and/or rehabilitation, design and supervision. There was also ongoing disagreement among SAED, the TA team and USAID regarding the actual need for new construction of PIVs (see Annex G).

The evaluation team recommends that all parties show more flexibility in coming up with a solution. Given the experience so far with badly-constructed PIVs, USAID should not relax its design and construction criteria to accommodate sub-professional standards. By the same token, it should not oppose funding conditional upon the development of SAED's strategy for private sector involvement in project activities to meet USAID's satisfaction. This will be subject to judgement calls from USAID officers in Dakar who may not be fully familiar with the problems Bakel is facing.

Recommendations for an action strategy are detailed in the Private Sector Annex (Annex G).

C. Increase in Commercial Production

The increase in areas under production, together with an increase in yield and cropping intensity, were supposed to result in farm surpluses for marketing through local channels. Except for a small number of commercially-oriented PIVs run by individuals or individual families, irrigated agriculture has not resulted in surplus production destined for the market. Farmers are unwilling to take financial risks which involve increased water application and increased fertilizer inputs for a yield increase that may never happen.

Production in Bakel remains one of subsistence. Sorghum on the PIVs is mainly for household consumption. Rice, until SAED's withdrawal from project activities, was sold chiefly to SAED, which purchased paddy at a fixed price. Maraichage yields--fruit and vegetables--grown during the dry season are generally sold at nearby market centers. For example, the town of Kidira is a market center serving the PIVs along the Faleme River. (It should also be noted that market gardening is popular among women's groups who often irrigate from a well and apparently consider it a lucrative activity, given limited options for women to earn cash.) Despite potential profits from maraichage yields or any increased production output, the general lack of marketing facilities would render surplus production at worst futile or at best frustrating, were the market to be quickly glutted with the same product. Some farmers commented that they were forced to sell their produce at extremely low prices because of competition, putting them at the mercy of traders, wholesalers and retailers.

Roads present another real constraint. The Bakel-Kidira-Tambacounda highway is unpaved, poorly graded and virtually impassable during the rainy season. The train that connects Dakar with Tambacounda and with Bamako is said to be slow, unreliable and costly. Marketing possibilities in Mali are hampered by customs inspections and saturated market conditions, particularly in vegetables. There are no storage facilities, packing or processing plants for perishables. Rice hulling and milling machines are few. Moreover, the closing of the border with Mauritania last year has placed added restrictions on marketing outlets. Commercial production is likely to proceed at a slow pace unless a marketing strategy is put into place, production of various commodities through crop diversification properly organized, and regional infrastructural improvements made.

V. PROJECT ACTIVITIES

A. Planned Project Outputs

1. Rehabilitation of 400 Hectares of PIVs

Only 50 hectares were rehabilitated by SAED in 1986. The Harza team did not participate in the rehabilitation. Neither has Harza rehabilitated any hectares since its involvement.

2. Construction of 800 Hectares of New PIVs

The project was involved in the construction of 239 hectares of new PIVs from 1986-88, and SAED constructed 122 hectares in 1989 on its own initiative. The PIV construction from 1986-88 under PSC contracts was not designed and implemented according to acceptable professional standards. It should also be noted that since it was fielded in September, 1988, the Harza team has not participated in building any new PIVs.

3. PIV Prototype Design

The Harza team has failed to design an acceptable PIV prototype. Only a draft report was recently prepared.

4. Socio-Economic Monitoring System

A socio-economic monitoring system designed to provide data on the benefits of irrigated agriculture and establish a reliable base of economic tracking for the project has been put in place. This data will be used for the creation of a computerized PIV and Farm Economic Model to determine PIV profitability under a variety of conditions.

5. Training and Extension

Plans called for an improved ongoing training programs for pumping operations, operation and management of irrigation systems and an animal traction methodology involving not less than 100 pairs of oxen. The training of farmer group technical functions only got off the ground in August, 1989 and has thus far affected a small percentage of the PIVs. The Demonstration Farm, as a focus for training and extension, resumed operations in 1988/89 and has proven to be well-coordinated and functioning, despite personnel and budgetary constraints. The animal traction program is underway, although presently the Demo Farm has only one pair of oxen and only one farmer has acquired several pair of oxen for training (see Section V.B. below for more details).

6. Land Tenure Study

The land tenure study was conducted by the Land Tenure Center, University of Wisconsin-Madison. The final report provides a checklist of perimeter design questions for minimizing land tenure problems and improving the chances of success of irrigated agriculture.

7. Feasibility Study for a Medium-Scale Irrigation System

Upon completion of the feasibility study by the Harza Team in March, 1989, it was decided that the idea of a medium-scale perimeter would not be pursued.

B. Other Accomplishments of the Technical Assistance Team

1. Reassessment of Project Goals and Objectives

The TA team has recently realized that not much was being accomplished according to the terms of reference of its contract based on the Project Paper, which as mentioned earlier, contained unrealistic goals. The TA team leader submitted to the evaluation team a document stating that the project needs modification and/or redesign.

Ideas for redesign would include the implementation of four model PIVs. These are essentially demonstration farms at the farmer group level, where good quality construction, crop diversification, optimal water application and fertilizer inputs will serve as a model. Intensified production, marketing of produce, and the provision of extension and training will be integral components of these model PIVs. Accurate records of inputs and outputs will be analyzed by an Agricultural Economist to determine FIRR and the PIV's replicability.

In the TA team's plan for the model PIVs, it is recommended that a credit program be started. However, since no viable technology exists at this time, it is better to concentrate on production first. Credit, without a profitable technology, has not been successful elsewhere in Africa.

2. Agricultural Training, Extension and Demonstration

The TA team has designed an excellent program for the Demonstration Farm, which is now making good progress, although some minor redirections are necessary (e.g., the proposed program to improve the local chicken genetic pool by crossing with imported *hybrid* broilers cannot be accomplished on genetic grounds).

Extension activities, the responsibility of the zone chiefs (chefs de zone), are problematic in that the four chefs de zone are overextended and should be supplemented by four "animateurs" or development organizers who could assume responsibility of motivating farmers parallel to the progress being made by the model PIVs. More emphasis needs to be placed on farmer group management of financial, credit, production and marketing requirements with the assistance of a short-term business management specialist.

Training of SAED technicians in Morocco should be postponed for the time being. The observational tour to Niger was considered inappropriate to the PIV experience and a better site should be selected, such as the Niger perimeters at Birni n'Konni or irrigation schemes in Mali.

Finally, some progress has been made with introducing animal traction, and extension efforts should be aimed at removing cultural and physical constraints.

Detailed findings and recommendations are presented in the Sociological Annex (Annex C).

3. Development of the Private Sector

There has been recent awareness by the Bakel team that a private sector and marketing strategy should be put in place. The project assumption that the private sector at Bakel would play a significant role in PIV design, construction and rehabilitation was not sound. SAED is the only local entity that can carry out the function of PIV design, and then, only with technical assistance. It is obvious that the local capacity for quality construction is extremely limited. "Tandia Enterprise," a local construction company, appears to have some rudimentary resources, and it needs technical advice and support from SAED and the TA team. It is premature to make major efforts to try to encourage the provision of agricultural construction services by the private sector in the Bakel Delegation at this time. The demand for these services has to be developed first.

Detailed findings and recommendations are described in the Private Sector Annex (Annex G).

4. The Socio-Economic Monitoring System

This component is one of the few concrete achievements of the project. It has obvious potential for informing future planners of irrigated perimeters in the Bakel. Accomplishments have included a baseline survey of 42 farm families, an analytical model for irrigated agriculture, and an analysis of baseline data and socio-economic monitoring for the rainy season 1989-90. The SAED/Bakel Office for Monitoring and Evaluation has just begun working on a databank which is broader in scope and more focused on the PIVs. The two systems need to be integrated and more responsibility given to the SAED counterpart.

The agricultural economist who will be part of the three-person TA team (see Section VII, B. 2. Recommendations) should be charged with the periodic analyses of the data and should train the SAED counterpart so that this function becomes a permanent capacity of SAED efforts. The survey of farm families should not be expanded (see Annex C).

VI. CONSTRAINTS

1. The TA team has not been successful in the establishment of an effective working relationship with SAED counterparts. The TA team has been unable to integrate its activities within SAED's system, and neither has SAED made any discernible effort. In the evaluation team's assessment, there are strong doubts that anything meaningful can be accomplished with the present Harza team's structure.

2. The TA team has spent an inordinate amount of its time on purely theoretical work at the expense of practical undertakings it was supposed to accomplish under its contract with SAED. Studies contracted out to short-term consultants also did not contribute to a plan of action.

3. The expertise of the TA team is not tailored for the most part to the work required under the project.

4. The perceived stalemate which has thwarted the construction and/or rehabilitation of PIVs in the last six to ninth months could be attributed to confusion over who was responsible for devising a private sector strategy. The blame could be placed on USAID's intractable conditions on the private sector strategy, on SAED's overemphasis on expanding new construction for increased paddy production as mandated by the GOS, or perhaps Harza's lack of initiative in a stalemate situation.

5. There is no clear line of authority at Bakel headquarters between the Harza team and SAED, nor is it properly understood what that line of authority should be. On the one hand, SAED's Ingenieur Delegue is SAED's representative in Bakel, and since SAED is the employer, he should have the authority for decision-making in all matters of administration. However, the Ingenieur Delegue sees himself in more of a hands-off role, signing off on documents requiring his signature but not getting involved in technical decision making.

   On the other hand, the leader of the TA team should be able to make all final decisions pertaining to technical matters after conferring with the Ingenieur Delegue. This, however, is not happening.

6. Halfway through the project implementation, it became apparent that the ambitious program of the Project Paper could not be realized. Facing an unsurmountable task is a constraint that should be relieved, and a more realistic achievement goal should be planned. The delays attributed to logistical and personnel problems notwithstanding, there are two constraints of a different nature that are, in a sense, built into the project:

   (a) As a USAID Project, it inherits from the policy making level the mandate to engage the private sector in activities related to the irrigation schemes.

(b) Unrealistic production objectives are a burden that has been passed on from one project phase to the next. Target goals of seven mt/ha of paddy and five mt/ha of maize remain illusory.

VII. RECOMMENDATIONS

A. Alternatives for the IWM-I Project

The IWM-I Project was assessed in the context of three alternative orientations for recommendations to USAID: Terminate the project, redesign the project, or modify project objectives and goals. What follows are considerations given by the evaluation team to each of these alternatives.

1. Project Termination:

- The FIRRs of the PIVs under the present production system are unquestionably and invariably below the cut-off minimum of 10 percent accepted by the World Bank and the Asian Development Bank.

- The likelihood of achieving the project goals, purpose and objectives is nil.

- Project assumptions were too ambitious and the goals unrealizable within the time frame.

- There is little hope that a replicable PIV can be demonstrated by the end of the project in September, 1992. The PIVs are ***not*** financially viable and are unreplicable for the crop mixes that were tried. This is based on the assumption that production would be carried out in both the rainy and dry seasons to achieve a crop intensity after five years of 1.5. It is currently 0.7 and has actually been declining in recent years.

- PIV quality constructions over 1,992 hectares and after 13 years are still of poor quality.

- The project has already absorbed 75 percent of the budget and there is little justification for investing more money. There has been enough time, effort and money spent to prove the replicability of the PIV. If financial viability was evident, it should have been adopted by now by the farmers. They continue to participate because they did not have to pay for the groupe motopompe (GMP), PVC pipes or construction of the PIVs. They have nothing to lose. On the contrary, the irrigation system is there as an insurance against poor rainfall which might jeopardize their subsistence production.

- Financial analyses covering a number of crop mixes and conservative assumptions show that the PIVs in the present context are not financially viable. The FIRRs are

all negative even if the capital costs of the GMP pump set system and construction are not amortized in the analyses. A fortiori, if those costs were included, the negative returns are so high that the non-replicability of PIVs in their present form is beyond question. It is calculated that the break-even point for paddy is 6.7 mt/ha, for maize 2.7 mt/ha and for sorghum 2.35 mt/ha if the GMP is amortized, but only if the analysis does not include field leveling and construction costs (see Annex F).

- PIV extensions have not been accomplished with an upgrade in design or level of technology, and the project's current emphasis on profitability and economic viability is an onus for perimeters originally designed in a context of self-sufficiency in food and equitable distribution of benefits. Further, the idea of a medium-scale perimeter was abandoned after an evaluation of the feasibility study which in essence did not finalize its own conclusions.

2. Total Project Redesign

This alternative takes into consideration the unrealistic project goals, assumptions, and objectives but also the problems associated with the TA team:

- For the most part, the Harza team has not proven to be tailored to a fair number of major tasks, even after personnel changes. The type of expertise needed under a different project design would require organizational changes.

- A lack of integration and collaboration between Harza and SAED has persisted since the beginning of their working relationship and severely hindered project performance.

- While Harza itself recently recognized the need for project redesign, its approach has been too theoretical and not practical enough.

The major drawback of this alternative is that a new request for bids would have to be made which essentially would be equivalent to terminating the present project.

3. Scaling Down the Present Project

Scaling down the present project would involve a substantial modification of the project's scope, objectives and expectations, as enumerated below. This alternative precludes project termination and pares the project down to an actionable, more focused program that would raise the potential over the present one for achieving sustainable development via a modified concept of the PIV.

- Since the demonstration farm is one of the best achievements of the project, it should continue its operations with some modifications. The farm should be financed under the project, its access road rehabilitated, and its training component fully supported.

- There have been too many studies and not enough action. The evaluation team finds no urgency in studies on erosion and water retention. The road study to Faleme deserves consideration if the financing for its implementation can be secured.

- New PIV construction has already been ruled out. PIV rehabilitation should be put on hold pending the results of the new approach outlined in this report.

- As suggested by Harza, four model PIVs each covering about 50 hectares should be implemented, but the format and formulation should be revised. The goals, objectives and purpose of the model PIVs should be clearly defined.

- The goal should be to rehabilitate those PIVs that meet already-established criteria and where farmer groups are interested in crop diversification. They should be willing to make an effort to reach a crop intensity of 1.5, without which financial profitability and replicability of PIVs cannot be shown. The crop mix should include rice, maize and sorghum during the rainy season (hivernage), and sorghum, onions, chillies and cowpeas, among others, in the dry season (contre-saison).

- The model PIVs should be rehabilitated according to strict designs and specifications, with reconstruction closely supervised by the Irrigation Engineer. Farmer groups participants should also be consulted during this stage to avoid modifications of layout later, which has often occurred. Complete and accurate records of all costs should be kept. Water pumped from the river should be monitored by a reliable in-line water meter saddled on the PVC pipe prior to the stilling basin. A PVC conduit could be installed in one or two of those PIVs where (and if) unacceptable high permeability of the primary canal warrants it. Comparative accurate costing should be recorded. Infiltration and percolation rates should be measured. Fertilizer inputs should be optimal and their application adequately supervised. Yield data should be collected according to accepted random sampling techniques. The Agricultural Economist would then analyze all inputs and outputs, all costs incurred (capital and recurring, excluding technical assistance) and benefits, and prepare a financial analysis of each of the four PIVs.

- The analytical results of the four PIVs would then provide the basis to determine the FIRR and the replicability of PIVs.

- Drip/subsurface irrigation, because of its water application efficiency and its potential to increase yields (the two main components that have made PIVs non viable so far), should be installed to run parallel with the four demo PIVs. The same accurate measurements of all inputs and outputs will allow comparison of FIRR with the demo PIVs. The empirical FIRR with the drip system is depicted in Annex F (Table F.12), and for water costs (Table F.13).

On the assumption that USAID concurs with the recommendations of the evaluation team, we recommend this third alternative, a scaling down of the present project with

modification of project purpose, goals and objectives. Analysis of the project schedule, team requirements and personnel expertise, and estimated projected cost is summarized below.

B. Proposed Plan for Scaling Down the Project

1. Project Schedule

The present project is scheduled to be completed in September, 1992, a two-year period insufficient to implement the recommended proposals. Time will be needed to gather and share information with farmer groups. This would be followed by topographic surveys and designs, land leveling and land preparation, which should be completed by March, 1991 at the latest, and the system checked prior to planting in June. Time should be devoted also to proper planning for crop mixes, data collection and analytical procedures.

2. Team Requirement and Personnel Expertise

There would be a change in personnel expertise tailored to the tasks that need to be accomplished. The work required of the TA team would be scaled down by the elimination of PIV construction and rehabilitation, except for the four model PIVs, the drip/subsurface irrigation pilot project and the model farm. The long-term team should be made of three persons, with support from short-term specialists as required. The new long-term team would be contracted for three years and include the following personnel:

- An Agricultural Economist/Team Leader who would be responsible for administrative operations and work closely with the Ingenieur Delegue.

- An Irrigation Engineer with hands-on experience in the building of perimeters under somewhat similar conditions. The engineer would be responsible for organizing PIV construction according to pre-designed criteria; advise on design quality; inspect and supervise the rehabilitation and/or construction of the four model PIVs and the drip irrigation pilot projects; and devise and deliver training courses in the construction of irrigation infrastructures and the in-field management of irrigation systems, including maintenance and operations.

- An Agronomist with on-farm development and management capabilities and experience in tropical crop diversification and production under Sub-Saharan conditions.

Short-term studies and consultancies on the Bakel project are overabundant and very few have proved necessary. Unless further studies can be translated into concrete actions in the field, they should not be approved. Short-term consultants may be needed to provide specific professional support to the TA team, to be combined with short courses in Bakel for the benefit of a maximum number of participants. This would be

preferable to sending one or two people for out-of-country training, except under exceptional circumstances.

The high quality of most SAED counterparts in Bakel has impressed the evaluation team. Work under the difficult conditions of Bakel may discourage some of them, which would be a loss to the project. Motivation in the form of added cash benefits in their monthly remuneration (hardship post differential) would be appropriate, inasmuch as their colleagues in other projects down the river are enjoying benefits in the amount of FCFA 50,000 per month. Such motivation can be conditional on performance.

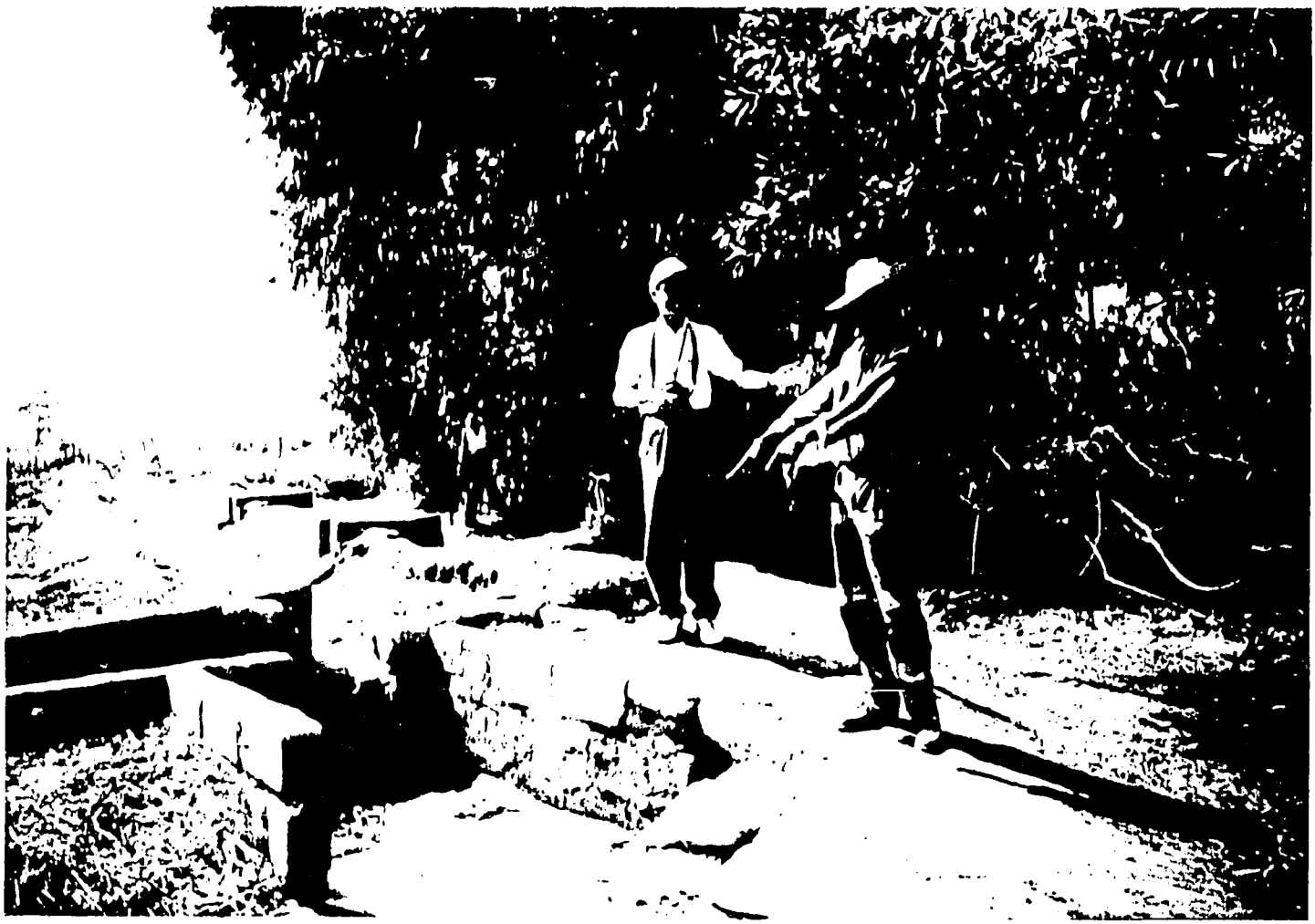
3. Estimated Projected Cost

The lack of progress by the TA team towards achieving project goals may have been the basic reason for delaying approval of expenditures by USAID. The TA team, in turn, blames the lack of progress on USAID's delays. While the evaluation team understands USAID's attitude, some relaxation of the tight control exerted so far may be necessary to permit the new team to achieve its mandate.

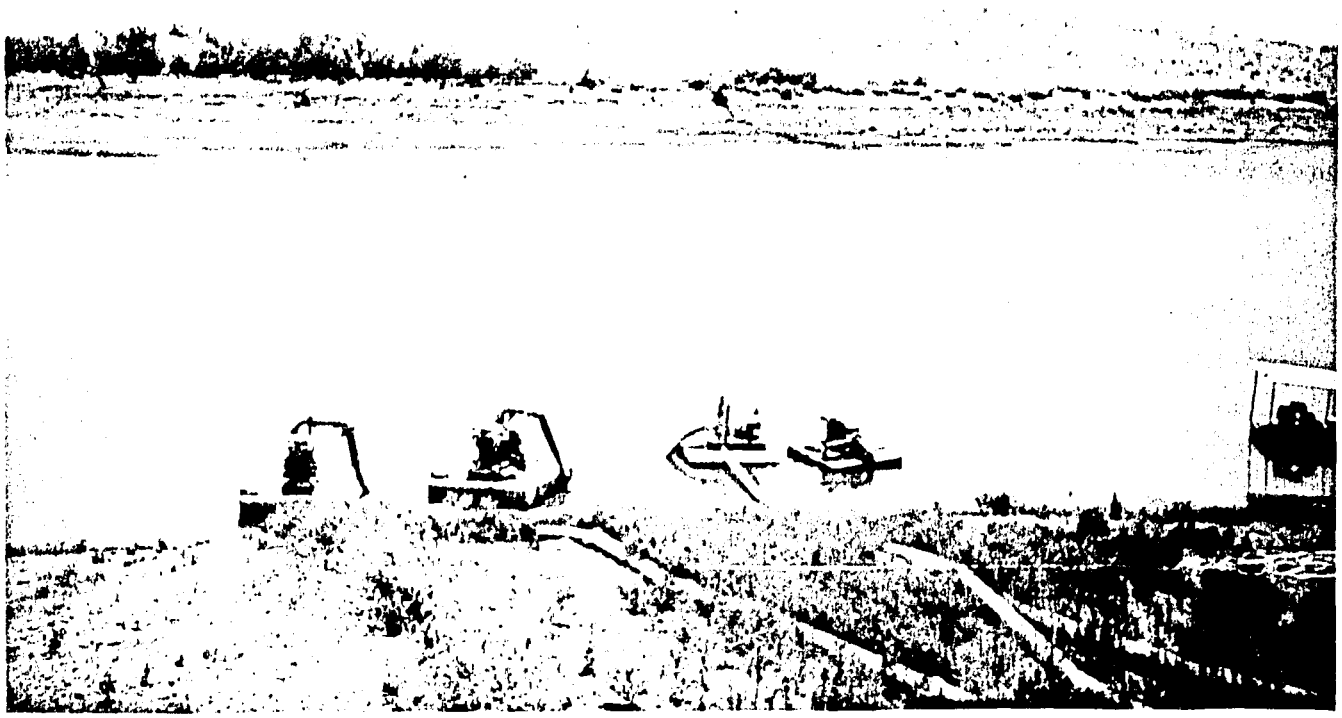
Approval should be given for SAED's request for USAID funding of $25,000 to purchase PVC pipes so that the 122 hectares installed in 1989 can function. The evaluation team believes that the requested sum is a small amount if this is what it takes to put 122 hectares under irrigation. However, such approval should be made conditional upon certification by the TA team's engineer or an independent professional engineer that the perimeters have been constructed satisfactorily and will perform according to design. This recommendation should not be taken as a precedent for SAED in the future. The evaluation team stresses that such an action should not be repeated.

The financial analyses dictate that the fixation on paddy production should be relinquished so that appropriate attention be given to crop diversification both at the farm and the PIV level, including the drip/subsurface irrigation pilot project. Candidate crops could include chillies, onions, carrot, sesame, bananas, potatoes, tomatoes, beans, cowpeas, pineapple, soybean, cashew nuts and fruit trees. Concurrently, preliminary studies on the export marketing potential of these products outside Bakel by a Senegalese marketing strategist could be funded under the project.

Assuming the recommendations are approved by USAID, there is a need to extend the life of the project by 15 months to December, 1993 to give time to the new team to implement the recommended scope of work.



The Perimeter of Mannel. Division boxes located at different intervals along the main canal to direct flow into secondary canals and to protect the junction from erosion. Example of a fairly successful scheme. This PIV recently acquired a second pump, has a well-organized and managed farmer group, and a collective maraichage field with fruit trees and a diversity of vegetables which the group sells to finance pump amortization.



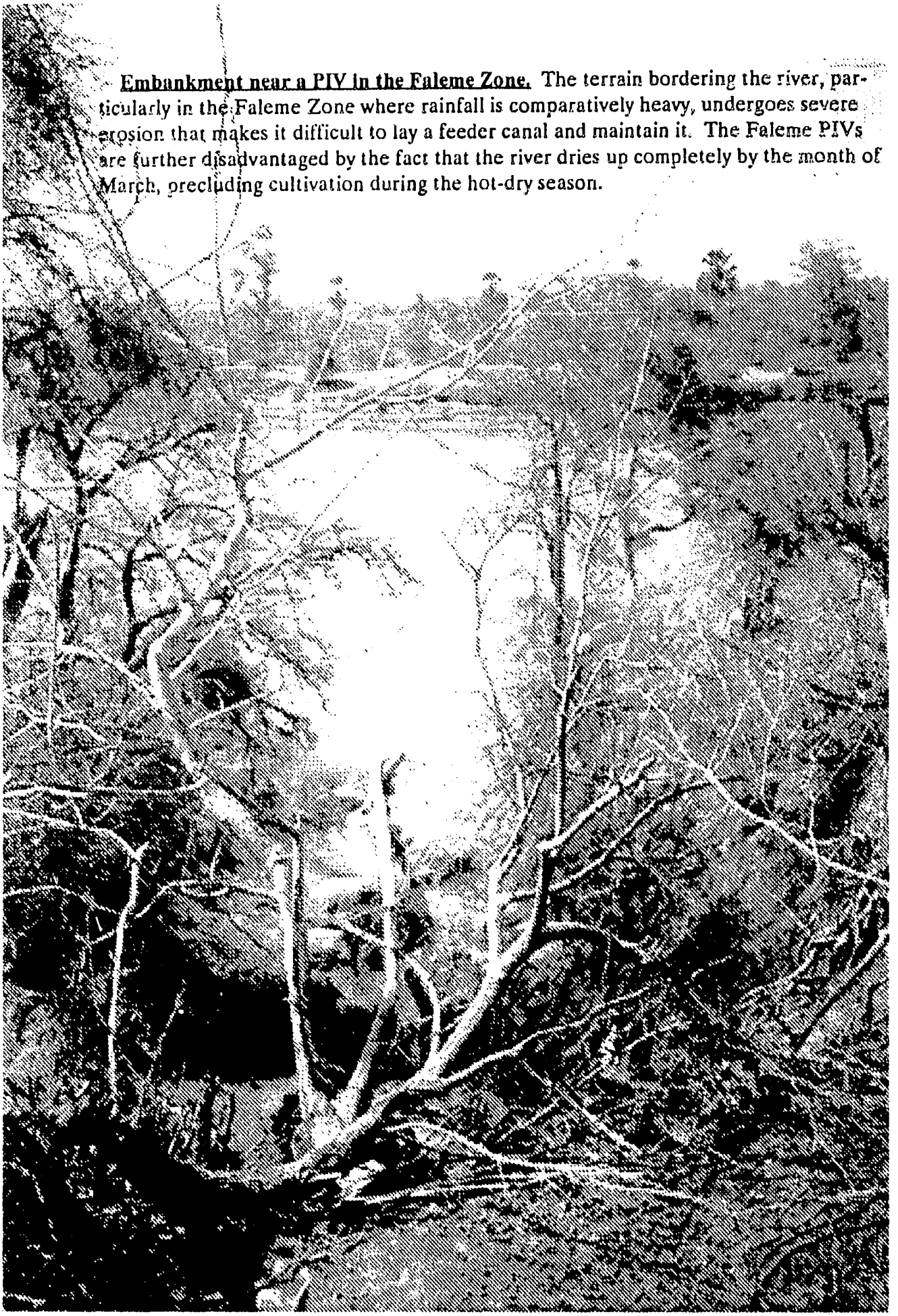
Group Moto-pompe (GMP) Diesel pump mounted on a floating raft along the banks of the Senegal River, designed to accommodate changes in the level of the water. These four pumpsets with their feeder canals traversing relatively steep embankments serve the collanga perimeters in the Bakel commune. For some PIVs, such as Collanga Kafo, situated a maximum distance from the river, water delivery to the fields takes as much as 10 hours. In other cases, pumped water loses velocity and stagnates in the main canals, never reaching the fields. Farmers also complain that some areas of the schemes cover inappropriate soils with a high percolation rate.

Rice Trials on Demonstration Farm. Different rice varieties are being tried during the off-season. The SIPI rice variety is already being adopted by local farmers. Rice during the growing period requires constant guarding against attacks from birds, wild pigs, and other predators.

Training at Demonstration Farm. While the Farm has 14 temporary hires, it pays farmers during training to assist with agricultural tasks. These tasks, such as hoeing, are performed using simple hand implements, as much of the work on the Farm is done by hand.

Small Agricultural Machinery on Demonstration Farms. Machinery as appropriate technology is used for demonstration to help reduce labor requirements at peak periods during the season. This particular machine is for stripping corn kernels from the ears.

Storage on Demonstration Farm. Storage facilities have been constructed for on-farm produce and demonstration.



Embankment near a PIV in the Faleme Zone. The terrain bordering the river, particularly in the Faleme Zone where rainfall is comparatively heavy, undergoes severe erosion that makes it difficult to lay a feeder canal and maintain it. The Faleme PIVs are further disadvantaged by the fact that the river dries up completely by the month of March, precluding cultivation during the hot-dry season.

ANNEX A

LIST OF PEOPLE CONTACTED

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Government of Senegal

Cheikh A. Cissoko, Minister of Rural Development and Hydraulics

M. LeMaitre, MDR Technical Advisor

Tran Minh Duc, MDR Technical Advisor, Coordinator for SAED Program

SAED Staff at St. Louis

Sidy Moctar Keita, President Director General

Mamadou Sambe, General Secretary

Alioune Badara Diallo, Director of Bureau d'Etudes (BEC)

Ibrahima Diallo, Assistant Project Coordinator, BEC

Ousmane Dia, Chef Service Etudes, BEC

Mamadou Faye, Chief of Monitoring and Evaluation Of

J.F. Belieres, Cellule Suivi-Evalution

SAED/Bakel Staff

Moussa Tacko Sow, Chief Engineer

Salla Dior Dieng, Rural Development Officer

Mamadou Kane, Irrigation Engineer

Mor Fall, Agronomic/Extension Agent

Jean-Pierre Senghor, Bureau Suivi-Evaluation

Harza Technical Assistance Staff

Ronald Gaddis, Design Engineer

Jeffrey Gould, Administrative Advisor

Stephen Copeland, Irrigation Operation Specialist

William Patterson, Rural Development Specialist

Clarence Burgett, Agronomist

USAID Staff

Julius Coles, Mission Director

Gar Nelson, Acting Director

William Egan, Project Manager

Mamadou Ndaw, Project Coordinator

Rodney Kite, Agricultural Development Office

David Robinson, Project Development Officer and Evaluation Coordinator

Seydou Cisse, Evaluation Officer

T. Myers, Project Development Officer

P. Jones, Agricultural Development Office

D. Watts, Agricultural Development Office

M. Keita, Agricultural Development Office

A. Barro, IWME

Jean LeBloas, IWME

C. Shorter, IWME

B. Gilson, PRM

A. Kader, PRM

Other Interviewees

Brian Ngo, World Bank

Kurt Lonsway, Dames and Moore

Joe Tabor, Dames and Moore

H. Schar, Dames and Moore

Dana R. Younger, Dames and Moore

Adrian Adams, Federation of Organized Farmers of Bakel

Diabe Sow, President of Federation of Organized Farmers of Bakel

Abdou Khadre Tandia, President Collanga Nafe

Zeynil Tandia, Collanga Nafe

Fainke Sylla, Gassambilakhe

Collanga Kafo

Harouna Magassa, Data Collection Supervisor

Marcia Nation, Researcher

Bob Reeser, Consultant

Chef de zone, Goye Inferieur

Chef de zone, Bakel Commune

Ibrahima Dia, ISRA

Village Irrigated Perimeters Visited

Collanga Faloboula

Collanga Jeunes

Collanga Nafe

Collanga Kafo

Collanga Sursaut

Demonstration Farm

Gassambilakhe

Tuabou

Mouderi 1

Mouderi 2

Mouderi 3

Mouderi Femmes

Mouderi 7

Mouderi 9

Mouderi 10

Mouderi 11

Mouderi 12

Diawara 2

Diawara Emigres

Diawara Femmes

Manael

Gande

Kounghani

Aroundou Emigres

Ballou 1

Ballou 2

Sebou

Golmi Femmes

Djimbe

Sénédébou

ANNEX B

LIST OF REFERENCES

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ANNEX C

SOCIOLOGICAL ANNEX

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I. INTRODUCTION

The purpose of this annex is to place the Project assumptions, objectives, outputs, and performance within its sociological context. To this end, the concept of the "perimetre irrigue villageois" (PIV) and its variations will be reviewed for relevancy to project assumptions and objectives. These variations are also reflected in the changing nature of the groupements de producteurs (GP). Among the more recently established PIVs and GPs which are frequently extensions or breakaways from the original PIV in any particular village, there is a trend towards greater "privatization" of perimeters. The characteristics of these different types of PIVs provide sociological criteria for selecting PIVs for rehabilitation.[1/] A section will also be devoted to assessing the region's land and labor resources for suitability to irrigation development and improvement. The Land Tenure Study completed by the Land Tenure Center of the University of Wisconsin-Madison, as a Project output, will be included in the examination of land resources. Finally, the components of the Project intended to monitor and stimulate social adaptation to irrigated agriculture will be directly assessed. These two components are (1) the socio-economic monitoring system, and (2) the training and extension program.

II. THE CONCEPT OF THE PERIMETRE IRRIGUE VILLAGEOIS (PIV)

1. Throughout the life of the Project, SAED and USAID have insisted on their objectives, but the performance of the PIVs has, generally speaking, lagged behind. The PIV is now in its fifteenth year, and it is germane to use a historical perspective to discern and understand the changes that have led to the current state of the small-scale irrigation schemes in the Bakel. The Project has now reached a stage where the long-term objectives of 1975 should have been realized. If they had been, the PIVs would have evolved into commercially-oriented medium- and large-scale schemes.

[1/] There is a total of 54 PIVs, according to SAED statistics, concentrated in 29 villages.

Although most of the PIVs have been extended or increased in hectarage, they hardly operate beyond a level of production for subsistence. One would expect that, in concert with the objective to make irrigated agriculture economically viable, farmers would have mastered the technical knowledge by now; reached a point where they are investing in irrigated agriculture, are reallocating more and more labor to irrigated crop cultivation as compared to dryland cultivation, and are ready to start building up supporting commercial enterprises. Overall, there would be evidence of a trend away from subsistence-orientation in the direction of a market orientation. The current objectives of the project continue to inhere this thinking and the expectations of a program that has been in existence for 15 years.

2. Other indicators for measuring the impact of irrigated agriculture on the region's population are employment and income. One of the original project objectives was to provide young male adults immigrating to France, as is traditionally done among the Soninke and less so among the Toucouleur, with an economic incentive to stay in Senegal. Contrary to expectations, migrant remittances are in many cases what enable PIVs to survive. This begs the question of whether migration should be conceived as an integral part of the production system, if not in the long-term, perhaps for the short-term. It is questionable whether regional income or employment has improved as a result of perimeter development. Further, does irrigated agriculture represent an increasing percentage of total cereal production and consumption? Based on conversations with members of several groupements, irrigated agriculture continues to complement, rather than substitute for, their other productive activities. Bakel farmers remain at a stage of development characterized by crop and land use diversification as a means of spreading and reducing risk.

3. The original concept of the PIV has over time lost some of its relevance. Initially, the concept of the village irrigated system entailed a technical design and layout kept simple and conducive to farmer management. The PIV generally averaged 25 hectares and individual plots about .20 ha. Inputs, the pumping station, the design and construction were all subsidized by SAED and USAID. Sites were selected on lands that were not subject to customary land tenure. The village population as the socio-economic unit for perimeter management and organization was chosen for its relative homogeneity and cohesion to minimize problems of cooperation. The general idea was to "keep

it simple" to facilitate rapid adoption of the irrigation technology by the riparian population. The rate of hydro-agricultural development for the Senegal River Valley as a whole was dictated by the conditions which would ensue from the construction and operation of a large water-retention dam. The Manantali Dam would regulate the flow of the river to permit double-cropping on an annual basis while eliminating flood recession agriculture.

4. The Project was more focused on an equitable distribution of benefits in the beginning. Hence, when PIVs were first being introduced into the Bakel region, SAED and USAID were concerned that the technology be made available to as broad a population as possible, i.e. to introduce it to a maximum number of villagers to prepare them for the effects of the dam, although the Faleme zone would not be affected. In the same vein, consideration was given to equal access to irrigated agriculture at the intra-village level, cross-cutting all social strata. Another measure was to stipulate equal sized plots for all participants to ensure a modicum of equity in land distribution within the perimeter. Whether or not guidelines were translated into action is another issue. The fact is that early in the project the notion of a fair distribution of resources was discernible. Indeed, the concern for broad and equal access came at a time when farmers everywhere in Senegal were severely affected by the 1968-1973 drought.

5. The proper functioning of the PIVs was impeded by a multiplicity of problems related primarily to technical aspects. To begin with, while the number and size of PIVs and size of groupements have grown, they have all become bogged down in physical and technical problems. Despite expansion and rehabilitation, there has been a concomitant regression caused by poor construction (amenagement) and poor technical choices related to soil types, topography, long irrigation schedules and rotations, inter alia. Some perimeters were expanded without upgrading pumping capacity. Extensions were added to extensions of original perimeters in piecemeal fashion. All these factors hinder good management and maintenance which even a rigorous training program could not rectify.

6. Most of the groupements are in debt to SAED. Farmers had also come to expect much of the work which they could have done themselves to be done for them. That debt repayment was not forthcoming could be based on one of three positions: (1) SAED did not do the job right to begin with, (2) why not wait for another hand-

out to pay off the debt, or (3) they were losing money after they were told they would get high yields and could not pay their debt. The present situation requires that farmers interested in improving their perimeters must now begin to pay for these and all other services left to the so-called private sector, but cannot obtain credit until and unless SAED grants them a moratorium on the debt. Inasmuch as conditions and problems will vary from one perimeter to another along the Senegal and Faleme rivers, two conditions, based on reports and field observations, are common to almost all: poor design and construction and a state of indebtedness.

7. In the meantime, the Project objectives have come to rest more squarely upon the economic aspects of irrigated agriculture - its profitability and economic viability which are contingent upon the production of a cash crop in addition to rice and a double-cropping system. To wit, the emphasis has shifted away from conditions which would facilitate the introduction into the local milieu, since most villages have by now had some exposure to irrigated agriculture. Nonetheless, the underlying assumption, by necessity, is that conditions are ripe for this transition from subsistence to commercialized production.

8. A certain categorization of existing and emerging PIVs is useful to identify trends and the effects of SAED's relaxation of its original guidelines for establishing a perimeter. It also illustrates how some groups (e.g. with political ties) get formed at the behest of other marginal groups where an opportunity to derive some benefits presents itself.

III. PIV EMIGRES (MIGRANTS)

There are only two PIVs in the Bakel region that are run by a migrant and his family. Aroundou Emigres was established in 1978 and Diawara Emgires in 1982. Both cases benefitted from about ten years of employment in France. The Aroundou perimeter grew from five hectares to 11 over the course of twelve years. While the migrant was interested in growing crops for a profit, various problems (delays in delivery of spare parts for the pump or the financial ability to pay for them, low level of soil fertility for growing rice, inadequate market for surplus production of onions) have caused him to forego irrigation over the last three years. The more recent PIV, Diawara, is said to be progressive and commercially-oriented and has applied for a GIE (groupement d'interet economique). While it is not

unusual for young Soninke men to spend upwards of ten years abroad, not all migrants choose to invest specifically in irrigated agriculture or to use their savings for start-up costs for developing a perimeter.

IV. PIV FEMMES (WOMEN)

There are officially (according to SAED records) three PIV Femmes (Mouderi, Diawara, Yellingera). Women's groups are not unusual. Women are traditionally accustomed to collective work and pool their labor to cultivate vegetable gardens. They obtained financial and technical assistance from NGOs or the ministry of agriculture. Golmi Femmes, for instance, is a collective engaged in market gardening with a well built by the Forestry Service (Service Eaux et Forets). There are a number of these market gardening collective workgroups that are not recorded by SAED. Although SAED does not have a mandate to specifically encourage women to form their own groupements, there are no restrictions on the creation of perimeters for women only, just as there are none for individual families. Nonetheless, support for these groupements has not been sufficient to enable them to function; Mouderi Femmes still have not been given their own pump and Diawara is still waiting for pipes. All three PIVs are a phenomenon of the late 1980s. Women are clearly interested in gaining access to possibilities for augmenting their personal cash incomes which on the regular PIVs are more limited because of gender relations and male-dominated decision making. Gender issues will be addressed in the section on the Groupements.

V. PRIVATE PIV

There a certain number of PIVs created since 1985 that are ascribed to local politicians or businessmen (commercants) and their individual families, particularly in the town of Bakel (Commune) and in Mouderi in the Goye Inferieur. Some of these are breakaways from the classic or original PIV and are sometimes comprised of the leadership of the first PIV who requested an extension for their own use. The ten perimeters in Mouderi are also a result of extensions of the original perimeter requested by individuals or groups of individuals.

The Mouderi case is a good micro example of a new group formation process. 12. The first perimeter had over 500 members and a good representation of the village

population. At that time, collective farming was being practiced. Membership declined rapidly before plots started becoming individualized. Then perimeters were being offered to distinct groups. Mouderi II was for male household heads, with less representation of lower-status individuals; Mouderi III was for the National Assembly depute and his family; Mouderi IV was for the members of the Al Fala Moslem sect; Mouderi V was for the President of the Rural Council and his allies; Mouderi VI for youth; and Mouderi VII was for women. According to Bloch,[2/] "dispossessed groups have managed to gain access to land in the new perimeters, but only on a 'separate but somewhat equal' basis."

There is also one perimeter (Gangala) in the Goye Superieur which is dominated by one family, the landowning family who then recruited more people to join. It is said to be commercially-oriented, has already obtained credit from the bank, and qualifies as a "perimetre irrigue commercialise" or PIC, as coined by the Harza team. The March 1990 Quarterly Progress Report outlines what Harza envisions to be the contrasting characteristics of the PIV and the PIC (See Appendix to this Annex). It is worth mentioning the three essential differences of PIC: (1) commercial production, (2) privately owned and financed, and (3) a well-defined management with a chain of command thought to be more authoritative and effective than that of the PIV.

Golmi 3 created in 1989 is another case of a politician who has formed a GIE to cultivate his own land. There is also supposedly a private perimeter in Djimbe (apart from village PIV) and there may be other "unofficial" PIVs. Another perimeter (Diawara 2) is based on a sect, the Al Fallah and is supported financially and spiritually by Arab nations. It is made up almost exclusively of returned migrants and by virtue of the religion, women are not allowed to join. One of the Mouderi perimeters (Mouderi 4) is also organized around the Al Fallah sect. Even where local elite have not established their own perimeter, they generally claim a larger area on the PIVs to cultivate.

[2/] Bloch, Peter. 1989. "The Dynamics of Land Tenure on the Bakel Small Irrigated Perimeters. Final Report on the Land Tenure Center Research Program." Madison-Wisconsin: Land Tenure Center.

VI. PIV JEUNES (YOUTH GROUPS)

Mouderi 8 is a PIV claimed by a youth group. Collanga Jeunes is another one but is apparently not cultivated by them but by other people. The Tuabou PIV experienced problems in forming a groupement due to conflicts between women's group, jeunes, and elders who all wanted to lay claim to the PIV. The tension between elders and young males is understandable in the context of the social structure, as the latter may be obligated to work on the fields of their older brothers. It is probable that the youth groups perceive irrigated agriculture as an avenue for bypassing traditional labor obligations and making direct gains. They are becoming a dynamic and cohesive group easily mobilized to assume control.

VII. PIV MARABOUT

There are only two PIVs marabouts or traditional religious leaders - one in Kounghani and one in Golmi which date from 1980. They were both created for the benefit of one individual who could invoke the traditional labor obligation of his disciples, the talibe, to work the land for them. This is another type of patron-client relationship.

VIII. "FEDERATION" PIV

This is not a distinct category of PIVs. Groupement affiliation with the Federation of Organized Farmers of Bakel is significant for a couple reasons. The 13 groupements (11 villages) which belong to the Federation were all among the original perimeters to have been developed. Although these perimeters have not retained their original character, distinguished especially by collective cultivation, they are closer to the original version of the PIV in the composition of the groupement and general organization and management. Some of these villages may have a second perimeter - either emigres or women. They could be categorized into three types:

(i) Those that have strong ties with the Federation by definition draw on the services it offers - training and inputs which are paid for in cash. They also cede to the approval of the President to respond to SAED proposals or invitations. No credit or loans are involved.

(ii) Some villages fall somewhere in between, that is, they obtain inputs and services from outside the Federation as well and wish to take advantage of SAED's extension and training services. Some of these have demonstrated an interest in forming a GIE to obtain credit which the Federation generally tries to discourage.

(iii) Then there are those villages which merely pay their monthly dues and attend meetings which is probably to demonstrate their political support.

The objective of the Federation is to organize farmers first as a means of gaining greater access to benefits, resources, and knowledge implicit in which is the notion of empowerment. This is why education is a fundamental element in their program - that villagers acquire the awareness and the wherewithal to realize their own development and own objectives. For the Federation, the development of irrigated agriculture is perceived first as a component in the overall farming system, a complement to rainfed agriculture, and not as an objective in itself. This is reflected in their agricultural extension program which encompasses all types of land under production. Probably the most significant attribute of these villages which have had a long relationship with the Federation is their sense of initiative and self-reliance, underscored by a reluctance to depend on external assistance. Unfortunately, the Federation, which does not have NGO status, is limited in its activities, in relative terms, by capital constraints. Nevertheless, they have made continuous progress in the development of a support system for villagers that will sustain them in their endeavors.

IX. FINDINGS RELATED TO THE CONCEPT OF THE PIV

A. The classic notion of the PIV geared towards subsistence production and equitable distribution of benefits is in conflict with the Project's current emphasis on profitability and economic viability.

B. The functioning of the PIVs was impeded by many technical problems.

C. In the process of perimeter extension and as a result of SAED's disengagement policy, local interest groups, traditionally cohesive groups, and private individuals have begun to compete in seeking access to their own perimeter.

D. There is a growing trend towards privatization of irrigated perimeters epitomized by the "perimetre irrigue commercial" or PIC.

E. The Federation PIVs are, on the one hand, the least likely to proceed full force with commercially-oriented production, but, on the other hand, have strong potential to making irrigated agriculture sustainable outside the purview of the Project.

X. RECOMMENDATIONS BASED ON THE PIV CONCEPT

A. The selection of PIVs for rehabilitation should not be focused too narrowly on commercial orientation or entrepreneurship but on the identification of traditionally cohesive groups (women, youth groups, emigres). The justification is two-fold: (1) these groups should not be disadvantaged as perimeters managed by private entrepreneurs or local politicians begin to develop which is likely to pave the way for socioeconomic differentiation; (2) a group which is cohesive and held together by some common ground implies a strong organization which can often compensate for technical or externally-related problems.

B. In rehabilitating schemes, the design (layout, initial level of technology) should be tailored to the specific needs and characteristics of the group, i.e. based on socio-economic data. This can be reinforced by participation of groupement members in the design and construction phases. The West African Rice Development Association (WARDA), in collaboration with the Institut Senegalais des Recherches Agricoles (ISRA), has carried out research in the Bakel region and other parts of the River Valley to evaluate the appropriateness of PIV design from a sociological perspective. It is recommended that SAED and the technical assistance team consult with these organizations on this question and on formulating a methodology for participation in design.

C. To effect attitudinal changes vis-a-vis perimeter development (from subsistence to market orientation) requires a "big push" in the area of extension and training. See section on Extension and Training below.

D. In light of the Federation's pattern of initiatives and program of services, it should

the project level as do the private sector.

E. Assuming the project alternative of focusing on four model PIVs, the selection should be based on the most progressive PIVs. For the Lower Goye and Bakel Commune, a PIV should be selected from the area where there is a concentration of PIVs (Mouderi and Collanga) to maximize the demonstration effect.

XII. THE CONCEPT OF THE GROUPEMENT DE PRODUCTEURS (GP)

1. The characteristics of the GP fit well with those of the PIV. Like the perimetre irrigue villageois, the concept of the groupement de producteurs has been around for a long time, i.e. as long as the PIV. Here again the object was to enable as many villagers as possible to participate in irrigated agriculture. All villagers who contributed to clearing the land for the PIV were eligible to participate and lots were drawn for plot allocation. Within the framework of the PIV, the GP served as a logical organizational structure that would operate and manage the PIV autonomously from the regional development authority, SAED which could increasingly transfer its responsibilities over to the groupements.

2. The autonomy of a village groupement in making its own management decisions with technical advice being given by SAED would explain the variations in quality of decision making and implementation of irrigation tasks from one perimeter to another. These qualitative differences are a function of the ethnic group in question, the pre-existing social relations (gender, caste, age) at the village level and at the household level, the element of leadership in the community, and level of training. For perimeters such as Collanga Nafe and Collanga Kafo which are family-run operations with only 10 or 20 members in a groupement, not all these factors may apply. The private perimeters also tend to hire more labor.

3. In general, the social determinants of access to land and labor will have a bearing on their allocation within the perimeter and initially when the perimeter is installed. The Land Tenure Study was completed for the purpose of identifying the impacts of traditional rules of access on groupement and PIV performance. The research and findings of this Study will be considered below under Land Tenure Issues.

4. There are two major distinctions with regard to the groupements that exist in the Bakel region:

(i) population: the population of the region consists of two ethnic groups: the Soninke who dominate the areas along the Senegal River, including the Goye Inferieur, the Bakel Commune, and the Goye Superieur; the Tukulor who live along the Faleme River, a tributary of the Senegal River. The latter are a sedentarized Pulaar-speaking ethnic group with a strong tradition of livestock raising.

(ii) climate: the Faleme Zone receives substantially more rainfall that the other zones. From June to October of 1989, for example, 762.8 mm were recorded for the Faleme and 328.2 for the Goye Inferieur.[3/] In most villages along the Faleme, however, the river dries up completely by the month of March. Sebou and Gangala are the only villages that have water year-round.

A. Organizational Aspects

1. The principle of equitable distribution of resources was promoted by SAED in the early days of perimeter development. All villagers alike, regardless of caste, gender, or age, had the right to obtain a plot. Plots were supposed to be of equal size. However SAED never really enforced these principles with the result that the noble and landowning families have proportionately more surface area to cultivate on the schemes, and women generally have smaller plots of about half the size of men's plots. Caste representation on the PIVs in proportion to their percentage of village population has not been determined so much as caste proportions on the PIVs which show no specific pattern across the board.

2. Among the Soninke groupements, plots are allocated to the ka or extended family which is about twice as large as the Tukulor basic social unit. In the latter case, plots are

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[3/] Brusberg, Frederick. 1990. "Analysis of Baseline Data and Socio-Economic Monitoring for the Hivernage Period 1989-90." Prepared under USAID Contract No. 685-0280, SAED - Harza Contract No. 58/88.

allocated to the head of the nuclear household. The Soninke are said to have a strong tradition of social cohesion and collective action, as has been reported in project documents since the inception of the Project. Prior to SAED intervention, the Soninke migrants had taken the initiative to develop vegetable gardens that would be farmed collectively by the village. Some PIVs have retained a collective field from which to cover expenses such as pump amortization. Otherwise, plots are allocated on the basis of the ka. The Tukulor who traditionally cultivate land at the level of the household tend to be more individualistic. It is not uncommon, for instance, for farmers whose plots are not adequately watered for technical reasons not to be compensated by the groupement. Each plotholder fends for himself. Some farmers contend that inequities have been built into the system so that some must struggle to maintain their plots. This was reported for the PIV at Naye on the Faleme.

3. Among the Soninke the groupements are organized into subunits or workgroups assigned to different watering zones. Workgroups are charged with maintenance and collective work requirements on a rotating basis. Each workgroup has a leader and appoints ditchmasters to manage the distribution of water to each zone and its subsequent intrazonal allocation. This arrangement may differ somewhat from one perimeter to another. In Gande, for example, there are three permanent groups of irrigators who irrigate every day according to their turn. They irrigate collective plots and women's plots first. Then each team irrigates their own plots. The workgroups are also subdivided by gender and women are leaders of their own workgroups.

4. The classic groupements have demonstrated a capacity to organize themselves for the purpose of accomplishing the different tasks at the system and cultivation level. The cultivation tasks are generally performed based on the division of labor applied to traditional farming. Certain labor obligations reflecting patron-client (inter-caste and elder-junior) relations persist on the irrigated perimeters, although no systematic study has been done to show trends over the last fifteen years. Labor

composition may be different on the smaller, private schemes who may have a tendency to hire more wage labor. Attention to the system level tasks, such as repairing canals, which affect all members of the groupements, is more contingent on the general state of the PIV and the financial state of the groupement. A large percentage of PIVs have accumulated sizeable debts to SAED and are not able to apply for a GIE (groupement d'interet economique) until they have negotiated a moratorium on the debt with SAED.

5. According to Waldstein's report[4/] of his visits to some of the perimeters, none of the groupements reported any organizational problems, although it was observed that internal conflicts at Yafera, Tuabou, and Naye had an impact on the level of cultivation and production.

B. Management Aspects

1. SAED originally excluded participation of civil servants, businessmen and local officials from participation but in the Bakel region, they have had a lot of influence, particularly in Mouderi, Diawara, and Bakel Commune. In fact, the local elite has control over the communautes rurales. Most groupement presidents are from the noble caste and have close links with the communautes rurales. Gande which has a former slave as president but that is because the village leadership is from the former slave caste. Generally, groupement officers are either elected or self-nominated and the number of officers varies from one GP to the next.

2. Participation in the decision making on the PIVs is not very equitable. The decision making is squarely in the hands of the officers and not the individual plotholders.

3. It has been reported that perimeters with some of the following management practices tend to have more success:

[4/] Waldstein, Alfred. 1989. "Trip Report - Senegal Irrigation and Water Management I Project (19 March to 14 April 1989)." Associates in Rural Development.

(i) members pay for their share of fuel at the beginning of the season rather than at end.

(ii) members pay for fuel whether or not they irrigate.

(iii) male and female supervisors are appointed to respective workgroups (women prefer to be supervised by women).

(iv) A mechanism for assisting members whose parcels are partly watered due to perimeter layout or faulty canal work.

(v) Maintaining a collective field, the proceeds of which will cover expenses of fuel and pump amortization.

4. Some groupements have a penalty system to ensure farmers participate in irrigation activities. A farmer can be excluded for not paying irrigation charges, failing to cultivate his plot for no legitimate reason, or failing to fulfill obligation on collective maintenance work.

5. Each PIV is supposed to have a group of individuals trained in technical and management aspects corresponding to the following functions: (1) pump operator, (2) village technician, (3) water controller, (4) treasurer, (5) input supplier, and (6) supervisor(s). Training for these functions is not mandatory and has only partially been completed. One of the fundamental problems noted in performing these tasks adequately is the poor level of literacy. Further, the technical deficiencies in the irrigation works frequently preclude good water management. Perimeters are not properly graded; secondary canals get silted up so irrigation is done from basin to basin; or perimeters are not located on proper soils.

6. There is a caveat that SAED's disengagement policy is likely to place more responsibility on the groupements than what they are prepared to handle. Groupement acquisition of inputs such as fertilizer, pesticides, diesel fuel, and agricultural equipment is one such responsibility that has been divested from SAED. Inputs are no longer furnished by SAED on credit. SAED's withdrawal from design and construction further assumes that the groupements have both the access

to credit and access to private enterprises for providing these services. While there is evidence that some groupements or individuals have gone so far as to form GIEs, obtaining credit from the bank, the Caisse Nationale de Credit Agricole Senegalais (CNCAS) is still a matter of negotiating debt repayment with SAED first. In some GPs, these new credit policies have caused them to halt irrigated cultivation, especially since subsidies on inputs were stopped. In some cases, diesel fuel was not even available. New credit conditions add to farmers' costs of irrigation because they now have to pay interest (12.5%) on loans which is prohibitively high. On one perimeter in the Faleme, the groupement has reverted to individualizing the purchase of fertilizer.

C. Labor Availability or Constraints

1. The question of whether or not there is a shortage of labor to fulfill labor requirements on the irrigation schemes has loomed since the Project began. According to the Irrigation and Water Management I Project Paper, the labor factor of production is significant for projecting the number of hectares of irrigated agriculture it would allow; based on soil resources, 10,000 hectares are irrigable, but with the labor constraint, only 4,500 hectares are possible. Labor availability has been addressed mostly in association with the Soninke tradition of migration. It has been reported that the Lower Goye, which has the highest proportion of migrants of all four zones, has a short supply of labor, hence, more hired labor. However, this does not necessarily translate into a constraint on irrigated agriculture so long as migrant remittances are being directed towards maintenance of the schemes and enable their families to hire labor. Research is being conducted in this area on the basis of a 42-family survey which thus far confirms a higher percentage of remitters among the Soninke than among the Tukulor. Remittances in general are intended for the reproduction of Soninke society and culture, and villages have mosques, dispensaries, and schools to show for it. Often, remittances are invested first in real estate in urban areas to generate further wealth used to support the villages. A portion of remittances from sample family concessions or households in the Soninke zones are, nevertheless, applied to the purchase of inputs for irrigated rice production. The Upper Goye Soninke are now showing signs of improving

their integration of migration as a revenue source for the villages into their survival strategies. The Tukulor along the Faleme who are more accustomed to migrating to Central Africa than to France and Dakar like the Soninke, tend to apply their remittances more directly to food purchases.

2. Labor availability for irrigated agriculture can only be conceived in relative terms. Farmers make decisions about how to allocate their labor in the face of multiple alternatives. The labor requirements of rainfed cultivation, for instance, is said to conflict with those of irrigated agriculture. Irrigated land in the beginning of the hivernage needs to be watered in order to work the soils. Pre-irrigation may conflict with planting the dieri or rainfed fields. The peak labor demand period occurs during rice planting. Other labor bottlenecks arise during the year. Harvest time coincides with the planting season for sorghum on walo fields and legumes on falo soils along the slopes of the river bank, although in recent years rainfall conditions have virtually eliminated flood recession agriculture. The Tukulor tend to favor rainfed cultivation because of good environmental conditions. For them, dry season irrigation comes into conflict with livestock raising, as large numbers of livestock in the villages are a threat to their crops and fencing is an expensive input.

3. In general, irrigated agriculture is more labor- and capital-intensive than rainfed or flood recession agriculture. Farmers' labor allocation decisions in general reflect the continued necessity to diversify land use and crop cultivation and to spread risk. Farmers are reluctant to assume, on a constant and incremental basis, the costs of production for irrigated agriculture under numerous constraints: credit accessibility, technical problems in the design and construction, persistent uncertainty of input availability, and uncertain or non-existent markets for their crops. As optimizers, they will continue to treat irrigated agriculture as supplemental. That farmers regard rainfed agriculture as giving them a higher payoff and less risk in terms of cash investment suggests it is debatable that an increase in the size of individual irrigated plots to .35 hectares per adult labor unit would stimulate an improvement in the economic performance of irrigation and encourage the return of migrants. Rather, farmers will continue to

justify larger families (unpaid labor) and migrant remittances as an integral part of their production systems, barring any qualitative changes in their socio-economic conditions.

4. At the intra-village level, labor availability is also a question of how social relations determine individual access to labor as a factor of production. The marabouts or religious leaders, for example, can call upon their disciples or talibe to work for them. This is why they are able to have their own irrigated perimeters. Other such labor obligations exist between castes and are reproduced on the schemes. No systematic study of this has been done to indicate whether these practices are on the decline or to what extent they are invoked. Access to hired labor is more a function of an individual's economic status which might be correlated with caste or class, but here again, no data exists on this for the Bakel region. Women do not usually have the same access to hired labor as men because their cash earnings are less significant. One of the land tenure reports based on a sample of three villages found evidence that adequate hired labor is available in the Bakel region and that labor is rather a family constraint. This is because the kagumme or head of household in Soninke society has full control over access to family and non-family labor. He decides how labor is to be divided up and can mobilize family labor to work on the irrigated plot if he chooses to consider it part of the family field. Women and young men are thus at a disadvantage.

D. Land Tenure Issues

The Land Tenure Center produced 16 individual reports devoted to customary land tenure and land allocation arrangements in the Bakel region. The objectives of this study, according to Annex 9.3 of the Grant Agreement were to:

1. develop a baseline of current land tenure practices in the Bakel;

2. monitor the effects of expanding perimeter development on land tenure and;

3. undertake studies of land tenure tradition, law and administrative services in Senegal of significance to village and medium-scale irrigation systems; and

4. conduct a site evaluation of land tenure consequences of a medium-scale system at the site of the feasibility study.

With regard to the last objective, the Land Tenure Center was, however not able to participate in the pre-feasibility study of the medium-scale irrigation system. In fact, the idea of a medium-scale perimeter was abandoned subsequent to the feasibility study. The fieldwork for the land tenure study was conducted by a team of researchers and data collectors from January to December 1988. Preliminary evidence was gathered in January and August, 1987.

The reports were written as discussion papers that could be treated separately but have the disadvantage of repetition in background information. Assessing the reports as a whole is difficult in the absence of an explicit research design. The papers are topical and do not lend themselves to synthesis. The hypotheses for the whole project do not appear in any outline form until the final report that refers to them directly. The "results" appear as short summaries of each individual report, while one report based on research in one particular village is discussed at length. There is no clear methodology for data collection, particularly with regard to the two baseline survey reports. This is especially the case when dealing with sensitive issues such as caste. Significant discrepancies have also been noted in comparing the data from the land tenure reports and data collected through the socio-economic monitoring system. In fact according to Annex 9.13 of the Grant Agreement, the data for the study was supposed to have been compiled by the socio-economic monitoring system of the project.

Much of the qualitative data based on informal interviews with villagers tends to be anecdotal. Further, it is unclear whether the emphasis of this research on equity and access to resources, primarily land, is commensurate with the importance which the current project ascribes to these issues. The stated objective of the current project which is the replicability and profitability of the PIVs may only indirectly assume the importance of an equitable distribution of benefits, i.e. that disparities will negatively affect the economic performance of the PIVs.

The conclusions and recommendations of the land tenure study are concentrated in the last ten or fifteen pages of the final report. The major trends and findings most relevant to project objectives are enumerated here:

1. As perimeters are expanded and new ones created, there is evidence of changing access to irrigated land that supports the formation of new groups: some commercially-oriented and family-based, some previously disadvantaged. Most perimeters do not have rules for permitting the continued cultivation of plots abandoned by original owners.

2. For the most part, the tendency for traditional elites to retain control over access to land has been somewhat counteracted by the role of the communautes rurales. This is more true of the Lower Goye than of the Faleme zone where traditional elites are closely linked with local administration.

3. Women's access to irrigated land is not equal to men's access. In the Faleme women are excluded as members of groupements and on the Soninke PIVs, their access is conditioned by the decisions of the male head of household. The move to provide a women's group in Mouderi with their own PIV is a positive sign.

4. The data collected does not permit an evaluation of the relationship between differential access to land and productivity. Production data exists for only one village, Mouderi I which will be the subject of a dissertation (by David Miller).

Project planners should be referred to the final section of the summary report which gives a checklist of perimeter design questions for minimizing land tenure problems and improving the chances of success of irrigated agriculture in the Bakel. It must be recognized that the Land Tenure Study came as a response to a set of long-term expectations on the part of the Project, to wit, that irrigated agriculture in the Bakel would expand beyond the village unit and that medium-scale perimeters would be constructed. Were irrigated agriculture to reach a stage of development whereby requests for installing schemes implied the appropriation of land belonging to another village or lineage, the land tenure

question would have to figure prominently in the planning process. Thus far, the social conflicts engendered by the village irrigated perimeters have not proven to be irreconcilable. The land tenure reports, nevertheless, constitute a baseline study which will prepare planners and government for the kinds of patterns or trends they may expect to see, as a result of the expansion of irrigated agriculture, in the near future.

E. Gender Issues[5/]

1. The concept of the perimetre irrigue villageois is no different from most irrigation schemes in taking the household as the basic unit in plot allocation and assuming the goals and objectives of household members to be the same. Women's position in traditional society is thereby reproduced on the scheme. As was previously mentioned, plots on the Soninke schemes are allocated to the ka and on the Tukulor schemes, to the galle. The galle is a smaller unit about half the size of the ka.[6/] In the Tukulor villages, the women are commonly excluded from access to irrigated land. This may in part be related to the fact that traditionally women do little agricultural work apart from cultivating small plots of peanuts. They have a larger role in livestock raising and control income from the sale of milk. When groupements were first created, anyone who helped clear the land was an eligible plotholder. Men in some of the Tukulor villages alluded to the fact that women cannot clear the land. However, men were able to pay a membership fee to obtain a plot while women were not.

[5/] Sources of information for this section are: (1) interviews with village women, (2) WARDA reports, (3) Land Tenure Center reports, and (4) interview with Marcia Nation, field researcher.

[6/] The size of the production-consumption unit is rational in the context of the livelihood practices of each ethnic group; in the case of the Soninke, it was purposeful for extensive cultivation of dieri and diversification of land use as well as to compensate for the absence of young males. In the case of the Tukulor, their primary engagement in stock-raising and transhumance may account for a fragmentation of the extended family unit.

2. On the Tukulor PIV of Djitta, women were originally assigned plots. But the requests of male heads of household for more plots were met by repossessing female plots. Women are still expected to contribute their laborpower on the scheme.

3. In Soninke society, the basic unit of consumption and production is the ka or extended family organized around the eldest male member or kagumme. The whole ka shares one compound. There is a well-defined division of labor and land in the Soninke production system. The male members are responsible for grain cultivation and the kagumme coordinates production and distribution. Women have their own plot(s) for growing crops that serve as supplemental ingredients to meals - groundnuts, vegetables, and red rice. She is also charged with all the domestic responsibilities.

4. The significant factor in gender relations among the Soninke is that women do not have full autonomy in cultivation activities; she must ask her husband or in his absence another male member for permission to use the land for cultivation. In the peak season, the women are often obligated to assist men with their crops. Until now, women's only source of income is the surplus production from own plots which she must spend on her children's needs, for instance, her daughter's dowry. On the PIVs, married women may be counted as members of the ka, but it has been observed that when women are signed up as members of the groupement, it is more of a means to expand the area of the texoore or collective field than for women to acquire control over their own plots. Furthermore, women's plots are typically about half the size of men's plots. It is also argued that women must allocate their labor to other fields besides the irrigated plots. Among the Tukulor villages, it is expected that women's revenues will be retained for their own needs, while yields from men's plots benefit the entire household. 5. Every groupement elects a committee of officers for various decisions mentioned above in the section on organization and management. The committee is run entirely by men. Although women are leaders of their own workgroups, they are consulted by male members of the groupement but are not allowed into the decision-making process. Women do not attend the committee meetings and are informed later of their decisions. It is assumed that women should not participate fully in the costs of irrigation,

the argument being that they cannot pay. This constraint is perpetuated by the small size of their plots. Without contributing monetarily, women have less say in all other decisions, such as crop choice, quantity of inputs, and benefits from the sale of yields.

6. Access to labor is another consideration. Traditionally, women of the same ka assist one another in cultivation practices. Women have access to the labor of young girls and children but rarely hire wage labor themselves because they cannot afford it. The one activity which women rely upon to earn cash is vegetable gardening (maraichage) on the falo which they cultivate in the dry season. Access to this form of cultivation will be lost when flood recession agriculture is eliminated.

7. On new perimeters in the Lower Goye, women are being further disadvantaged as men have the political ties and the financial wherewithal to acquire more irrigated land. There is some indication that as perimeters take on a commercial orientation, women, who typically cannot contribute financially, are being excluded with perimeter extensions. Aspects of site selection and design of a perimeter, in general, do not address women's needs, such as proximity to the village or allocation of plots to allow a diversity of crop cultivation.

8. There are, nevertheless, some positive outcomes in recent times. At Mouderi women have finally been granted access to their own perimeter and a Diawara groupement of women has also been formed. The Lower Goye has benefitted from an FAO Project called "Promotion Feminine." Women's groups are being targeted for literacy and training in boutique selling, bookkeeping, and other activities. In fact, the Bureau Suivi Evaluation (BSE) reports that there are an additional 15 groupements, mostly women, that are not counted among SAED's total of 54, depending on SAED's criteria for what constitutes a groupement.

9. There has also been some training of "conseilleres feminines" (female extension agents) supported by the FAO with assistance from CNAPTI and the Division of Rural Promotion. The four women who are currently being trained (from the villages of Gallalde, Mouderi, Yellingara, Diawara) are initiating different activities, such as a

poultry house and a village store. They are also being solicited to participate in a literacy program. A group of women in Bakel and Matam are investigating the possibility of buying produce in bulk and selling it in St. Louis. The Federation of Organized Farmers of Bakel also has a training program aimed at providing women access to basic literacy skills and technical knowledge to improve their participation on the perimeters. The Federation has a female agricultural advisor/ extension agent. It is not known whether this training has a component of "consciousness raising" directed at men with regard to women's roles.

10. Field visits confirmed the interest which women have in initiating production activities that will increase their income and give them greater autonomy. As previously mentioned, there are a few examples of women's groups receiving external assistance for the purpose of starting a vegetable garden.

XIII. FINDINGS RELATED TO SECTION ON THE GROUPEMENT DE PRODUCTEURS

A. The groupements de producteurs in the Bakel region have had sufficient experience in irrigated agriculture that they have developed a system of work organization on the schemes appropriate to their particular ethnic group or village. The Soninke, for instance, operate very differently from the Tukulor and should not be expected to change their work patterns on the basis of endogenous forces.

B. Changes in organizational structure and management arise with the emergence of groups not based on the village unit -- individual families, youth groups, local politicians, women's groups, individual entrepreneurs. That most of these new groups are smaller units than the village is telling; it suggests that social cohesion and the ability to organize should determine size of group and less directly size of scheme.

C. On the one hand, the classic village groupement (generally speaking) has demonstrated its resiliency by continuing to rely, in varying degrees over time, on irrigated agriculture in the face of systemic or externally-induced problems. On the other hand, it has been dealt a setback in accumulating sizeable debts with SAED.

D. While some groupements may be more lax in their management practices than others, no groupement can be expected to make progress without improvements in perimeter design and construction and access to training in all irrigation functions.

E. Labor availability at the level of the region is said to be a problem in the Lower Goye which has the highest percentage of migrants. Assuming substitutability of capital (in the form of remittances) for labor, the problem becomes focused on the willingness of farm families to direct remittances to irrigated agriculture.

F. Farmers are reluctant to assume, on a constant and incremental basis, the costs of production for irrigated agriculture under numerous constraints: credit accessibility, technical problems in the design and construction, persistent uncertainty of input availability, and uncertain or non-existent markets for their crops. These factors negatively affect level of groupement motivation.

G. Labor availability at the intra-village level is determined by pre-existing social relations which put women and lower status castes at a disadvantage.

H. Conflicts related to land tenure have thus far not proven to be insurmountable and have not had a major impact on the performance of irrigated agriculture. An expansion of irrigated agriculture or creation of medium-scale schemes as in the Middle Valley, however, is likely to entail larger-scale conflicts.

I. Women have unequal access to wage labor, decision making, plots, and technical knowledge on the irrigated perimeters.

J. There are signs that women's position is further disadvantaged as more land is put under irrigation at the request of politicians, local elite, and private individuals.

K. Some programs, such as those initiated by the FAO and the Federation are underway to assist women in improving their status and bargaining power. Two groups of women have also been granted land for irrigation.

XIV. RECOMMENDATIONS RELATED TO THE GROUPEMENT DE PRODUCTEURS

A. Extension efforts should be aimed at giving full exposure to the model PIVs to all groupements alike. With the expansion of training and extension efforts under project redesign, training sessions in irrigation-related tasks should be offered more frequently in the villages and on the model PIV (not just on the Demonstration Farm).

B. All groupements should be consulted by each zone chief as to what crops and cultivation techniques on the model scheme would best serve the needs of their socio-cultural and agro-climatic milieu and how complementary production activities (livestock raising, rainfed cultivation, marketing, small businesses) could benefit.

C. The remaining two years of the project are a crucial period for demonstrating to farmers the potential of irrigated agriculture and raising their awareness of the potential benefits of initiating private enterprises. This calls for supplemental training in business management and the intervention of development organizers or animateurs (see training section).

D. The female extension agents should begin to play a greater role in strengthening the participation of women on the PIVs and in keeping an open dialogue going between SAED technicians, groupement presidents, and village women. They should ensure that women (e.g. the workgroup supervisors on the PIVS) are equally represented in the training programs and are permitted to spare time from their myriad domestic and agricultural chores to attend meetings, go on observational tours to improve their access to technical knowledge. The female extension agents should also work closely with the development organizers to promote women's equal access to and control over resources and benefits.

XV. THE SOCIO-ECONOMIC MONITORING SYSTEM

A. Objectives

The socio-economic monitoring system for the Project was designed to provide data on the social and economic benefits of irrigated agriculture and to establish a reliable base of economic tracking for the project. The data monitored on a weekly basis would be analyzed

at the end of each crop season and also fed into a computerized PIV and Farm Economic Model to determine PIV profitability under a variety of conditions. The analysis and the modelling were performed by two short-term consultants.

B. Components of the Monitoring System

The work style of the Harza technical assistance team and SAED has produced two separate monitoring systems for the project:

1. Survey of 42 farm family compounds. Harza employs a rural development specialist to manage and supervise a monitoring system which it conceptualized. The rural development specialist collaborated with an outside consultant and USAID to design a sample study of 42 farm family compounds in all four zones of the Bakel region which would provide insight into household annual survival strategies, inclusive of all types of farming, livestock enterprises, and off-farm income opportunities, and the potential role of the private sector. The baseline survey for the 42 families was begun in June 1989 with monitoring on a weekly basis. This monitoring system put in place four data collectors residing in each of the four zones. The data collector for the Bakel Commune was also the data supervisor. More recently, a data entry person was hired to regularize the input of data into a computer system. All the data has since been entered into dBase4.

USAID has been placing heavy emphasis on developing baseline data on the PIVs. This aspect of the monitoring system requires clarification. It was not the understanding of the Harza team that baseline data pertain to a detailed account of the perimeters, past and present. What exists is a miscellaneous collection of information culled from different sources on the PIVs which is gradually be entered into the databank. Nonetheless, more specific information relating to the PIVs is being collected by the SAED Bureau Suivi-Evaluation (BSE) (Monitoring and Evaluation) conducted by the SAED counterpart of Harza's rural development specialist.

2. SAED's Cellule Suivi-Evaluation (CSE). SAED Headquarters at St. Louis has an Office of Monitoring and Evaluation that collects and centralizes various categories of data from all the

Delegations along the Senegal River. It is working on establishing a databank on:

(i) all the perimeters (hectares constructed and developed; costs of development)

(ii) farmer organizations (internal and external changes)

(iii) villages.

The CSE has formulated standard questionnaires for the data collection which have just been tested in the Bakel Delegation. The BSE is now adapting the questionnaires to fit the Bakel situation on irrigation systems.

The chef of the BSE who is the counterpart of the rural development specialist submitted a work proposal in May, 1990 outlining the goals, procedures, and specific elements of the data collection to be accomplished. The program assumes its own set of data collectors for each of the zones.

It is clear in reviewing the BSE workplan that the substantial amount of data required by the CSE will amply meet the project objective to establish baseline data on PIVs and GPs in the Bakel region.

C. Accomplishments to Date of the Socio-Economic Monitoring System

1. Baseline for 42-farm family survey. This baseline survey which includes information on family composition, land assets, crops, livestock assets, off-farm employment, buildings, and equipment, was supposed to have been completed in December of 1989. The short-term consultant who arrived in Bakel at that time found a number of elements missing who then devoted most of his time to reinforcing the baseline survey and refining survey instruments for use in the monitoring program with the four data collectors. New instruments and questionnaires were to enable the first comprehensive analysis to include data on rainfed, irrigated, and walo cultivation.

2. Analytical Model for Irrigated Agriculture. This was developed by the two short-term consultants in order to compare the profitability of the irrigated crop choices Bakel farmers have. Net returns per hectare and the returns to labor

are calculated. The model can be used to do further analyses of the profitability of crop mixes and economic viability at the perimeter level, such as cost/benefit analyses.

3. Analysis of Baseline Data and Socio-Economic Monitoring for the Hivernage Period 1989-90. This was completed in March 1990. The report produced findings related to the following:

(i) the importance of irrigated agriculture based on labor allocation decisions, yields, fulfillment of cereal subsistence needs, remittances.

(ii) performance of rainfed agriculture, and

(iii) role of migration in the household economy.

Continued monitoring will serve to develop criteria for participant selection or the establishment of "ideal types" of households participating in irrigated perimeters and to identify, for example, optimal size of irrigated land per family, irrigation crop preferences and profitability, and constraints or opportunities related to factors of production.

XVI. FINDINGS ON THE SOCIO-ECONOMIC MONITORING SYSTEM

A. The Socio-Economic Monitoring System is one of the few concrete and functioning accomplishments of the Irrigation and Water Management I Project and has obvious potential for informing the future planning of irrigated perimeters in the Bakel Delegation.

B. The monitoring program under the Harza rural development specialist and the planned monitoring program under the SAED counterpart (the Bureau du Suivi et d'Evaluation) are conducted separately at the level of program planning, data collection and supervision with some coordination occurring at the data entry or database level.

C. The program is not effectively integrated into the functioning of SAED and currently has no potential for sustainability after the project.

D. The Analytical Model for Irrigated Agriculture can help provide direction in the demonstration farm's

research efforts to find those crops and crop mixes that have the potential to improve the viability of PIV crop production. In the extension efforts of the project, it can indicate those crops and crop mixes that farmers should be encouraged to grow.

E. Short term consultants have made a good start by developing the Analytical Model and by beginning the analysis. However, it is necessary that the responsible person be intimately involved in the data collection process (to ensure that the critical data is collected, as this changes over time). He/she should also be available to produce needed analysis in a timely fashion when it is needed.

XVII. RECOMMENDATIONS FOR THE SOCIO-ECONOMIC MONITORING SYSTEM

In view of the proposed modification of project objectives, it is recommended that the socio-economic monitoring system be retained as a project component but tailored in the following manner in accordance with those objectives:

A. That the Harza monitoring system and SAED' monitoring system program be merged at the level of data collection, supervision, and management. The survey of farm families should not be expanded as proposed by the consultant who has been doing the analysis. The data on the PIVs and GPs as required by SAED Headquarters should continue to be carried out, despite the option not to rehabilitate or extend perimeters. This data will measure the activities or non-performance of the GPs in the absence of technical assistance and monitor the impacts of the model PIVs in the four zones.

B. The rural development specialist should devote the remainder of his contract time to training the BSE chef in dBase4 and turning over his responsibilities to him as they relate to the 42-farm family survey.

C. There should be only one set of data collectors (4) who should work together with the chefs de zone to coordinate the data gathering process. The data collectors, for instance, who have been working on the farm survey could additionally assume responsibility for the questionnaires formulated by the CSE and revised by the BSE with assistance from the chefs de zone.

D. The profitability analysis done with the Analytical Model for Irrigated Agriculture should be continued and the program strengthened.

E. The agricultural economist who will be part of the three-person technical assistance team should be charged with the periodic analyses of the socio-economic data. This person will take the place of the short-term consultant.

F. The ag. economist should train a counterpart so that this function becomes a permanent capacity of SAED efforts. Learning budgeting is a simple and extremely useful form of institutional development. The SAED staff member in charge of "Suivi et Evaluation" is the likely candidate and he is a trained Ag. Economist.

G. The economist should be available to interact on a permanent basis with other members of the SAED/Harza team and teach them how to utilize this information in their planning activities. This will be one of the primary activities of the "new" SAED. It is neither efficient nor sufficient to delegate this critical task to short-term consultants.

H. A small effort should be made as part of the Socio-economic Monitoring System to collect crop output prices at several local markets. This will add greatly to the validity of the analysis of the ag. economist and the information provided by the Analytical Model.

I. The socio-economic and monitoring studies and baseline data should incorporate a component on landholding patterns and land use at the village level (see "Land tenure issues in perimeter design" in LTC final report).

XVIII. TRAINING AND EXTENSION

A. Project Objectives

The training and extension program serves project objectives in directly assisting groupements de producteurs (GPs) to master all aspects of PIV operations and to continually seek improvements in productivity. A measure for verifying its effectiveness in promoting the project objective of perimeter profitability and replicability lies in the transition from subsistence-level PIVs to self-sustaining profit-making enterprises.

SAED's structural changes and its policy of disengagement carve out a distinct and prominent role in extension for its regional level staff, concomitant to the policy of both the GOS and USAID to transfer responsibilities to the private sector. The GOS 3eme Lettre de Mission provides guidelines for strengthening extension ability.

B. Components of Training and Extension Program

This section will examine the components in place in terms of project target goals vs. what have been accomplished, and their effectiveness and appropriateness for achieving project objectives.

1. Demonstration Farm. The 14-hectare Demonstration Farm which had ceased its activities from 1986 to 1988 and resumed operations for the 1988/89 cropping season under constraining budget conditions. A prolonged discussion over who was to provide funding for the Farm's technical personnel (the contract agreement specified it as a host country contribution) accounted for significant delays in the Farm's operations. According to the Harza team, Harza finally offered to support the Farm's staff and USAID agreed to this. A contract amendment was issued to cover these expenses from September 1988 through 1989. The Farm is run by a Harza agronomist and his SAED counterpart assisted by 14 temporary hires.

The Farm's goals are stated as follows:

(i) to work with other agencies or institutes to determine the adaptability to Bakel of research and procedures documented elsewhere in Senegal;

(ii) to serve as a training center for local farmers by extending improved production management packages to farmers, groupement members, and leaders;

(iii) to serve as the focal point for research, extension and farmer coordination;

(iv) to act as a seed multiplication center;

(v) to become self-financing through revenues obtained from the marketing and sale of outputs on the Farm.

In the CY 1990 Work Plan for the Demonstration Farm, purposes additionally include the introduction of elements of privatization and commercialization into farming/groupement operations. This is perceived as a crucial measure to take in light of project objectives and the subsequent assistance required of the groupements to overcome marketing, credit, production, and management constraints.

Some of the Farm's accomplishments to date are:

(i) The 1989/90 cropping season covered 5.10 ha of trials in new varieties of maize, sorghum, and rice on the Demo Farm and sorghum and rice on demonstration plots (en milieu paysan). The yields obtained were exceptionally high and caution should be taken in extrapolating from small plot trials. Organic and inorganic fertilizer application were tried in conjunction with crop varieties. Seed multiplication of rice varieties has also been tested.

(ii) Fruit/forest tree trials and demonstrations in collaboration with the Ministry for Water and Forestry of Bakel.

(iii) Aviculture including improved imported layers and broilers and a sheep feeding trial. At the time of the evaluation visit to the Farm, the chickens were infected with a virus.

The details of the Farm's on-going program and plans for improvement are spelled out in the Proposed CY 1990 Work Plan Implementation Schedule and Budget on Adaptive Research/Demonstration Farm, Extension, and Training.

The Farm does not have a system for monitoring adoption of new technologies by local farmers and groupements apart from standard reports from the chefs de zone. So far, it appears that the SIPI rice variety is being adopted.

2. Animal traction program. The Project Paper and Logical Framework anticipate a program of 100 pair of oxen. The Demonstration Farm has one pair of young oxen, and one farmer has already received assistance training his pair of oxen. The Farm has had some difficulty selecting, training and managing oxen, although it plans to hold four

training sessions in animal traction, on the Farm and one in each of the four zones, which will include training 10 pair of oxen along with their handlers (bouviers). These oxen teams are expected to extend services to other farmers. According to the SAED Farm manager, there are plans to start a training center for animal traction in the Bakel Commune.

The village of Sebou in the Faleme which is dominated by livestock raising has expressed particular interest in animal traction and in training and selling oxen. The president of the Sebou groupement had participated in the observational tour to Niger where all the work on the irrigation schemes is done by animal traction. He currently has nine pair of oxen. This particular case notwithstanding, farmers in the Faleme have never developed a farming system that integrates livestock and crop cultivation, except for the fact that animals usually graze on the same dryland fields for about two years, thereby contributing to soil fertility. They also may graze on the irrigated fields after the harvest. The Soninke and the Peul are accustomed to using donkeys and horses for transport and traction on the lighter soils. There is a cultural impediment to the use of oxen for traction; according to one informant, cattle are a symbol of prestige and wealth and are treated accordingly. Extension efforts should take this into consideration as well as points made in the Engineering Annex.

3. Extension. Extension efforts are intended to cover:

   (i) maintenance of motor pumps
   (ii) upkeep of canals and pipe systems
   (iii) groupement management, including literacy
   (iv) crop planning and care
   (v) water management
   (vi) agricultural input supply and marketing.

Currently, the extension activities are being carried out by the chefs de zone acting as agricultural advisors. The chefs de zone typically receive six months of training at the Centre Nationale d'Application et de Perfectionnement aux Techniques d'Irrigation (CNAPTI), three months in the field, and then three additional months at the Center. Those with no prior experience in agricultural extension might receive two years of

training. The chefs de zone are not specifically trained in "animation" or the equivalent of development organizers who are responsible for motivating and organizing villagers. As extension agents, they are tasked with serving as liaison between the Farm and the groupements, preparing farmers for the coming season with regard to such questions as sowing time, land preparation, where to obtain fertilizer, recruiting oxen for traction, etc. They also conduct the training sessions of groupement technical functions, such as pump operators, water controllers, accounts/management assistants, with assistance from the Harza technicians and the SAED Division of Training and Research Development (DFRD).

The chefs de zone whose mobility is fundamental to making regular visits to all the perimeters and performing extension work were not equipped with motorcycles until November 1989. In an interview with two chefs de zone of the Bakel region, they expressed their dissatisfaction over the lack of formal incentives or benefits they receive as compared to other Delegations. Prior to SAED's disengagement policy, it employed more extension agents and used to have Peace Corps volunteers to assist them. The last training session of SAED technical staff was supposed to have resulted in two additional agricultural advisors to Bakel. Thus far, only one has been added to the staff. In the 3eme Lettre de Mission, the guidelines for personnel needs specify a ratio of one extension agent for a maximum of 350 hectares in zones dominated by PIVs. This corresponds to roughly six to 15 groupements ranging from 20 to 60 hectares each. Currently, in the Bakel Delegation, two of the zones exceed a total of 350 hectares of irrigated land.

Every zone has a demonstration plot. The groupements from each choose the farmers who are invited to the Demonstration Farm to view new varieties and then to try them on 500 m2 demonstration plots. This allows the farmers to demonstrate the adaptation of the crop to the local milieu, for example, its resistance to pests. Three criteria for adaptation of new varieties are established: (1) its facility of adaptation -crop cycle, resistance, labor requirements, etc.; (2) yields; and (3) suitability to local palate.

4. <u>In-Country training</u>. In-country training pertains to training of SAED/Bakel technicians and

to the training of groupement personnel in the four zones in the following functions: pump operator, water controller, village technician, PIV accounts/management assistant, and individual farmer/leader.

The Project's output indicators for the training program are: 100 pump operator trainees, 50 trainees in farm records, 100 trainees in irrigation, and 100 trainees in animal traction. The Farm's accomplishments to date are:

(i) 7 pump operators (from 7 new PIVs)
(ii) 30 water controllers (from 30 PIVs)
(iii) 20 village technicians (from 20 PIVS)
(iv) 20 treasurers (from 20 PIVs)

The attendance for pump operators was low due to a previous FAO training course offered to Bakel farmers. The training of pump operators is aimed at care and maintenance of the groupe-motopompe (GMP). The pump operator is supposed to keep track of water delivery, fuel consumption, etc. for which he is provided a standard form to record the information. Training is for a five-day period.

Village technicians are responsible for cultivation techniques associated with irrigated vegetable production; corn, sorghum, and rice production; and arboriculture. One unavoidable problem is that groupement members trained as village technicians or in other irrigation tasks sometimes leave the PIVs and are not necessarily replaced.

One common constraint noted in the training of groupement members for the above functions is the level of literacy which limits the selection of trainees. Consequently, some of the recording is done in Soninke, some in Arabic, some in French, for example. This makes close monitoring difficult as well. The need for improvements in the accuracy and consistency of all functions requiring documentation and in follow-up operations cannot be overestimated. A FAO Project (no. SEN/82/002) in the Lower Goye had, as part of their program, conducted some training in literacy for which the chefs de zone were paid a little extra to assist. The Federation of Organized Farmers of Bakel also has its own seminars for teaching villagers basic literacy skills in the local language.

For the training of treasurers which took place in Bakel in December 1989 and was conducted by CNAPTI

trainers, it was reported that the three-day seminar proved not to be adequate to complete the training. For reasons not revealed, the attendance required of the chefs de zone and the Chief of the Division of Rural Promotion (DPR) was not forthcoming.

Within the same training framework undertaken by CNAPTI, SAED and DPR, there have been some accomplishments in the training of female extension agents ("promotion feminine"). There are presently four women (from Gallalde, Mouderi, Diawara, and Yelingara) undergoing training centered around different projects in which the women are interested, such as the women's groupement.

One major deficiency in the capability of the training and extension program relates to the project objective of establishing a prototype for private sector investment in the efficient use and rapid expansion of irrigated agriculture. It assumes that the kind of project support needed by the groupements to undertake requisite management responsibilities is forthcoming. The current project design, however, is sorely lacking in the program approach and supporting resources to help the groupements attain privatization objectives. (See Private Sector Annex.)

5. Third country training. This type of training is in response to the project output consisting of three annual observation tours of about two weeks each for ten progressive basin farmers and village leaders to learn about small, locally-controlled irrigation practices in other countries. To date, one such tour to the Office National des Amenagements Hydro-Agricoles (ONAHA) in Niger took place. In attendance were nine groupement presidents, two SAED technicians, and one Harza technical assistant. ONAHA's irrigation project is more advanced in all its aspects than the PIVs which raises the question of whether ONAHA is the most appropriate place for an observation tour. The Niger PIVs are as large as 2,000 with full water control, concrete-lined primary and secondary canals, and central water pumping stations. Farmer groups are organized into highly structured, state-supervised cooperatives which provide a number of services. They provide inputs on credit and assume the costs of personnel and electricity for its offices, for example. Production and marketing aspects are controlled from the top-down. The entire production of paddy is commercialized and

sold to a state organization for processing so that each participating farmer has to purchase his cereals on the market for home consumption.

In sum, the production practices, water management strategies, and management problems within the context of the ONAHA perimeters are not relevant to the PIV experience in the Bakel. Taking Bakel farmers to visit these perimeters can only result in raising their expectations beyond reality. There are, however, more appropriate irrigation schemes in Niger that are analogous to the PIVs. These are located at Birni n'Konni in South Central Niger. Although these perimeters are fed from reservations and not a river, they are organized in a similar fashion to the groupements in Bakel and have developed systems of diversified production that would prove meaningful to the Bakel experience. It includes a particularly good example of dry season, high-value, cash crop production and the use of appropriate intermediate technologies such as animal traction. Furthermore, there is an animal traction training center run by ICRISAT, USAID, and the National Agricultural Research Institute, INRAN of relevance to the current stage of training and exposure at Bakel. Additionally, there are appropriate sites that can be visited in Mali, and these would involve far lower transportation and lodging costs.

Two more tours to Niger were planned for this year, the first one being interrupted by the evaluation visit. The demonstration effect of the first tour on the groupement presidents has not yet been monitored, although the responsiveness is reported to have been quite positive.

6. Morocco training. This refers to plans to send ten SAED/Bakel staff for training or short courses in irrigated agriculture. Harza proposes sending two SAED technicians for a six-week period to Hassan II University in Rabat for theoretical, classroom and field observation training. This component is geared to improving their understanding of the planning, production and management aspects of irrigated agriculture.

XIX. FINDINGS ON TRAINING AND EXTENSION

A. Despite delays in start-up, the Demonstration Farm has produced a training and extension program of substance that has thus far proven to be well-coordinated, operational, but stretched to the limits of its current staff and budget capacity.

B. The animal traction program, while suitable to PIV operations, needs to address the cultural and physical constraints of the Bakel milieu.

C. The chefs de zone or SAED extension agents are not adequately equipped to provide the high level of extension efforts required to make the PIVs economically viable.

D. The training of groupement pump operators, village technicians, treasurers, etc. which only got off the ground in August 1989 has affected a small percentage of the PIVS.

E. A general bottleneck in training of PIV functions is the level of literacy of the Bakel population.

F. The profitability and privatization objectives of the project were established without the requisite mechanisms in the project design to prepare and re-orient the groupements and the PIVs for SAED's total disengagement from all services except extension and training.

G. The ONAHA Irrigation Project in Niger is not appropriate to the Bakel PIV experience.

XX. RECOMMENDATIONS ON TRAINING AND EXTENSION

A. The operations of the Demonstration Farm and training and extension program should be fully funded, as it will be the locus for all project activities in the case of the alternative to restrict the project to four model PIVs. Even if new construction and rehabilitation is written in to the project, this component of the project should not undergo budgetary cuts.

B. In placing more emphasis on extension efforts, it is recommended that the chefs de zone be supplemented by two agricultural advisors per zone and by one local-hire "animateur" or development organizer per zone. The latter would have a large role to play in motivating farmers parallel to the

progress being made by the model PIVs. Assuming rehabilitation, the animateur could be instrumental in monitoring and facilitating the efforts of new and formerly disadvantaged groups to organize.

C. Funding should be provided to hire local teachers, under the supervision of the chefs de zone, who are fluent in the local language, to serve the basic literacy needs of the groupements.

D. Rehabilitation of PIVs as an alternative should be conditional upon member participation in training of irrigation functions.

E. It is imperative that extra emphasis in training and extension be placed on groupement management of financial, credit, production, and marketing requirements in line with project objectives. The assistance of a short-term business management specialist may be in order.

F. The third-country training should go on but at a different site such as the Niger perimeters at Birni n'Konni or irrigation schemes in Mali.

G. Training of SAED technicians in Morocco should be postponed if the project is to be limited to four model PIVs.

APPENDIX TO ANNEX C

CONTRASTS BETWEEN THE PIV AND THE PIC

Table of Contents

A. Introduction

It is said that there are some 13,000 hectares of PIVs (Périmètres Irrigués Villageois) in the Sénégal River Valley - including those of the Falémé. The irrigation development in the Bakel Delegation of SAED consists entirely of PIVs. In December 1989, the official count was 1,972 hectares.

The current USAID program for irrigation development emphasizes the requirement that perimeters be, or become, profitable. The Harza TA team members have come to the conclusion that there are fundamental characteristics of the classic PIV that limit the perimeter's profitability and commercial viability. These characteristics, which are related to the origins of the PIV, are discussed below in an effort to contrast the PIV with what the Harza TA team now calls the PIC (Périmètre Irrigué Commercial).

The concept of the PIC is offered in order to eliminate the potential confusion in discussing a commercially viable perimeter, replicable by the private sector, which differs from that now understood and accepted as a PIV. The PIC is a natural evolution of the PIV. However, the implications of commercial use require that it be distinguished from the PIV. The difference is not confined to the sale of the crops produced, but is also based upon fundamental differences in organization and function, reflected in all its aspects from the choice of perimeter site to the engineering design of the perimeter itself and its basic operations.

There are currently several PIVs in the Bakel area which already display some of the characteristics of PICs. It is not coincidence that these are among the most successful perimeters. The TA team feels that the current goal of viable, profitable, and replicable perimeters requires the recognition of certain handicaps of the PIV. While it is obviously unrealistic to expect each PIV to become a PIC, there are benefits to examining the characteristics of the PIC and thereafter determining the possibilities of each PIV to assimilate, to the extent possible, those characteristics which may lead to becoming a more profitable enterprise.

B. Origins and Evolution of the PIV

The PIV was initiated in 1975 at Bakel as an effort to combat the disastrous effects of drought upon the traditional rainfed and flood recessional

agriculture of the region alongside the Sénégal River. Early perimeters were small hand-made plots very near to the river. There was no attempted land grading. The watered plots were made small enough so that the sloping surface did not cause large differences in water depth. The plots were watered by a canal system of simple ditches. Pump basins were little more than holes scooped out of the ground in which the end of the pump discharge pipe or hose was placed. Motor pumps were small and moved up and down the sides of the river bank as the waters rose or receded. As an emergency technique for food supply, everyone was interested and people (even whole families) had only small holdings within the perimeter - 100 to 150 people with 0.1 hectare each for example.

Thus the classic PIV, from the time of inception, has been established with certain characteristics, many of which have remained to the present time:

- production of small quantities of food for family consumption,
- plot sizes too small for total subsistence,
- emergency fall back system in time of need such as insufficient or no rainfall,
- farmer participation in construction,
- very simple irrigation system, i.e. low investment and no land grading,
- small plot sizes and a large number of people per perimeter,
- low production per family.

The attempts to improve these systems were begun with the support of an outside donor (USAID) and through the assistance of SAED, the established Sénégalese Agency charged with irrigation development of the valley. Initial efforts began in 1975, 1976 and 1977. Donor support was limited to purchase of larger motor pumps which were placed on rafts floating in the river, cement was used to stabilize some of the water control points (basins, etc.), pipe was purchased, canals lengthened to include more irrigated area, new perimeters were established. Heavy equipment (graders and dozers) were used to construct canals across low areas and to enlarge existing canals.

Farmers were glad to receive any assistance offered. They cleared the fields of trees, stumps and roots and were willing to complete the rough land shaping by applying the finishing touches by hand. Farmer organizations became official groupements, with officers, etc.. Land allocation procedures were developed. People from several neighboring communities who had gone together to work in a single perimeter, dispersed in order to establish individual perimeters for their own villages and never become victims of drought again.

Design help was given to people who had but little real understanding of irrigation techniques, crop water needs, soils suited to different crops, etc.. Credit was extended in the form of fuel and fertilizer in order to better the crop production. Improved seed was distributed. Crop sales after harvest were to provide the basis for payment of the needed inputs purchased on credit for improved production necessary to efficiently utilize the water pumped.

Motor pumps needed care and repair. Instruction and support to accomplish these was provided by SAED.

Farmers needed help, began to expect it and obtained such, although at the same time they felt it was inadequate. Crop production seemed always to be consumed and cash was scarce when it was time to repay the loaned monies for the required inputs.

New donor support provided large fuel tanks at each site and better floats for motor pumps. Physical support for new facilities outran the extension and technical assistance efforts. Village groupement debts increased. Logistics of fuel, seed and fertilizer broke down occasionally and crop failure resulted, thereby giving farmers reason to say they could not pay their debts.

The early perimeter construction was no longer deemed adequate. Extensions had been added to extensions of original perimeters, resulting in poor and inefficient overall irrigation system design. Farmers said that if the construction had been better they could have grown more and paid their debts. Farmer organizational capabilities were stretched to the limit and were less capable of organizing the perimeter finish work required after the irrigation system was "roughed in" by SAED's construction division (la Regie). Even organizing regular maintenance of canals and structures was difficult. Weed removal became critical, especially in canals that had been extended beyond their original length and capacity. It was easy for some farmers to blame the canal as being too small instead of cleaning it so that water could easily arrive at its destination. The "pipe is too small" and the "perimeter is poorly constructed" are easier to defend than admission that "our groupement is poorly organized", etc.. Admittedly, many of the perimeters were not sufficiently well designed nor constructed, but in fact, there is much the farmers could and can do to overcome their own problems.

Furthermore, many of the farmers began to look too often to others to blame and too often to expect too much to be done for them instead of asking what they could do for themselves. SAED accumulated large deficits due to the inability or unwillingness of some farmer groupements to repay their debts.

Rice was viewed as the crop which would produce a surplus and could be marketed to repay debts. SAED purchased rice surpluses. But not nearly all the developed land of the Délégation is suitable for growing rice and some farmers resisted being required to grow it in order to repay SAED. Meanwhile, rice consumption at Bakel increased and surplus rice could be sold in small quantities without channeling it through SAED.

SAED, along with many other government agencies, realized in the mid-Eighties that the Government could not continue to supply agricultural support services to the nation's farmers at the expense of continually going further into debt. As a result, SAED initiated a policy of disengagement from the activities of credit, subsidized motor pump repair, furnishing tractor services and even the selling of seed and fertilizer. A new SAED goal was defined - a planned program of withdrawal from these activities, activities which must thereafter be taken over by the private sector. SAED is now to become the irrigation development planning agency for the River Basin and the technical assistance support agency through extension work.

C. Privatization of the PIV

The present donor program of assistance in support of the New Agricultural Policy of Sénégal, is to discover the ideal, or model, PIV which can be replicated throughout the Valley by the private sector. This PIV is to be profitable, viable and, as such, able to attract the investment of the private sector. That investment could be in the form of a commercial farming endeavor or farmer groupements who invest their own time, labor and/or finances in irrigation with the assurance that they will be able to earn enough to pay for the required:

- fuel,
- pump repairs/maintenance,
- canal maintenance,
- seed, fertilizer, pesticides,
- any custom farming services required, and
- credit which may be needed for the above.

In addition, the farmers must, according to prior and present Project requirements, be able to replace the motor pump originally furnished them by the donor through SAED.

All the above are realistically possible in the present or near future, given a functionally effective irrigation system, proper groupement organization and an effective ongoing education/extension program - effective in developing the irrigation technology required.

The goal of privatization, in general, is to avoid collapse of the irrigation development upon withdrawal of outside donor support - to achieve a prototype development which is capable of being profitably supported by those who own and operate it.

This goal makes explicit the requirement, present or in the foreseeable future, that not only the operating costs be borne by the "farmer", but also the fixed costs of development as well.

Several progressive levels of perimeter development costs may be considered. The following order of inclusion is suggested as a reasonable progression:

- pump and pipe,
- the cost of water control structures,
- the earthwork required,
    - canals,
    - main,
    - secondary,
    - tertiary,
- drainage system,
- flood water protection dikes,
- the inspection costs,
- the preliminary design work,
    - topo mapping and other surveying information,
    - soil studies,

- preliminary plan,
- farmer discussion,
- the final design,
- administration costs.

TA team experience to date and the results of several reports by consultants have led to the conclusion that various physical aspects of the PIV, as well as certain organizational deficiencies impede it's achievement of maximum production and profitability which are necessary for viability and emulation throughout the Valley. In general, these are 1) poor perimeter performance due to poor construction and maintenance, and perhaps more importantly, 2) the general organizational and management inefficiency and weaknesses of the present groupement systems. These deficiencies have great import to the economic performance of Bakel area PIVs.

While it is certainly true that excellence in either of the above two factors can go far in overcoming the other, it is very obviously necessary for the Project to expend maximum effort in bettering both. Examples of poorly built perimeters which are nevertheless reasonably successful due to dynamic groupements, prove that even the limitations of construction deficiencies can be minimized if the groupement is motivated by the conviction that irrigation is indeed a profitable endeavor. On the other hand, there exist as well, virtually ideal irrigation sites with groupements whose internal organizational problems completely block any effective attempts to irrigate.

D. Concept/Definition of the PIC

To illustrate the potential improvements required of the classic PIV, the concept of the Périmètre Irrigué Commercial, or PIC, is developed.

The PIC is defined by several basic difierences in purpose and operation: a) the purpose of the PIC is commercial production, b) it is privately owned and financed, and c) the management is well defined with a chain of command which is more authoritative and effective than that of the current groupement system.

Commercial in Purpose

Crop(s) selected on the basis of a targeted market (location, price, etc.).

Owned by a Private Enterprise

Not dependent upon a pre-existing labor force entity.
Management and leaders selected according to management skills and technical expertise.

Small or Powerful Management Group

Planning can be formulated and executed with minimal unforeseen complications.

Unexpected events and circumstances (insects and illnesses) are more easily overcome.

Even these few changes have wide ranging consequences to the design and operation of the perimeter. The PIC is perhaps best defined or described by contrasting the differences between them in almost all aspects of their operation.

Characteristics PIV - PIC

PIV Tendency	PIC Tendency
System Design/Layout	
Design determined by need for very flexible but complicated field operation adapted to complex water management.	Design can be determined according to crop need - more rigid but simpler field operation design.
Small individual plots. - Need to be equal in area and opportunity for each groupement member. Odd areas used for collective fields.	Virtually one large field with various large sections though able to easily accommodate plots of varying size as the whole perimeter is dedicated to one 'group'.
Convenient site selection - close to village and therefore likely to be less suited to the most profitable cropping system.	More careful site selection for purpose of its suitability for the intended profitable crop(s).
Water Management	
Can enforce only elementary water control functions.	Able to execute sophisticated water control.
Water control system must be very flexible. In the extreme case, it can be characterized almost as 'water on demand' by each farmer.	Control is rigidly scheduled and enforced according to crop needs, - hours of operation, amount and rotation of irrigation follow set routine.
Lower water use efficiency due to erratic wetting of canals, primitive structures, uncompacted canal fill and weed-filled channels.	Higher water use efficiency due to routine water rotation, less water loss in clean, compacted canals and through water control structures.
Farmer Participation	
Farmers are involved in: - clearing and cleaning site, - perimeter finish work, - maintenance of perimeter.	Minimal farmer participation in construction: most farmer tasks under PIV are done by contractor for the PIC. Large contractor unwilling to be dependent upon farmers in order to complete his work.
Family labor force made up of men, women and children. Unable to easily alter its size or composition.	Hire adult men (or women) as needed, can change composition of labor force relatively rapidly.

PIV Tendency	PIC Tendency
Motivation/Agricultural Strategy	
Irrigation not likely highest priority, but rather a fall back system, or one among several agricultural and economic activities.	Irrigation is the unique activity. First priority.
Laborers work for themselves and in their own best interests.	Labor force works for daily wage unless an incentive/share system of some sort exists.
Labor conflict with other agricultural activities.	No conflicting agricultural activities.
Farmers wait for rain to plant perimeter and complete needed water with irrigation.	Farm plan would be to maximize use of fixed cost investment by all-season irrigation, if possible.
Privatization	
Supports a "lower" level, more diffuse individual private sector.	Requires and supports a "higher" level of the private sector such as food processing, machinery, transport, etc.
Cropping System and Activities	
Production polyculture geared toward the family food needs as related to all their other agricultural activities.	Production monoculture aimed at crop or crops for which economic prospects appear to be the best and for which a market is available. Irrigation is the major, if not sole, agricultural activity.
Changes in method/technology happen slowly. 10-15% maximum change - others wait/watch.	Method/technology changes can be quickly adopted - convince only a few people and it's done. Universal change is possible.
Double cropping not easy to instigate.	Could double crop easily if proven financially attractive.
Organization/Management	
Many plots, each with its own independent boss. Personal problems reflected in missed planting dates, missed water turn, etc..	One boss - hired laborers to carry out his instructions when and how he directs. Perimeter operation is insensitive to individual workers' personal problems.
Many management schemes - almost infinite liberty to do or not do anything or to do it later. Good overall management very complex or impossible to carry out.	Simple overall scheme can result in well organized management and more efficient use of resources. However, one poor manager affects entire perimeter.
Everyone for himself. No chain of command as such. Group decisions only after group discussions.	Responsibility for making system work lies in definite chain of command of highly trained people. Decisions are quickly made.

ANNEX D

ENGINEERING ANNEX

ANNEX D

ENGINEERING ASPECTS

I. INTRODUCTION

A. Project Goals: To increase food production, create more employment opportunities, and raise income in the Bakel region.

B. Project Purpose: To expand and improve village-level irrigated farming in Bakel with the participation of the private sector in the design, construction, operation, and maintenance of the related structures.

C. Project Objectives: The design and construction of 800 hectares and rehabilitation of 400 hectares of perimetres irrigues villageois (PIV).

II. PURPOSE OF THE ENGINEERING EVALUATION

The Engineering Evaluation has been undertaken to assess progress made in the rehabilitation of 400 hectares of existing PIVs and the construction of 800 hectares of new PIVs. This evaluation covers the following aspects:

- Design and construction
- Operation and maintenance
- Pump sets and costs of pumping
- Ongoing training program for operation and management of irrigation systems and animal traction methodology in use in basin agriculture
- Criteria established for PIV rehabilitation and construction
- SAED support for a privatization program
- Private sector participation in the replicability of prototype systems.

A. Assessment of Design and Quality of Construction

1. Design and Topographic Surveys

The design of PIVs built from 1986 to 1989 are for the most part technically sound. The designs were based on data

gathered by the Bakel Small Irrigated Perimeters Project (No. 685-0208). The technical data used to develop the design are:

- Agro-climatic conditions in the Bakel area
- Soil and physical characteristics
- Water quality and availability
- Crop water requirements.

These were used to determine the sizes of different structures such as canals, stilling pool, division boxes, and drainage systems.

The engineering design of these PIVs is not to be blamed for the claims made by groupement farmers that the "PIVs are not functioning properly." Irrigation designs for flood irrigation are fairly simple. The engineer always relies on the topographic map submitted by the land surveyor. Engineering design errors are very remote, and therefore, there is a need to improve the accuracy of the topographic survey as a first step towards good PIV construction.

The same approach as the one carried out by the irrigation technician of the BSIP Project could be used for future small size systems.

2. Construction Quality

The groupement heads and farmers complained that the bad "amenagement" caused important losses of water and limited land use. This was verified on-site during field visits to a sample of 15 PIVs. Feeder canals are not correctly levelled and often have reversed slopes, and the bottom of the feeder canals as well as their banks suffered heavy erosion. In general, there was uneven water distribution in the PIVs.

Unsatisfactory construction quality is the leading cause of the defects mentioned above, but the lack of a proper regular maintenance is also a contributing factor.

The PIV Building Unit (SAED/REGIE) was equipped with a bulldozer and a motorgrade. However, there were some deficiencies:

- No equipment for compaction (such as compactor, front end loader, dump trucks, water trucks, etc.) was available. The lack of compaction resulted in the erosion of the canal banks and bottoms.

- Inadequate leveling equipment (wheel tractor with planing blade, not the motorgrader) was the main cause of uneven water distribution.

- Inadequate supervision during construction reported by some groupements was also a cause for faulty levelling.

Maintenance of the tertiaries--the responsibility of farmers themselves--was inadequate.

B. Quality of System Operation and Maintenance

The completed systems should consist of a groupe-motopompe (GMP) and pipes. This equipment was maintained by SAED through its mechanics in the Delegation. Before the rainy season, SAED's mechanics regularly checked the GMP and pipes and performed a routine maintenance check-up of the irrigation structures in the perimeter (such as canals, stilling pool, division boxes and drop structures). These structures were to be operated and maintained year round by the groupements.

Up to now, the GMP and pipes seem to be correctly maintained. The remaining structures suffered damages such as erosion, and cracking due to lack of regular maintenance or to crossing of animals.

Since SAED's mechanics will no longer be available for maintenance of the GMP, the groupement is now responsible for the operation and maintenance of the whole system, including the GMPs, pipes and irrigation structures.

Recommendation: SAED Bakel should inform all groupements of their new responsibilities and assist them in establishing a formal contract between the groupement and the new private mechanics in the area. This action should be carried out as soon as possible through the chefs de zone.

C. Evaluation of Pump Set and Pumping Costs

1. Pump Efficiency and Appropriateness

The fuel use per hectare for pumping varied from 131 l/ha (Balou) to 360 l/ha (Collanga Nafe) during the rainy season of 1989. These figures were not always recorded in the logbook by pump attendants nor justified by bills from gas dealers. The lack of accurate data did not permit an accurate assessment.

The most reliable data on appropriateness, cost and effectiveness of the pumping operation in Bakel are still

those being reported by the BSIP in its final report. For example, the selection of pumps is the concrete result of field tests in the area during a long period. No similar follow-up has been done since 1986.

About 60 percent of the GMPs have been in service for more than eight years.

Recommendations:

(1) The efficiency of the irrigation system (and particularly that of the pump) can be improved by many factors involving the PIV. Technicians should try to make the best choice, the water users should observe the rotation timing as suggested and/or make appropriate proposals based on field observations to increase the viability of the operation.

(2) To evaluate pumping operations, an in-line water meter should be installed in the PVC pipes prior to the stilling basin and a full documented fuel consumption should be devised.

2. Pumping Costs

With reference to the proposal submitted by the technician of the BSIP Project in his final report, some changes are recommended. The Gorman Rupp pump is too expensive, costing approximately 6,932,342 FCFA. The proposed Deloule pump costs approximately 3,523,568 FCFA (1990 adjusted price) (see Table D.1).

The pumping costs explained in Table D.3 are based on the pump set performance of the HR3 plus G.R. shown in Table D.4.

Recommendation: Since the savings are substantial and the quality is better (Deloule vs. G.R.), USAID should allow a waiver so that Deloule pumps can be purchased.

D. Ongoing Training Program

1. On-Farm Water Management

The demonstration farm reported having provided a three-day training course for 30 water controllers to operate and maintain the irrigation system in 1989. Increasing water use efficiency will cut the cost of irrigation. This may be done by improving the quality of the amenagement (with a technically sound design) and by improving the water use process including timing of irrigation cycle.

TABLE D.1

IMPROVED SYSTEM TO SAVE 31.6% OF GMP COST

ITEM	Actual High Cost GMP	Proposed Low Cost GMP	
	-Lister HR3, G. Rupp -Imported floats -Fast coupling pipe	-Lister HR3, Deloule -Local made floats -Buried PVC pipe	
-Lister HR3 -Pump -Assembly on skid	6.932.342 CFA*	-Lister HR3 -Deloule -Assembly	2.336.078 758.922 428.568
-Floats for Motor -Floats for discharge column	892.850 232.141	-Local made -no need	510.200
-Section column -Discharge column -Foot valve -Flexible pipe/6m	62.933 44.642 175.381 110.968	same	
-PVC pipe 0 214 225 fast coupling on river slope(60m)	757.647	same	757.647
-PVC pipe on land to stilling pool (100m)	1.262.745	buried pipe	478.312
Transport	10:790.526		7.381.752

Notes:

*1990 cost (1985 cost multiplied by 1.2755 to account for inflation)

Source: BSIP Final Report, 1986.

Recommendations: There is a need for more training of water controllers such as the session scheduled by SAED/Bakel for July-August, 1990 at the Bakel Demonstration Farm (by DAGE/Demo Farm). The program should include the determination of the irrigation cycle, calculated for each crop such as rice or corn, on a prototype PIV of 40 hectares with double cropping with maize, sorghum and other crops. The training program should be at least five days long with on-the-job training at the Demo Farm instead of three days as scheduled on the training program prepared by the Bakel Delegation.

2. Program of Animal Traction

The team could not visit the ongoing training at Sebou (instructor was not available). It is recommended that the animals selected for the program be separated from the herd. These animals must be fed adequately during the dry season, because the farmer will need these animals at the end of the dry season, the leanest time of the year. The force of traction (pulling) is proportional to the weight of the animal. Poorly-fed animals do not have enough strength for plowing. The traction strength needed is estimated at 60-80 kg while an ox can develop an effort equal to 1/6th of its weight during six hours a day. Thus the weight of the animal should be above 350 kg.

E. Selection Criteria Established for PIV Rehabilitation and Construction

The teams's criteria for the selection of PIVs to be rehabilitated or constructed were reviewed. One of the main criteria for selection should be potential for financial viability. Modifications of the old format were discussed with SAED/DAGE and then submitted to SAED/Bakel for discussion with the Harza team. The modified format was handed over to Mr. Sow, the Delegue Engenieur/Bakel.

F. SAED Support for a Privatization Program

SAED supported the privatization program proposed by USAID and gave its approval for the participation of the private sector in the construction and rehabilitation of the PIVs in Bakel. Both SAED and USAID/Bakel required a high level of technical capabilities and sophisticated equipment from eventual bidders. This is not responding to the realities of the work to be performed. There is no possibility of using a sheep foot roller (as required) over a bank of a canal which is 0.50 m width and 0.50 m high on average. A very small rubber roller may be suitable as the mallet (dames) seems to be the right tool for compaction in these small structures.

SAED/Bakel, the Harza team and USAID need to reach an agreement to continue the rehabilitation and/or construction of the four model PIVs. Additional construction and rehabilitation should be put on hold pending the results of the model PIVs.

G. Private Sector Participation in the Replicability of Prototype Systems

For the privatization of services such as pump repairs and design and construction of the PIV, SAED and Harza should make a survey of existing capacities and facilities for these activities in Bakel. They should contact some contractors and visit construction underway around Bakel.

There are some doubts regarding essential participation of the local private sector in the areas of supply of inputs and marketing (because of the credit factor). However, involvement of the local private sector in the building of small structures and the rehabilitation of the PIV is a distinct possibility. The local private sector is not currently able to carry out the design of the PIV. Training is a necessary prerequisite.

Rehabilitation of PIVs is the first priority of the project. USAID/Dakar and SAED/St. Louis should review their agreement concerning the participation of the private sector in the rehabilitation of the PIV in Bakel. Since most of the work to be done does not require the use of heavy equipment, the local contractors in Bakel may be able to participate in the bidding for the PIV construction.

The construction program for rehabilitating PIVs is described in Table D.2 on the following page.

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TABLE D.2

CONSTRUCTION PROGRAM FOR PIV REHABILITATION

No.	Description of Recommended Actions	Completion Dates
1	Selection of PIV to be rehabilitated, using the format being reviewed by SAED/Bakel and the engineering consultant.	End of June '90
2	Preparation of prototype of irrigation pattern in Bakel	End of June '90
3	Preparation of bidding document to contract out the topographic mapping of the PIV needing map.	
4	Preparation of bidding document to contract out analysis of soils where there is a need.	July '90
5	Starting the design of PIV and estimation of works as soon as topo maps are delivered.	Nov '90
6	Preparing bidding document for each PIV as soon as design is completed.	Nov '90
7	Submitting bidding document to SAED and USAID for approval.	
8	Proceed to biddings (local and St. Louis)	Dec '90
9	Hiring additional personnel, acquiring facilities for controlling the construction. SAED/DAGE should need 3 supervisors. Transport facilities must be provided (3 motos). Topographer, roadmen, drafter should be hired. Transportation must be provided.	Jan '91

*First construction may start on or about Jan/Feb, 1991.

TABLE D.3: GMP INVESTMENT & OPERATING COSTS

ITEM				Rainy Season	Dry Season
GMP SPECIFICATIONS					
Motor: make, model, size		1 Lister HR-3			
Pump: make, model, size		G-R			
Rated pump output, M3/hr	B	352			
Operating head in Rainy/Dry season, M	B			7	16
Pump output in Rainy/Dry Season,M3/hr	B			352	290
Pump Efficiency	H			0.56	0.71
Brake HP hrs/liter of fuel		4.45	(default	4.45	4.45
GMP INVESTMENT COSTS (FCFA)					
Motor and Pump	S,B	6,932,000			
Float Set	S,B	1,125,000			
Suction & Discharge Pipes	S,B	394,000			
PVC - 160 meters	S,B	2,000,000			
Transport/Installation	S,B	319,000			
Civil Engr Works for Water	S	865,000			
TOTAL GMP INVESTMENT COST,FCFA		10,770,000			
GMP AMORTIZATION BREAKDOWN					
Hrs of service (pipes 2x)	S,C	8,000			
Amortization of GMP/hr		1,346			
Amortization of repair costs/hr		619			
Amortization of pipes/hr		179			
Amortization per hour		2,145			
FIXED COSTS or Amortization / M3 of water pumped,				6.09	7.40
GMP OPERATING COSTS					
Fuel used per hour, liters	H			3.65	5.43
Fuel cost/liter, 1990 price		210			
GMP fuel cost per hour				767.48	1139.91
GMP oil + lube, % of fuel cost	S,H		17	130.47	193.79
GMP routine maintenance, % of fuel cost			6	46.05	68.39
Pompiste salary as % of fuel cost			6	46.05	68.39
VARIABLE (Operating) COSTS PER HOUR OF PUMPING				990.04	1470.49
VARIABLE COSTS / M3 WATER PUMPED, Rainy/Dry season				2.81	5.07
FIXED + VAR. COST OF WATER PER M3 PUMPED				8.91	12.47
Assumed water conveyance efficiency, percent ********				50	50
Water delivered to field, M3/hour, Rainy/dry season				176	145
VAR. COSTS PER M3 DEL'D TO FIELD, Rainy/Dry season				5.63	10.14
FIXED COSTS PER M3 DEL'D TO FIELD, Rainy/Dry season				12.19	14.79
FIXED + VAR. COST OF WATER PER M3 DELIVERED:				17.81	24.93

Sources of data:
S =SAED data, H = Harza engineers, K = Keita
B = BSIP EOP report, C = Evaluation Team

TABLE D.4:

PERFORMANCE OF PUMP SETS

(Matching HR2 & HR3 with Deloule and GFE pumps)

TABLE B.3 : PERFORMANCE OF PUMP SETS
(Matching HR2 & HR3
with Deloule and GFE pumps)

Pumping Set	Discharge M3/hr Low water	Efficiency	Discharge M3/hr High water	Efficiency
HR2 plus GFE	227	0.8	315	0.68
HR3 plus G.R.	290	0.71	352	0.56
HR3 plus Deloule	261	0.78	388	0.82

Source: Calculated from BSIP End of Project Report, Vol. II, page 441

Observation: All other matching sets lead to motor overload.

ANNEX E

AGRICULTURAL ANNEX

ANNEX E

AGRICULTURE ANNEX

I. INTRODUCTION

A. Project Goals

The main goals of the IWM-I Project were to increase food production, employment and farmers' income in the Bakel Delegation in the northeastern region of Senegal. There are three ways to achieve any of these goals:

(1) by increasing cultivated areas

(2) by improving yields per unit area, and

(3) by a combination of both.

The Project mid-term evaluation study was to determine if the above goals as specified in the Project Paper (PP) were being achieved, and if not, to identify constraints and submit recommendations towards goal achievements.

B. The Government of Senegal (GOS) Rice Policy in the Early 1960s

The importation of rice in the early 1960s was reaching an alarming proportion in Senegal. GOS decided to increase national paddy production and created the Societe d'Amenagement et Exploitation du Delta (SAED) in 1963. SAED, a parastatal body with the mandate to increase national rice production at almost any cost, was given full authority to implement irrigation infrastructures throughout the Senegal river valley with the sole aim of filling the gap between the country's production and consumption. To achieve this objective, SAED financed and developed irrigated perimeters. It would purchase at fixed prices the totality of production from these irrigated perimeters. The support of SAED to farmers was conditional upon their willingness to cultivate paddy on their land, exclusive of other crops, coupled with the monopoly of paddy purchase by SAED from the farmers who had no choice but to comply or lose their irrigation facilities.

C. SAED's Objectives

SAED's objectives were to open as much irrigated land as possible for paddy production without giving a second thought to the profitability of such endeavors to

farmers. Expectations of unrealistic potential of paddy yield per ha were set in motion, reaching an average figure of 7 metric tons per ha (mt/ha) in the mid 1980s, and perhaps more in recent years. In 1985, this expectation had achieved such an impact that the USAID project paper # 685-0280 quoted the 7 mt/ha figure as an easy goal to achieve, provided paddy fields were irrigated with adequate fertilizer inputs. In the same vein, maize yields of 5 mt/ha were projected, and with a cropping intensity of 1.5, the financial internal rate of return was calculated to be 15.7%. These unrealistic overestimates, running parallel to GOS policy of increasing rice production by construction of small, medium and large scale irrigated perimeters, gave birth to the present project under evaluation. SAED's strategy has actually boomeranged, and it is difficult to argue now with its staff that such high yield expectations are highly unrealistic in the present context. Ongoing sampling procedures of sack counting (estimated to weigh each 80 kg of paddy) from single 10 square meter (sq.m) plots to provide estimates of paddy yield/ha are statistically unscientific and unreliable. These 10 sq.m plots of 5m X 2m have often been interpreted to mean 10 meter square, in other words, 100 sq.m. It bears mentioning that the world record for average paddy production is held by Korea at 6.8 tons/ha, whereas average yields in west Sub-Saharan Africa are at a low 1.1 mt/ha.

II. THE BAKEL DELEGATION

1. Zones

The Bakel delegation is divided into four zones: Goye Inférieur, Bakel Commune, Goye Supérieur and Faleme. Each zone has a number of groupements which consist of a group of families that sometimes collectively farm the land.

2. USAID Involvement

USAID involvement in the four zones started in 1977 with the construction of 1,250 hectares (ha) of "Périmètres Irrigués Villageois" (PIV). These were essentially the implementation of irrigated infrastructures where water pumped from the Senegal river was delivered to adjacent lands to improve crop yields. Thus, both an increase in cultivated area and an increase in yield could be expected as a result of this intervention. Unfortunately, reliable statistics on agricultural productivity per ha basis in the Bakel area were unavailable in 1977 when the first USAID project in the region was begun. They still are in June 1990, and this precludes any meaningful

financial analyses of cropping pattern and achievements in the Bakel delegation. Traditionally, the farmers of Bakel have practiced subsistence agriculture, planting seasonal crops during the wet months of the year (paddy, sorghum and maize) from June to September. They also cultivated various crops in recession lands, but these were relatively negligible. During the cool dry season which lasts from October to March, mostly vegetables with some maize and sorghum were grown.

3. Cropping Areas

Because of poor PIV construction, 500 ha were abandoned, and increases in yields of paddy in the area, then the main concern, was not well documented for the remaining 700 ha. Figure 1 illustrates the number of hectares constructed, planted and harvested during the rainy season (hivernage) and harvested in the dry season (contre-saison) in Bakel[1]. Construction progressed at a rapid rate from 1985 onwards, whereas the number of planted and harvested ha lagged behind. The dry season areas increased gradually from 1980 to 1986, then started to decline. Harvested areas by crops for the decade are depicted in Figure 2. There was a dramatic increase in areas under paddy up to 1985 with a substantial decrease in 1986 and 1987 probably due to low rainfall, before climbing back up again in 1988 and 1989. Is rice cultivation financially viable?

The farm budget analyses (see Economic Assessment Annex) indicate that only supplementary irrigation of rice may be profitable in the short run (when only variable production costs are included) because of the high cost of pumping. The team found that this is exactly what the farmers are doing. Perhaps this is an alternative to making PIVs replicable, because trying to achieve maximum yields is definitely not an economic proposition due to the high cost of pumping water. It follows that there is a need to review the objectives of the Project Paper where maximum yields (7 mt/ha) with maximum water supply and maximum fertilizer inputs were the expectations. The financial analyses show that because of the high water costs, supplementary irrigation with optimal fertilizer inputs (rather than maximum) and a lower yield expectation coupled with a crop mix intensity of 1.5 might prove financially attractive, thus possibly making PIVs replicable under these conditions. The Harza team

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[1] Composed from SAED-CSE data of 1989.

suggested the implementation of four Model PIVs, which may be either newly constructed or rehabilitated ones. These should be designed to test the above assumptions. The target completion date of these model PIVs should not be beyond March 1991, with accurate data covering a period of three crop years.

Fig. 1 - Bakel Delegation

Areas Constructed, Planted & Harvested

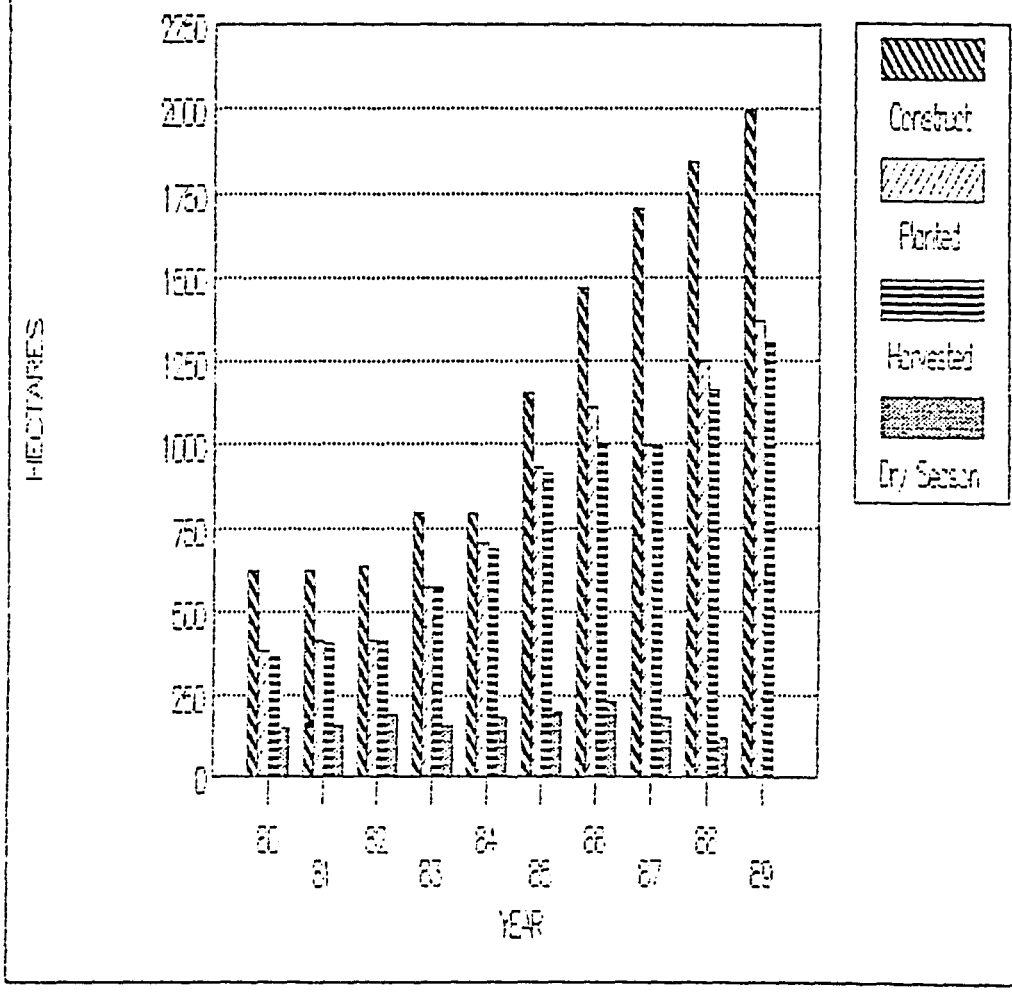
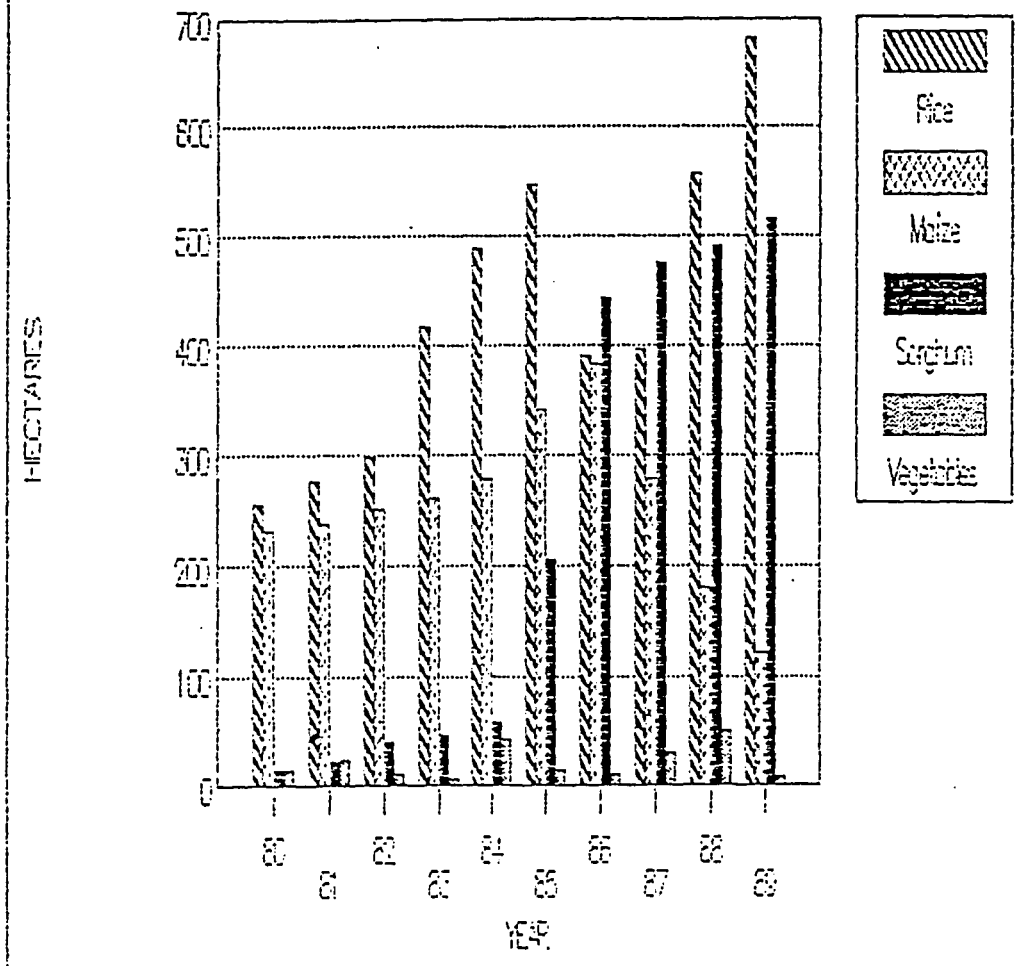


Fig. 2 - Bakel Delegation

Harvested Areas by Crops



4. Crops Other than Rice

Maize hectarage steadily increased from 1980 to 1986 when it reached almost 400 ha, after which there was a rapid decline with less than 200 ha in 1988. Despite reports to the contrary, financial analyses do not indicate that this crop is financially attractive. Since 1986 there has been a rapid decline in harvesting, with only about 120 ha in 1989. This may be due to the difficulty of marketing this crop, or to its non-profitability.

The sorghum figures are illuminating. After a timid increase from a negligible 20 ha in 1980 to 60 ha in 1984, harvested areas jumped rapidly from 1985 to attain more than 500 ha in 1989. Are the farmers telling us that sorghum cultivation is lucrative? Are the soils where sorghum is grown not suitable for paddy ? Obviously, more attention should be given to this crop for optimal production and marketing facilities.

The vegetable production curve shows production for the last decade never exceeded 50 ha, an area considered insufficient to provide an adequate supply to the population of Bakel. It would appear that there is a need to increase vegetable production in the Bakel area to supply at least the local demand.

5. Agriculture of the Four Zones

The crop production patterns in the four zones of Bakel, namely Goye Inferieur, Bakel Commune, Goye Superieur and Faleme for 1988 and 1989 are depicted in Figures 3 and 4. These histograms reflect the most recent trend which could have been influenced by the project intervention in each of the four zones. The number of hectares constructed and developed in Goye Inferieur, Bakel Commune and Faleme increased while Goye Superieur showed a decrease. However, only the first two zones increased the planting area while Goye Superieur showed a slight decrease. Despite a relatively large increase in construction in Faleme, the planted area decreased by about 25 percent which affected all crops grown in the area. Paddy production increased at Goye Inferieur and Bakel, but a slight decrease occurred at Goye Inferieur with maize and sorghum production remaining relatively constant. Interest in sorghum production is more evident at Goye Inferieur with a timid but increasing trend in Bakel Commune. Figure 5 compares the areas developed and planted in 1988 and 1989. Again, Goye Inferieur and Bakel Commune show an increase in both developed and planted areas. Despite an increase in developed area at Faleme, the planted area decreased, indicating a particular

problem in that particular zone which could be attributed to its isolation during the hivernage.

FIGURE 3

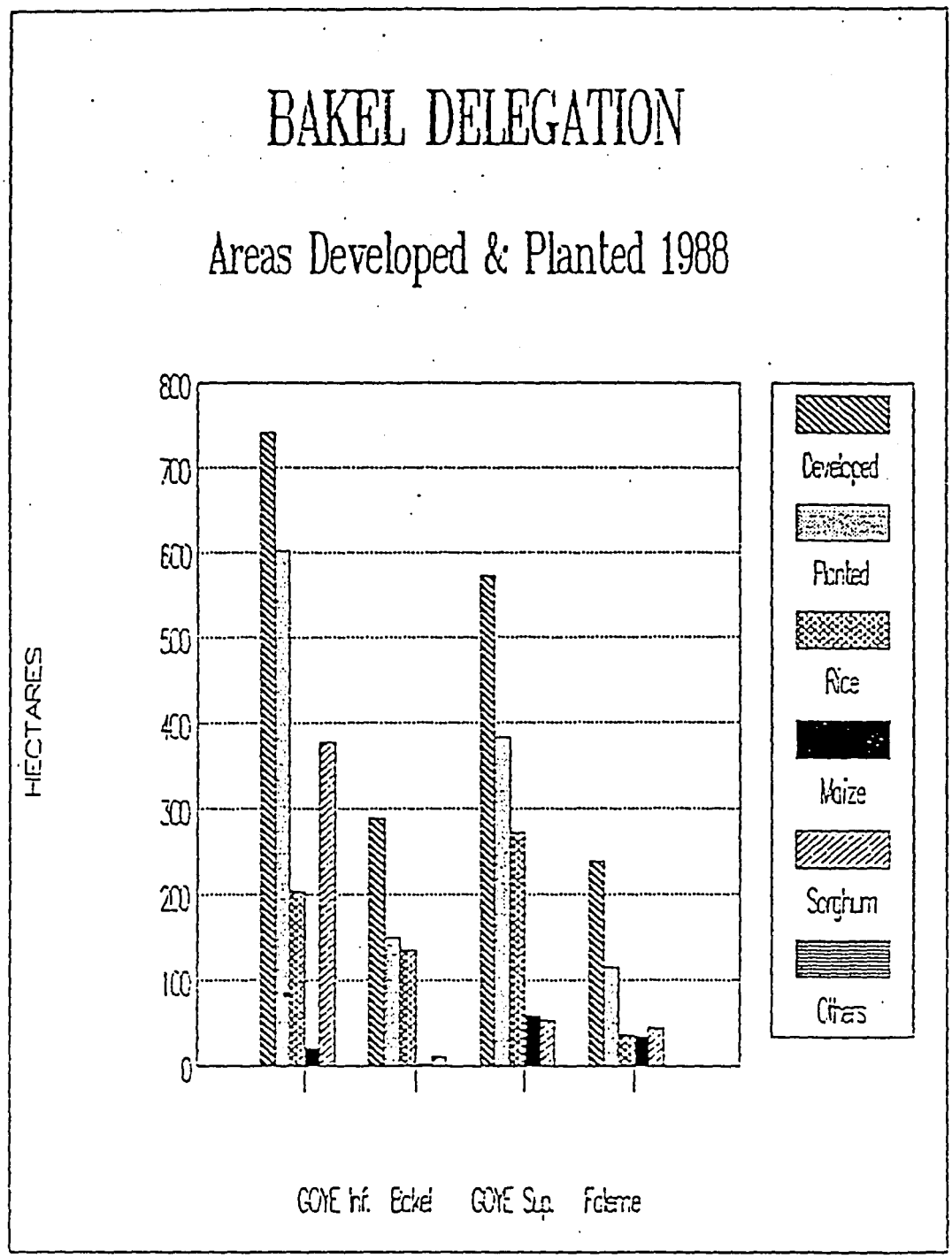

BAKEL DELEGATION
Areas Developed & Planted 1988
HECTARES
800
700
600
500
400
300
200
100
0
Developed
Planted
Rice
Maize
Sorghum
Citrus
GOYE Inf.
Ecke
GOYE Sup.
Fdeme

FIGURE 5

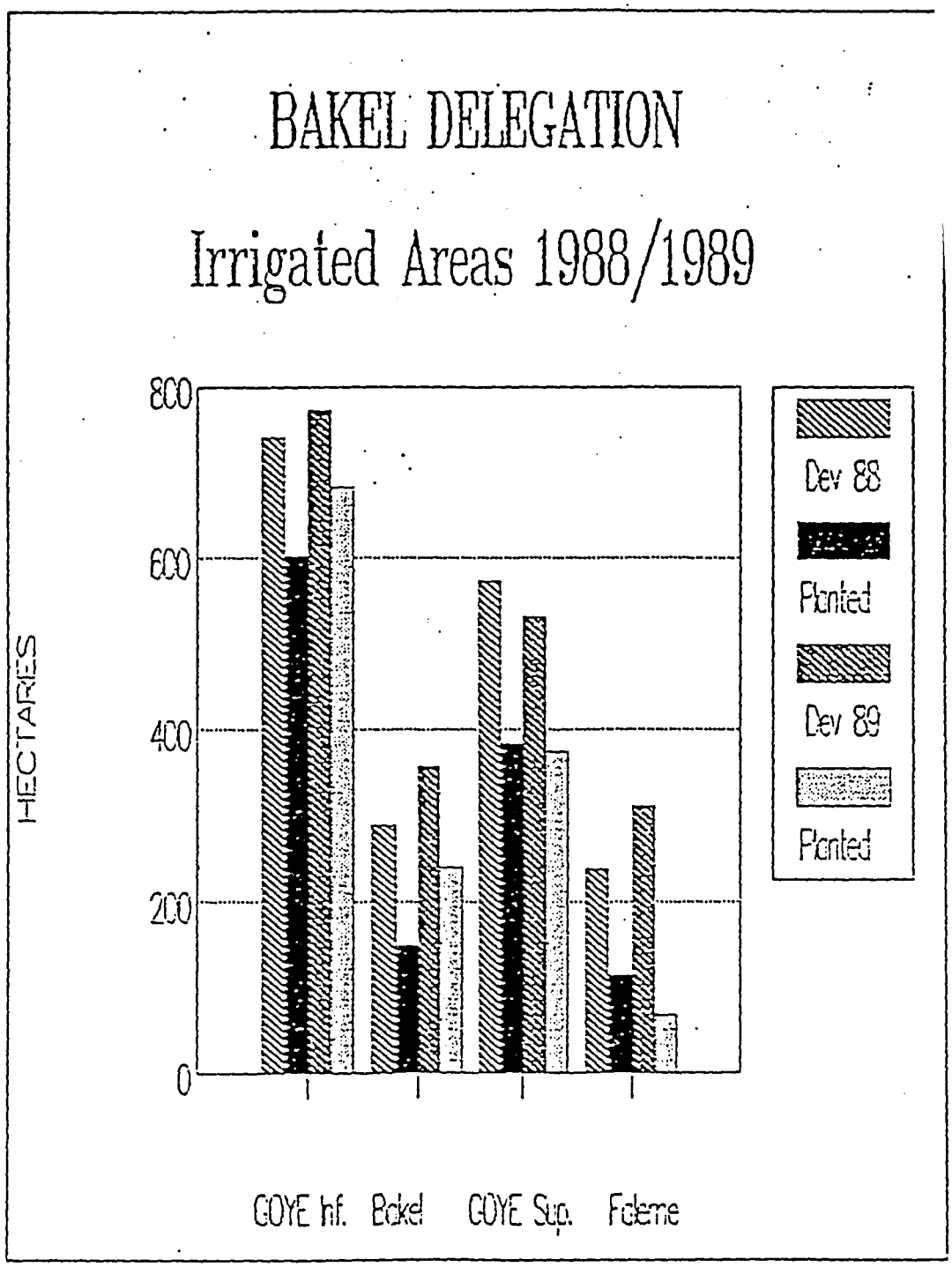
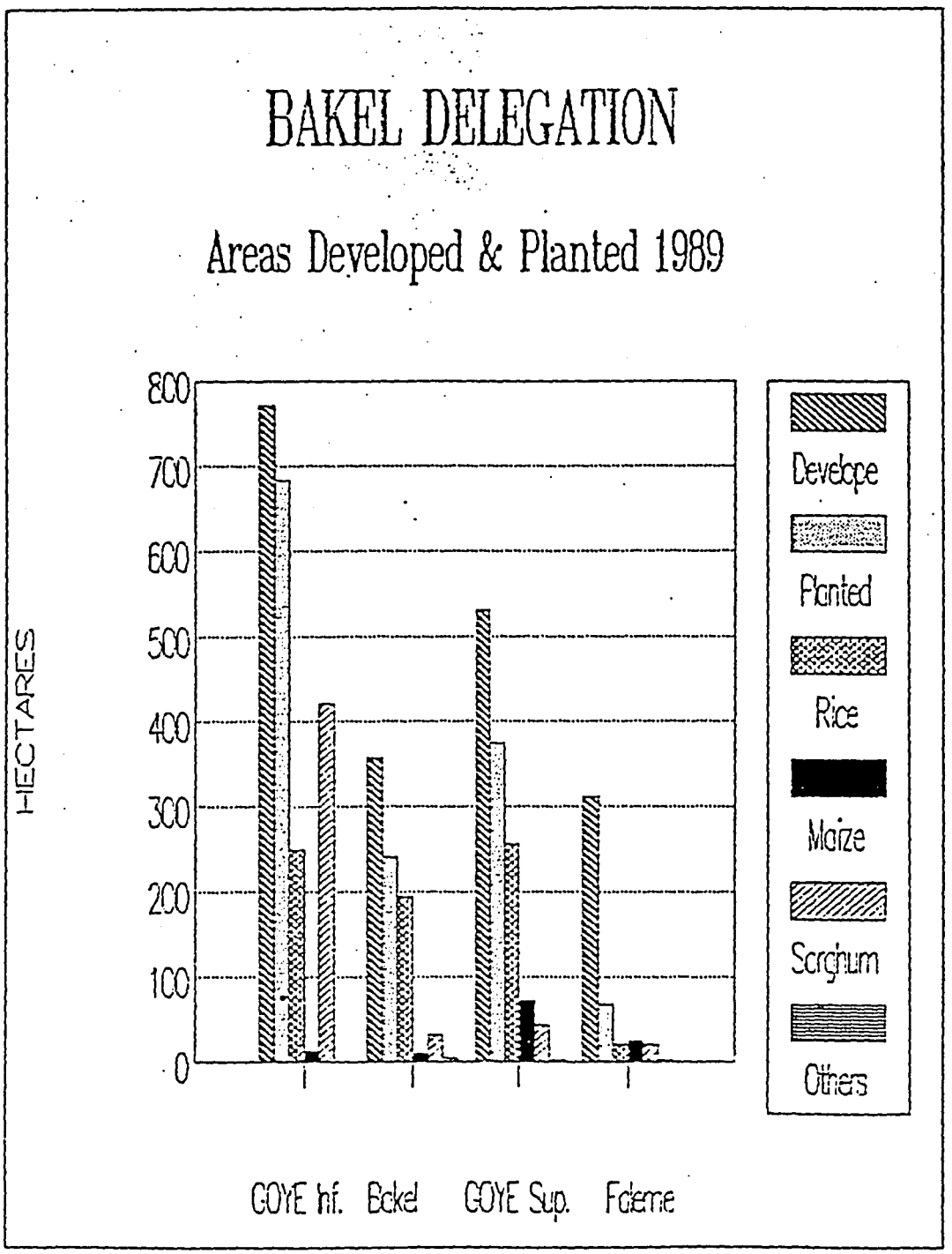

BAKEL DELEGATION
Irrigated Areas 1988/1989
HECTARIES
800
600
400
200
0
Dev 88
Planted
Dev 89
Planted
GOYE Inf.
Bakel
GOYE Sup.
Fdeme

FIGURE 4


BAKEL DELEGATION
Areas Developed & Planted 1989
HECTARES
800
700
600
500
400
300
200
100
0
Develope
Planted
Rice
Maize
Sorghum
Others
GOYE Inf.
Bakel
GOYE Sup.
Falerne

III. TECHNOLOGY TRANSFER

A. Improvement of Technology

1. Appropriate Technology

Disseminating appropriate technology to farmers is one way to improve production. A training program is burgeoning in Bakel and should be encouraged. In this connection, the groupements themselves could be of great help by communicating their needs to the training program organizers. The PIVs are only a means to an end which is to increase yields of **all** crops per unit area through judicious use of water, fertilizers and other agricultural inputs. Bakel farmers are relatively unaware of the effects of improved technology on yield increase. They mistakenly believe that USAID intervention will be an ongoing process designed to give them handouts on which they can rely for ever after to mitigate their potential financial losses.

2. Purpose of Model Farms

Admittedly, USAID intervention in Bakel has had so far a negative impact which is described in the main report. There is a need to impart to the planters that cash inflow from USAID will be terminated in a near future, and that they will have to rely on their own resources. To help them achieve independence, the implementation of the demonstration farm and the model PIVs should serve primarily as **model** cases to demonstrate profitability by applying improved technologies. These include increasing cropping intensity, applying optimal irrigation water amounts, optimizing fertilizer inputs and pest control, timing of harvest and reducing post-harvest losses. Attention should be focused on the operation and maintenance of the pumps, motors and the perimeters which has so far been tremendously slack. Adaptive research and essentially no basic research should be undertaken at the model farm, and the model PIVs should be designed as industrial showcases, one in each zone with all necessary data duly recorded.

3. SAED and TA Team Roles

Both SAED's staff and the TA team should work closely and in unison to prepare a program designed to improve production technology, stressing on seven basic steps for a successful achievement goal in paddy production without neglecting a crop diversification program badly needed in Bakel and which will be discussed presently. The seven recommended steps in paddy production

technology are:

(a) Good land preparation, good land levelling and deep ploughing

Training in the use of tractors and draft animals which has already started at the demo farm should be given more propaganda to attract more farmers into the program. Good land levelling can only be achieved during the construction of the PIVs. Farmers cannot be expected to correct poor construction works. Good land preparation and deep ploughing require months of hard manual labor that many farmers are reluctant to do if they are not assured of good returns. The use of tractors and draft animals in land preparation will relieve farmers of arduous work and their time could be devoted to less painful and more remunerative occupations. However tractors may not be available or utilizable in some areas, and an increased use of draft animals can only come about through training and example. A few years will elapse before farmers can become convinced of increased financial returns through the use of improved technology.

(b) Use of high yielding varieties (HYVs) and shorter crop cycles to reduce pumping costs

Despite claims to the contrary, the evaluation mission reached the conclusion that paddy yields in the Bakel area are very low on the average. No evidence was gathered that could show average yields in excess of 2.7 mt/ha. The use of local varieties with poor land construction and poor land preparation, poor water distribution and inadequate fertilization are the main reasons for these low yields. Yield improvement through better technology is not easy in Bakel because it carries a certain element of financial risk which farmers are not willing to take under the present undesirable conditions of poor PIV construction and high pumping costs. The use of HYV's with optimal irrigation and adequate agricultural inputs may increase yields to some 5 mt/ha in some fields, although in some poor soils such yield may never be attained.

(c) Optimal fertilization

Because of the high costs of agricultural inputs, the establishment of a yield response curve to

fertilizers should be a high priority at the farm. Recommendations on levels of agricultural inputs based on current knowledge should be given to farmers. Fine tuning of these practices is at present a luxury that the model farm can ill afford because of budget constraints and staff limitation. There is a financial risk involved in the use of fertilizers. Unless the irrigation system is functioning properly, increased amounts of expensive fertilizers will not provide financial benefits if yield increases are not proportionally substantial. In fields where irrigation water distribution cannot be guaranteed for the duration of the crop, increased fertilizer inputs should not be recommended. To protect farmers against potential losses, credit facilities for fertilizer purchases should be approved only if good irrigation water distribution can be guaranteed by SAED's and the TA team's engineers.

Fertilization of all crops in Bakel is below optimal. The use of agricultural inputs which varies from 0 to 300 kg/ha (both urea and NP) has no scientific basis. The amounts vary depending on financing capabilities of individual farmers or groupements, and on their perception as to whether or not rainfall and irrigation will be insufficient quantity to promote crop growth. Since there exists an interdependent synergism between water availability and fertilizer amounts on yield, it is inadvisable to recommend fertilizer dosage requirements without knowing the water availability to a particular crop under specific growth parameters (temperature, radiation, soil characteristics, etc.).

(d) Judicious use of irrigation facilities

The high cost of pumping water cannot justify the tempting desire to achieve maximum paddy yields. Even at 6 mt/ha, there is no financial return in the adoption of increased water and fertilizer inputs with a view to obtaining maximum yields.

Advice to farmers on the use of irrigation facilities and pumping hours should be tailored to their own specific conditions, appropriate to the crop being grown and their soil needs. There are 3 main types of soils: the hollalde with a high clay content suitable for paddy, the "faux" hollalde which will tolerate a crop mix of paddy, maize and sorghum, and the sandy fonde where no paddy should

be grown. Excessive use of water especially in fonde soils is wasteful and expensive, and in hollalde soils it increases drainage problems and reduces yields of crops, including rice if the water level is too high and soil aeration is impaired. The soil pH and chemical composition should be given the consideration they deserve. Recommendations from SAED should be tailored to other crops as well, and not only for paddy.

Supplementary irrigation and optimum fertilization to achieve a modest harvest appear to be financially viable. The demo PIV's should include some variables to determine the validity of these calculated risks and assumptions, bearing in mind that a financially non-viable PIV is not replicable.

(e) Plant protection measures

Pests can totally destroy a crop in a matter of days. The need to take preventive actions without undue negative effects on the environment should receive particular attention. Insecticides, rodenticides and some herbicides are highly toxic especially if they are persistent in the soil. Farmers use sometimes neighboring shallow wells for drinking water. Chemicals are colorless and odorless when diluted in minute quantities. This makes detecting their presence difficult.

(f) Harvest timing

Paddy production is relatively new in Bakel and some farmers may not be able to quantify losses due to untimely harvest.

(g) Reduction of post-harvest losses

These losses may reach over 20 percent of harvested paddy. Information on how to reduce them should form part of the training program. Grain drying and processing facilities in Bakel are not sufficient to accommodate an increase in paddy production. An increase in small rice mills as production increases should be envisaged.

Paddy production may increase exponentially if the PIV irrigation system becomes functional and financially attractive with a mixed crop intensity of 1.5. The present milling and storage facilities at the groupement level may become bottlenecks of

production. Post-harvest losses can sometimes nullify profitability without proper planning. If this happens, farmers will reduce their production until they are certain of the availability of adequate processing facilities and marketing arrangements.

For the time being, SAED is purchasing all surpluses. It can be surmised that with an increase in production, financial constraints at SAED may hamper its ability to purchase all the paddy produced in the valley, including Bakel.

IV. CROP DIVERSIFICATION

A. Crop Mixes and Paddy Cultivation

1. Crop mixes needed

SAED's help and recommendations to farmers should include all crops grown in the region. A high percentage of farmers' revenues originates from crops other than rice, namely maize and sorghum. Other crop mixes are almost non existent. Crop diversification is badly needed in Bakel. Present efforts are still governed by organization planning that was in force in mid 1970s. Paddy production should no longer have the importance it had at project conception. Adjusting to change and finding alternate means to make best use of the irrigation infrastructures that will be functional in the future deserve serious consideration. The original crop production design should be altered to include an increase in crop production other than paddy on 40 to 50 percent of constructed perimeters during the wet season.

2. Paddy cultivation needs re-evaluation

SAED's tacit support for paddy production predominates throughout the organizational system with the ingrained but disavowed notion that one has to make use of the PIV structures for the purpose they were originally intended - rice production. Objectives of the 1970s, although still true to-day for the country as a whole, should be revised and brought up to date at least for the Bakel region. This should take the form of an intensive campaign in favor of crop diversification, without which the PIVs will not be functional in the 1990s. Indiscriminate encouragement towards paddy cultivation in Bakel should be critically evaluated. The use of irrigation facilities to increase the productivity of other crops in addition to scaling down paddy production

on unsuitable soils deserves more attention. It would be unwise to increase rice production beyond the needs of the area.

B. Other Potential Crops

Production of other crops with inadequate agricultural inputs should be flourishing in Bakel. Soils are not excellent, but they are good. Except for the very hot months of April and May, temperature is adequate for almost any tropical crop now that uncertainties of precipitation are no longer a constraint provided the PIV irrigation systems are made to function properly. This is the main challenge with the highest priority. The marketing of crops produced will subsequently become the main factor that may stifle future production.

1. Maize

Maize is already grown in Bakel, although the area under this crop is gradually decreasing. Yields are poor, but with improved varieties, irrigation and fertilizers, they can be substantially improved. However, because the soils are rather poor for maize cultivation, the dosage of fertilizers required to improve yields may prove too expensive to compete economically with other producing areas, unless high yielding varieties are introduced and accepted by farmers. The demonstration farm should lead these innovations and propagate positive findings among farmers. However, production should not exceed the amount required for local consumption unless a marketing outlet is established. The price of this commodity is low and marketing extremely difficult when transport costs to areas outside Bakel are included.

2. Legumes

All legumes are nitrogen fixing plants which help increase soil fertility and are therefore recommended in crop rotations. Trials with cowpeas are already in progress at the model farm under furrow surface irrigation. These trials should give a first indication of yields obtainable under good water management and fertilizer inputs. The market price is attractive and cowpeas are a good source of protein in the diet. So are soybeans and mungo beans which can be economically grown provided a marketing channel comes into existence. These crops need high fertile soils which are not abundant in the Bakel region, thus limiting their production and export potentials. Groundnuts are usually confined to alluvial soils and the labor requirements are high, but this crop could be successfully grown in restricted

perishable value added products in the form of chips and conserves that can be exported outside the region. Papaya can also be grown for the production of papain for export. There is a lucrative market for papain. Processing is fairly simple and a study of the marketing potential is needed, as well as trials to determine economic yields under local conditions.

7. Pineapple

Pineapple will grow well in Bakel, especially under drip/subsurface irrigation. The Senegal market is completely open to pineapple which is now being imported from other countries, especially Ivory Coast. This crop has a fairly long shelf life and can be sold as fresh fruits throughout Senegal. It also has an export potential outside of the country, including the European common market. Value added products in the form of juices and concentrates can absorb overproduction of the targeted fresh fruit market. The model farm is the right place to determine the potential for pineapple growing in Bakel.

V. REASONS FOR PIV FAILURE

A. Poor PIV Construction

1. The basic reason for PIV failure as gathered from farmers throughout the four zones of Bakel is that the PIVs were originally badly constructed. It is impossible to judge with the eye if planing was not done correctly without water flowing in the field. No irrigation was being applied at the time of the team's visit and no crop was being grown. It was stated that during irrigation, it took a long time for water to reach the field. This is understandable where fields are located a long distance away from the river, sometimes exceeding 2 kilometers. In sandy soils where the primary and secondary canals have not been compacted, the situation is evidently worse, with an abundance of water just percolating through the soil. Another reason for poor conveyance is that some of the pumps are not properly maintained and are therefore not pumping water according to design because of low efficiency.

areas. Mungo beans and cowpeas are not likely to graduate into export crops and they will be grown mainly for local consumption, whereas soybean and groundnuts have good potentials as export crops.

3. Root Crops

In Bakel, cassava is not widely and easily grown but it is a good addition to the carbohydrate diet. Its production is limited for local consumption and sales. Unless processing facilities are brought in for starch production and export of the value added product planned, expansion of cultivated areas under this crop will be minimal. Sweet potatoes and other root crops are mainly recession crops and they will continue to be grown for local use only, barring the effects of the dams soon to be completed on availability of recession lands. Their production under irrigated conditions should not however be eliminated.

4. Fiber Crops

Cotton has not been tried in Bakel and its potential in the area is rather limited. The possibility of growing cotton should not be overlooked, especially with drip/subsurface irrigation systems. Suitable varieties that could adapt to local conditions need to be identified. Poorly drained soils are not suitable for this crop and these areas should be avoided. It also needs to be adequately fertilized and irrigated to produce an economic yield.

5. Nuts

Coconuts are not grown in Bakel. This crop adapts itself to harsh climatic conditions and copra is a good export product. Cashew nuts and peanuts production could be increased. Cashew is a high non-perishable cash crop that can be exported depending on the marketing and transport facilities that could be put into place by the private sector.

6. Bananas and Papayas

These crops can be grown in Bakel and some farmers are increasing production of bananas, for example at Manael where 5 ha were grown in 1989 with plans for 10 ha in 1990. Papayas were not found in Bakel and some good varieties could be tried at the model farm. These two crops are highly perishable and area expansion should not increase beyond what the local consumption market can absorb, unless they can be transformed into non-

B. Water Requirements

1. Paddy

Flooded rice is a crop that requires a large amount of water and fields should remain flooded to produce acceptable yields. Assuming that the land has been adequately prepared, the following calculation illustrates the volume required in cubic meters (cum) for a rice crop in the Bakel area.

Field flooded at 10 cm depth/ha	=	1,000 cum
Daily evaporation (Eo)= 8 mm (estimate)		
Replacement of evaporation losses for 110 days (80 cum x 110)/ha	=	8,800 cum
Crop transpiration factor (Eto=1.2)	=	1,680 cum
Percolation losses 2 mm/day for 110 days (higher in sandy soils) (20 x 110) cum/ha (includes presoaking)	=	2,200 cum
Conveyance and distribution efficiency estimated conservatively at 50%	=	12,680 cum
Total per crop/ha	=	26,360 cum
Minus rainfall (120 days)	=	5,000 cum
Water required to be pumped	=	21,360 cum

The cost of pumping is prohibitively high even if average yield of paddy, with adequate fertilizer inputs, reaches 5 mt/ha. (see Economic Assessment Annex) where the financial internal rate of return (FIRR) is still negative.

It follows that paddy cropping for **maximum** yields at Bakel, even under the best of conditions, is not a financially viable concern. The replicability of PIVs throughout the Senegal valley, with paddy as the only crop, is therefore not possible. A different approach is therefore necessary.

2. Maize

Daily evaporation (Eo)	=	8 mm (est.)
Crop transpiration factor (0.4) for 60 days	=	1,920 cum
Crop transpiration factor (0.8) for 50 days	=	3,200 cum
Percolation losses 2 mm/day for 50 days	=	1,000 cum
Conveyance and distribution efficiency (50%)	=	6,120 cum
Total per crop/ha dry season	=	12,240 cum
Total per crop/ha wet season	=	7,240 cum

C. **Reduced Yield Expectations**

Because the high cost of pumping water is the main reason for the PIV's non viability if one wants to achieve maximum paddy yields, reduction of this cost by reducing water inputs and accepting a more modest average paddy yield expectation (3 mt/ha) seems to be an alternative solution. Such a reduction of water inputs should go parallel with a mixed cropping system with a crop intensity of at least 1.5 if one is to expect financial viability. Different crop mixes and the their financial viability are discussed in the Economic Assessment Annex. The model PIVs should be set up to prove or disprove in practical terms the approach suggested here on theoretical and economic grounds.

1. Drip/subsurface irrigation alternative

The evidence shows flood paddy irrigation using pump water is not a paying concern. The volume of water to be pumped and the high costs of pumping preclude the use of this irrigation method based on simple financial assessments. If agricultural development is to take place in Bakel, paddy should be considered an essentially subsistence crop with no hope of getting any commercial return, and more attention should be given to crop diversification. All other crops utilize less than 30 percent of the water volume paddy requires. Nevertheless the cost of pumping remains high, and attempts to use alternative techniques to reduce pumping costs will go a long way towards solving the financial stumbling block of pump irrigation water. Drip/subsurface irrigation is the best technique available to-day. Its advantages and disadvantages are described in the next section.

2. The drip/subsurface irrigation technology

Drip irrigation is a completely enclosed system where water flows through a system of PVC pipes and

polyethylene tubings with no loss of water, either by percolation, evaporation or seepage until the water reaches the crop roots through minute orifices in the polyethylene tubing. Fertilizers are injected gradually into the pipe networks at frequent intervals thus reducing losses through leaching. The water application and distribution efficiency is more than 95% compared to 40% for furrow surface irrigation and 60% for sprinklers. Water is applied daily keeping water in the root zone always at near zero potential conducive to maximum growth. Yields of most crops have doubled when compared to either furrow or sprinkler systems. These crops include sugarcane, cotton, tomatoes, potatoes, pineapple, strawberries, artichokes, asparagus, bananas, and even fruit and nut trees like mangoes, oranges and macadamia nuts, to name just but a few. Because drip irrigation is an enclosed system with water under pressure at 2 to 4 kg/sq.cm in the main and distribution pipes, with 0.7 to 1.0 kg/sq.cm in the irrigation lateral tubing, undulating terrain does not affect water distribution at the field level. Thus, accurate and expensive land planing and levelling are not required, and these economies help defray in part the capital cost expenditure of the system which amounts to about $ 4000/ha. Because of the high efficiency of water application and distribution, pumping costs are less than one third of those incurred for furrow irrigation. Unfortunately, this system is not suitable for rice. Because crop diversification should be developed in Bakel, neglecting to consider the applicability of drip/subsurface irrigation because of an unawareness of its potential and the belief that the system is too sophisticated to be applicable in Bakel would be an error.

3. Short description of the drip irrigation system

Under Bakel conditions, water would be pumped from the river using the same pump and motor group that could raise the energy of the water to about 4 kg/sq.cm, with a volume of water flow at 1 liter/second/ha (l/sec/ha). The water would then be filtered through a minimum two-tank sand filter unit connected to a fertilizer injector apparatus. The water would leave the filter tanks under pressure of about 3.5 kg/sq.cm, channelled through a network of PVC pipes of varying diameters allowing friction losses up to 2 kg/sq.cm. Each ha would be controlled by headworks reducing the water

pressure to 0.7 or 1 kg/sq.cm (according to design) in the lateral irrigation tubing that will run along the crop rows. The lateral tubings should have partially pressure compensating orifices with a factor of at least 0.5. These will regulate water flow per emitter with a variation of less than 10% of designed criteria. Tubing with less than 1% plugging after two years of service should be specified. The depreciation of land preparation costs ($ 1000) and filter tanks as well as buried PVC pipes ($ 2,000) is 20 years, and that of the lateral tubing and accessories ($ 1000) is 8 years. Water pumping cost for maximum crop production would be less than 25% of that needed in furrow surface irrigation systems.

The system installation and specifications should be designed by an engineer qualified and experienced in drip irrigation technology. Training of counterparts is an essential component of success. The physical installation of the filter system and the pipe distribution networks should be closely supervised by a technician trained in PVC installations. After the system is installed, it is very easy to control its operations which can be carried out by one literate farmer who can take charge of at least 50 ha. Crop planting and harvesting will remain the most arduous tasks. A typical financial analysis is illustrated in the Economic Assessment Annex.

4. Recommendations on Irrigation Systems

The evaluation team strongly supports the 4 model PIV covering about 50 ha in each of the four zones of Bakel. These model PIVs will definitely prove or disprove, once and for all, the financial viability and replicability of the PIV system under flood irrigation. By the same token, the team also strongly recommends the implementation of two drip/subsurface irrigation pilot projects covering each 50 ha to compare the benefits that could be accrued under a crop diversification program. Experience in the drip irrigation technology indicates a higher chance of success, and therefore replicability, despite the reluctance to use it in developing countries. It has been successful in other developing countries like Ivory Coast, Kenya, Mauritius, Venezuela, India to name but a few. Although a difficult area, Bakel presents no specific constraints regarding the utilization of improved irrigation technology.

ANNEX F

ECONOMICS ANNEX

ANNEX F

ECONOMICS ANNEX

I. INTRODUCTION

A. Historical Background

1. The "Perimetre Irrigue Villageois" (PIV) Concept

PIVs became the basis for development projects along the Senegal River in the Bakel Region in response to the drought of the early seventies (USAID, 1977). In the face of this climatic disaster, a means was sought to assist rural households to insure enough production to meet their subsistence consumption requirements. The first USAID financed irrigation project in Bakel, the Bakel Small Irrigated Perimeters (BSIP), 1978-1985, financed the construction of 1,250 ha. of PIVs.

PIVs were, thus, not originally intended to be commercial in nature and produce mainly for the market. This self-subsistence orientation was consistent with the policy of the Government of Senegal (GOS) to achieve food self-sufficiency and reduce the vulnerability of food production to unreliable rainfall. Commercial viability and the potential for replicability through private investment were not major concerns at that time.

2. Evolution of the PIV Concept

By the early 1980s, the need for PIVs to become self-sustaining was recognized. Commercial viability and potential for replicability became important considerations. Government and donor subvention of the PIVs could not continue indefinitely. The GOS began to reduce the role played by its development agency for the Senegal River Valley, the "Societe d'Amenagement et d'Exploitation des Terres au Delta du Fleuve Senegal" (SAED).

The final evaluation of the BSIP project argued that PIVs should become self-sustaining and eventually rely on private investment to expand the area under irrigated production. A primary purpose of the current project, Irrigation and Water Management I (IWM-I), is to develop PIVs that could be replicated by private individuals or groups of farmers.

3. Past Economic Analyses

A considerable number of cost/benefit analyses of the two projects undertaken to expand and improve PIVs have been done

in the past. This includes the analysis done in the Project Paper (PP) for the IWM-I project. These have either been inconclusive or over-optimistic about the potential benefits from investing in such projects.

A penetrating and concise critique of past analyses, and in particular the analysis done in the PP, has been provided by Jaeger of the World Bank (IRBD, 1987). Jaeger argues that many of the assumptions of these past analyses have been unrealistic. Although, not directed specifically at the question of PIV replicability, his analysis may be taken as an indication that these analyses have overstated the long-run profitability and, hence, the replicability of PIVs in the Bakel Delegation.

B. Objectives of the Economic Assessment

This assessment has been carried out to:

1. Determine the Validity of Project Economic Assumptions

The PP assumes that the project investment would have a significant impact on the production practices and incomes of farmers, resulting in the PIVs becoming commercially viable and replicable.

2. Determine if Project Goals are Realistic

The analysis seeks to determine whether the development of improved PIVs can be achieved. The project goals are commercial viability and replicability.

a. Commercial Viability

The project was meant to bring about increased production that would result in farm surpluses sold at more reasonable prices through local marketing channels. Farmers are not, however, paying back debts incurred with SAED. This indicates they may not be producing enough to have a marketable surplus that can be sold to pay back debts.

Viability is here defined to mean that farmers make enough profit to cover their variable production costs incurred during the crop production season (short-run profit) and enough additional profit to enable them to amortize the pumping equipment provided to them by the project. They would, therefore, be able to replace the pumping equipment after its useful life of 7-8 years. This would make the PIV sustainable through the life of the project.

b. Replicability

Whether farmers would continue irrigated production after project support is withdrawn is not clear from the economic analysis of the PP or the current functioning of the PIVs. Farmer groups are, in fact, not amortizing their pumping equipment. Short-run profit that covers only production costs incurred during the season is not enough to ensure sustainability and replicability.

Replicability requires that the profit from production activities be sufficient to cover long-run average costs and make possible capital investments, including the construction of the PIV and purchase of pumping equipment.

c. Increased Average Parcel Sizes of 0.35 Ha.

Farmers ask for larger parcels, arguing that parcel size is one of the main constraints to profitability and the production of marketable surpluses. This is an empty demand, however, if irrigated production in the PIVs is not profitable enough for them to be viable and replicable.

3. Determine the Current Viability of the PIVs

Current profitability is the starting point for assessing the potential of the PIV concept. This leads to an identification of the constraints to improved PIV viability and potential solutions for overcoming these constraints. The factors considered include:

(i) choice of crops and crop mix
(ii) water use strategies
(iii) fertilizer use
(iv) cropping intensity

4. Recommend Alternative Production Strategies

(i) crop choices and mix
(ii) water and fertilizer use strategies

5. Recommend Actions to Improve Irrigated Production IN PIVs

II. THE PP ANALYSIS OF THE PROJECT BENEFITS

A. The PP Economic Analysis

1. Past Criticism of The Project Assumptions

The PP analysis concludes that the project will result in substantial increases in crop output and farmer income. Yaeger has convincingly criticized the following unrealistic assumptions made in the analysis (IBRD, 1987):

a. Crop Yields

Rice yields are assumed to increase from 4.5 to 7.0 tons per hectare and corn or maize yields from 2.5 to 5.0 tons over the life of the project, although these yields are not obtained anywhere in Africa or in other parts of the world.

b. Fertilizer Use

Yield increases are based on increases of fertilizer use from 250 kg. to 450 kg. for rice and 150 to 300 kg. for maize, although yield increases due to fertilizer response in these ranges of fertilizer use are minimal .

c. Fertilizer Price

The PP assumes a decline in the economic price of fertilizer (policy distortions removed) from 100 FCFA per kg. to 85 FCFA over the life of the project due to increased consumption and marketing, although both are already significant. Furthermore, Jaeger argues that the price should be about 23% higher to start with, based on the economic prices computed by the AID/MSU/BAME Project (Crawford et al., 1985).

d. Onion Revenues

Onions are assumed to account for 25% of total value product without consideration given to how they would be marketed or the downward effect of the increase in supply on price.

e. Marketing of Increased Output Locally

This assumption is implicit in the use of higher output prices than would be possible if produce had to be shipped beyond regional markets and compete with goods at Dakar or St. Louis. Whether the local population could purchase and consume this additional food and do so without prices declining is not considered.

2. Results and Further Unrealistic Assumptions

Adjusting for these unrealistic assumptions causes the economic rate of return, the measure of the net benefits attributable to the project to go from 16.9% to between 5 and -10% (IBRD, 1987). Furthermore, other assumptions made in the analysis are also highly questionable.

a. Water Use Levels and Yields

First, the water use levels assumed in the PP analysis cannot support even the reduced level of yields used by Jaeger in his modification of the analysis. The yields should be reduced further by at least one ton in for both rice and maize. This reduces the maximum rice yield assumed to 5.5 to 4.5 tons/ha. and the maximum maize yield from 4.o to 3.0 tons/ha.

b. The Life of the Project

Second, the life of small scale perimeters assumed in the analysis (20 years) is also unrealistic. Under conditions such as those found in the project region of Bakel, one would not expect PIVs to last more than 15 years. Even this is optimistic when one considers the empirical evidence gathered by SAED and Harza. Of about 2,000 ha. built, 500 ha. have been abandoned and most of the rest need rehabilitation.

Based on these considerations, it can be reliably concluded that the net economic effects on the Senegalese economy from investment in the IWM-I Project are not positive. The relevant question, then, is to ask if the project will have a positive impact on Bakel farmers participating in PIV crop production.

[II. THE FINANCIAL VIABILITY OF THE PROJECT

A. Farm Budget Analysis

1. Current Irrigated Practices

Table F.1 presents the net returns or gross margins (short-run profit) from the irrigated crop choices that farmers have in the Bakel Delegation at this time. They represent measures of the returns to the resources of the farm household. Since labor is the critical factor that has to be allocated by the household, the returns per man-day of family labor is the criterion that one would expect farmers to use to compare these alternatives.

Although the net returns per hectare to rice are higher than either maize or sorghum, the returns per man-day for rice are 10% lower than those from maize and 13% lower than those from sorghum. The returns per man-day for rice are 374 FCFA, while those for maize and sorghum are 417 and 428 FCFA, respectively.

The available data on area by crop for the Bakel Delegation shows a steady increase over the last four years in the area planted to sorghum and a decline in the area devoted to maize (see Agriculture Annex). This is the case, although recent budgeting by Reeser and others shows higher returns to maize than sorghum.

The survey work of Keita shows, however, that farmers do not use fertilizer on sorghum. This explains the results presented here. If farmers do not use fertilizer on sorghum, they only have to get 800 kg./ha. to get a higher return from sorghum than maize at 1100 kg./ha.. This is only 100 kg./ha. higher than the yield they are believed to get on rainfed fields (Dames & Moore, 1990). When using manure yields would be expected to increase substantially.

2. Current Rainfed Practices

Table F.2 presents the net returns or gross margins (short-run profit after only variable cash costs are deleted) from rainfed crops grown in the region. The rainfed crop returns per man-day are 743 FCFA for rice, 950 FCFA for maize and 443 FCFA for sorghum.

The returns per man-day for rainfed production on similar type land not under irrigation provides the relevant opportunity cost for the resources allocated to irrigated production. It is not the hired labor wage, which is most often used in economic analyses, because this is not the use to which available farm household labor would be allocated if the irrigated perimeters developed by the project did not exist.

It is necessary to distinguish the type of land that would be chosen for perimeters to determine which crops' return per man-day should be used as the opportunity cost in the evaluation of irrigated crops. Since rice is mainly grown in low lying areas and maize is mainly grown on small areas close to the compound,it can be concluded that most land chosen for irrigated perimeters would been sorghum land.

The opportunity cost of irrigated production, therefore, for the different crop choices is the returns to rainfed sorghum, 443 FCFA per man-day. This will be used to evaluate the net benefits to farmers from irrigated crop production.

3. Comparison of the Returns from Rainfed and Irrigated Production

Comparison of the returns per man-day from irrigated crops presented in Table F.1 and those from rainfed crops in Table F.2 shows that the returns from rainfed sorghum are higher than those from all the irrigated production activities except onions. Only in the case of rice are per hectare returns higher, but this activity uses more than three times more labor. As currently practiced, one can conclude that irrigated crop production provides little incentive to farmers.

Given the current relatively low returns to irrigated grain crop production, the relevant question to ask is if the current practices of farmers can be improved to make irrigated production more attractive and profitable.

4. Improved Irrigated Crop Production

Under irrigated conditions, the interaction of water application and fertilizer determines crop yield to a large extent (cultivar choice can also be important, but improved varieties can be assumed because they are available and cost little). Under irrigation water availability can be controlled so it is necessary to try to find the combination of water and fertilizer that will result in the highest profitability. This is not usually the level of these factors that would give the highest yields because the costs of water and fertilizer have to be considered.

Table F.3 presents the returns per hectare and per man-day possible under improved water availability and fertilizer use. In all cases except that of dry season maize, the net returns per man-day above variable costs are higher than the opportunity cost of 443 FCFA, indicating that the benefits of participating in the project can be positive, if these yields can be obtained (and if the pumping equipment and perimeter infrastructure provided by the project does not have to be replaced). However, motor pump sets last only 7-8 years under conditions found in the Bakel Delegation. This is half the estimated life of a PIV (15 years) and there is no provision in the project to supply additional motor pump sets to farmer groups participating in the project.

5. Income Above Amortization Costs

Farmer groups are required to have an amortization account and to contribute to these regularly on an annual basis. These costs have to be accounted for, for the project to be successful and self-sustaining over the life of the project. This also does not take into consideration the construction costs of the project, which would have to be included in the

analysis if replicability of the PIVs after the life of the project were to be considered, as well as construction of new PIVs with private funds.

Table F.4 presents the returns above variable and fixed pumping costs (or the costs including the amortization of pumping equipment) from the improved irrigated crop practices introduced into the analysis in Table F.3. These returns are based on the pumping equipment specifications, investment costs and operating costs outlined in Appendix B - Engineering Assessment, Table B.2.

When the motor pump amortization costs are included in the analysis, only onions has a higher return per man-day than the opportunity cost of 443 FCFA associated with rainfed sorghum.

These results indicate that if farmers grew crops other than onions under the conditions assumed and had to amortize their pumping equipment, they would be better off if they did not participate in irrigated production, but allocated the land and available labor to rainfed sorghum and the other rainfed crops.

Furthermore, these results indicate that farmers would not amortize their pumps even if they produced with these improved practices. This helps to explain why farmers do not amortize their pumps at the present time. Under current farming practices (presented in Table F.1) these costs cannot be covered and farmers are observed not to make payments into their amortization accounts.

6. Average Yields Needed to Cover Amortization Costs

If an irrigated crop activity cannot result in average yields that provide returns high enough to cover fixed pumping costs and at least match the opportunity cost of family labor, that activity cannot provide positive net benefits to participant farmers. It would not add to financial viability or lead to sustainability of the PIV during the life of the project.

If the crop production did not cover these fixed costs and the opportunity cost of labor it would also not add to replicability. It would have to be combined with some other activity that could make up for its lack of profitability. Table F.5 shows the average yields required to cover amortization costs and the opportunity cost of labor. The average yield required for rice would be 6.7 tons per hectare, which could not be achieved in one season. A rice crop intensity of more than one would necessitate double cropping or growing rice during the dry season when variable water costs are even higher, 10.1 FCFA/cubic meter of water pumped in the dry season as opposed to 5.6 FCFA/cubic meter of water

pumped in the rainy season (This difference in cost is due to the river water level and the lack of rainfall in the dry season).

Based on this required average yield of 6.7 tons, one can conclude that rice, irrigated with water that has to be pumped, is not a viable crop alternative for a sustainable and replicable PIV. To be included in the crop mix, other crops would have to make up for its lack of profitability.

Dry season maize would have to reach an average yield of 4.8 tons to become profitable enough to cover amortization and opportunity costs. Maize, therefore, would not add to sustainability or replicability.

Rainy season maize and sorghum with average yields of 2.7 tons and 2.4 tons both appear to have potential to add to PIV profitability, sustainability and replicability. This is also true of dry season onions. These crop show the potential to add to the profitability of the crop mix.

B. The Financial Analysis

The financial analysis measures whether it would be attractive to farmers to allocate their resources to participate in the project. It provides a measure of the benefits of the project from the point of view of participating farmers. It makes use of a financial rate of return (FIRR) to measure the net benefits with the project over those that would exist without the project.

1. The Financial Analysis with the Current Crop Mix

a. The Current Crop Mix

The crop mix found by the socio-economic monitoring system of the project to be grown in the Bakel Delegation consists of 60% rice, 20% maize and 20% sorghum during the rainy season. During the dry season, mainly maize is grown, with a small area devoted to vegetables. The financial analysis will first consider this rainy season crop mix, with 70% of the area assumed to be planted to maize in the dry season and remaining area assumed to be planted to onions.

The current cropping intensity is about 70% and this is allowed to increase from 90 % to 150% over the 15 year life of the project. Efforts are currently under way by SAED and Harza project staff with extension duties to encourage higher cropping intensity.

b. Yields Over the Life of the Project

Yields are allowed to increase over the 15 year life of the project with complementary increases in water availability and fertilizer use. This is based on expected improvements in production practices over time due to the technical assistance provided by the project.

Rice yields increase from 2.9 ton to 4.3 tons, rainy season maize increases from 1.3 tons to 2.7 tons, and sorghum increases from 1.2 tons to 2.6 tons. These are very optimistic yield increases given the performance of PIV crop production over the last fifteen years.

c. The Production Data

The project life is broken into three periods to simplify the analysis and average yields and returns are calculated for each period. The data used in the analysis for each period is presented in Tables F.6, F.7 and F.8. The relevant yields, water costs, fertilizer and other input costs, as well as the opportunity cost of labor, which represents the benefits without the project are presented for each crop choice on a per hectare basis.

The per hectare returns for all crops except maize are positive. No alternative grain crop was found to lose less money that maize in the dry season. This may explain the reluctance of farmers to cultivate maize during the dry season in the Bakel Delegation.

d. Financial Returns to Participating Farmers

Table F.9 presents the analysis of the benefits of the project to participating farmers. Shown are the investment costs, perimeter operating costs, and net income from production activities included. Since the project provides the capital costs of perimeter construction, except for land clearing and some construction materials purchased by the farmer group or "groupement", the construction of the PIV is a net benefit received by participating farmers. The investment cost of PIV construction, therefore is netted out in the analysis and, hence, is not included in Table F.9.

The financial rate of return (FIRR) is -2.6% and indicates that the net benefits to farmers participating in the project are indeed negative if they amortize their pumps. This supports the contention previously made that if farmers amortize the pumping equipment provided at the start of project, they lose money or are worse off than without the project.

2. The Replicability Analysis

This analysis measures the net benefits to farmers after all costs involved in participating in the project are accounted for. Included are variable and fixed water costs and other operating expenses, as well as the investment cost of constructing a PIV.

Table F.10 presents the resulting FIRR if it is assumed that participating farmers also have to pay for PIV construction costs, the requirement for replicability.

The FIRR is -7.6% in this case. It is clear that if farmers had to invest in PIV construction, as well as pumping equipment, they would be worse off and they would lose money on their investment. This is a conservative finding since this analysis has been done without consideration of financing charges.

PIVs cannot be considered to be replicable at this time and would not be even if the optimistic production improvements assumed in the above analysis could be obtained. Furthermore, the analysis indicates that farmers would not continue irrigated production in PIVs after the project ends or if project support were withdrawn.

3. A Change in Crop Mix

The analysis done clearly points to a lack of viability for irrigated rice production in PIVs in the Bakel. This is due to large water requirements, heavy labor requirements and insufficient yields under the conditions found in the Bakel Delegation.

At the same time, the analysis points to potential viability for maize and sorghum production, if improved production practices can be achieved. This can be seen by considering the data presented in Table F.5. It is interesting to ask what would be the result on profitability and replicability, if rice was eliminated from crop mixes on the PIVs.

Table F.11 presents the results for a crop mix that includes 60% maize and 40% sorghum during the rainy season, and 50% maize and 50% onions in the dry season. The cropping intensity is assumed to improve from 0.9 to 1.5 over the 15 year life of a PIV. Maize yields are allowed to increase to 2.7 tons per hectare and sorghum yields to 2.4 tons per hectare.

These improvements do not cause the FIRR to become positive, although it improves from -7.6% to -1.17%. These results indicate that it will be difficult to find a crop production

system that will make PIV agriculture replicable under conditions found in the Bakel Delegation.

IV. CONCLUSIONS AND RECOMMENDATIONS

1. Unrealistic Assumptions - Current Viability of PIVs

Finding - The PIVs in their current form are not financially or economically viable and are not replicable. Recommendation - Make one project goal for the next two years the development of four model PIVs (one in each zone and of different type) that are profitable and replicable.

2. High Value Cash Crops

Finding - The most promising crop found in the analysis was onions. Although very conservative assumption were made for onion yields and prices, onions were found to be very profitable. The yield potential is 40 tons per hectares under ideal growing conditions and this has been achieved on the experimental farm of SAED. In the analysis onion yields were only allowed to increase from 15 tons to 30 tons.

Furthermore, although the farm gate price in Bakel is reported to be 125 FCFA per kilogram, the price was held constant at 50 FCFA/kg. over the life of the project. One would assume that they would decrease to this level at some time in the future if production did increase to this extent, but not immediately.

Conclusion - Effort at the experimental farm should be concentrated on finding high value cash crops that can be grown in the dry season to improve the viability of the PIVs. Since marketing will most likely have to be done outside the region of Bakel, these efforts should concentrate on nonperishable crops such as pimento (hot or red pepper), garlic, potatoes, cashews, etc. Since no data was available on these crops, their potential profitability could not be assessed, but the profitability of onions, relative to cereal crops is an indication that this is the direction that demonstration farm efforts should take.

The PIVs are not financially viable and not are unreplicable, for the crop mixes that were tried. This is based on the assumption that production would be carried out in both the rainy and dry seasons to achieve a crop intensity after five years of 1.5 (it is currently 0.7 and has actually been declining in recent years with less and less dry season maize and vegetable production; see Agronomy Annex for details).

The crop mixes tried include the current mix of 60% rice, 20% maize and 20% sorghum grown during the rainy season, and 70%

maize and 30% onions during the dry season (dry season production was therefore allowed to increase to a level of 50% of the available irrigated area). The FIRR was found to be -7.6%. Rice production was not found to be viable due to high water use and cost (yields were assumed to be higher than those found anywhere in Africa or most of the rest of the world).

Since maize and sorghum showed promise of being better alternatives than rice, and onions proved highly profitable, even with a farm gate price of 50 FCFA/kg. (less than 50% of the reported farm gate price), a crop mix of 60% maize and 40% sorghum during the rainy season and 50% maize and 50% onions during the dry season was tied. This mix also did not prove to be financially viable (before financing FIRR of -1.2%) and this would not be expected to be a production system that would lead to replicable PIVs.

These results point to the need to do further research at the demonstration farm level and afterwards on-farm to find other high value cash crops that can be used alongside onions during the dry season to improve the profitability of PIV agriculture. These would need to be nonperishable, since marketing channels are not well developed at this time.

As well, further work need to be done to improve the profitability of grain production (rice, maize and sorghum), since these crops provide the basis of the local diet. Their production would not be expected to be dropped by farmers, although the prominent position of rice in the crop mix may not continue after SAED stops acting as a reliable purchaser of large quantities at a fixed price.

TABLE F.1

CURRENT IRRIGATED PRACTICES
ALTERNATIVE SORGHUM ASSUMPTIONS
RAINY AND DRY SEASON

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Current Technology				
	Rice	Maize	Sorghum	Onions-CS	Maize-CS
Yield, kg/ha	2700	1100	800 **	18000	1500
Value of crop / kg	82	80	80 **	50	80
Total value of crop	221400	88000	64000	900000	120000
Fert. kg/ha:					
Urea	150	100	0 **	300	150
18-46-0	150	100	0 **	300	150
KCl	0	0	0	0	0
Pesticide	2	0	0	0	0
Seed	150	20	4	0.4	20
F, S,& P inputs cost	46200	22000	240	62400	31400
Total Labor (Mandays	343	108	108	660	108
Hired labor cost	607	607	607	607	607
Hired Labor Cost	8498	2428	2428	15782	2428
Hired Traction	0	0	0	0	0
Water used, M3	7800	3600	3000	10700	8600
Water cost-VAR	43680	20160	16800	108070	86350
Total Prod'n costs	98378	44588	19468	186252	120688
Prod costs/crop valu	44.4	50.7	30.4	20.7	100.6
Net Income per:					
Hectare	123022	43412	44532	713748	-688
MD Family Labor	374	417	428	1125	-7

TABLE F.2

CURRENT RAINFED PRACTICES

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Current Technology		
	Rice	Maize	Sorghum
Yield, kg/ha	850	850	700
Value of crop / kg	100	80	60
Total value of crop	85000	68000	42000
Fert. kg/ha:			
Urea	0	0	0
18-46-0	0	0	0
KCl	0	0	0
Pesticide	0	0	0
Seed	10	4	4
F, S,& P inputs cost	800	320	320
Total Labor (Mandays	110	70	90
Hired labor cost	607	607	607
Hired Labor Cost	2428	1214	1821
Hired Traction	0	0	0
Total Prod'n costs	3228	1534	2141
Net Income per:			
Hectare	81772	66466	39859
MD Family Labor	743	950	443

Data Sources:
Reeser, Mar. 1990
Brusberg, Mar. 1990
Unpublished Socio-Eco. Monitoring Data
Keita, 1983; 1986
Dames & Moore, 1990

TABLE F.3

IMPROVED IRRIGATION PRACTICES
ALTERNATIVE RAINY AND DRY SEASON CROPS
BAKEL DELEGATION

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Improved Technology				
	Rice	Maize	Sorghum	Onions	Maize
Yield, kg/ha	4000	2500	2000	28000	2500
Value of crop / kg	82	80	80	50	80
Total value of crop	328000	200000	160000	1400000	200000
Fert. kg/ha:					
Urea	200	200	150	350	200
18-46-0	200	150	100	350	150
KCl	100	50	50	100	50
Pesticide	2	0	0	0	0
Seed	150	20	4	0.4	20
F, S,& P inputs cost	64600	40650	28290	80800	40650
Labor, Mandays	177	108	108	660	108
Hired labor cost	4249	2428	2428	36420	2428
Hired Traction	30000	20000	20000	20000	20000
Water used, M3	21000	6000	5000	15000	11000
Water cost	117600	33600	28000	151500	111100
Total Prod'n costs	216449	96678	78718	288720	174178
Prod costs/crop valu	66.0	48.3	49.2	20.6	87.1
Net Income per:					
Hectare	111551	103322	81282	1111280	25822
MD Family Labor	684	993	782	1753	248
M3 of water	5	17	16	74	2

TABLE F.4

INCOME ABOVE PUMP AMORTIZATION COSTS
ALTERNATIVE RAINY AND DRY SEASON (CS) CROPS
IMPROVED IRRIGATED PRACTICES-BAKEL DEL.

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Improved Technology				
	Rice	Maize	Sorghum	Onions-CS	Maize-CS
Yield, kg/ha	4000	2500	2000	28000	2500
Value of crop / kg	82	80	80	50	80
Total value of crop	328000	200000	160000	1400000	200000
Fert. kg/ha:					
Urea	200	200	150	350	200
18-46-0	200	150	100	350	150
KCl	100	50	50	100	50
Pesticide	2	0	0	0	0
Seed	150	20	4	0.4	20
F, S,& P inputs cost	64600	40650	28290	80800	40650
Labor, Mandays	177	108	108	660	108
Hired labor cost	4249	2428	2428	36420	2428
Hired Traction	30000	20000	20000	20000	20000
Water used, M3	21000	6000	5000	15000	11000
Water cost-VARIABLE	117600	33600	28000	151500	111100
Water cost-FIXED	256200	73200	61000	222000	162800
Total Prod'n costs	472649	159878	139718	510720	336978
Prod costs/crop valu	144.1	84.9	87.3	36.5	168.5
Net Income per:					
Hectare	-144649	30122	20282	889280	-136978
MD Family Labor	-851	290	195	1403	-1317
M3 of water	-7	5	4	59	-12

TABLE F.5

YIELDS NEEDED FOR INCOME ABOVE OPPORTUNITY COSTS
PUMP AMORTIZATION COSTS INCLUDED
ALTERNATIVE COMPARED TO OPPORTUNITY
IMPROVED IRRIGATED PRACTICES-BAKEL DEL.

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Improved Technology				
	Rice	Maize	Sorghum	Onions-CS	Maize-CS
Yield, kg/ha	6700	2700	2350	28000	4800
Value of crop / kg	82	80	80	50	80
Total value of crop	549400	216000	188000	1400000	384000
Fert. kg/ha:					
Urea	200	200	150	350	200
18-46-0	200	150	100	350	150
KCl	100	50	50	100	50
Pesticide	2	0	0	0	0
Seed	150	20	4	0.4	20
F, S,& P inputs cost	64600	40650	28290	80800	40650
Labor, Mandays	177	108	108	650	108
Hired labor cost	4249	2428	2428	36420	2428
Hired Traction	30000	20000	20000	20000	20000
Water used, M3	21000	6000	5000	15000	11000
FIXED & VAR. Costs	373800	106800	89000	373500	273900
Total Prod'n costs	472649	169878	139718	510720	336978
Prod costs/crop valu	86.0	78.6	74.3	36.5	87.8
Net Income per:					
Hectare	76751	46122	48282	889280	47022
Manday of labor	431	443	464	1403	452
M3 of water	4	8	10	59	4

TABLE F.6

FIRST FIVE YEARS -ALTERNATIVE IRRIGATED CROPS
RAINY AND DRY SEASON
WITH LABOR VALUED AT OPP. COST

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Improved Technology				
	Rice	Maize	Sorghum	Onions-CS	Maize-CS
Yield, kg/ha	3100	1500	1400	18000	1500
Value of crop / kg	82	80	80	50	80
Total value of crop	254200	120000	112000	900000	120000
Fert. kg/ha:					
Urea	150	150	100	300	150
18-46-0	150	100	100	300	100
KCl	50	0	0	0	0
Pesticide	2	0	0	0	0
Seed	150	20	4	0.4	20
F, S,& P inputs cost	50700	26750	19040	62400	26750
Labor, Mandays	177	108	108	660	108
Hired labor cost	443	443	443	443	443
Total Labor Cost	78411	47844	47844	292380	47844
Hired Traction	30000	20000	20000	20000	20000
Water used, M3	15000	4000	3000	11000	9000
Water cost-VAR	84000	22400	16800	111100	90900
Total Prod'n costs	243111	116994	103684	485880	185494
Prod costs/crop valu	95.6	97.5	92.6	54.0	154.6
Net Income per:					
Hectare	11089	3006	8316	414120	-65494
Manday of labor	63	28	77	633	-606

TABLE F.7.

SECOND FIVE YEARS -ALTERNATIVE IRRIGATED CROPS
RAINY AND DRY SEASON
WITH LABOR VALUED AT OPP. COST

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Improved Technology				
	Rice	Maize	Sorghum	Onions-CS	Maize-CS
Yield, kg/ha	3600	2000	1900	23000	2000
Value of crop / kg	82	80	80	50	80
Total value of crop	295200	160000	152000	1150000	160000
Fert. kg/ha:					
Urea	200	150	150	300	150
18-46-0	150	150	100	300	150
KCl	1	50	50	50	50
Pesticide	2	0	0	0	0
Seed	150	20	4	0.4	20
F, S,& P inputs cost	51040	35900	28290	66900	35900
Labor, Mandays	177	108	108	660	108
Hired labor cost	443	443	443	443	443
Total Labor Cost	78411	47844	47844	292380	47844
Hired Traction	30000	20000	20000	20000	20000
Water used, M3	18000	5000	4000	13000	10000
Water Costs-VAR	100800	28000	22400	131300	101000
Total Prod'n costs	260251	131744	118534	510580	204744
Prod costs/crop valu	88.2	82.3	78.0	44.4	128.0
Net Income per:					
Hectare	34949	28256	33466	639420	-44744
Manday of labor	197	262	310	1009	-414

TABLE F.8

THIRD FIVE YEARS -ALTERNATIVE IRRIGATED CROPS
RAINY AND DRY SEASON
WITH LABOR VALUED AT OPP. COST

(Per HA./Per Crop)
(Quantities in Kg, Values in FCFA)

	Improved Technology				
	Rice	Maize	Sorghum	Onions-CS	Maize-CS
Yield, kg/ha	4100	2500	2400	28000	2500
Value of crop / kg	82	80	80	50	80
Total value of crop	336200	200000	192000	1400000	200000
Fert. kg/ha:					
Urea	200	200	150	350	200
18-46-0	200	150	150	350	150
KCl	100	50	50	100	50
Pesticide	2	0	0	0	0
Seed	150	20	4	0.4	20
F, S,& P inputs cost	64600	40650	32940	80800	40650
Labor, Mandays	177	108	108	660	108
Hired labor cost	443	443	443	443	443
Total Labor Cost	78411	47844	47844	292380	47844
Hired Traction	30000	20000	20000	20000	20000
Water used, M3	21000	6000	5000	15000	11000
Water Costs-VAR	117600	33600	28000	151500	111100
Total Prod'n costs	290611	142094	128784	544680	219594
Prod costs/crop valu	86.4	71.0	67.1	38.9	109.8
Net Income per:					
Hectare	45589	57906	63216	855320	-19594
Manday of labor	258	536	585	1296	-181

TABLE F.9

FINANCIAL ANALYSIS
CONSTRUCTION PROVIDED BY PROJECT
FROM PERSPECTIVE OF GROUPEMENT

All costs in thousands of F CFA

Costs and Benefits	Cost, (FCFA/HA.)	Useful Life,yrs	P 0	P 1
INVESTMENT COSTS				
Registration/Amort. Account	1200		1323	
Land Clearing	24000		26460	
Prelim/final studies/design	0	15	0	
Materials for construction	40700		44872	
Construction	0	15	0	
GMP and pipes	191900	8	211570	
Final land leveling	0	8	0	
Bunds	0	8	0	
Purchase of GMP	346600	8	382127	
TOTAL INVESTMENT COSTS	604400		666351	0
ANNUAL OPERATING COSTS				
Maintenance & Repair of GMP	800	1	0	costed
Fuel, oil, salaries for GMP	1800	1	0	elsewhere
Maint. & Repair of Canals	500	1	0	"
TOTAL OPERATING COSTS	3100		0	"
TOTAL COSTS BY YEARS	260900		1332702	0
Net Income above labor value			0	27178
Benefit Years 1-5	27178			0
Benefit Years 6-10	113566			0
Benefit Years 11-15	173018			0
TOTAL BENEFITS per year			0	27178
Net Benefits/CASH FLOW			-1332702	27178
Cash Flow, Discounted at	-2.58	Percent	-1332702	27898
Cumulated PV of Cash Flow	-1034			
Internal Rate of Return, Estimated		-2.58 Percent		
Internal Rate of Return	-0.0258625	Percent by @IRR function		
Internal Rate of Return	-2.58	Percent by Iterative Calcul		

TABLE F.10

REPLICABILITY EVALUATION
FINANCIAL ANALYSIS
FROM PERSPECTIVE OF GROUPEMENT

All costs in thousands of F CFA

Costs and Benefits	Cost, (FCFA/HA.)	Useful Life,yrs	INITIAL INVESTMENT	TIME PERIOD ONE 1
INVESTMENT COSTS				
Registration/Amort. Account	1200		1323	
Land Clearing	24000		26450	
Prelim/final studies/design	0	15	0	
Materials for construction	40700		44872	
Construction	230000	15	253575	
GMP and pipes	191900	8	211570	
Final land leveling	100000	8	110250	
Bunds	72400	8	79821	
Purchase of GMP	346600	8	382127	
TOTAL INVESTMENT COSTS	1006800		1109997	0
ANNUAL OPERATING COSTS				
Maintenance & Repair of GMP	800	1	0	costed
Fuel, oil, salaries for GMP	1800	1	0	elsewhere
Maint. & Repair of Canals	500	1	0	"
TOTAL OPERATING COSTS	3100		0	"
TOTAL COSTS BY YEARS	663300		2219994	0
Net Income above labor value			0	27178
Benefit Years 1-5	27178			0
Benefit Years 6-10	113565			0
Benefit Years 11-15	173019			0
TOTAL BENEFITS per year			0	27178
Net Benefits/CASH FLOW			-2219994	27178
Cash Flow, Discounted at	-7.64	Percent	-2219994	29428
Cumulated PV of Cash Flow	-1145			
Internal Rate of Return, Estimated		-7.6	Percent	
Internal Rate of Return	-0.0764056	Percent	by @IRR function	
Internal Rate of Return	-7.64	Percent	by Iterative Calcul	

TABLE F.11

FINANCIAL ANALYSIS
IMPROVED CROP MIX
FROM PERSPECTIVE OF GROUPEMENT

Costs and Benefits	Cost, (FCFA/HA.)	Useful Life,yrs	INITIAL INVESTMENT	TIME PERIOD ONE
INVESTMENT COSTS				
Registration/Amort. Account	1200		1323	
Land Clearing	24000		26460	
Prelim/final studies/design	0	15	0	
Materials for construction	40700		44872	
Construction	230000	15	253575	
GMP and pipes	191900	8	211570	
Final land leveling	100000	8	110250	
Bunds	72400	8	79821	
Purchase of GMP	346600	8	382127	
TOTAL INVESTMENT COSTS	1006800		1109997	0
ANNUAL OPERATING COSTS				
Maintenance & Repair of GMP	800	1	0	costed
Fuel, oil, salaries for GMP	1800	1	0	elsewhere
Maint. & Repair of Canals	500	1	0	"
TOTAL OPERATING COSTS	3100		0	"
TOTAL COSTS BY YEARS	663300		2219994	0
Net Income above labor value			0	48809
Benefit Years 1-5	48809			0
Benefit Years 6-10	214987			0
Benefit Years 11-15	282822			0
TOTAL BENEFITS per year			0	48809
Net Benefits/CASH FLOW			-2219994	48809
Cash Flow, Discounted at	-1.165	Percent	-2219994	49384
Cumulated PV of Cash Flow	-201			
Internal Rate of Return, Estimated		0	Percent	
Internal Rate of Return	-0.0116579	Percent	by @IRR	
Internal Rate of Return	-1.165	%	by iteration	

The crop mix is 60% maize and 40% sorghum in the rainy season and 50% maize and 50% onions in the cold dry season. The cropping intensity goes from 0.9-1.5 over the project life.

TABLE F.12

FINANCIAL ANALYSIS
DRIP IRRIGATION

Costs and Benefits	Cost, (FCFA/HA.)	Useful Life,yrs	INITIAL INVESTMENT	TIME PERIOD ONE
INVESTMENT COSTS				
Registration/Amort. Account	1200		1323	
Land Clearing	24000		26460	
Contingency +10%	150000	20	150000	
Materials for construction	40700		44872	
Construction	275000	20	275000	
GMP and pipes	76760	10	84628	
PVC, Filters, etc.	558000	20	558000	
Tubing	333000	10	333000	
Purchase of GMP	138640	10	152851	
TOTAL INVESTMENT COSTS	1597300		1761023	0
ANNUAL OPERATING COSTS				
Maintenance & Repair of GMP	800	1	0	costed
Fuel, oil, salaries for GMP	1800	1	0	elsewhere
Maint. & Repair of Canals	500	1	0	"
TOTAL OPERATING COSTS	3100		0	"
TOTAL COSTS BY YEARS	1461760		1626133	0
Net Income above labor value			0	47831
Benefit Years 1-5	47831			0
Benefit Years 6-10	297182			0
Benefit Years 11-20	437807			0
TOTAL BENEFITS per year			0	47831
Net Benefits/CASH FLOW			-1626133	47831
Cash Flow, Discounted at	5.33	Percent	-1626133	45411
Cumulated PV of Cash Flow	1197			
Internal Rate of Return, Estimated		5.33	Percent	
Internal Rate of Return	0.05307888	Percent by @IRR		
Internal Rate of Return	5.33	% by iteration		

The crop mix is 60% maize and 40% sorgho in the rainy season and 50% maize and 50% onions in the cold dry season. The crop intensity goes from 0.9-1.5 over the 20 YR. project life.

TABLE F.13 DRIP IRRIGATION GMP INVESTMENT & OPERATING COSTS

ITEM				Rainy Season	Dry Season
GMP SPECIFICATIONS					
Motor: make, model, size		1 Lister HR-3			
Pump: make, model, size		C-R			
Rated pump output, M3/hr	B	352			
Operating head in Rainy/Dry season, M	B			7	16
Pump output in Rainy/Dry Season,M3/hr	B			352	290
Pump Efficiency	H			0.56	0.71
Brake HP hrs/liter of fuel		4.45	(default	4.45	4.45
GMP INVESTMENT COSTS (FCFA)					
Motor and Pump	S,B	6,932,000			
Float Set	S,B	1,125,000			
Suction & Discharge Pipes	S,B	394,000			
PVC - 160 meters	S,B	2,000,000			
Transport/Installation	S,B	319,000			
Civil Engr Works for Water	S	865,000			
TOTAL GMP INVESTMENT COST,FCFA		10,770,000			
GMP AMORTIZATION BREAKDOWN					
Hrs of service (pipes 2x)	S,C	8,000			
Amortization of GMP/hr		1,346			
Amortization of repair costs/hr		619			
Amortization of pipes/hr		179			
Amortization per hour		2,145			
FIXED COSTS or Amortization / M3 of water pumped,				6.09	7.40
GMP OPERATING COSTS					
Fuel used per hour, liters	H			3.65	5.43
Fuel cost/liter, 1990 price		210			
GMP fuel cost per hour				767.48	1139.91
GMP oil + lube, % of fuel cost	S,H		17	130.47	193.79
GMP routine maintenance, % of fu		H	6	46.05	68.39
Pompiste salary as % of fuel cost			6	46.05	68.39
VARIABLE (Operating) COSTS PER HOUR OF PUMPING				990.04	1470.49
VARIABLE COSTS / M3 WATER PUMPED, Rainy/Dry season				2.81	5.07
FIXED + VAR. COST OF WATER PER M3 PUMPED				8.91	12.47
Assumed water conveyance efficiency, percent ********				95	95
Water delivered to field, M3/hour, Rainy/dry season				334	276
VAR. COSTS PER M3 DEL'D TO FIELD, Rainy/Dry season				2.96	5.34
FIXED COSTS PER M3 DEL'D TO FIELD, Rainy/Dry season				6.41	7.78
FIXED + VAR. COST OF WATER PER M3 DELIVERED:				9.37	13.12

Sources of data:
S =SAED data, H = Harza engineers, K = Keita
B = ESIP EOP report, C = Evaluation Team

ANNEX G

PRIVATE SECTOR ANNEX

ANNEX G

PRIVATE SECTOR ANNEX

I. INTRODUCTION

A. Objectives of the Private Sector Evaluation

i. Re-examine the project goal
    a. significantly expand the role of the private sector
ii. Identify alternative objectives
iii. Determine if project assumptions and targets are realistic
iv. Identify the constraints to implementation
v. Examine actions taken to promote the private sector
vi. Compare results with progress indicators of PP
vi. Assess SAED's capacity for oversight of private contracting
vii. Make recommendations
    a. achievable objectives
    b. actions to be taken

B. Project Private Sector Objectives

1. Expanding and Encouraging Private Sector Participation

The Project Paper (PP) for the Irrigation and Water Management I Project called for the expansion and improvement of village level irrigated farming in the Bakel Delegation and the encouragement of private sector participation that can be replicated throughout the Senegal River Valley. It called for the construction and rehabilitation (C&R) of 800 and 400 hectares, respectively, during the life of the project.

The PP anticipated the involvement of the private sector in all facets of project implementation; design and construction, as well as PIV operation and maintenance functions, and the provision of services to the agricultural sector. These activities are to be progressively taken on by the private sector as SAED is divested of these functions (ostensibly, those agricultural services related to irrigated crop production in the "Perimetres Irrigues Villageois" (PIVs) developed under the project).

The private sector could take the form of private individuals, "groupement" or "Groupement d'Interet Economique" (GIE) of farmers or private companies,

i.e., any non-governmental, non-parastatal or non-public entity.

How these objectives were to be pursued was not specified at the start of the project and a strategy was to be developed over time, this being one of the goals of the project given to the technical assistance team.

3. Project Paper Assumptions

In the mid-term evaluation of the predecessor project to IWM-I, Bakel Small Irrigation Perimeters (BSIP), the quality of design and construction done by the Government of Senegal's (GOS) development agency for the Senegal River valley, the "Societe d'Amenagement et d'Exploitation des Terres au Delta du Fleuve Senegal" (SAED) was criticized and it was recommended that future programs involve the private sector. This led to specific recommendations regarding the involvement of the private sector in the follow-on project, IWM-I. These included the following assumptions which were explicitly incorporated into the design of the current project:

a. Private Sector Involvement in Perimeter Construction

The recommendation that the private sector be involved in perimeter construction was based on the assumption that local contractors exist and would be able to construct irrigation perimeters in the Bakel Delegation.

b. Private Sector Involvement in Agricultural Services

It was also assumed that the private sector would eventually become involved in the provision of the full range of agricultural services, from the sale of inputs to the purchase of farm produce, as well as such activities as perimeter maintenance, tractor services, pump repair, and transport.

c. Replication of Private Sector Involvement

Lastly, it was assumed that the private sector involvement in the development of PIVs and PIV crop production activities would provide a model that would be replicated throughout the Senegal River Valley.

How realistic these goals are was recently called into question by the USAID internal audit carried out in 1989. The capacity of the private sector to produce replicable prototype PIVs is not clear. As well, there is concern that private sector involvement cannot be counted on due to the lack of a specified mechanism within the project to increase and strengthen the private sector.

4. Historical Background

a. Disengagement of SAED

The agricultural policy of the GOS calls for changing the role of SAED from an agency responsible for all aspects of irrigation development, to a planning and extension agency, meant to encourage and counsel the development of irrigated agriculture through the private sector. Its original responsibilities included design and construction, input and credit provision, land preparation services, pump repair, and marketing as the sole purchaser, processor and marketer of rice.

The GOS has begun to eliminate some of the historical roles of SAED. It no longer provides credit, sells production inputs, or is the sole marketer of rice. The private sector is supposed to fill the void created by the divestiture of SAED's responsibilities. This is to be propelled by opportunities created by the increased profitability of irrigated agriculture that will accompany the full functioning of the Manatali and Diama Dams.

b. Recent Project History - Construction and Rehabilitation (C&R)

Although the Grant Agreement for IWM-I was signed between USAID and SAED in 1985, the technical assistance (TA) contract with Harza Engineering was not signed until April 5, 1988.

During 1986 to 1988, USAID funded the construction of 239 hectares and the rehabilitation of 50 hectares by SAED. Although perimeter design was judged to be adequate, construction was found to be substandard. Consequently, in 1989 USAID informed SAED and the Harza TA team that funding of future C&R would be conditional upon USAID approval of:

(i) SAED design and construction standards
(ii) A SAED private sector strategy

These conditions were meant to ensure that SAED began to fulfill its mandate to encourage private sector participation in perimeter design and C&R, as well as in the provision of agricultural services. These conditions have not been met. The construction of 122 hectares has taken place in 1989, funded by the GOS without USAID assistance and, thus, outside of the project.

B. THE PRIVATE SECTOR CONSTRUCTION & REHABILITATION STRATEGY

No C&R has taken place under the contract since the arrival of the TA team. The inability to achieve any new C&R can be traced in large part to a stalemate over a private sector strategy (PSS) for C&R. The stated positions of SAED, USAID and Harza are:

1. The Strategies of Parties Involved

a. The SAED Position

After one week of the two week visit of the Evaluation Team in May, 1990 to Bakel, SAED presented its PSS to USAID and the evaluation team. SAED wants new construction of PIVs to take place in the Bakel Delegation, as well as rehabilitation of existing PIVs. Although it acknowledges the eventual need for C&R to be done with local resources, it recommends using the Dakar firms that work regularly in the other delegations along the Senegal River during the transition phase to prevent a rupture in the increase of PIV area under production. SAED wants responsibility for oversight of construction. It recommends this strategy since it maintains that no local firm has the equipment or experience to build PIVs.

b. The USAID Position

AID does not want new construction, but has been recommending rehabilitation of existing PIVs. It wants the local private sector to have a significant input into any construction work that takes place under the project. However, it recognizes that the local capacity to meet all of the necessary technical requirements of the work may not exist at the present time, as one of the primary objectives of the project is to encourage the development of the private sector. It also

recognizes that the functioning of the PIVs is far from optimal, due to the low quality of construction, poor maintenance and production practices that make farmers' (financial) profitability questionable.

USAID has recommended rehabilitation of existing PIVs to take place with input from as many local resources as possible. In this way, the local private sector can gain PIV construction experience. It is agreeable that SAED/Bakel can maintain its responsibility for design and construction oversight for the time being.

c. The Harza Position

Harza has developed its own program for the construction and rehabilitation (C&R) of the PIVs that is based on the premise that AID would not agree for SAED to be involved directly in the engineering or design aspect of C&R in any way, or agree to a Dakar or St. Louis based firm carrying out construction. The Harza program entails the development of a new locally based private firm.

The TA team has prepared a proposal for such a locally based construction firm called "Societe d'Amenagement a Bakel" (SAB), that would carry out the design and construction, maintenance, and rehabilitation of PIVs.

This enterprise, which would be owned and staffed by Senegalese, has many laudable aspects and if realized could accomplish some of the important privatization goals of the project. It could develop local engineering expertise that would exist after the life of the project. As well, it could involve PIV farmers in many aspects of the work, from design to construction. Farmers could be used as unskilled labor and thus gain experience that would help them to better maintain perimeter structures and canals in the future. (Since the details of the SAB approach is not the concern here, this is evaluated in the following section).

d. Communication between AID, SAED and Harza

Apparently, Harza does not understand the positions of SAED and USAID, and this appears to be due to a lack of communication and good working relations with both. Harza, of course, cannot be

blamed for the existing situation entirely, but the Chief Of Party (COP) may take responsibility for not taking enough initiative to remedy the problem.

e. A Strategy to Break the Impasse

The Harza SAB plan calls for USAID to fund the loan made to the company to get started, and for the TA team and SAED to provide a considerable amount of time to help the firm to get organized and to begin to function properly. Harza foresees that financial and technical assistance could be phased out after five years, beyond the end of the project intervention period. Harza would administer the loan and pay for the rehabilitation work done under the project with project funds.

In an apparent oversight, this proposed private firm would have the advantage of relying on donor funds to become established without any initial investment by the ownership. An initial investment could, of course, be required to create an incentive on the part of the owner to make the firm successful.

Instilling the motivation to meet obligations when donor (or government) funds are involved is not easily accomplished. It is difficult to overcome the perception that such funds are a gift that does not have to be paid back or can be squandered. As well,the donor is often viewed as a source of more funds if work is not done on schedule or budget over-runs occur. Finally, embezzlement of such funds is common. Maintaining tight control of these funds would be a full-time job.

Whether the effort that would be required of the TA team to make this scheme successful would be the best use of TA time is another issue that calls this strategy into question. The TA team has responsibility to train its SAED counterparts so that after the project improved capacity on the part of SAED will exist to carry out its newly defined role of planning and extension. One of the serious weaknesses in the performance of the TA team has been its inability to develop effective counterpart relationships and to provide appropriate and effective homologue training.

The local capacity to carry out construction is extremely limited, if not nonexistent at this time. There is tenuous evidence of only one local construction firm (Tandia Enterprise) that may have the resources to undertake PIV R&C. Substantial technical assistance in all aspects of the work, especially design would be required. The only alternative uncovered during the evaluation would be to use the privatized construction branch of SAED, Regie. This will be owned and staffed by SAED employees who will lose their jobs when Regie is closed. They are reported to be planning to form a private firm and purchase used SAED equipment.

The project assumption regarding the potential of the private sector at Bakel to play a significant role in PIV design, construction and rehabilitation is unrealistic. SAED is the only local entity that can carry out this function and then only with technical assistance.

C. THE PRIVATE SECTOR STRATEGIES (PSS) FOR AGRICULTURAL SERVICES

1. The Strategy of SAED

In a cursory document, SAED outlines its strategy for the promotion and encouragement of the private sector in the provision of agricultural services. In brief, the document calls for farmers to organize themselves, as best they can, to get credit to make the necessary purchases.

a. Inputs and Gas Oil

To purchase production inputs and gas oil, it recommends that farmers organize through their existing "groupements" as GIEs or otherwise as associations, youth groups, etc., to qualify for and obtain credit from the "Caisse Nationale de Credit Agricole du Senegal" (CNCAS).

b. Tractor Services

To take care of land preparation, it suggests that credit be extended to those "groupements" that are better organized and have the best credit history. It suggests that other "groupements" can hire these services from those who get credit and buy the equipment. It also suggests that farmers organize themselves into "Sections d'Utilisation

du Materiel Agricole" (SUMAs), as is done down-river at Nianga in the Podor Delegation.

c. Pump Repair and Maintenance

The document only touches briefly on this crucial aspect of PIV viability. It suggests that since SAED pump technicians are about to lose their jobs, they should organize themselves as an enterprise and offer their services to the "groupements".

In essence, the SAED document is not a strategy at all. Although it can be criticized from many angles, it does point to the possibility that there is little potential for private sector involvement in PIV agriculture at the present time, and may remain so until agricultural production is improved and results in increased marketed surplus. This is borne out by the work of van Leeuwen, the Privatization Specialist, who was commissioned by Harza to develop options for privatization.

2. Harza's Agricultural Strategy for the Private Sector

Harza was asked to assist Saed in its efforts to develop a PSS. Harza developed a fairly detailed and well-thought out plan based on the roles and responsibilities that SAED will be progressively adopting as the downsizing of its staff and its disengagement from its historical roles take place. The plan contains many ideas that would be useful as the project is modified and evolves, and the role of SAED evolves to that of a planning and extension agency.

a. Liaison Role with the Private Sector

The Harza plan calls for SAED to build on its present activities and designate a liaison person to help establish contact between the "groupements" and support service industry representatives. This person's role would be to assist farmers and "groupements" to gain access to credit, production inputs, etc. This liaison person would also be in contact with a SAED/St. Louis liaison person, who could relay information concerning the various private sector contacts already established in the other delegations.

The SAED liaison person, and his TA counterpart, would make a survey of other projects in Senegal which are attempting to encourage or sponsor private sector participation in supply of

agricultural materials and services. An example of this is Catholic Relief Services (CRS), which is involved in small business development in the Casamance.

In addition, it is foreseen that SAED staff, would act as advisors and participate in private sector activities with the TA team. Although it is not specified, this is taken to mean activities like small business development activities, such as those carried out by CRS.

Whether the current Harza staff has the technical expertise to provide this kind of assistance is not known. The current Administrative Officer has the educational background and the expressed interest to do this kind of work.

b. Expansion of SAED's Extension Activities

Harza recommends that SAED's extension role be emphasized by providing technical training to farmers and "groupements" to improve all aspects of irrigated production, and to "groupement" management to improve the effectiveness of their organization with the goal of encouraging the assimilation of "Perimetre Irrigue Commercial" (PIC) management techniques for their PIVs (see the analysis of the Harza PIV/PIC Discussion Paper in the Training and Extension Section of the Sociological Annex).

c. Agro-Business Extension

Harza suggests that the third aspect of extension is outside of SAED's institutional authority and should therefore be carried out under the project. This is small agribusiness TA support. Harza recommends that this technical support target the following agribusiness support activities.

(i) Grande Agricole a Bakel (GAB)

Harza suggests starting a farm store. The store would overcome the lack of interest on the part local merchants in stocking most agricultural supplies and equipment. Furthermore, it would circumvent the fact that individual Dakar suppliers cannot afford to set up shop and keep inventory at Bakel.

The enterprise would need technical assistance to arrange financing, the logistics of supply, and to organize the management of the business. Harza maintains that eventually it would either run on its own or be absorbed by local merchants who would by then recognize the value of offering such a service.

Who would undertake the investment of personal resources and effort to start the GAB has not been specified by Harza. If USAID, through the project, was to provide the financing, the same potential problems as those that surround the SAB can be envisioned.

(ii) Local Banking Institution

Harza also envisions the need for the establishment of a banking institution at Bakel, that would provide credit and hold the savings of farmers and "groupements". It sees the encouragement of this as a legitimate role for the project small agro-business extension effort. The SAED/Harza team would work closely with the Bakel institution. The team would insure that the enterprises of the bank's clients are technically sound and that the clients are fully aware of the responsibilities and terms involved in accepting a loan.

Credit can be placed in the same category as the GAB described above. It is thoroughly documented that credit programs without a profitable technology have not been successful anywhere in the world. In most cases, if a profitable production activity is introduced to farmers, they will not need credit, but will spontaneously adopt the technology with their own resources (Univ. of Ohio). There is also ample evidence provided by the Socio-economic Monitoring System of the project that the level of remittances from "emigres" or migrants to most families in the Bakel is very high. It was found to average around US$100/month to the families in the sample survey carried out.

iii. Cooperative Agricole a Bakel (CAB)

Harza recommends supporting an organization which is capable of marketing surplus produce. Extension assistance would help the marketing entity to work with the "groupements" in the production and marketing phases in order to communicate market needs to the growers and plan the "flow of produce."

This entity has been called "Cooperative Agricole a Bakel" (CAB) by Harza. Harza recommends that a marketing entity such as the CAB is needed until the "groupements" mature in the Bakel region. It would be intended to become either self-supporting or would eventually become a private enterprise. As well, it is envisioned that the organization would not restrict its activity to only irrigated crops. It is also suggested that it would also be useful in finding market outlets for high value cash crops.

Cooperatives that function well are the white elephants of Africa. One of the major stumbling blocks is getting the members to abide by their marketing agreements and sell through the cooperative (coop) when they find a higher price on their own (also a problem in the U.S.). As well, it has too often been found that either those put in charge take advantage of their position to the detriment of the coop. There are also too many cases in which coop officers steal the profits or are believed to, since they are often the only ones who read and write.

D. THE CONSTRAINTS TO PRIVATIZATION

1. Local Capability

The Privatization Specialist, van Leeuwen, surveyed the potential for the private sector to fill the void created by the on-going disengagement of SAED. Without saying so explicitly, his recommended strategy underlines the lack of potential found. In the case of most of the services considered by van Leeuwen, he recommends, as did SAED, that laid off SAED staff be assisted to start a private enterprise to continue to do the job they do at the present time under employment to SAED. This includes the tractor services, the pump repair services, and the engineering services involved in perimeter design.

a. Pump Repair

Local capacity to maintain pumps is very limited. A repair shop belonging to SAED is operational, as well as one belonging to the "Federation des Organisations Non-Gouvernementales Senegalese" (the Federation or FONGS).

A survey of the facilities available in Bakel was undertaken by visiting all of the automobile repair facilities in town. Although, simple

maintenance and repairs could be undertaken, rebuilding pumps cannot be done since the necessary machinery to re-grind pistons and cylinder heads does not exist.

b. Tractor Services

The evaluation team found two groups of local entrepreneurs who are interested and have taken steps to get credit to purchase tractors to provide land preparation services. The team was able to meet one of the partners of one of these teams that has formed a GIE to obtain credit. This group is being assisted by SAED/Harza staff to make the arrangements to obtain a loan.

Detailed discussions with this individual showed that he is not convinced of the profitability of such an enterprise at Bakel and has a backup plan to move the tractor for most of the land preparation period to Matam, where there is more potential to find clients.

The individual interviewed knows the proposed plan for privatization of the SAED tractor services outlined by van Leeuwen. He feels that this analysis was over-optimistic and based on false assumptions such as the ability to find work transporting goods during the off-season; there is little produce to move during that time.

2. Preconditions for Credit

The constraints to obtaining credit are not addressed in the SAED Private Sector Strategy (PSS). It recommends that access to credit be facilitated for those who are most deemed creditworthy, but it does not specify who fits this definition or how it should be facilitated.

Many farmers and "groupements" are indebted to SAED at this time and cannot get credit without signing a moratorium that acknowledges responsibility for this debt and includes a promise to pay. Although SAED no longer provides credit, it must give its approval to all credit applications.

Poor PIV design and construction have been major contributing factors leading to the lack of profitable irrigated production and the inability of farmers to pay their debts incurred with SAED. Farmers should not have to pay for services that have not been competently provided and have led to the nonviability of their PIVs.

E. MARKETING OF CROP PRODUCTION

1. SAED's Role

It was reported in USAID documents that the "groupements" sell most of their marketable surplus in local markets and are reluctant to sell rice to SAED. They purportedly even transport some produce such as onions as far as the Tambacounda market, a distance of about 250 kilometers.

SAED still plays the major role in rice marketing in the region. It was repeatedly reported by farmers and "groupements" that SAED was the only reliable purchaser of appreciable quantities of rice. This was especially reported to be the case by more commercially oriented farmers who are responsible for most of the marketable surplus sold. They reported that it is possible to sell rice on the local market for up to 100 FCFA/kg., but only in small quantities. SAED purchases at 82 FCFA/kg. (not 85 FCFA/kg. as is often maintained).

2. The Existence of Other Marketing Opportunities

a. Trade Opportunities with Mali

(i) Rice

According to Quan, the short term marketing consultant engaged by Harza, Senegalese rice is sold on a regular basis at Kidira to Malians. He reports that Malians are attracted by a price of 140 FCFA/kg., as opposed to 180-200 FCFA/kg. in Mali. However, the quantities are very small, as Malians are only allowed to take one sack duty free over the border.

(ii) Vegetables

According to Quan, vegetables are brought to Kidira by Malians and sold during the months of March and April, after the "contre-saison chaude". The price is about 30% lower than local products (Quan).

The TA team assumes that a ready market exists for "contre-saison" production. This information provided by Quan contradicts this. Markets for vegetables, especially perishables, are often thin (i.e., not much demand) and one cannot assume that local production can be produced at lower cost or will be protected on the local market by transport cost differentials.

It also cannot be assumed that production and transport costs will not price local production out of important domestic markets. A thorough and systematic, although simple domestic resource cost analysis (using simple budgeting type techniques), needs to be done. Up until the present time, this is not being done.

F. CONCLUSIONS AND RECOMMENDATIONS

1. Lack of Communication between Harza, USAID and SAED

A serious lack of communication on the part of all the parties involved may be the most serious constraint facing accomplishment of project objectives. There is considerable friction, lack of trust and ill feelings. The monthly tripartite meetings do not seem to be remedying the situation.

Recommendation - The AID Project Officer should make bi-monthly visits of reasonable length, such as two full days at the project site, to conduct discussions and resolve problems.

2. The Private Sector's Role in Construction and Rehabilitation (C&R)

The local capacity to carry out construction is extremely limited, if not nonexistent at this time. The local capacity to carry out PIV design is nonexistent. There is tenuous evidence of only one local construction firm that may have the resources to undertake PIV C&R (Enterprise Tandia), and then, only with substantial technical assistance in all aspects of the work, especially design.

The project assumption that private sector at Bakel would play a significant role in PIV design, construction and rehabilitation is unrealistic. SAED is the only local entity that can carry out the function of PIV design and then only with technical assistance.

Recommendation - If any more rehabilitation and construction (R&C) is to be done, SAED, with the assistance of the Harza TA team should continue the task of design for the two years remaining in the project. During this time, if a local construction firm is chosen to do the R&C, SAED/Harza should train the firm in PIV design.

3. Focusing on Encouraging the Development of the Private Sector

It has been assumed that the private sector will eventually become involved in the provision of the full range of agricultural services from the sale of inputs to the purchase of farm produce, as well as such activities as perimeter maintenance, tractor services, pump repair, and transport. It was also assumed that the private sector involvement in the development of PIVs and PIV crop production activities would provide a model that would be replicated throughout the Senegal River Valley.

Recommendation - It is premature to make major efforts to try to encourage the provision of agricultural services by the private sector in the Bakel Delegation. The demand for such services has to be developed first. Extensive and well documented experience from elsewhere in Africa and other parts of the world has shown that the place to start is the improvement of agricultural production. The supply of the needed services will develop spontaneously when farming is profitable and farmers are willing to pay for them.

4. Encouragement of the Extension Role of SAED

Farmers and "groupements" are the most important private sector entities involved in the project and are the project's main clients.

Recommendation - Harza recommends that SAED should expand its extension role to increase its contact with the farmers. This entails expansion of its role of technical assistance.

5. A Market for Vegetables

One cannot assume that vegetables can be produced at lower cost or will be protected on the local market by transport cost differentials. It also cannot be assumed that production and transport costs will not price local production out of important domestic markets.

Recommendation - A thorough and systematic, although simple domestic resource cost analysis, using Nominal Protection Coefficients (a simple, but powerful budgeting type technique), needs to be done.

6. Pre-conditions for Credit

Recommendation - The payment of outstanding debt to SAED should not be a precondition for obtaining credit from CNCAS, since poor construction of the PIVs by SAED makes it difficult to pay back loans. (This will in effect result in the forgiveness of this debt without explicitly doing so which would be unpalatable for SAED).

7. Special Opportunities for Encouraging Privatization

a. The Demonstration Farm

The Demonstration Farm provides an opportunity to show farmers productive practices that are also profitable by making the operations of the farm self-supporting. A beginning has already been made to bring this to realization by selling crop and livestock production such as multiplied rice and maize seed, dry season vegetables and broiler chickens. It would not be beyond the capacity of the farm to accomplish this fully over the next two years.

The goal of making the farm self-supporting, however, should not include the training and extension aspects of the farm. These can be legitimately be funded separately and should not be diminished, but strengthened over the rest of the project life. The demonstration function of the farm should also not be neglected, since it already has proven to be powerful. The farm cannot meet all of the demand for the improved rice and maize seed that it multiplies and the diffusion of these varieties in this way has occurred spontaneously.

b. The Prototype PIVs

Harza recommends that four prototype PIVs be established to act as on-farm demonstrations for the improved technologies tested on the demonstration farm. These would be supported by the technical assistance of SAED in conjunction with the TA project staff. The PIVs would be used in the extension program to bring other farmers to see what their neighbors have accomplished by adopting the new technological recommendations.

c. The Soninke Federation

The Federation is clearly the best example of private initiative found in the Bakel Delegation. It is a farmer group that is well-organized to provide services to its members on a cash basis. Indebtedness and dependency on the government and donors are strongly discouraged. It provides a full range of services from pump maintenance to land preparation to the provision of fertilizer.

The Federation is everything that the project goals call for in its objective to develop private enterprise in the provision of agricultural services. A way should be found to overcome the inability of SAED to work together with the Federation. This probably will not be accomplished, however, since the ideology of the Federation is self-reliance and it discourages farmers from depending on the government or donors for material assistance.

d. Animal Traction

Bovine traction would appear to be a naturally successful endeavor in this region, since farmers are already expert at raising cattle and there is a well developed market in which these animals can be purchased and sold. The profitability of this enterprise rests on this aspect far more than on the use of the animals to accomplish the land preparation of the small irrigated plots. However, studies in other similar regions in the Sahel show that this can be very profitable, can result in significant labor savings for farmers on their irrigated and rainfed fields, and in combination with other cash inputs such as fertilizer and improved seed, can lead to increased yields and profitability (O'Neill and Shapiro).