

FILE: Bailsa Dam

Senegal

PN-AAA-641

BN 44202

REVIEW TEAM REPORT
of the
PROGRAM FOR THE DEVELOPMENT
OF THE BAILS MARIGOT

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for

USAID/DAKAR
Dakar, Senegal

by

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and

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under

USDA/USAID PASA
PIO/T 685-0929.7-2-0009

May 1980

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PROGRAM FOR THE DEVELOPMENT
OF THE BAILA MARIGOT

INTRODUCTION

Senegal suffers from a chronic cereal deficit which entails rice imports approaching 200,000 tons annually. It is thought that the Lower Casamance Region, because of its favourable rainfall, alluvial soil deposits and good human resources has the agricultural potential to help overcome the large food deficits. However, salt intrusion into the lower lying marigots and the need for supplemental irrigation waters have been limiting factors in growing rice in those areas.

ILACO, a Dutch Firm, conducted experiments beginning in the early 1960's in the lower marigots to develop improved local techniques for growing rainfed rice under saline conditions. At the request of the Government of Senegal (GOS), ILACO also prepared documentation for the construction of saline intrusion control dikes and gates in the Nyassia and Guidel Marigots.

On the basis of the ILACO experiments, the GOS requested AID to finance a study for the construction of similar salt-intrusion control dikes and gates on the Baila Marigot. Louis Berger International, Inc. (The Consultant) was awarded the contract to conduct a study of a "Program for the Development of the Baila Marigot in Casamance".

Berger Interim Report

The Louis Berger interim report, Program for the Development of the Baila Marigot in Casamance, concerns an area of some 164,500 hectares located north of Ziguinchor. The objective of the contract was to prepare a feasibility study for the planning and development of an area which is believed to have an important potential for increased crop production, especially rice, under both irrigated and rainfed conditions.

The contractor work was to be performed in two phases, the first phase lasting 12 months, was to include (a) a detailed inventory of the area resources that would be important in the development program and (b) definition and comparison of several possible development schemes. During Phase II, lasting six months, the contractor is to make a detailed technical and economic feasibility study of the development scheme selected on the basis of the analyses carried out in Phase I.

The interim report in four volumes covers Phase I. It includes a report on the detailed investigations of the soils, water, vegetation, human and institutional resources of the project area and a description of present agricultural activities, services and infrastructure. Land use and tenure conditions were studied in detail and finally the report describes alternative schemes for the integrated development of the Baila Marigot basin. Volume I, Main Report, summarizes the findings in the above subject matter areas, describes the resources and constraints to development, and outlines three possible schemes for development.

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Water control for irrigated use will necessarily be the main engineering undertaking of any comprehensive development program and Volume II is devoted to a description and analyses of the climatology, hydrology and hydrogeology of the basin.

Volume III concerns the soils of a portion of the basin, their nature properties, classification and aptitude for crops.

Volume IV deals with socio-economic and environmental conditions.

Purpose of Visit

Through a Participating Agency Service Agreement (PASA) with the U.S. Department of Agriculture, Dr. Carl Ferguson (soil scientist) and Dr. Jerry Hammond (agricultural economist) were requested to travel to Dakar to review the Louis Berger Interim Report. The purpose of the review is to (a) comment on any individual elements of the study; (b) identify any areas which need strengthening in the final report; and (c) review and comment upon the scheme(s) recommended by the Consultant for future development of the Baila Marigot.

Major Recommendations

(1) That Scheme 2 be selected as the plan for the initial development efforts in the Baila Marigot basin. By definition scheme 2 includes those activities in agricultural extension, research and training described under Phase I. The Review Team agrees that if Scheme 2 can be successfully carried out it will show that the people living in the Baila region are interested in improving both their soils and way of life.

- Comment - Scheme 2 will be no small task for the Senegalese to carry out effectively in view of administrative inefficiencies and frequent lack of motivation of personnel for field work. Other Senegalese agricultural development programs, SAED in the Senegal River Valley, for example, can serve as a guide to steps that should be taken to avoid some of the more common problems encountered in the implementation scheme recommended by the Review Team.

(2) That the Consultant should concentrate on the further definition and feasibility study required for implementation of Scheme 2 and defer consideration of Scheme 3 until the success of scheme 2 is assured. At that time planning for Scheme 3 could be undertaken.

- Comment - There are possible economic benefits, as well as positive psychological benefits, to be gained from the construction of salt water intrusion dams and dikes. However, implementation of scheme 3(a) or (b) should be delayed until better information on the infrastructure needed and improved methods for use of saline soils are available.

Organization of report

The following sections include a description of the development schemes presented in the Berger "Interim Report", as well as general comments on the report itself. Also, recommendations are offered throughout the discussion, which if followed, should help in the preparation of the final report.

Alternative Development Schemes

Following is a description of the different schemes that were discussed in the "Interim Report". The Schemes are not mutually exclusive. For example, Scheme 3 would include the activities proposed under Schemes 1 and 2 plus major water control structures for the reclamation and irrigation of salty soils in the lower part of the Marigot.

- Scheme 1 - This, the simplest and least expensive of the three alternatives, consists of a package of improved technical practices and other actions which would improve the level of production in the Baila Valley.

The major elements of the scheme are:

- Varietal improvement including a seed multiplication program;
- Improved cultural techniques; and
- Strengthened extension demonstration and farmer training programs.

Senegal has several rice varieties adapted to both rainfed and irrigated condition that are superior to the local ones currently grown in the Casamance. Multiplication of selected varieties would require the production of foundation seed at the Diourbel agricultural station and the establishment of a seed multiplication farm(s) to produce seed for farmers. Improved cultural techniques would include land levelling, early transplanting, use of chemical fertilizers and manure where available, insect and disease control measures and better water control structures and systems. Harvesting, threshing, drying and storage techniques and methods would be improved. Extension services would be strengthened by in-service programs including both foreign and in-country training of extension personnel and intensive farmer training programs. Increased production of other cereal crops including corn, millet and sorghum would be achieved by the introduction of improved varieties and better cultural techniques.

An important potential for fruit production, particularly the planting of grafted mangoes and oranges would be pursued.

The Consultant estimates the potential for increased rice production under Scheme 1 on 7,000 ha of available land as follows:

Rice Production

<u>Year</u>	<u>With Project</u>	<u>Without Project</u>	<u>Increase</u>
1	7,700 T	5,500 T	2,200 T
5	10,500 T	5,500 T	5,000 T
10	12,600 T	5,500 T	7,100 T

- Scheme 2 - This scheme involves all the actions of the first alternative plus supplemented water for irrigation during critical periods.

The Consultant's agro-climatological and hydrologic studies show that lack of adequate water for seedbed (nursery) irrigation and inadequate water near the end of the growing season in four years out of five effectively limits rice production in the Baila Marigot basin.

Under Scheme 2, these limitations would be solved by:

- Drilling deep wells to tap an aquifer lying some 100 to 140m deep. These wells would be economical for the irrigation of rice nurseries but not for irrigation of rice fields.
- The construction of 43 small reservoirs upstream, each of which would provide supplemental water near the end of the growing cycle for 100 to 500 ha of rice, as well as water for some of the rice nurseries. The water available from these reservoirs would be sufficient for an additional 7,400 ha for a total of 12,400 ha of irrigated rice.

The impact of Scheme 2 (including actions under Scheme 1) on yields and production is estimated as follows:

<u>Year</u>	<u>Without Project</u>			<u>With Project</u>		
	<u>area</u>	<u>yield</u>	<u>Production/year</u>	<u>area</u>	<u>yield</u>	<u>Production/year</u>
1	5,000 ha	I.I T	5,500 T	5,000 ha	2.2 T	11,000 T
10	5,000 ha	I.I T	5,500 T	12,400 ha	4.0 T	49,600 T

Thus additional annual production is estimated at 5,500 T the first year increasing to 44,100 tons by year 10.

- Scheme 3 - The objective of this scheme, in addition to the actions under Scheme 2, is to reclaim or improve production in the lower reaches of the Baila Marigot. This area of salt-affected soils cover some 15,500 ha. of which about 6,800 hectares are classed as fair to good for rice.

Successful rice production in this area requires control of salt-water intrusion during high tide, and the use of fresh water to leach the soils of salt and other undesirable chemicals.

Within Scheme 3, three variations are described each of which, it is stated, would accomplish the objective above. These are:

- 3(a) - Construction of a system of polders (an area of lowland subject to flooding which is enclosed by dikes) and leaching of salts by use of fresh water and the control of salt water intrusion. A dam at Baila would control the entry of salt water into the Marigot and store fresh water for leaching and for supplemental irrigation.
- 3(b) - This scheme is the same as 3 (a) except the dam would be one meter higher permitting greater water storage.
- 3(c) - Under this variant polders would be constructed but not the Baila dam. Nurseries would be irrigated from wells. It would also include action of schemes 1 and 2.

Schemes 3(a) and (b) would require the construction of 101 kilometers of dikes, 38 water control structures and pumping stations and the dam at Baila. Scheme 3(b) differs from 3(a) in that the height of this dam is increased by one meter giving a reservoir capacity of 40 million cubic meters instead of 24. This would permit the production of a second crop of rice on 1500 to 2000 ha.

Scheme 3(c) as noted in referenced table involves construction of polders, deep wells for irrigation of nurseries but without the construction of the large dam or supplemented irrigation. The canal network would be reduced to those required only for drainage.

Scheme 3(c) would require the successful completion of rice research in Senegal to find or develop rice varieties with a 100-110 day maturity and the farther refinement of a special method for production of rice seedlings which shorten the time in the nursery thereby reducing the need for nursery irrigation water and permitting earlier transplanting in the field. The need for supplementary irrigation at the end of the growing season would be sharply reduced and perhaps eliminated.

The increase in rice production under Scheme 3 over that for Scheme 2 is estimated at 42,750 T. This increase would come from the 9,500 hectares of reclaimed salty land in the lower reaches of the Marigot.

- Berger's Conclusions - The Consultant following the summary of the three schemes and their variants concludes that schemes 1 and 2 are complementary and should be implemented.

With respect to Scheme 3 involving the salt-affected soils of the lower Marigot the Consultant states that precise identification and descriptions cannot yet be given and should await the results of "careful and specific research. Reduced scale experiments are required to perfect the leaching and desalinization procedure for these difficult lowland soils".

The Consultant finally concludes that although Scheme 3 or one of the variations should be selected as the Master Plan for the Marigot, the first steps in the implementation Phase should be limited to Scheme 2.

- Comment - A key issue in each of the development schemes is the improved use of the area's land and water resources to increase agricultural production and income. However, the rapid increase in projected agricultural production apparently would be impossible without institutional as well as physical changes. For example, the increase in rice production through increased use of irrigation would be impossible without the organization and training of "irrigator's associations" to insure timely and equitable distribution of irrigation water. Increases in production through added quantities of fertilizer would not be likely without a credit program to enable farmers to purchase more fertilizer and a concentrated program of extension to encourage them to use the recommended amounts.

Critical assumption in the analyses include the amounts and scheduling of inputs. This is particularly true of the use of fertilizer. Farmers must be convinced of the profitability of the added investment if they are to be expected to borrow money for it. Thus, both a strong extension, teaching and demonstration program will be necessary, and a favorable relationship between fertilizer prices and rice prices must be maintained. Increases in fertilizer prices would tend to make it less attractive to farmers and prevent them from achieving target yields. The reluctance on the part of farmers to apply recommended amounts of fertilizer already exacerbates a low-yield situation. However, the prospects of more certain supplies of irrigation water and the salt water intrusion control aspects of the development program should reduce the uncertainty of crop yields and thus encourage the farmers' willingness to borrow money for fertilizer.

A second critical assumption is that farmers will be able and willing to pay for the increased cost of water associated with the complementary irrigation program. A strong collection program will be needed, and periodic reviews of farm yields, incomes and expenses will be needed to determine whether farmers actually have the ability to pay for the increased water usage at the same time they are paying for other needed agricultural inputs.

Also, the increase in production forecasted as a result of the various schemes indicate that there would be a large surplus over and above local food needs. Provision must be made for marketing needs, methods and costs, including storage and transportation costs. Otherwise, a surplus build-up in the region would tend to depress farm prices, which would lessen the incentive for farmers to grow more than their current needs.

In general, the development schemes offered by the Consultant appear to be practicable. However, only after the technical and economic feasibilities are completed for each scheme, will we know their overall soundness. Standards and procedures used in the analyses should conform to World Bank and other donor agency requirements. Also, the use of sensitivity analysis would permit general conclusions on the effects of increasing costs and decreasing benefits on the internal rate of return and the benefit-cost ratios.

COMMENTS ON THE INTERIM REPORT

The Consultant has done a very capable job of fulfilling the goals, objectives and requirements specified in the project agreement. The "Interim Report" is detailed and contains much useful information and data that has, until now, not been assembled in one document. The report is well organized, with some separate volumes covering specific information that supports the three development schemes proposed by the Consultant.

The Review Team offers the following specific comments and questions concerning various aspects of the Interim Report in hopes of helping the Consultant successfully complete the Final Report. Also, comments are included for three basic subject matter areas--soil resources, environmental considerations, and financial/economic considerations - that should be of use to the Consultant.

Specific Comments and Questions

(1) An important part of the construction of dikes, dams and canals, the report states, would be done by the farmer beneficiaries of the development program without remuneration. It is very unlikely that farmers will contribute any significant amount of free labor for construction of structures not located on their farm.

(2) In view of the importance of livestock raising in the Baila Marigot basin - about 46,000 head - a study of possibilities for livestock forage production, and incorporation of livestock in the cropping systems should be included in the final report.

(3) The lack of timely availability at the farm level of production inputs such as fertilizers, pesticides and improved seed and the need for farmer credit are recognized as major constraints in Senegalese agricultural production programs. The need for production inputs and credit should be discussed in greater depth including quantitative estimates of requirements.

(4) The geographic limits of the project area are not clearly defined in the report. The soils study area covered 46,000 ha in the swampy areas of the river basin including a "sampling" of the unland soils of about 8,500 hectares. However the water resources study includes the entire Marigot basin (drainage area) or about 164,500 ha.

(5) Will the development program encompass the entire basin, or only the area covered by the pedologic study?

(b) Are salt-water barrier dams desirable? If so, what is their best operation method? What are the advantages and disadvantages in building such a dam on the Baila marigot?

(7) If a dam is found suitable, which is preferable - one large dam at the mouth of the Baila marigot to reclaim all land upstream or several small dams to reclaim limited areas above them?

(8) Is animal traction recommended? If so, how best can it be introduced to replace the traditional cultural practices?

(9) What small implements that can be produced with local resources can be introduced to improve the agriculture in the region?

(10) After taking into consideration the dietary and nutritional needs of the local population, will there be surplus of agricultural produce? What market exist for exportable produce, locally, nationally and internationally?

Soil Resources

The Contract requires the Contractor to conduct detailed soil classification and interpretation studies in the project area and to prepare soil classification and soil suitability maps at a scale of 1/20,000 "in accordance with Senegalese standards". Potential crop-production systems and yields are to be assessed by review of existing studies and experimental data.

The Contractor, through sub-contracts with ORSTOM, studied and make soil maps covering 37,500 ha of lowland (valley-terraces) and 8,500 ha of upland. The soil studies were based on a review of existing pedological information in the Casamance and photo-interpretation using infra-red photography taken in June 1978 at a scale of 1/30,000 and enlarged to 1/20,000. Ground verification was obtained by digging pits at 150 different sites with detailed study of 56 soil profiles. Chemical and physical data on 157 samples were obtained in the ORSTOM laboratory in Dakar. These studies were the basic for the identification and mapping of 28 kinds of soils.

A series of 6 soil maps with a scale of 1/20,000 cover the area mapped. The 28 different soils identified are also shown on a single map of scale 1/50,000.

The report also includes soil aptitude (land capability) maps at a scale of 1/20,000 as required by the contract.

The contractor found that of the 37,000 ha mapped only 2,116 ha were either good or very good for rice; 13,144 ha were classed as average and 16,870 ha or 45% of the area was rated as poor or very poor. These figures are very important or they indicate that almost half of the soils are unsuited to rice and consequently the map user must be able to identify on the map any field or farm in which he is interested in order to determine its suitability or lack thereof for crops.

After a careful examination of the 1/20,000 scale soils classification maps and their accompanying rice suitability maps (carte de vocation rizicole des sols) the reviewers comment as follows:

(1) The technical soundness and accuracy of the soil types identified, described and plotted on the maps are not questioned, although important soil characteristics such as texture, structure, permeability and drainage would have been given greater emphasis in a U.S. soil survey of this kind. Also soil colors would have been precisely determined by use of the Munsell color notation charts.

(2) The usefulness in the field of the soil and land capability maps is limited. A map of any kind to be readable and useful in the field must show at least a minimum of the physical features, by the use of conventional symbols, which can be readily identified on the ground as well as on the map. This enables the map user in the field to orient the map with respect to direction and to locate on the map the fields and farms he sees on the ground. Soil boundaries, although clearly shown on the map are often obscure or not readily seen on the ground and thus of little use for orientation of the user.

The contractors soil and rice suitability maps have been drawn on a plain base map which shows only marigots and the general location of the major towns. The only road shown is the approximate alignment of the trans-Gambian highway.

The review team recommends that in the final report the base map on which the soils boundaries are drawn include sufficient ground features (roads, trails, villages, houses etc..) to permit better field use of the maps.

(3) The contract specifies that the soil aptitude map will be in color. A map in color would be much easier to use. It is suggested that this requirement be followed, or deleted from the contract.

(4) Aptitude of the different soils for the several crops grown in the Casamance are shown in Table 7-12 page 7-92 vol. 3.

An alternative method for showing the suitability of the different soils in tabular format is to list the soil numbers in the left hand column with the different crops across the top of the table. The degree of aptitude of each soil for every crop; good, average, poor etc. is then inserted in the table. The contractor may wish to consider that method of presentation.

A number of errors of translation were noted as well as several misspelled words. The contractor will wish to correct these in the final report.

Environmental Considerations

In Chapter 11, ENVIRONMENT, the Consultant took a very narrow view and only analyzed the "particular environmental aspects of the project zone not directly linked to agricultural development, but which could pose constraints to parallel development opportunities". The Review Team feels that the consultant should consider taking a broader view of the environment in Phase II of the study. Whether funding for the project comes from AID, the World Bank, or other sources, knowledge of the environmental problems will lessen the overall costs of the project in the long-run.

The following is an illustrative list of the environmental considerations not covered in the Interim Report. It is not meant to be all inclusive, but should serve as a guide in preparing the Final Report.

(1) Assess Potential Environmental Impact of the Construction of a Salt-Water Intrusion Barrier

- A. Determine the impact on vegetation along the Baila marigot of which mangroves are the most common, considering rainy and dry season variations.
- 1) If destruction of vegetation is to occur, what measures must be taken for:
 - a. clearing and removal of trees and brush?
 - b. prevention of soil erosion along the bank?
 - 2) Propose alternative vegetation which could be planted along the marigot banks to control possible erosion.
 - 3) Discuss potential problems from water-loving aquatic plants in planted areas.
- B. Marigots are used as navigable waters for transportation of people and commodities, especially during the rainy season. In assessing the impacts on these activities consider:
- 1) The extent to which portage will be necessary;
 - 2) The economic and operative feasibility of a lock system between salt and fresh water.

(2) Assess the Impacts of Land Clearing and Agricultural Expansion

- A. Determine the potential erosion problems likely to result from extended land clearing, proposing measures to minimize any foreseen problems.
- B. Assess the extent to which agricultural chemicals will be used as a result of expanded agriculture.
- 1) Determine the extent to which ground water and stream pollution by pesticides may occur.
 - 2) Assess the need for a pest control/plant protection service at the local level.

- a. Consider the effectiveness of the existing operation.
 - b. Assess the requirements for expansion of their services for increased agricultural activity.
- 3) Determine what pesticides and their quantities are presently being used.
- a. Assess changes in types and quantities of pesticides expected due to agricultural expansion.
- 4) Consider the impacts of these chemicals on the ecological balance of the area.
- (3) Assess the Impact on Agriculture Resulting from Salinity Changes in the Soil and Water
- A. Determine if it will be necessary to change crops, seed varieties or cropping patterns due to the decrease in soil and water salinity.
 - B. If need is foreseen, then:
 - 1) Determine the impact of crop and yield losses;
 - 2) Propose changes which should be made to minimize such losses, particularly during the transition period.

Financial/Economic Considerations

Economic feasibility in the U.S. is generally interpreted to mean that the benefits, to whomsoever they may accrue, are in excess of the estimated costs. Therefore, the basic aim of economic analysis is to demonstrate the economic worthiness or profitability of a project or sub-project. This is normally accomplished with a presentation of the projects costs and benefits which, after appropriate discounting, permit the calculation of an estimated internal rate of return for the project.

The Consultant did not perform any of the standard financial or economic analyses that are usually the basis for an economic feasibility study. They stated (p.iii - Vol. I) that "the usual ratios for economic evaluation of projects (internal rate of return, net present value, impact of payments, increase of farmer's revenue, etc..) are not given in this report, they will only be calculated during Phase II for the development scheme selected by the Administration". The Consultant further clarified his position concerning an economic feasibility study stating (p. vi - Vol. 1) that "This first phase of the development of the Baila valley is the one for which the Consultant recommends

a technical and economic feasibility evaluation during Phase II of the study". The first phase of the development program is understood by the Review Team to include both Scheme 1 and scheme 2, which include the improvement actions for cultivation techniques and the deepwells and surface runoff storage structures, respectively.

The Consultant further states (p. viii - Vol. 1) that "The uncertainties presently attached to Scheme 3 lead the Consultant to recommend that further economic and technical studies of this scheme be deferred until experiments and investigations can resolve the questions mentioned above". The only uncertainty discussed by the Consultant was whether applied rice cultivation research would eventually produce new varieties and agricultural procedures that would make supplementary irrigation, and the large anti-salt dam at Baila, unnecessary.

However, in discussing the objectives for Phase II of the Study, the Consultant proposed (p.3 - 77 - Vol. 1) that the study include an economic evaluation of the project (scheme 3) and a sensitivity analysis. This is somewhat contradictory to the statement made by the Consultant above, so the Review Team finds it somewhat difficult to understand exactly what the Consultant plans to do during Phase II. Nevertheless, since Scheme 3 is such an important aspect of the development program proposed by the Consultant, the Review Team feels that if one of the alternatives for Phase 3 is chosen by the Administration, the Consultant should complete an economic feasibility for it just as he would have done for Scheme 1 or Scheme 2.

The Review Team also recommends that the standard benefit-cost analysis be included with those "usual ratios" of economic evaluation that the Consultant discussed above. Additionally, the Review Team recommends that the Consultant take into consideration some of the following points that were excerpted from AID Manual M.O. 1221-2, "Feasibility Studies, Economic and Technical Soundness Analysis, Capital Projects", in dealing with the financial and economic aspects of the development scheme chosen by the Administration. They are as follows:

(1) Financial Aspects

A. Estimated Capital Cost

Estimates of cost of land, engineering and construction.

Total estimated capital cost in U.S. dollars and local currency:

- to be financed by applicant,
- to be financed by loan/grant.

Estimated average cost per hectare of land benefitted.

B. Maintenance and Operating Cost

Annual cost of labor, supervision, equipment, operation, operating supplies and repair parts, training expenses, administration.

Breakdown to show dollar costs and local currency costs.

Annual cost per hectare benefitted.

C. Estimate of overall annual costs

Annual depreciation and interest on total project investment based on estimated life of the project and on the going interest rate for development projects in the country.

Annual operating and maintenance expense.

Total annual cost.

Average annual cost per acre benefitted.

D. Estimated Revenue

Total annual benefit to landowners and average benefit per acre.

Estimates of maximum amount which land owners should be able to pay annually in water charges or land taxes to meet annual cost of project and still retain reasonable profits on their operations.

Proposed schedule of taxes on water charges to be collected from landowners.

Estimated total revenue for each of the first 10 years after completion of project.

E. Economic Soundness of Project

Benefit-cost ratio taking into account:

- Benefits measured by expected net farm income,
- Economic cost of the project including operation and maintenance, and replacement costs.

Ability of project to meet costs, demonstrated by proforma Profit and Loss Statements showing anticipated operating revenues as against maintenance and operating cost and interest.

(2) National Economic Benefits

A. Overall increase in land values within and surrounding the project.

B. General increase in business and industry caused by additional crop production.

C. Increase in general tax receipts.

D. Raising of standard of living in project area.

E. Gains on savings in foreign exchange, where farm products are exported.

F. Direct benefit to population through local expenditures of project funds for labor, materials, food, rent, etc. (Temporary Benefit).